IRMA-17: COMPREHENSIVE SATELLITE DETECTED BUILDING DAMAGE ASSESSMENT OVERVIEW AS OF 21 SEPTEMBER 2017

Version 1.0

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Overview

Hurricane IRMA-17 originated as a tropical storm in the eastern part of the Atlantic Ocean on 30 August 2017 and gained strength as it moved west to the Caribbean. On September 6, 2017, it first made landfall in Antigua and Barbuda as a Hurricane of category 5 and continued its path though several Caribbean Islands until September 10, 2017 when it hit the southwest of the United States of America. IRMA-17 severely affected several Caribbean Islands with storm surges, intense rainfall and strong winds that reached 298 km/h. According to UNOCHA, 48 people have been reported dead, 1.2 million people have been affected by damage to water infrastructure and 17,000 people are in immediate need of shelter. The Caribbean disaster emergency management agency (CDEMA) in the last Hurricane IRMA-Situation Reports (#7, #8 and #9) are still listing the ongoing priority needs, including food and medicine, in several islands such as Anguilla, Virgin Islands (UK), or Turks and Caicos among others.

On 05 September 2017, UNITAR-UNOSAT on behalf of UN OCHA activated the International Charter on Space and Major Disasters to support the planning and coordination of emergency response operations with satellite imagery analysis covering most affected areas in the Caribbean region. Within the operational framework of this Charter Call, UNITAR-UNOSAT and SERTIT have supported emergency response operations by providing satellite-derived value-added analysis & mapping products covering the following countries and territories: Antigua & Barbuda, Anguilla, Turks and Caicos, Saint Barthelemy and Saint Martin. In addition, due to the magnitude and widespread of damages caused by the powerful hurricane IRMA-17, satellite imagery analysis support was also provided by other agencies and satellite mapping groups such as COPERNICUS EMS and NGA who covered with satellite analysis as many affected countries / territories as possible.

UNITAR-UNOSAT provided overall satellite analysis coordination support for this event by regularly updating the GDACS Satellite Mapping and Coordination System platform (SMCS). An access link to the GDACS-SMCS platform was shared with all end-users to provide them with updated information about satellite acquisition and analysis plans including expected product delivery by different agencies or satellite mapping groups. In addition, due to the magnitude and widespread damage caused by the powerful hurricane IRMA-17, other agencies and satellite mapping groups such as COPERNICUS EMS and NGA also provided satellite imagery analysis support in order to analyze as many affected countries / territories as possible. Findings and results of this comprehensive analysis are described in the present document.

Comprehensive Satellite-Detected Building Damage Assessment: Methodology and considerations

In response to the emergency caused by IRMA-17, UNITAR-UNOSAT, Copernicus EMS, SERTIT and NGA performed building damage assessment analysis using pre- and post-event satellite data covering different areas of interest within most affected countries and territories.

Damage estimates reported in the table below, are exclusively based on satellite imagery acquired from the 7th to the 16th of September 2017, as well as pre baseline data (building footprints) from Humanitarian Open Street Map. It is important to note that satellite derived damage assessment has not been validated in the field.

Table 1 – UNITAR-UNOSAT Comprehensive Satellite-Detected Building Damage Assessment – IRMA-17 as of 21 September 2017

Country Territory Island	Pre-event buildings (baseline)	Damaged buildings	Percentage of damaged buildings	Percentage of cloud cover	Analysis Extent	Agency or Mapping Group
Antigua	41,474*	66	< 1%	NA	Main Island	UNITAR-UNOSAT
Anguilla	5,111*	2,147	42%	24%	Main Island	UNITAR-UNOSAT
Bahamas	1,771*	515	29%	NA	Acklins,Black Point, Crooked Island, Exuma, Inagua & Ragged Island	NGA
Barbuda	1,203*	1,071	89%	27%	Only Condrington town	UNITAR-UNOSAT
British Virgin Islands	9,702*	2,106	22%	NA	All islands, except Anegada	NGA
Turks and Caicos Islands	9,089*	2,847	31%	5%	Providenciales & South Caicos	UNITAR-UNOSAT
Saint Barthelemy	5,721*	456	8%	NA	Main island	SERTIT & COPERNICUS EMS
Saint Martin	15,743	15,497	98%	NA	Marigot Grand Case	SERTIT & COPERNICUS EMS
Sint Maarten	13,451	11,435	85%	NA	Philipsburg Cole Bay	COPERNICUS EMS

Note: Sustained minimal to no damage was reported by NGA in Montserrat, Saint Kitts and Nevis and Saba.
*Pre-event buildings provided by Humanitarian Open Street Map.
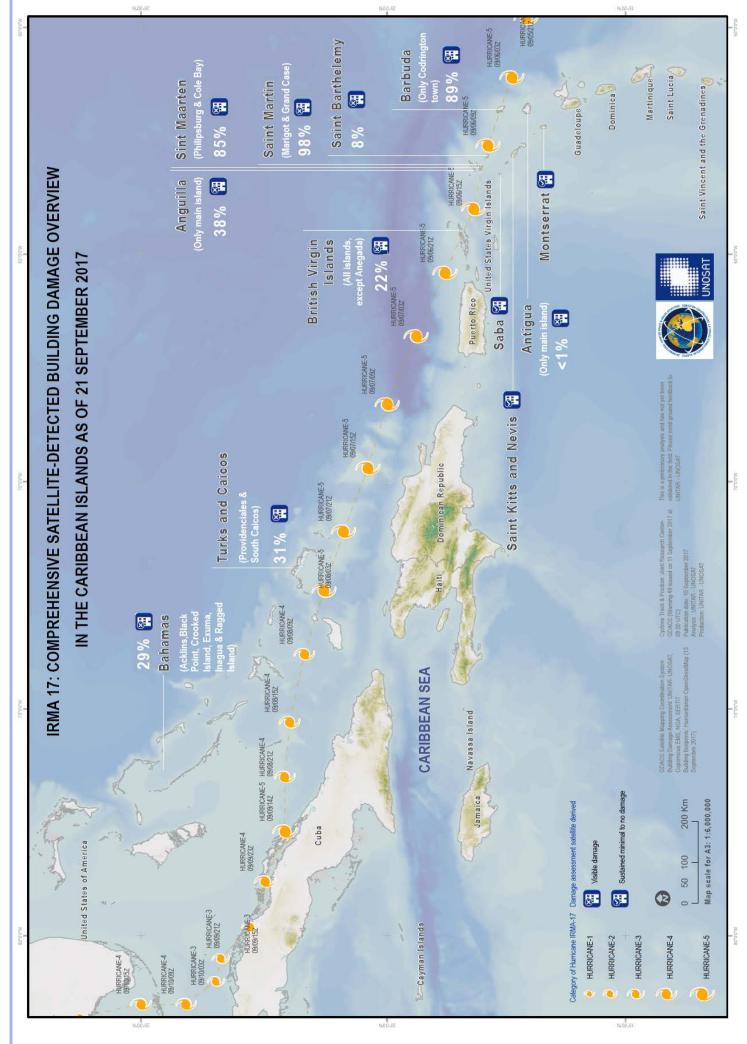
Disclaimers and considerations:

1. **Pre-event buildings footprint (baseline data)** were provided by Humanitarian Open Street Map as of 13 September 2017. The percentage of damaged buildings could be influenced by the completeness of this data. Please note that UNITAR-UNOSAT considered OSM building footprint as baseline data, unless the specific number of buildings (pre-event) was provided by the agency or satellite mapping group.

2. **Damaged buildings** refers to the results of satellite-derived analysis that used pre- and post-event data to identify the potentially affected structures. This analysis was performed over cloud free areas and within the extent of the satellite image. In the case where several mapping groups were working in the same area, the damaged buildings results were chosen based on the most complete dataset.

3. **Percentage of damaged buildings** refers to the number of damaged buildings in relation to the total number of pre-event buildings, while taking in account the following two considerations:

   - **Cloud cover**. In certain areas, the percentage of cloud cover was not available or not provided. In the "NA" case, the percentage of damaged buildings was computed with the total number of pre-event buildings of the island or territory. On the contrary, if the cloud cover was provided, the percentage of damaged buildings was computed only with the total number of pre-event buildings within the cloud-free area.

$$\frac{Damaged\ buildings}{Pre\ event\ buildings} * 100 \quad or \quad \frac{Damaged\ buildings}{Pre\ event\ buildings - Buildings\ under\ cloud\ cover} * 100$$

   - **Analysis extent.** In certain areas, the analysis extent was not available or not defined. In the "NA" case, the percentage of damaged buildings was computed considering the total number of pre-event buildings of the island or territory. On the contrary, if the extent was defined, the percentage of damaged buildings was computed with the total number of pre-event buildings within the image extent.

$$\frac{Damaged\ buildings}{Pre\ event\ buildings} * 100 \quad or \quad \frac{Damaged\ buildings}{Pre\ event\ buildings - Buildings\ outside\ analysis\ extent} * 100$$

IRMA 17: COMPREHENSIVE SATELLITE-DETECTED BUILDING DAMAGE OVERVIEW

IN THE CARIBBEAN ISLANDS AS OF 21 SEPTEMBER 2017

Bahamas
(Acklins, Black Point, Crooked Island, Exuma, Inagua & Ragged Island)
29%

Turks and Caicos
(Providenciales & South Caicos)
31%

Anguilla
(Only main island)
38%

Sint Maarten
(Philipsburg & Cole Bay)
85%

Saint Martin
(Marigot & Grand Case)
98%

Saint Barthelemy
8%

Barbuda
(Only Codrington town)
89%

British Virgin Islands
(All islands, except Anegada)
22%

United States Virgin Islands

Puerto Rico

Saba

Antigua
(Only main island)
<1%

Montserrat

Saint Kitts and Nevis

Dominican Republic

Haiti

Cuba

Jamaica

Cayman Islands

United States of America

Navassa Island

Guadeloupe

Dominica

Martinique

Saint Lucia

Saint Vincent and the Grenadines

CARIBBEAN SEA

HURRICANE-4 09/10/15Z
HURRICANE-4 09/10/09Z
HURRICANE-3 09/10/03Z
HURRICANE-3 09/09/21Z
HURRICANE-3 09/09/15Z
HURRICANE-4 09/09/23Z
HURRICANE-5 09/09/14Z
HURRICANE-4 09/09/21Z
HURRICANE-4 09/08/15Z
HURRICANE-4 09/08/09Z
HURRICANE-5 09/08/03Z
HURRICANE-5 09/07/21Z
HURRICANE-5 09/07/15Z
HURRICANE-5 09/07/09Z
HURRICANE-5 09/07/03Z
HURRICANE-5 09/06/21Z
HURRICANE-5 09/06/15Z
HURRICANE-5 09/06/09Z
HURRICANE-5 09/06/03Z
HURRICANE-5 09/05/21Z

Category of Hurricane IRMA-17
HURRICANE-1
HURRICANE-2
HURRICANE-3
HURRICANE-4
HURRICANE-5

Damage assessment satellite derived
Visible damage
Sustained minimal to no damage

Map scale for A3: 1:6,000,000
0   50   100   200 Km

UNOSAT

For further information, please contact directly the pertinent mapping group: UNITAR-UNOSAT, Copernicus EMS, SERTIT or NGA

This document is part of an on-going satellite monitoring program of UNITAR-UNOSAT for the Irma-17 Tropical cyclone in support of international humanitarian assistance and created to respond to the needs of UN agencies and their partners. Please send feedback to UNITAR-UNOSAT at the contact information below.

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