



Impact-based Forecasting and Risk Analysis

Shawn Boyce
Caribbean Institute for Meteorology and Hydrology

Understanding Risk Caribbean Conference
May 27 – 31, 2019
Errol Barrow Center for Creative Imagination
University of the West Indies Cave Hill Campus

Presentation Overview



Impact-based Forecasting



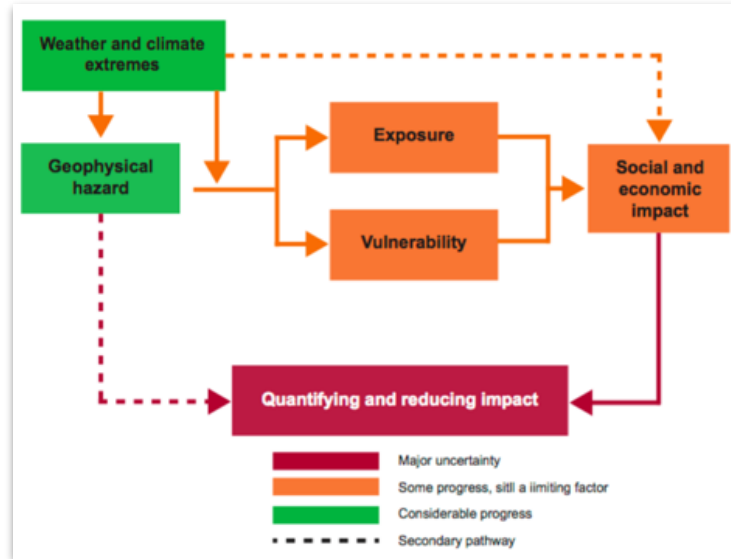
The RASOR Platform



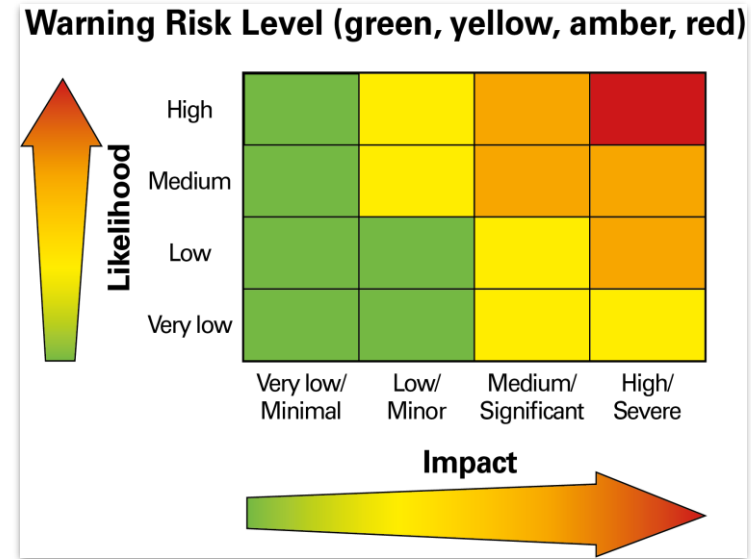
Risk-based Forecasting



Impact-based Forecasting

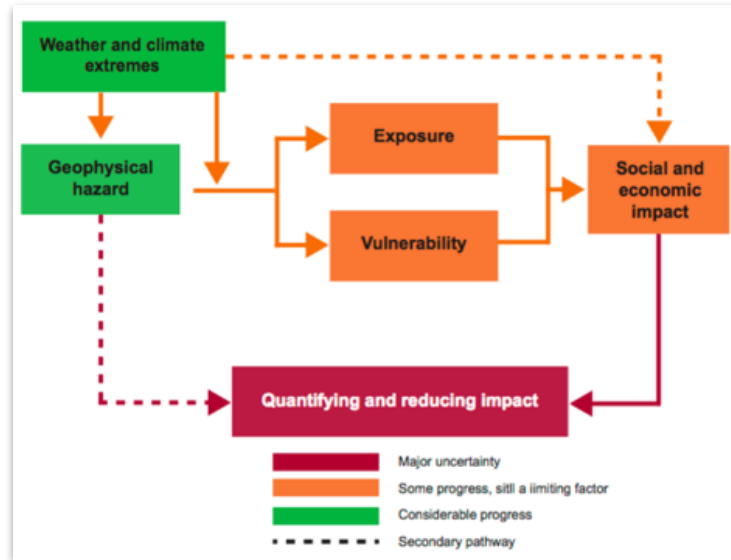


Impact-based Forecasting System
(source: WMO 2105)

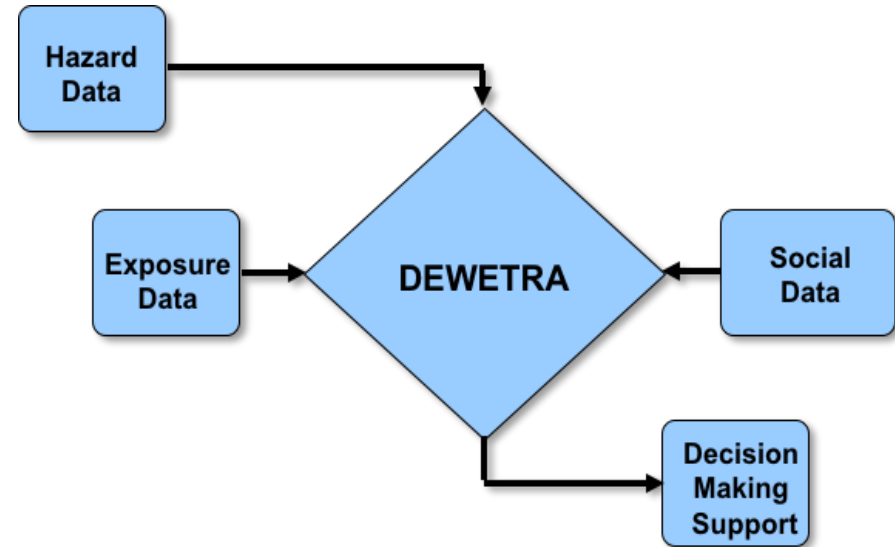


Warning Matrix
(source: Weather Ready Nations)

Impact-based Forecasting...cont'd



Impact-based Forecasting System
(source: WMO 2105)



Caribbean Dewetra Platform

Impact-based Forecasting...cont'd

Caribbean Dewetra Platform

- Online spatio-temporal data fusion decision making platform
- Supports impact-based forecasting and near real time hydro-meteorological monitoring
- Supports the qualitative assessment of risk
- Multiple hazards can be included



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 impact 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: CDM den WRF rainfall accumulation prediction output (Hurricane Mary)

Fig. 4: CDM den WRF wave height prediction output (Hurricane Mary)



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



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 (Dewetra) with rainfall accumulation prediction as an overlay.



Fig. 8: Major watersheds with population demographics map and shelter as an overlay.

Early Warning and Alerting Systems

The CDM 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 CDM 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: Aerial monitoring of freshwater and landslide prone areas. Fig. 10: Stage monitoring upstream of vulnerable areas. Fig. 11: Tide monitoring along coast. Fig. 12: CAP document production and dissemination.



Fig. 13: Near real-time rainfall during the onset of event (Hurricane Mary)

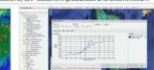


Fig. 14: Near real-time water levels during onset of event (Hurricane Mary)

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. 15: 150 days prior to the passage of Hurricane Mary across the Caribbean. Fig. 16: 150 days prior to the passage of Hurricane Mary across 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.



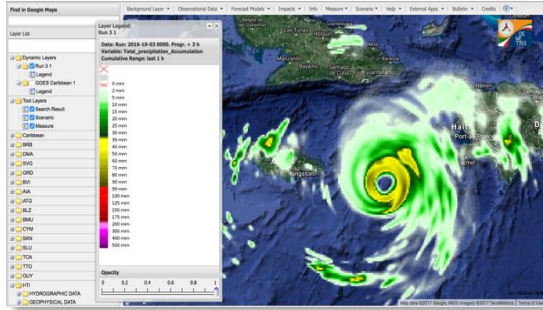
Fig. 17: Illustration of impact report collated from Twitter and RSS images (Hurricane Mary)

Summary

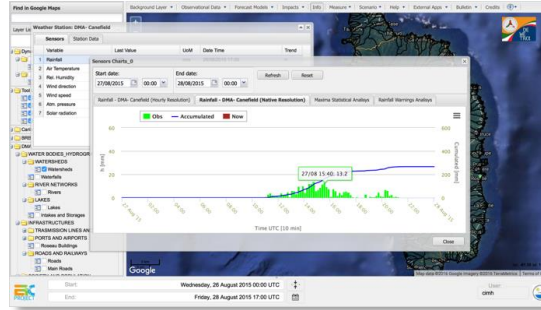
In order to significantly reduce losses, regional economies need to become more weather and climate resilient through actions that increase adaptation including improved targeted impact-based forecasting, early dissemination of accurate and easily understandable information and the delivery of data services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

Email: shawnboyce@imh.org
 Web: www.cdm-hy.com
 Facebook: www.facebook.com/CDMhy
 Twitter: @CDMhy
 YouTube: www.youtube.com/user/CDMhy

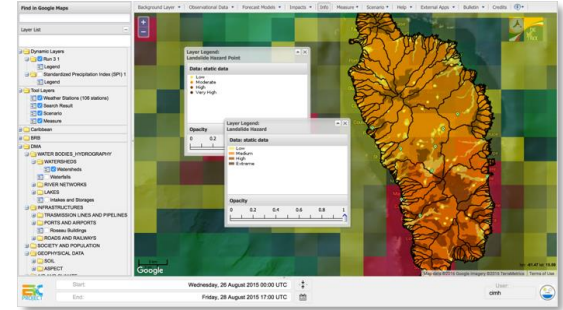
Impact-based Forecasting...cont'd



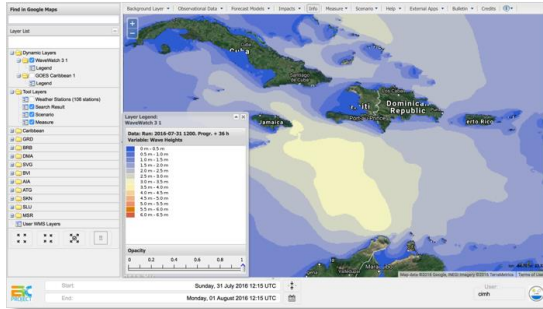
Numerical Weather Prediction



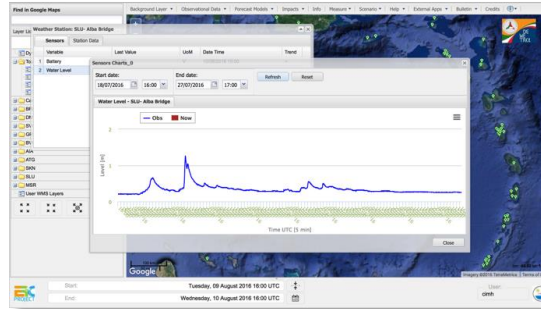
Automatic Weather Station



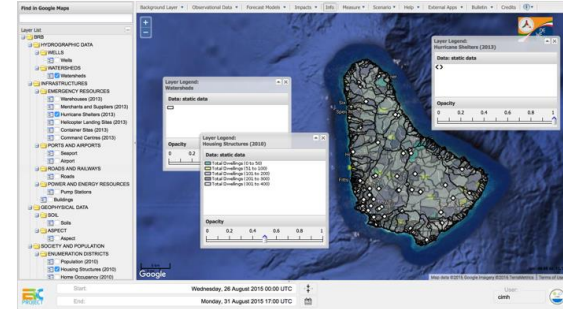
Hazard/Risk Exposure



Wave Height Prediction



Automatic Water Level Station



Population Vulnerability

$$\text{Risk} = \text{Exposure} \times \text{Vulnerability} \times \text{Hazard}$$

Impact-based Forecasting...cont'd

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

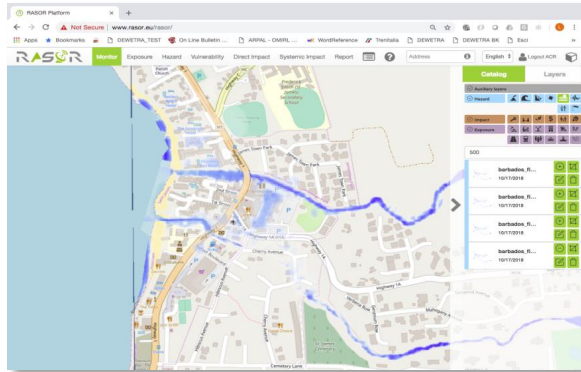
Communication and Public Dissemination

What the weather will be... vs. What the weather will do...

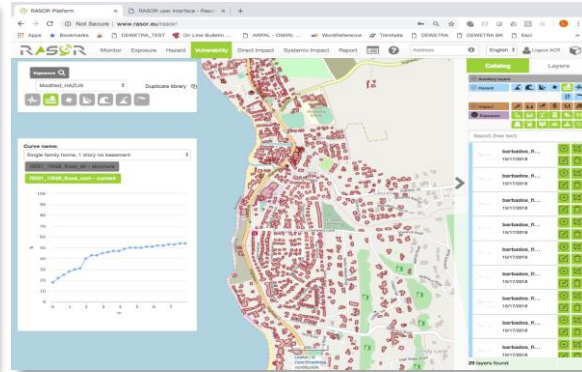
The RASOR Platform

Enhancing pre and post event monitoring and assessment

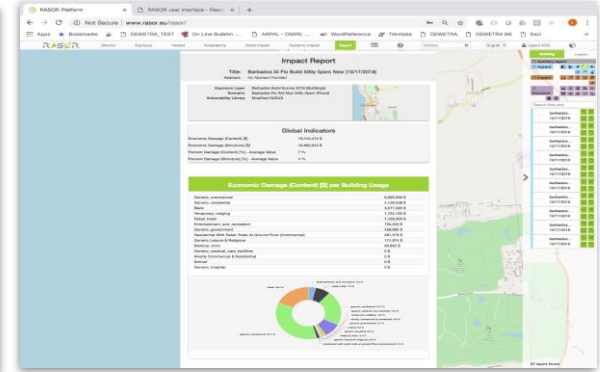
The Rapid Analysis and Spatialisation of Risk (RASOR) platform performs multi-hazard risk analysis for the full cycle of disaster management



Hazard Scenario



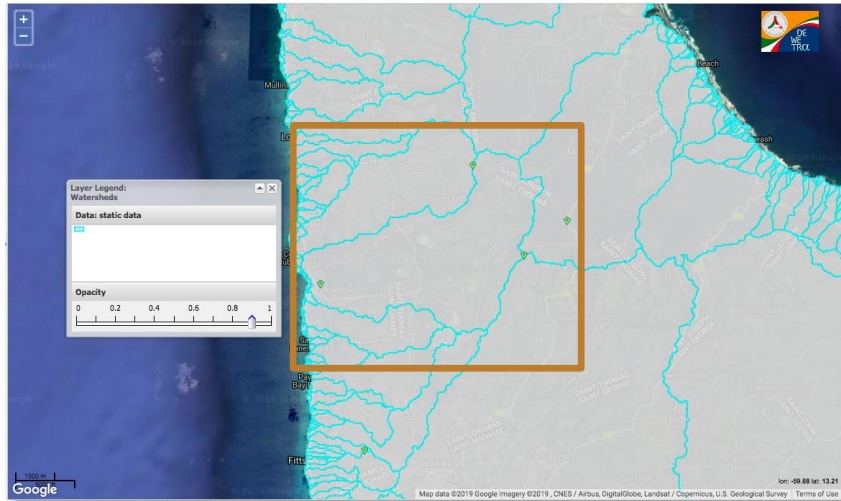
Vulnerability Curves



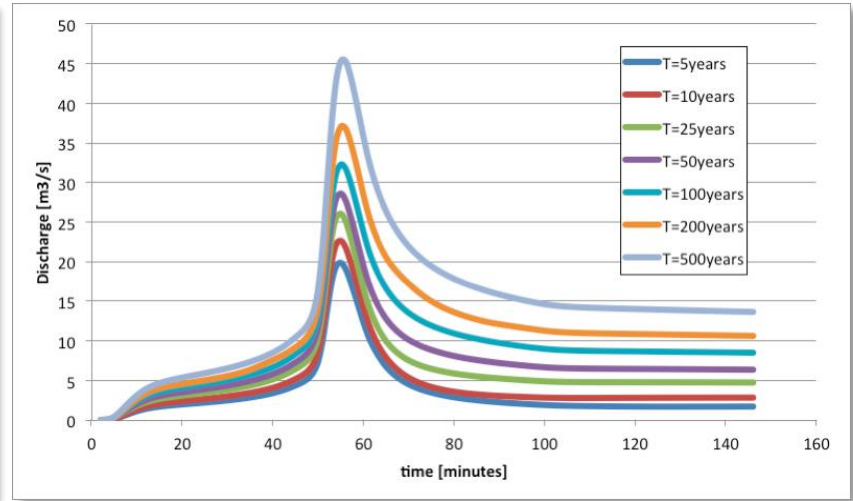
Quantification of Losses

The RASOR Platform...cont'd

Holetown Demonstration – Food Risk



Holetown Watershed



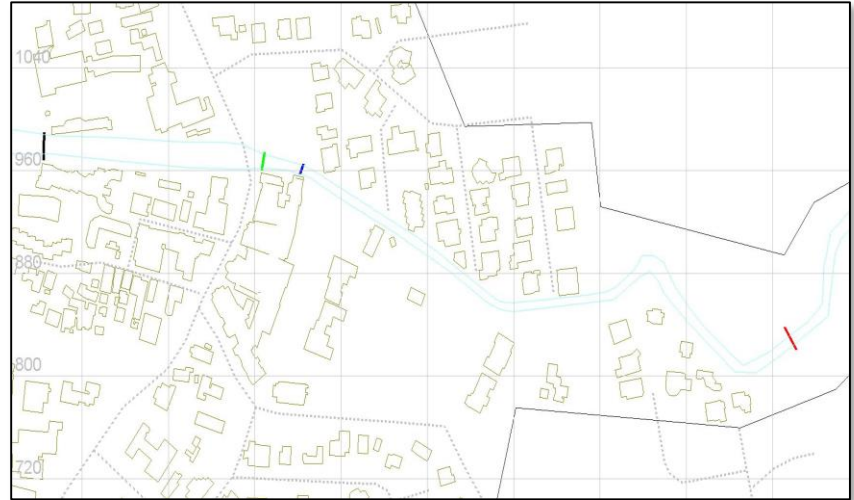
Hydrological Model Outputs

The RASOR Platform...cont'd

Holetown Demonstration – Food Risk



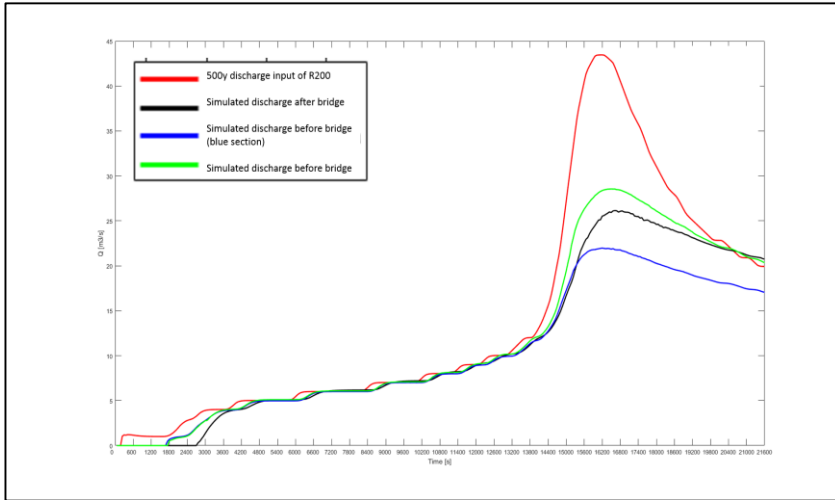
Hydraulic Model – Boundary Conditions



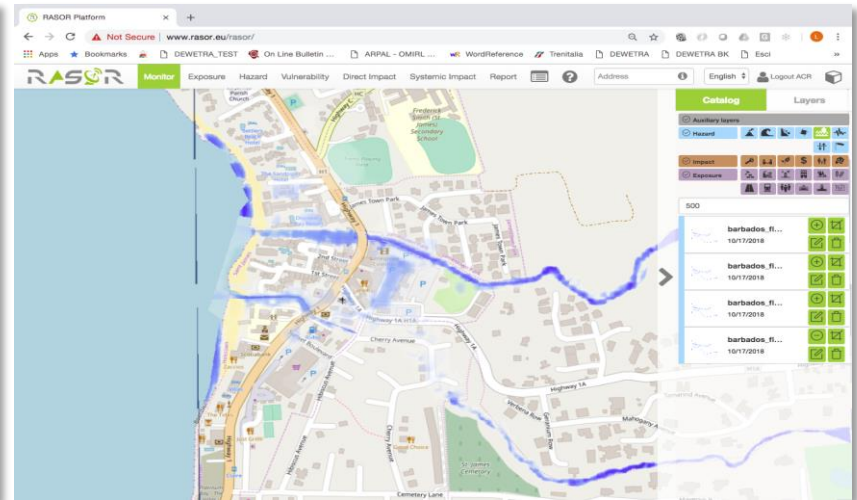
Cross-section Locations – Main Channel

The RASOR Platform...cont'd

Holetown Demonstration – Food Risk



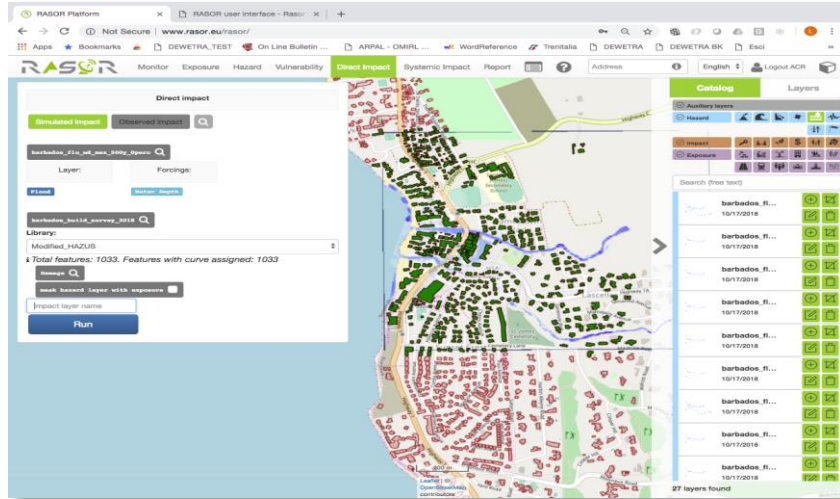
Hydraulic Model Outputs



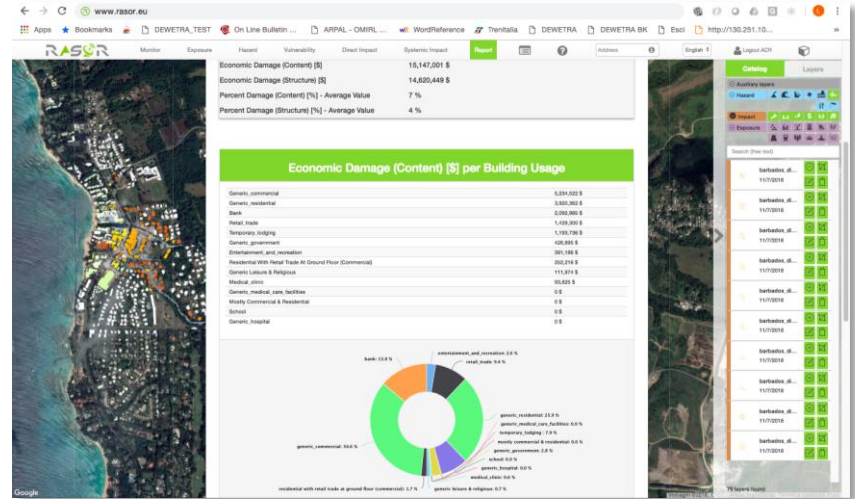
Inundation Scenario

The RASOR Platform...cont'd

Holetown Demonstration – Food Risk



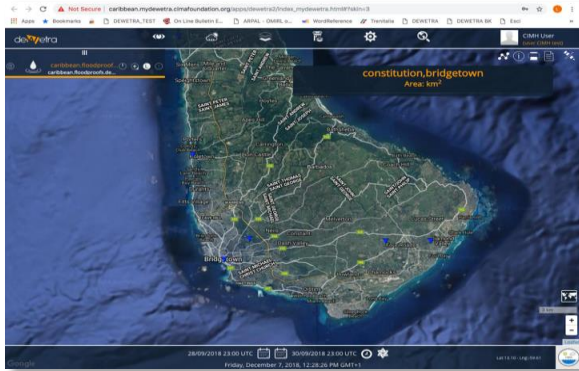
Impact Computation



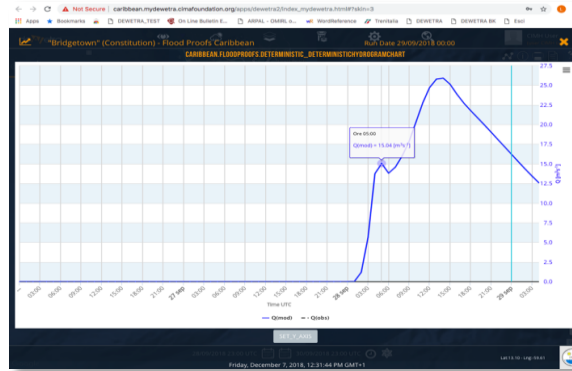
Impact Quantification

Risk-based Forecasting

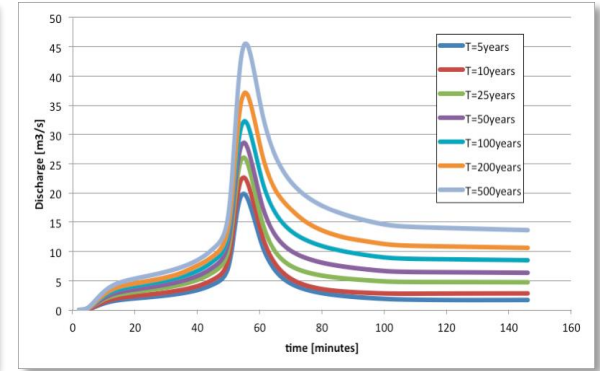
Caribbean Dewetra Platform and RASOR



Caribbean Dewetra Platform
WRF Real-time FloodPROOF



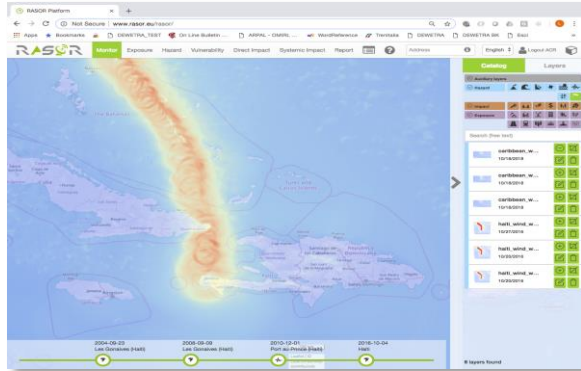
Hydrological Forecast



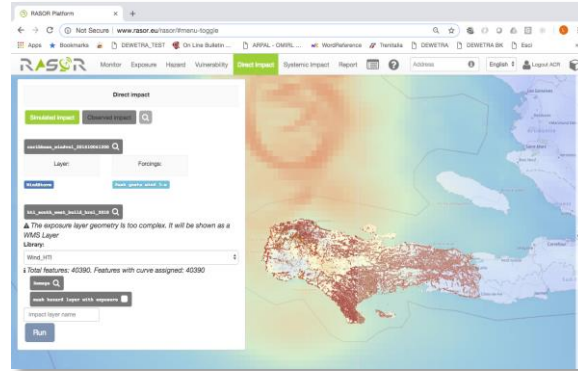
Analogue Output

Risk-based Forecasting...cont'd

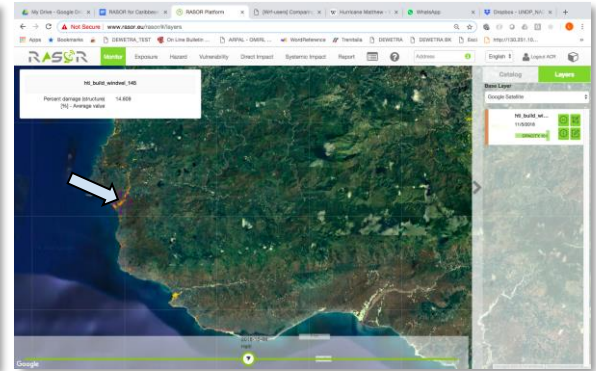
Caribbean Dewetra Platform and RASOR



Caribbean Dewetra Platform Layer
Hurricane Matthew (Wind Hindcast)



Damage Assessment



Impact Quantification

Questions/Discussion

Shawn A. Boyce

Chief Hydrologist

Caribbean Institute for Meteorology and Hydrology

Email: sboyce@cimh.edu.bb

Web: www.cimh.edu.bb

Facebook: www.facebook.com/CIMHbb

Twitter: @CIMHbb

YouTube: www.youtube.com/user/CIMHTV