

# A New Approach towards Hurricane Risk Reduction and Preparedness, Based on Near-Real-Time Impact Analysis: Hurricane Dorian Bahamas 2019

YingYing Yew, Rafael Castro Delgado, Pedro Arcos González

**Abstract**— Hurricanes are usually measured using wind speed intensities. The Saffir-Simpson Hurricane Wind Scale, which is currently being used in the United States and The Bahamas, mainly for a hurricane emergency response and preparedness for evacuation. However, it does not quantify the humanitarian needs at the point of impact or estimates the losses prior to the Hurricane landfall. This is a real challenge for various stakeholders in decision, and policymakers, especially in risk reduction and preparedness. The aim of this new concept approached towards an analysis of the Hurricane Dorian Bahamas Risk Reduction and Preparedness in measuring its' humanitarian impact. This was done by using the baseline ability to cope within local capacity, which includes the vulnerability and exposure population indicators, underpinned the definition of hazard or disaster in the new disaster metrics tool titled 'The YEW Disaster Metrics'. The near-real-time new concept analysis was submitted to the national and regional disaster authorities' on 6<sup>th</sup> September, 2019, within 72hours of the landfall.

**Keywords**— Dorian Bahamas, Dorian Impact, Disaster Severity Index, Hurricane Preparedness, Hurricane Wind Scale

## INTRODUCTION

Hurricane, Typhoon or Tornado scales are commonly measured using wind speed intensities; such as Saffir-Simpson Hurricane Wind Scale (SSHWS)[1],[2], Beaufort Wind Scale[3], Enhanced Fujita Scale[4],[5],[6] and Tornado and Storm Research Organization (TORRO) Scale[7]. However, none of these measured the humanitarian impact in terms of risk reduction, based on preparedness; such as 36-48 hours prior to the landfall, or impact analysis. This posed a challenge for various stakeholders such as decision and policymakers, affected populations, reinsurance, civil-military, and other relevant governmental and non-governmental agencies in providing risk reduction planning and preparedness.

To address this challenge, a new concept approach aiming towards an analysis of Hurricane Dorian Bahamas Preparedness and Near-Real-Time Humanitarian Impact, using a new disaster metrics tool titled 'The YEW Disaster Severity Index'. It uses 17 vulnerability and exposure population indicators, with median score 3, 100%, and Moderate DSI scoring, as the baseline, for the ability to cope within the local capacity. The 17 variable indicators[8] were mainly focusing on the aspect of search and rescue golden hours in terms of time occurrence and impact time, accessibility to the impact site and its' radius, topography, population density, exposed population, communication, social determinants of health, socio-politico and economics of the affected site, and basic survival resources including water and sanitation hygiene, food security and shelter.

In quantifying the projected preparedness and risk reduction, indicators scoring more than the baseline median score of 3, or 100% or a Moderate DSI category, indicate a non-

- YingYing Yew, PhD Candidate & Researcher, RN, MPH  
University of Oviedo  
Faculty of Medicine and Health Sciences, Unit for Research in Emergency and Disaster, Campus del Cristo, E-33006, Oviedo, Spain  
E-mail: ying.purelotus@gmail.com  
ORCID iD 0000-0003-2747-6730
- Rafael Castro Delgado, MD PhD  
ORCID iD 0000-0001-9520-656X
- Pedro Arcos González, MD PhD  
ORCID iD 0000-0003-4882-5442

preparedness for the forecasted Hurricane. As for the near-real-time impact analysis, scoring more than the baseline indicates a response is needed. The scoring criteria of the new disaster metrics tool was available on the YEW DSI [8]. This fast and short communication analysis is part of the ongoing research on the disaster metrics.

As Hurricane Dorian approached The Bahamas, the nearest satellite data available was from NOAA[9], and was used to quantifying hurricane preparedness, as well as its humanitarian aftermath impact, based on the wind speed intensities such as reported in the SSHWS[1],[2] and the Hurricane Dorian Advisory Reports[9],[10].

Consider this new concept and its' analysis:

# 1. HURRICANE DORIAN BAHAMAS PREPAREDNESS ANALYSIS: Table 1

**Table 1: Hurricane Dorian Bahamas Preparedness Analysis using Yew DSI[8]**

Dorian Bahamas Preparedness			
Saffir-Simpson Hurricane Wind Scale (SSHWS)	4		
YEW Disaster Severity Index (DSI)	6.8		
Requirement Title	Score	Fit Xtd	Fit %
Time occurrence	5*	15	167%
Impact time	3	9	100%
Topography	5*	15	167%
Radius from the impact site	5*	15	167%
Accessibility to the impact site	5*	15	167%
Population density	5*	15	167%
Main source of economy at impact site	3	9	100%
Public Infrastructure	5*	15	167%
Communication	3	9	100%
Type of country	3	9	100%
Governance-Corruption Perception Index	2	6	67%
Water and Sanitation Hygiene	5*	15	167%
Food security	3	9	100%
Shelter	4*	12	167%
Healthcare capacity	4*	12	133%
No of deaths	0	3	33%
No of affected	3	9	100%
<b>GRAND TOTAL</b>	<b>63</b>	<b>189</b>	<b>124%</b>

Note: Computed Bahamas Preparedness DSI Scores Analysis, 30/8/2019 at 08:30

**YEW DSI formula =**

**Total 17 indicators (vulnerability+exposure) x 3**

**8 (best fit scale of DSI 1-8)**

= 63 x 3 / 8 (best fit scale of DSI 1-8)

=189, best fit DSI 6 ≈ **High DSI 6.8**

DSI categories, based on scoring criteria of the YEW DSI (online supplementary):

Low DSI	1	0-32
	2	>32-65
	3	>65-98
Moderate DSI	4	>98-131
	(Baseline coping capacity) 5	>131-164
*High DSI	6	>164-197
	7	>197-230

*Preparedness Analysis showed\* 9/17 Indicators scoring more than 3 or 100% median score percentage (Fit %) in, with a High DSI, more than the baseline coping capacity, indicating High in Risk Informed and Preparedness needed.*

The NOAA [9] satellite at the National Hurricane Center at Miami, Florida, first detected Dorian as Tropical Depression on 24th August, 2019. Dorian later intensified into a Major Hurricane on 30<sup>th</sup> August, 2019 with a recorded maximum sustained wind speed, over the one minute averaging period of approximately 220km per hour and a Category 4 on the Saffir-Simpson Hurricane Wind Scale (SSHWS)[1],[2] , with additional strengthening to be expected, as recorded by NOAA[9] Hurricane Hunter

Aircraft. An immediate Hurricane Warning on Northwestern Bahamas and Hurricane Watch on Andros Islands respectively were issued 36 hours and 48 hours prior to the forecasted path by the NOAA[9] and The Government of Bahamas[10], Department of Meteorology.

Based on the report of the forecasted path and the wind speed intensities of the Hurricane Dorian on the 30<sup>th</sup> August, 2019, its' preparedness was plotted into the YEW DSI[8]. The estimated humanitarian impact calculated prior to the hurricane eye landfall scored a High 6.8 in the YEW DSI[8], with 9 of the total 17 indicators scoring more than baseline coping capacity. The 9 variable indicators' in the new disaster metrics<sup>8</sup> were mainly time occurrence, topography, radius from the impact site, accessibility to the impact site, shelter, public infrastructure (critical facilities), population density, water and sanitation hygiene, and healthcare capacity.

As forecasted by NOAA[9], Dorian will move over to the Bahamas on 30<sup>th</sup> August, 2019 Friday late at night or 31<sup>st</sup> August, 2019 Saturday early morning, scoring 5 in the YEW DSI[8]. It is expected to be near to United States, Florida, east coast on 2<sup>nd</sup> September, 2019 Monday late at night. The Dorian predicted path[9], impact time at the Bahamas from 30<sup>th</sup> August, 2019 late night to 2<sup>nd</sup> September, 2019 morning, ranging from 36-48 hours in the YEW DSI[8] scoring criteria, scored a 3. The forecasted path of Dorian[9] is expected to be over the Northwest Bahamas and Andros Islands, isolated islands situated 3 feet above sea level topography, scoring 5 in the Disaster Metrics[8]. The latest predicted path of Dorian<sup>9</sup>, from the Bahamas to the United States, Florida, which the radius of the impact site more than 100km[9], scoring 5 in the scoring criteria<sup>8</sup>.

The accessibility to the impact site of Hurricane Warning and Hurricane Watch at The Bahamas, based on the NOAA hurricane forecast advisory[9], scored 5, which is inaccessible due to the category 4 on the SSHWS[1],[2] and predicted storm surged with the minimum rise in the water level of 10 to 15 feet[9]. Shelter scored 4 [8], as more than 50% of the buildings

are 1 to 2 levels height[18], which is approximately 3 to 10 feet, with a high possibility of those buildings submerging underwater. The same with the Public Infrastructure (Critical Facilities) such as airports and ports, ceasing operations prior to the Dorian, scoring 5 [8],[10],[13]. Water and Sanitation Hygiene, scored 5[8], as sewage sanitation water will be overflowed and contaminated due to the predicted rise in water level[9], which is of public health concern, especially in communicable disease. Healthcare capacity overall scoring 4 [8], due to healthcare personnel shortage and strikes with referral to the Industrial Tribunal [14] prior to the Hurricane Dorian.

Population Density at the Dorian forecasted path[9],[19] is high, urban and slum, scoring 5[8]. Communication for early warning evacuation was done by the National Emergency Management Agency (NEMA) and the Bahamas Department of Meteorology via official websites[10],[12], as well as loudspeakers or hailers and door to door notifications[10],[12], scoring 3.

## **2. HURRICANE DORIAN BAHAMAS IMPACT ANALYSIS: Table 2**

**Table 2: Hurricane Dorian Bahamas Impact Analysis using Yew DSI[8]**

8 >230-263

	Dorian Bahamas Impact		
Saffir-Simpson Hurricane Wind Scale (SSHWS)	5		
YEW Disaster Severity Index (DSI)	7.3		
Requirement Title	Score	Fit Xtd	Fit %
Time occurrence	5*	15	167%
Impact time	5*	15	167%
Topography	5*	15	167%
Radius from the impact site	5*	15	167%
Accessibility to the impact site	5*	15	167%
Population density	5*	9	100%
Main source of economy at impact site	5*	15	167%
Public Infrastructure	5*	15	167%
Communication	3	15	167%
Type of country	3	15	167%
Governance-Corruption Perception Index	2	12	67%
Water and Sanitation Hygiene	5*	15	167%
Food security	4*	12	133%
Shelter	5*	15	167%
Healthcare capacity	4*	12	133%
No of deaths	0	0	0%
No of affected	3	9	100%
<b>GRAND TOTAL</b>	<b>69</b>	<b>207</b>	<b>135%</b>

Note: Computed Bahamas Impact DSI Scores Analysis, 5/9/2018 at 23:30

YEW DSI formula =

Total 17 indicators (vulnerability + exposure) x 3

**8 (best fit scale of DSI 1-8)**

=  $69 \times 3 / 8$  (best fit scale of DSI 1-8)

= 207, best fit DSI 7 ≈ **High DSI 7.3**

DSI categories, based on scoring criteria of the YEW DSI (online supplementary):

Low DSI	1	0-32
	2	>32-65
	3	>65-98
Moderate DSI	4	>98-131
(Baseline coping capacity)	5	>131-164
*High DSI	6	>164-197
	7	>197-230

Impact Analysis showed \* **12/17 Indicators** scoring more than 3 or 100% median score percentage (Fit %), with a High DSI, more than the baseline coping capacity, indicating external assistance or response needed.

The Hurricane Dorian made the first landfall over to the Bahamas on 1<sup>st</sup> September, 2019 late night[9], scoring 5. The impact time at the Bahamas, was from 1<sup>st</sup> to 3<sup>rd</sup> September, 2019<sup>o</sup>, scoring 5. Dorian was stronger than predicted, with a category 5 on the SSHWS[1],[2] and hurricane standstill for more than 24 hours[9]. Based on the near-real-time wind speed intensity of Category 5 on the SSHWS[1],[2], its' humanitarian impact calculated, scored a High 7.3 in the YEW DSI[8], with 12 of the total 17 variable indicators, scoring more than baseline coping capacity. The 12 variable indicators' in the new disaster metrics were mainly time occurrence, impact time, topography, radius from the impact site, accessibility to the impact site, shelter, public infrastructure (critical facilities), population density, main source of economy at the impact site, food security, water and sanitation hygiene, and healthcare capacity.

Northwest Bahamas with isolated archipelago islands topography[18], was hit by Dorian, scoring 5. Radius from the impact site, approximately more than 100km radius, at the Northwest Bahamas to the Florida[9],[18], scoring 5. It was inaccessible for evacuation or emergency search and rescue teams, during the hurricane eye landfall, as the wind gust was at 295km per hour[9],[13], scoring 5. The main public infrastructure (critical facilities), such as Ports were closed and Airports were submerged 6 feet underwater[10],[13],[18], scoring 5. With the wind speed gust of 295km per hour[9] and raised in water levels with a minimum of 18feet[9], more than 50 percent of the shelters, residential and commercial buildings were destroyed or submerged underwater[18], scoring 5. The tourism industry, the main source of economy of the country was greatly affected[10], scoring 5. The Dorian aftermath damage to the

archipelago islands marine life, public, and critical infrastructure were submerged underwater, as well as spillage of oil refinery [10],[12],[13],[18] has immensely impacted the country's main economy.

The Grand Bahama and The Abacos Islands consisting of the urban and slum community with a high population density[13],[18],[19], scoring 5. More than 70 percent of the people living in informal settlements of The Muds and The Pigeon Peas, at Marsh Harbour were unaccounted for, most of them were vulnerable migrant population[13],[18],[19].

Sewage water overflowing, contaminated the drinking water source and lack of proper latrine submerging underwater[10], scoring 5. Emergency food stockpile at the emergency shelter was damaged by floodwaters[10],[12], and needs to be transported from the non-affected areas, scoring 4. More than 50 percent of the hospital capacity was either damaged partially or destroyed[13],[18], submerging underwater and contaminated with sewage water, scoring 4. The 2 most affected government hospitals were Rand Memorial Hospital, flooded with sewage water and Princess Margaret Hospital[13],[18], lack of hospital personnel[10],[14].

Detailed near real-time humanitarian impact analysis severity score calculated on 5th September, 2019 and raw data collected was sent to the relevant national and regional emergency, and disaster authorities[12],[13] on 6<sup>th</sup> September, 2019.

### **3. BENCHMARKING EVIDENCE-BASED IMPACT PREPAREDNESS: Table1,2**

The Hurricane Dorian Bahamas Emergency and Disaster Preparedness and its' impact, benchmarking was based on the SSHWS[1],[2] reported and the YEW DSI[8] calculated, shown in Table 1.

Dorian Preparedness was done 36-48 hours prior to the hurricane eye landfall, with a Category 4 of the SSHWS[1],[2] recorded[9] and its' predicted humanitarian impact of 6.8, High in Risk-Informed, calculated in the YEW DSI[8]. In response to the commitment to the Sendai Framework 2015-2030, target c, in reducing economic losses from natural or climate change disasters, the UN Office for Disaster Risk Reduction (UNISDR)[15] emphasizes the importance of practice and investment by various stakeholders, to be based on risk-informed. This was supported by the UNISDR and Centre for Research on the Epidemiology of Disasters (CRED)[15],[16], showing the evidenced that for the past two decades, although there is a significant reduction in mortality rate due to natural disasters, the increased in economic losses by 2.5 is alarming for sustainable human development growth. Table 1 provides the YEW DSI[8] scoring in Preparedness. 9 of the 17 variable indicators' scored inability to cope within local capacity, scoring High in Risk Informed[8], hence pointing out the targeted key indicators for risk reduction.

The scoring for near-real-time impact or aftermath was the same as preparedness for the 9 indicators, unfortunately for some indicators, it scored worst, summarized in Table 2. The 9 variable indicators were mainly time occurrence, topography, radius from the impact site, accessibility to the impact site, population density, public infrastructure (critical facilities), Water and Sanitation Hygiene, Shelter and Healthcare Capacity. The 17 variable indicators' of the YEW DSI[8] Preparedness and Impact in Table1,2, showed a strong correlation coefficient of 0.9018, using Microsoft Excel 2013, Pearson Correlation Coefficient Statistical Analysis[17].

The actual Dorian landfall impact recorded a Category 5, on the SSHWS[1],[2] and its' humanitarian impact calculated, scored a High 7.3 in YEW DSI[8]. Then, Hurricane Dorian Preparedness and its' near real-time hurricane landfall impact of the SSHWS[1],[2] and the YEW DSI[8] were benchmarked, using Microsoft Excel



2013, Pearson Correlation Coefficient Statistical Analysis[17], showed a strong correlation coefficient of 1.

Declaration of Exigency was announced by the Government of The Bahamas on 2nd September, 2019[11], indicating an inability to cope within national and local capacity, regional and international assistance was needed, thus demonstrating the evidence on the tabulated YEW DSI[8].

## DISCUSSION

The computed analysis of the Hurricane Dorian Preparedness in the disaster metrics scored a High DSI in Risk-Informed. These indicators in the YEW DSI[8] will provide various stakeholders, such as policy and decision-makers, reinsurance establishments, emergency response and relief teams in preparedness, thus reducing any future impact. This is a new milestone, to be added into the evidence-based research and practice in public health and policy, complex mathematical modelling for disaster risk analysis, also for parametric insurance and climate change in natural disaster.

However, there are other challenges as satellite data from NOAA[9], were not easily available or accessible due to defense or security purposes. The satellite data, which is considered a reliable source was also triangulated with its' NOAA Hurricane Hunter Aircrafts data recorded[9] and also Google LLC satellite maps[18]. Other natural or climate changed real-time disaster data, or predictions using complex computer modeling were not easily accessible by the public, although it is available to the reinsurance

and risk transfer management agencies, as well as disaster centers globally.

A document searched, also on gray literature, found that World Risk Index[20] and Sea, Lake, and Overland Surge from Hurricanes (SLOSH)[21], Hurricane Hazard Intensity[22] and Hurricane Intensity Index[22] include hazard and vulnerability. However, it does not include socio-political and economic, as well as social determinants of health. Also the amplification of the economic impact by factoring political corruption in the disaster metrics. This was done by using an annually

updated Corruption Perception Index[23] from Transparency International, in quantifying the true magnitude and scale of the disaster such as hurricanes.

## CONCLUSION

As a conclusion, the analysis of the Preparedness and Near-Real-Time Impact using the new approach in disaster metrics showed a statistically significant correlation in the Disaster Metrics 17 indicators in quantifying the humanitarian aspect, and also the wind speed intensity of the SSHWS[1],[2] recorded. The State of Exigency was declared by the Government of The Bahamas on 2nd September, 2019[11] indicating an inability to cope within local and national capacity, demonstrating that regional and international assistance would be needed.

## LIST OF ABBREVIATIONS

**SSHWS** Saffir-Simpson Hurricane Wind Scale  
**TORRO** Tornado and Storm Research Organization  
**DSI** Disaster Severity Index

**NOAA** National Oceanic and Atmospheric Administration  
**NHC** National Hurricane Center, Florida  
**NEMA** National Emergency Management Agency

**SLOSH** Sea, Lake, and Overland Surge from Hurricanes

**UNISDR** United Nations Office for Disaster Risk Reduction

**CRED** Centre for Research on the Epidemiology of Disasters

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