STRUCTURAL WIND ENGINEERING RECONNAISSANCE OF HURRICANES IRMA & MARIA'S IMPACT IN THE US VIRGIN ISLANDS

DATA REPORT

	
Members of the joint US-Japanese research team	*Members of US Coastal and Structural Assessment Teams*

Report Authors: Tracy Kijewski-Correa (Principal Investigator) David Roueche (Data Standards Lead)	**Structural Assessment Team Lead:** David Prevatt
Structural Assessment Team:	Yue Li, David Roueche, Kwasi Perry
Contributing Members of Coastal Survey Team:	Andre Barbosa, Dan Cox
Data Librarians:	Oscar Lafontaine, Samuel Montalvo-Perez, Anthony Noto, Hadiah Rawajfih, Madeline Rihner
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1. RECONNAISSANCE TEAM

The active 2017 hurricane season included multiple hurricanes impacting the United States from its mainland to the US Virgin Islands and Puerto Rico. Hurricane Irma left a path of destruction across the Caribbean, including landfall on September 6, 2017 in the British Virgin Islands, just east of the US Virgin Islands, as a Category 5 hurricane. The hurricane inflicted minor impacts on Puerto Rico as it continued through the Caribbean towards Florida. Shortly thereafter, Maria made its way through the caribbean, eventually making its US landfall on September 20 near Yabucoa, Puerto Rico as a strong Category 4 hurricane, causing considerable damage to large portions of the island from wind, storm surge and inland flooding hazards.

As part of a wider coordinated effort to conduct assess damage resulting from this sequence of hurricanes, a reconnaissance campaign was organized for the US Virgin Islands November 10-14, 2017 to document the impacts of Irma and Maria in St. Thomas (STT), St. Johns (STJ), and St. Croix (STX). Separate efforts were organized for Florida as well as Puerto Rico, each curated as separate DesignSafe projects (PRJ-1828 and PRJ-1775, respectively). The investigations employed primarily door-to-door Damage Assessments to document the performance of buildings, using a customized Fulcrum smartphone application. At select locations, unmanned aerial surveys (UAS) were executed. Table 1 summarizes the leadership team surrounding this reconnaissance effort, and Table 2 summarizes the team members involved in the collection of structural damage assessments. The team coordinated with a larger team of coastal engineers from the United States and Japan, also listed in Table 2, who conducted a comprehensive coastal survey. While this larger US-Japan team generated additional data, well beyond the scope of this RAPID, this Data Report and the corresponding DesignSafe project focuses on the data associated with structural damage assessments.

Following the reconnaissance effort, a team of student Data Librarians were trained to execute a comprehensive Data Enrichment and Quality Control (DE/QC) process described in Section 3.1 and assist in curating data captured outside of the Fulcrum mobile data collection platform. These Data Librarians are listed in Table 3.

Table 1. Regional Coordination Nodes & Team Leads

Nodes	Coordination Node	Node Coordinator
Coordinating Node	University of Notre Dame	Tracy Kijewski-Correa
USVI Node	University of the Virgin Islands	Greg Guannel
Coastal Survey Leads	Oregon State University Kyoto University	Dan Cox (US) Nobuhito Mori (Japan)
Structural Assessment Team Lead	University of Florida	David Prevatt
Data Standards Lead	Auburn University	David Roueche

Table 2. Team Members		
Team Member	**Affiliation**	**Team Assignment**
David Roueche	Auburn University	Structural Assessment Team
Yue Li	Case Western Reserve University	Structural Assessment Team
Kwasi Perry	UAV Survey Inc.	Structural Assessment Team
Andrew Kennedy	Oregon State University	US Coastal Survey Team
Andre Barbosa	Oregon State University	US Coastal Survey Team
Richie Slocum	Oregon State University	US Coastal Survey Team
Chase Simpson	Oregon State University	US Coastal Survey Team
Taro Arikawa	Chuo University	Japan Coastal Survey Team
Takenori Shimozono	University of Tokyo	Japan Coastal Survey Team
Daisuke Inazu	TUMST	Japan Coastal Survey Team
Tomoya Shimura	Kyoto University	Japan Coastal Survey Team
Eisuke Shimakawa	NHK reporter	Japan Coastal Survey Team
Shinya Kimura	NHK camera man	Japan Coastal Survey Team

Table 3. Data Librarians	
Name	**Affiliation**
Madeline Rihner	Auburn University
Hadiah Rawajfih	Auburn University
Anthony Noto	University of Florida
Samuel Montalvo-Perez	University of Puerto Rico Mayaguez
Oscar Lafontaine	University of Puerto Rico Mayaguez / University of Florida

2. METHODOLOGY

2.1 Survey Classes

The teams employed two primary methodologies in their evaluation of Irma's and Maria's impacts to structures in Puerto Rico, now briefly summarized.

2.1.1 Damage Assessments

Damage Assessments were conducted door-to-door by the individuals in Table 2 for a detailed building classification and evaluation of condition/component damage levels. These were recorded using the Fulcrum smartphone data collection application, acquiring geotagged photos from the surveyor's mobile device. The App fields were informed by those used by team members who also surveyed Hurricane Harvey's impacts in Texas, but modified to include multiple assessment types (e.g., building, bridge, dam, power infrastructure) within the app. The building assessment form was also modified to be more appropriate for the building typologies expected in the Caribbean. The App supported in-line capture of geotagged photos and audio recordings directly from the user's mobile device, including all device-supplied metadata (date, time, etc.). The customized App then steps through major assessment categories.

The number of App fields for each assessment type were limited to focus on the most essential attributes common to most structures within each type. For buildings, all records receive a building condition rating, and if sufficient information were available on the building, individual component damage ratios were estimated. The condition rating scale for low-rise (less than 3 stories), single- and multi-family residential structures (majority encountered in field reconnaissance) is defined in Table 4. Attributes such as address and year built were not captured because such data was not available to researchers at the individual building level. Other building types were rated in accordance with the HAZUS-MH Hurricane technical manual. All Fulcrum damage assessment fields and response options are itemized in the Appendix.

2.1.2 Unmanned Aerial Surveys

Small Unmanned Aerial Surveys (UAS) were conducted by a professional contractor (K. Perry of UAV Survey Incorporated) to generate additional aerial imagery (photos and videos). At select locations, geolocated photos are captured using a deliberate pre-programmed grid for subsequent creation of photogrammetric products like 3D point clouds/textured meshes, Digital Elevation Models, and Orthomosaics. The use of such flight plans achieves a targeted ground sample distance (resolution) of 3 centimeters or less.

2.2 Chronology and Geospatial Distribution of Data Collection

The geographic focus of the damage assessments is visually depicted in Figure 1. Initial reconnaissance missions were conducted in PR between October 6-27 October, 2017, led by Dr. Luis Aponte-Bermudez. Missions were conducted as time, personnel and resources were available, but were limited due to the humanitarian needs on the island. A mainland support team led by Dr. David Prevatt rendezvoused with the Puerto Rican team between 16-18

November 2017 to conduct additional D2D and UAS deployments. Table 5 provides a more detailed breakout of the chronology of the deployments.

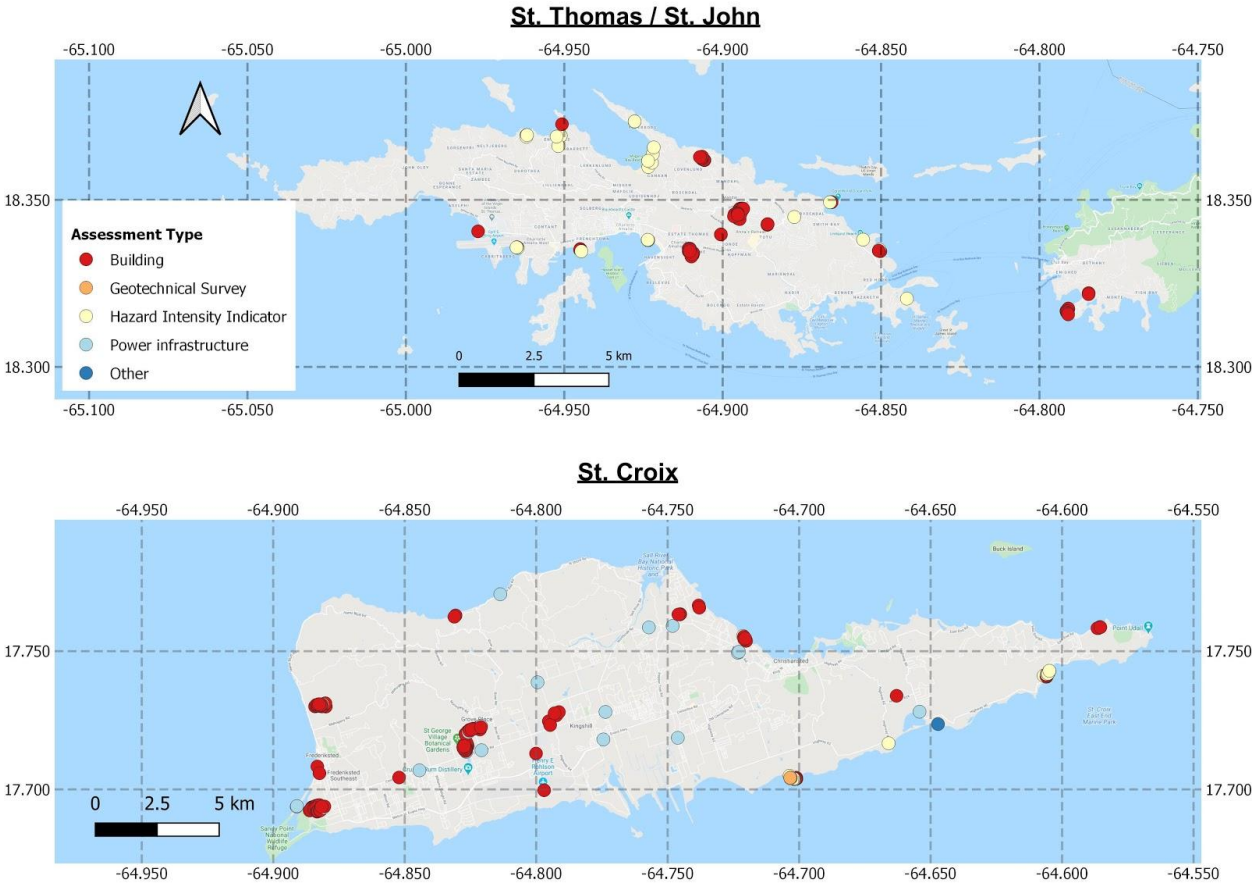


Figure 1. Spatial distribution of data collection activities in US Virgin Islands by assessment type.

Table 4. Building Condition Rating Scale	
4=Destroyed Major (>15%) roof failure and/or failure of wall frame. Loss of more than 25% of roof sheathing.	
3=Severe damage (major impacts to structural load path) Major window damage or roof sheathing loss. Major roof cover loss. Some roof structure failure.	
2=Moderate damage (load path preserved, but significant repairs required) A few roof sheathing panels damaged. Roof cover loss < 50%.	
1=Minor damage (damage confined to envelope) Up to one door or window failure. Some wall cladding and soffit failure noted. Up to 15% roof cover loss.	
0=Undamaged No visible damage.	

Table 5. Chronology of Deployments		
Date	**Structural Assessment Team Members**	**Region/Locale**
November 10, 2017	David Prevatt, Yue Li, David Roueche, Kwasi Perry	St. Thomas (Tutu, Charlotte Amalie)
November 11, 2017	David Prevatt, Yue Li, David Roueche, Kwasi Perry	St. Johns (Cruz Bay)
November 12-14, 2017	David Prevatt, Yue Li, David Roueche, Kwasi Perry	St. Croix (Frederiksted, Christiansted)

3. DATA PROCESSING

3.1 Damage Assessments

The entire Fulcrum Database was migrated into a Fulcrum Community Account to allow for immediate public access and agility in coordinating with those outside the team. Once active reconnaissance concluded, the entire Fulcrum Database was downloaded as a CSV file with accompanying photographs as a zipped file for curation. Then each record in the Fulcrum database underwent the Data Enrichment/Quality Control (DE/QC) process developed by the Data Standards Lead. Records were updated in real-time within the Fulcrum Community Account as they were revised in the DE/QC Process.

The DE/QC process for this dataset was less extensive than other recent hurricane events (e.g., Harvey, Irma), in part due to the lack of available supplemental data such as Streetview, high-resolution aerial imagery, and public property records. USVI records underwent a cursory QC to check accuracy of the chosen assessment type, and (if the record corresponded to a building) building type, damage rating, and number of stories. Again, typically a single Data Librarian was responsible for a given record, and only spot checks of the dataset were completed by the Data Standards Lead. as a secondary check.

As each record completed one of these stages, a code is updated in the record (see Table 6). A QC notes field is also provided for the Data Librarian to include any relevant information regarding changes made to the record in the process or unusual uncertainties. Once the process was completed, the final database was downloaded from Fulcrum for curation in DesignSafe in XLSX format and in GeoJSON format, along with geotagged photos and audio files.

While conducting Damage Assessments, some surveyors acquired additional photos outside of the Fulcrum App. These are also curated, as discussed in Section 4.

Table 6. QC Codes and Descriptions	
Code	**Description**
1a	Basic QC completed, including verifying assessment type, verification of approximate location, and (if building), building type, external damage rating, and number of stories.
2a	Full Data Enrichment and Quality Control process completed or mostly completed based on available data, including damage ratios added based on the portions of the structure visible to the Data Librarian, other visible building details added.

3.2 Unmanned Aerial Survey

In cases where imagery was acquired on a grid sufficient to generate other data products, the geolocated dataset is ingested into a standard UAS-compatible photogrammetry desktop application, in this case Pix4D Mapper Pro (licensing provided through the NHERI RAPID Experimental Facility at the University of Washington), which:

1. Checks the photo dataset for its integrity and positional accuracy based on the geolocation coordinated in the metadata of each image.
2. Establishes desired coordinate system (ie. WGS 1984 or others) and units of measurement.
3. Establishes options for processing quality, processing speed, data outputs, and other related parameters.
4. Generates data outputs such as point clouds, 3D models, Digital Elevation Models, and Orthomosaics using proprietary Structure-from-Motion algorithms.

Resulting data products can be ingested into a variety of proprietary and non-proprietary software, including Potree (available through DesignSafe Workspace) for points clouds, and QGIS (also available through DesignSafe Workspace) for Digital Elevation Models and Orthomosaics. Area, Linear, and Volumetric measurements can also be generated from the point cloud.

4. ARCHIVED DATA PRODUCTS

This section details the directory structure created in DesignSafe-CI and the contents therein.

🖿 Directory D1. Damage Assessments

FORMATS = XLSX, GeoJSON, JPG, PNG

The raw Fulcrum database of Damage Assessments, prior to DE/QC processing, is archived as a zip file in the folder **Damage Assessment Data -- original.** The folder **Damage Assessment Data -- processed** contains the final quality assured dataset (as XLSX and GeoJSON) for *273* individual assessments summarized in Table 7, with all the response fields in the Appendix. Assessments are normally tagged by their type, as summarized in Table 7. For those listed as “Other” in Table 7, the field investigator assigned a specific tag, such as “Cistern Water System.”

Those for which the assessor did not provide an assessment type are listed as “Blank” in Table 7. All referenced photos are contained in **HIM-PHOTOS-DA.**

Table 7: Summary of Assessments by Type in US Virgin Islands

Assessment Type	**Number of Records**
Building	198
Power Infrastructure	22
Hazard Intensity Indicator	49
Other	3
All	**272**

🖿 Directory D2. Surface Imagery

D2.1 Ground Level Photographs & Videos

FORMAT = JPG

This directory contains additional videos and photos captured by investigators outside of Damage Assessments in Fulcrum. Photos were reviewed to remove poor quality, redundant, ambiguous or irrelevant photos/videos. Photographs are organized into directories by locale, with a folder corresponding to each of the islands assessed (STJ = St. Johns, STT = St. Thomas, STX = St. Croix). Photos within each folder are organized by investigator last name and named with the following convention:

HIM_LASTNAME_ISLAND_MMDDYY_####.jpg

where HIM = Hurricanes Irma & Maria, LASTNAME = last name of the investigator, ISLAND = Location (StJohns, StCroix, StThomas), MM is the month (=11), DD is the day (e.g., 11), YY is the year (=17), and #### is a four-digit sequential chronological numbering of the photos (e.g., 0001).

D2.2 Photo-Video Log

FORMAT = CSV

Within each island sub-folder, a photolog is provided with the following naming convention:

Photo Log - LASTNAME - ISL.csv

where LASTNAME = last name of the investigator, ISL = Location (STJ=St. Johns, STX=St. Croix, STT=St. Thomas), MM is the month (=10), DD is the day (e.g., 06), and YY is the year (=17). Photolog columns are organized as follows:

A	B	C	D	E	F
Name	Date	Time	Camera	Latitude	Longitude

Date, time, and location (in decimal degrees) of the acquired image were extracted from the metadata of each geotagged photo.

🖿 Directory D3. Unmanned Aerial Survey
FORMATS = MOV, JPG, .TIFF, .TFW, .OBJ, .LAS, .P4D
A subdirectory is created for every island where UAS was acquired, with the following convention:

UAS_ISL

where UAS=unmanned aerial survey and ISL = Location (STJ=St. Johns, STX=St. Croix, STT=St. Thomas). Within each subdirectory, are date-specific folders, named as follows:

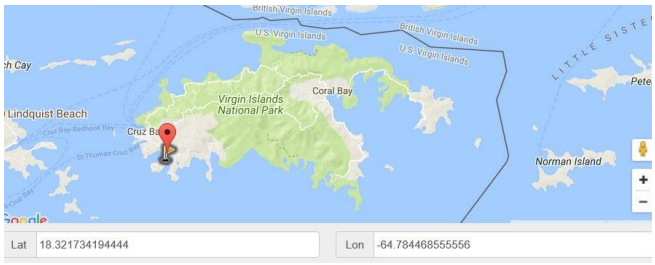
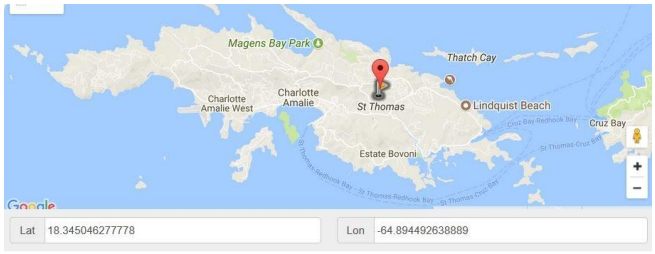
UASMMDDYY_ISL

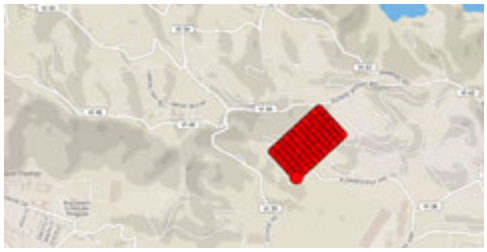
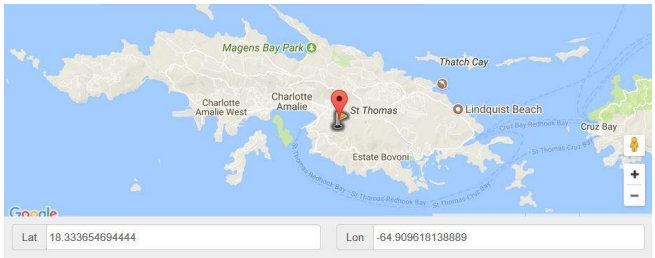
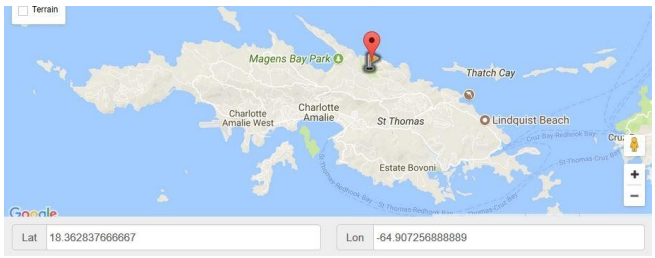
where UAS=unmanned aerial survey, MM is the month (=11), DD is the day (e.g., 11), YY is the year (=17), and ISL = Location (STJ=St. Johns, STX=St. Croix, STT=St. Thomas). Additional sub-folders may be used to further organize the data from that date by specific location. Files are not renamed to standard conventions (files retain the names assigned by the UAS device).

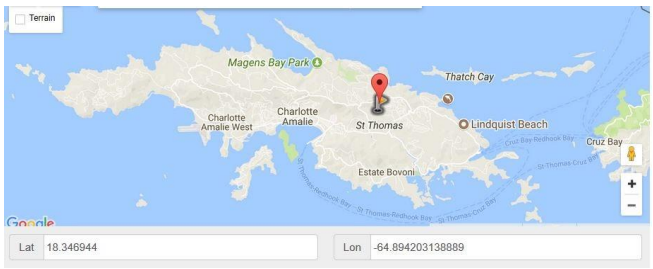
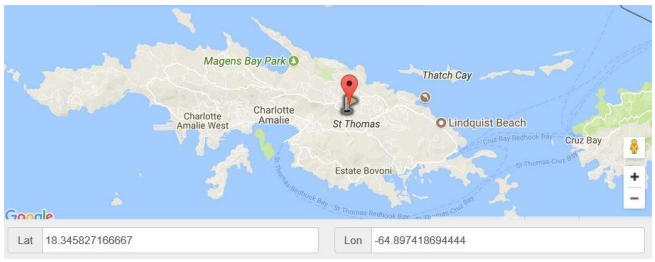
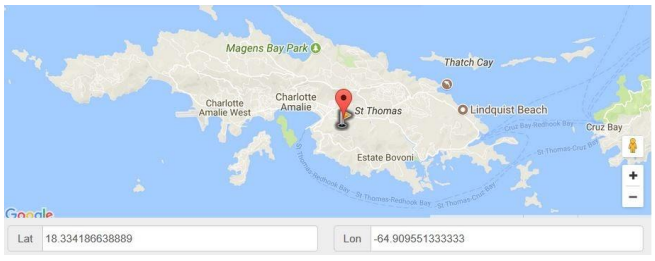
The table below catalogs the files contained in each subfolder, summarizing the date, location, number of photos and videos captured by the UAS. In addition to the UAS images (.jpg) and videos (.mov) collected, each folder contains a .Geo.JPG file showing the geolocation of the acquired dataset. A thumbnail of that file is included in the table below. A note under the directory indicates whether the data was collected on a grid sufficient to facilitate the generation of other data products via photogrammetry (point clouds). For those labeled as No Grid, only photos and videos are provided.

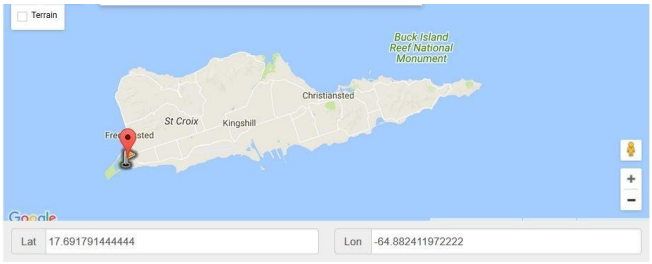
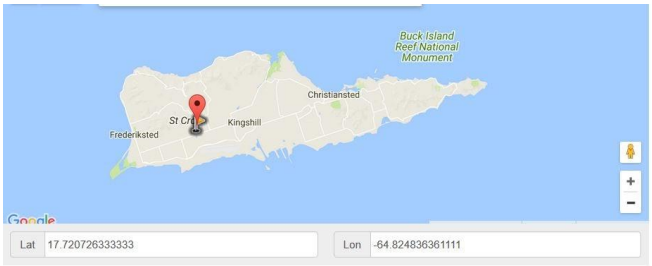
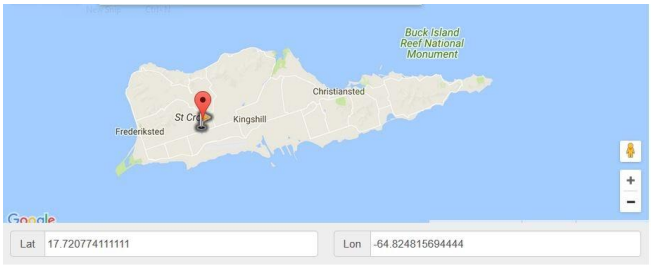
Those shaded in green (and not marked with “No Grid”) were suitable for conversion to in Pix4DMapper Pro to create photogrammetric data products. These are highlighted in green in the table below. For each, the directory contains:

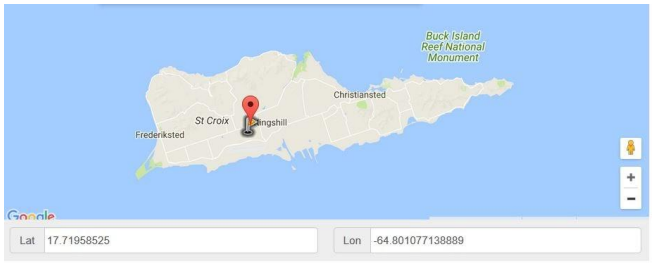
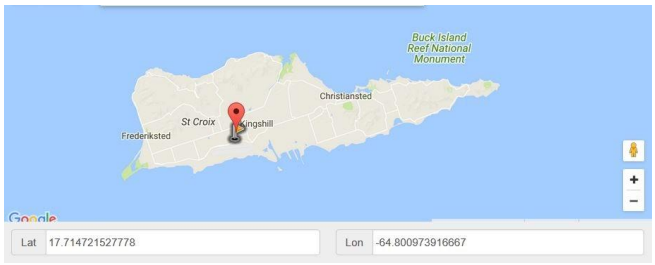
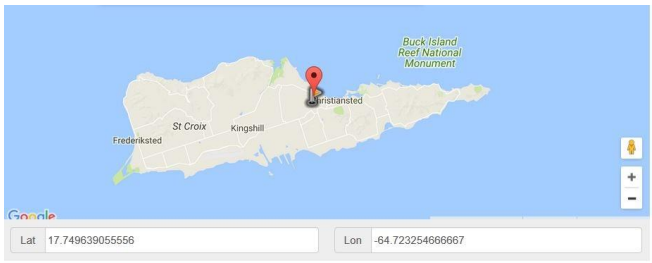
- .P4D executable file (with the name in the following table)
- A corresponding folder (of the same name) containing various supporting files, logs and reports documenting the data processing, and data products including point clouds (.LAS), orthomosaics and Digital Elevation Model (.TIFF with associated .TFW providing georeferencing details).
- A corresponding folder (Raw Images) with the original photos acquired along the grids (.JPG including .Geo.JPG with location information)

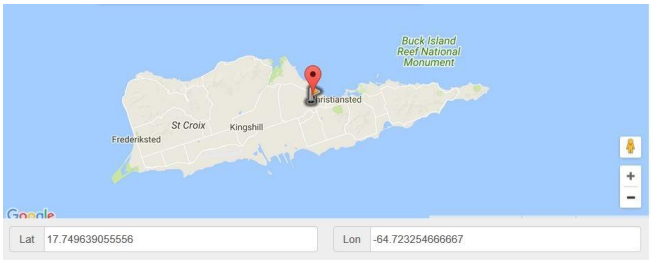
DIRECTORY	UAS FILES		LOCATION DETAILS
	.JPG	.MOV	GeoImage, City, zip code
🖿 UAS_STJ			
↳ 🖿 UAS111117_STJ			
↳ ↳ 🖿 Cruz Bay 1 (No Grid)	15	5	 Cruz Bay, St John 00830, USVI
↳ ↳ 🖿 Cruz Bay 2 (No Grid)	49	2	 Cruz Bay, St John 00830, USVI
🖿 UAS_STT			
↳ 🖿 UAS111017_STT			
↳ ↳ 🖿 Grids			
↳ ↳ ↳ 🖿 Annas Retreat-MacGregor			
↳ ↳ ↳ ↳ 🖿 Raw Images	263	0	
↳ ↳ ↳ ↳ 🖿 UAS111017_STT-AnnasRetreat-MacGregor & UAS111017_STT-AnnasRetreat-MacGregor.p4d			

			 MacGregor Ln, Anna's Retreat, St Thomas 00802, USVI
↳ ↳ ↳ 🖿 Weymouth Rhymer Hwy			  4001 Weymouth Rhymer Hwy, St Thomas 00802, USVI
↳ ↳ ↳ ↳ 🖿 Raw Images	403	0	
↳ ↳ ↳ ↳ 🖿 UAS111017_STT-WeymouthRhymerHwy & UAS111017_STT-WeymouthRhymerHwy.p4d			
↳ ↳ 🖿 Photos_Videos			
↳↳↳ 🖿 Barbados Ct (No Grid)	19	8	 Barbados Ct, St Thomas 00802, USVI
↳↳↳ 🖿 Annas Retreat - Sugarapple (No Grid)	18	2	

			 Sugarapple Rd, Anna's Retreat, St Thomas 00802, USVI
↳↳↳ 🖿 Annas Retreat - Triumph (No Grid)	0	1	 Triumph Rd, Anna's Retreat, St Thomas 00802, USVI
↳↳↳ 🖿 Weymouth Rhymer Hwy (No Grid)	3	1	 4001 Weymouth Rhymer Hwy, St Thomas 00802, USVI
🖿 UAS_STX			
↳ 🖿 UAS111217_STX			
↳↳ 🖿 Grid			
↳ ↳ ↳ 🖿 Raw Images	134	0	
↳ ↳ ↳ ↳ 🖿 UAS111217_STX-ArthurRichardsSchool & UAS111217_STX-ArthurRichardsSchool.p4d			

			 27 Stoney Ground, Frederiksted, St Croix 00840, USVI
↳↳ 🖿 Photos_Videos (No Grid)	42	5	 27 Stoney Ground, Frederiksted, St Croix 00840, USVI
↳ 🖿 UAS111317_STX			
↳↳ 🖿 Frederiksted 1 (No Grid)	26	3	 Rte 705, Frederiksted, St Croix 00840, USVI
↳↳ 🖿 Frederiksted 2 (No Grid)	10	3	 Rte 705, Frederiksted, St Croix 00840, USVI
↳ 🖿 UAS111417_STX			

Christiansted 1 (No Grid)	5	1	 Centerline Rd, Christiansted, St Croix 00820, USVI
Christiansted 2 (No Grid)	7	1	 Centerline Rd, Christiansted, St Croix 00820, USVI
↳ 🖿 UAS111517_STX			
↳ ↳ 🖿 Grid			  Northside Rd, Christiansted, St Croix 00820, USVI
↳ ↳ ↳ 🖿 Raw Images	210	0	
↳ ↳ ↳ 🖿 UAS111517_STX-SolarFarm & UAS111517_STX-SolarFarm.p4d			

↳ ↳ 🖿 Photos_Videos (No Grid)	0	1	 Northside Rd, Christiansted, St Croix 00820, USVI

🖿 Directory D4. Dissemination Products
FORMATS = PDF
Publication describing the mission, data collection and observations of damage.

5. CONTACTS
For inquiries on specific sets of data, please contact the individual overseeing the relevant data acquisition and processing.

General Questions	**Damage Assessments**
Tracy Kijewski-Correa Email: tkijewsk@nd.edu Phone: 574-631-2980	David Roueche Email: dbr0011@auburn.edu Phone: 334-844-6256

APPENDIX. ASSESSMENT FORM FIELDS

Column		Column Header	Field	Format	Response Choices/ Description
A	1	record_id	Record ID	Text	Auto-populated
B	2	latitude	Latitude	Decimal	Auto-populated
C	3	longitude	Longitude	Decimal	Auto-populated
D	4	date_of_survey	Date of Survey	Date	Auto-populated
E	5	type_of_disaster	Type of Disaster	Single Choice	Earthquake Fire Flood High Winds Hurricane Snow/Ice Tornado Tsunami
F	6	photos	Photo	Comma separated Values	Photos associated with record
G	7	audio	Audio	Audio	Surveyor-supplied audio file
H	8	exterior_damage_rating	Exterior Damage Rating	Integer	0 - Undamaged 1 - Minor damage 2 - Moderate damage 3 - Severe damage 4 - Destroyed
I	9	general_notes	General Notes	Text	Notes supplied by surveyor (if any)
J	10	assessment_type	Assessment Type	Single Choice	Building Power infrastructure Bridge Dam Geotechnical Survey Hazard Intensity Indicator Other
Buildings					
K	11	building_address	Postal address	Text	Auto-populated
L	12	number_of_stories	Number of Stories	Numeric	Surveyor-Supplied value

M	13	year_built	Year Built	Numeric	Surveyor-Supplied value
N	14	attached_garage	Attached Garage	Yes/No	Yes No
O	15	building_use	Building Use	Single Choice	Single-Family (Tract homes) Single-Family (Custom) Single-Family (Informal) Multi-Family Commercial Industrial Hotel Other
P	15	roof_shape	Roof Shape	Multiple Choice	Hip Gable Flat Monoslope Double lean-to Complex Unknown Other
Q	16	roof_extent	Roof Extent	Single Choice	No overhang Overhang (< 1m) Continuous Covered Porch Discontinuous Covered Porch
R	17	roof_system	Roof System	Multiple Choice	RC Slab Metal joists Wood rafter and purlins Hot rolled steel Cold formed steel Unknown Other
S	18	roof_cover	Roof Cover	Multiple Choice	Corrugated metal Standing Seam Metal Clay tiles Concrete tiles Asphalt shingles Metal shingle Slate N/A Other

T	19	primary_structural_wall_system	Primary Structural Wall System	Multiple Choice	Wood Frame Load Bearing Masonry (reinforced) Load Bearing Masonry (unreinforced) Load Bearing Masonry (unknown) RC MRF with infill Steel MRF with infill RC Frame Steel Frame Cold Form Steel Frame Unknown Other
U	20	building_envelope	Building Envelope	Multiple Choice	CMU infill Clay brick infill Metal panels Wood planks Wood sheathing Curtain wall Precast Elements N/A Other
V	21	other_details	Other Details	Text	Surveyor-Supplied details
W	22	elevated_living_space	Elevated Living Space	Yes/No	Yes No
X	23	elevation_height	Elevation Height	Numeric	Surveyor-Supplied estimate
Y	24	windows_protected	Windows Protected	Yes/No	Yes No
Z	25	pct_of_structure_visible	% of Structure Visible	Numeric	Surveyor-Supplied estimate
AA	26	damage_source	Damage Source	Multiple Choice	Wind Storm surge Wind-driven rain Freshwater flood Tree-fall Landslide Other
AB	27	interior_damage	Interior Damage	Single Choice	No Damage;0 Minor;1 Moderate;2

					Major;3 Unknown;9
AC	28	high_water_mark_above_grade_m	High Water Mark Above Grade (m)	Numeric	Surveyor-Supplied estimate
AD	29	structure_usable	Can structure be used for intended purpose?	Yes/No	1 = Yes 0 = No
AE	30	roof	Roof (damage level)	Single Choice	0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
AF	31	structural_system	Structural System (damage level)	Single Choice	0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
AG	32	envelope	Envelope (damage level)	Single Choice	0% 10% 20% 30% 40% 50% 60% 70% 70% 80% 90% 100%

AH	33	windows	Windows (damage level)	Single Choice	0% 10% 20% 30% 40% 50% 60% 70% 70% 80% 90% 100%
AI	34	entry_door_damage	Entry Door Damage	Yes/No	Yes No
AJ	35	garage_door_damage	Garage Door Damage	Yes/No	Yes No
AK	36	patiofrench_door_damage	Patio/French Door Damage	Yes/No	Yes No
AL	37	damage_notes	Damage Notes	Text	Surveyor-Supplied notes on damage levels
Power Infrastructure					
AM	38	type_pi	Power Infrastructure Type	Single Choice	Pole Tower Substation Lines
AN	39	material	Power Infrastructure Material	Single Choice	Timber Concrete Steel Other
AO	40	diameterwidth_m	Power Infrastructure Diameter/Width (m)	Numeric	Surveyor-Supplied estimate
AP	41	heightlength_m	Power Infrastructure Height/Length (m)	Numeric	Surveyor-Supplied estimate
AQ	42	damage_source_power	Power Infrastructure Damage Source	Multiple Choice	Wind Wind-borne debris Landslide Surge Flooding

					Other
AR	43	damage_type_power_infra	Damage Type	Single Choice	Undamaged Leaning Fallen Snapped Other
Bridges					
AS	44	bridge_use	Bridge Use	Single Choice	Pedestrian Vehicular Railroad
AT	45	material_bridge	Material	Multiple Choice	Pre-Cast Concrete Cast in Place Concrete Steel Timber
AU	46	length_or_span_bridge	Length or Span (m)	Numeric	Surveyor-Supplied estimate
AV	47	lanes_bridge	Number of Lanes	Numeric	Surveyor-Supplied estimate
AW	48	damage_source_bridge	Damage Source	Multiple Choice	Wind Wind-borne debris Surge Flood Landslide Other
AX	49	damage_state_bridge	Damage State	Single Choice	Undamaged;0 Light damage, still in use;1 Moderate damage, out of use but repairable;2 Severe damage, structure remains but not repairable;3 Collapsed;4
AY	50	functional	Functional?	Single Choice	Yes No Don't Know
Dams					
AZ	51	material_dam	Material	Single Choice	Earth Concrete Steel

					Other
BA	52	length_or_span_dam	Length or Span (m)	Numeric	Surveyor-Supplied estimate
BB	53	height_m_dam	Height (m)	Numeric	Surveyor-Supplied estimate
BC	54	thickness_dam	Thickness	Numeric	Surveyor-Supplied estimate
BD	55	damage_state_dam	Damage State	Single Choice	Undamaged;0 Light damage, repairable, maintaining function;1 Moderate damage, repairable, minimal loss of function;2 Severe damage, non-repairable, moderate loss of function;3 Destroyed, no longer serves function;4
BE	56	damage_source_dam	Damage Source	Multiple Choice	Wind Wind-borne debris Surge Flood Landslide Other
Geotechnical Investigation					
BF	57	damage_type_geo	Damage Type	Single Choice	Landslide Erosion Settlement Scour Other
BG	58	depth_geo	Depth	Numeric	Surveyor-Supplied estimate
BH	59	width_geo	Width	Numeric	Surveyor-Supplied estimate
BI	60	hazard_type	Hazard Type	Single Choice	Wind Surge (HWM) Inland Flooding (HWM) Other
BJ	61	hazard_units	Hazard Units	Single Choice	Meters

					Meters per second Other
BK	62	hazard_intensity	Hazard Intensity	Numeric	Surveyor-Supplied estimate
DE/QC					
BL	63	qc_id	QC ID	Text	Manually assigned identifier
BM	64	qc_code	QC Code	Single Choice	0 1a 1b 1c 2a 2b
BN	65	qc_notes	QC Notes	Text	Summary of modifications made to data in DE/QC process