

Summary of Progress: Hurricane Maria NCST Investigation

National Construction Safety Team Advisory Committee Meeting

June 10, 2021

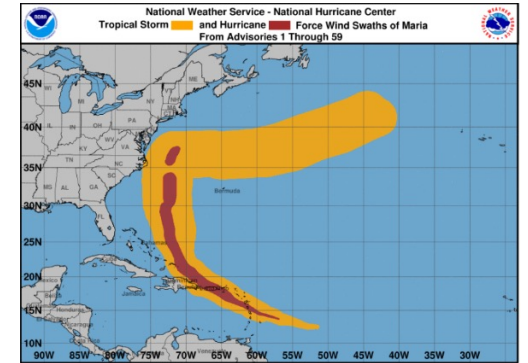
Joseph Main

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National Institute of Standards and Technology*

Hurricane Maria's Impacts on Puerto Rico

Factors considered in establishing a National Construction Safety Team (NCST)

- **Hazard Exposure:** Strong Category 4 hurricane with peak gusts near 140 mph (63 m/s), even larger with topographic speedup effects; rainfall up to 40 inches (100 cm), extensive flooding, landslides
- **Exposed Population:** Entire Commonwealth (~3.3M people)
- **Mortality:** Challenges in attributing hurricane-related deaths; official Puerto Rico death toll of 2,975 lives lost (excess mortality estimate)
- **Engineered Buildings:** Extensive nonstructural damage, rainwater intrusion, and loss of function
- **Emergency Response:** Challenges with rescues in flooded areas, complicated by loss of communications for extended periods
- **Infrastructure Systems:** Severe physical damage and complete/near complete loss of function for electrical and communications systems presented emergency response and recovery challenges
- **Education, Healthcare and Businesses:** Negative impacts on recovery due to power loss, non-structural building damage, generator failures, and road closures



NCST Technical Investigation of Hurricane Maria

In February 2018, the NIST Director established a National Construction Safety Team to conduct a technical investigation of the effects of Hurricane Maria on Puerto Rico

Goals of the NCST investigation are to characterize:

- 1. the wind environment and technical conditions associated with deaths and injuries*
- 2. the performance of representative critical buildings, and designated safe areas in those buildings, including their dependence on lifelines*
- 3. the performance of emergency communications systems and the public's response to such communications*

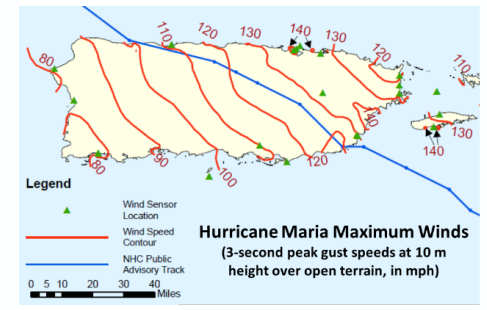
NCST Investigation Projects

Hazard Characterization: Document and understand the storm's wind environment and other hazards including storm surge, rainfall, flooding, and landslides

Performance of Critical Buildings: Evaluate how critical buildings performed (specifically hospitals, schools, and shelters) – including their dependence on electricity, water, and other infrastructure

Public Response to Emergency Communications: Document the role of emergency communications and the public's response to those communications – focusing on communications during response and recovery (during and immediately after the hurricane)

Morbidity and Mortality: Better understand how damaged buildings, and failures in supporting infrastructure, played a role in injuries and deaths associated with the hurricane



NWIRP Research Study of Hurricane Maria

Complementing the NCST Investigation, NIST is conducting a research study under the National Windstorm Impact Reduction Program (NWIRP) focused on post-hurricane recovery processes

Goals of the NWIRP study are to characterize the impacts to and recovery of:

- 1. small and medium-sized manufacturers, as well as businesses in retail and service industries*
- 2. education and healthcare services*
- 3. infrastructure systems, with a focus on infrastructure that supports critical buildings (i.e., hospitals and schools) and emergency communications*

NWIRP Research Projects

Recovery of Business and Supply Chains: Study the recovery of small- and medium-sized businesses – in the manufacturing, retail, and service sectors – to improve understanding of business continuity resilience planning and supply chain continuity

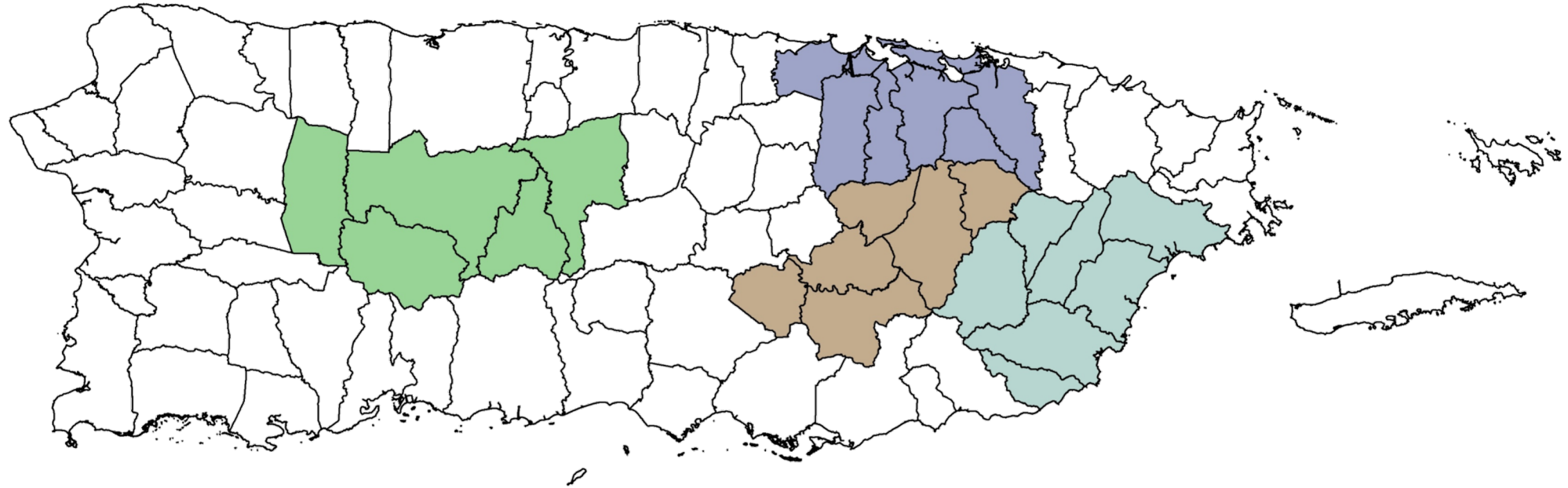
Recovery of Social Functions: Examine the recovery trajectories of sampled schools and hospitals to identify the underlying characteristics and conditions associated with recovery of critical social functions from Hurricane Maria

Infrastructure Systems Supporting Critical Buildings and Emergency Communications: Evaluate the dependencies of building function on infrastructure (power, water, and transportation), including cascading loss of function and sequencing of recovery activities and the causes of the loss of functionality and extended-duration outage of the wireless communication system

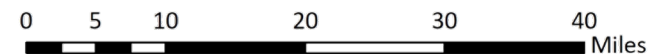
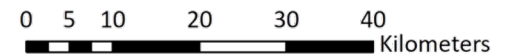


Regions of Focus

To facilitate coordination across projects, four regions of focus were selected, considering hazard exposure, geography, and socioeconomic factors:



- Municipality Boundary
- San Juan Region
- Utuado Region
- Caguas Region
- Humacao Region



January 2021 Progress Report

“This report is dedicated to those whose lives were lost or disrupted by this hurricane, and to those who will act on the findings and recommendations of future reports in order to improve the safety of people in Puerto Rico and elsewhere.”

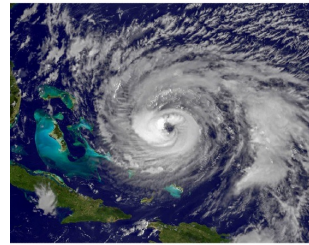


NIST SP 1262
A PROGRESS REPORT

LEARNING
from
**HURRICANE
MARIA'S**
IMPACTS
on
PUERTO
RICO

January 2021

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce



NIST SP 1262
UN INFORME DE PROGRESO

APRENDIENDO
del
IMPACTO
del
**HURACÁN
MARÍA**
en
PUERTO
RICO

Enero de 2021

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

<https://doi.org/10.6028/NIST.SP.1262>

<https://doi.org/10.6028/NIST.SP.1262es>

January 2021 Progress Report: Content and Organization

Executive Summary

1. Introduction

- 1.1 NIST's Role in Studying Disasters and Failures
- 1.2 Scope and Organization of Progress Report

2. Preliminary Reconnaissance and Decision to Establish a Team

- 2.1 Hazard Intensity
- 2.2 Exposed Population and Mortality
- 2.3 Physical Damage to Buildings and Infrastructure
- 2.4 Evacuation and Emergency Response Challenges
- 2.5 Economic and Social Impacts
- 2.6 Decision to Establish a Team

3. The NIST Hurricane Maria Program

- 3.1 Scope and Goals
- 3.2 Team Leadership and Members
- 3.3 Technical Plan and Projects
- 3.4 Advisory Committee
- 3.5 Coordination with Other Organizations
- 3.6 Estimated Duration and Cost
- 3.7 Impact of Events in Puerto Rico Following Hurricane Maria

4. Progress in Carrying Out the Hurricane Maria Program

- 4.1 Liaison Status with Other Agencies and Organizations
- 4.2 Award of Supporting Contracts
- 4.3 Initial Data Collection and Analysis
- 4.4 Advisory Committee Meetings and Reports

5. Final Reports and Recommendations



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January 2021 Progress Report: Stakeholder Outreach

- Website updates, including news update and new **“Progress”** page (see below)
- Federal agency principals updated through NWIRP Interagency Coordinating Committee
- Email updates to contacts in PR agencies, federal agencies, and other organizations
- Social media outreach by NIST Public Affairs Office
- Spanish-language TV interview of Drs. Mitrani-Reiser and Aponte-Bermúdez by Ada Monzón on “Noticentro al Amanecer” (3/4/21)
- Presentation to PR Chapter of APICS (Assoc. of Production and Inventory Control Society) by Drs. Dillard and Helgeson (3/11/21)
- Nearly 1000 unique external website page views in the three weeks following report release

NIST Search NIST Menu

Resilience

DISASTER & FAILURE STUDIES

Hurricane Maria

- News and Updates
- Progress**
- Hurricane Maria Projects
- Image Gallery
- Hurricane Maria Team
- Cooperating Organizations
- NIST's Authority
- Hurricane Maria Program Fact Sheet
- Frequently Asked Questions

Progress

Progress Report

In January 2021, NIST published a report summarizing progress in its [multi-year study of Hurricane Maria's impacts on Puerto Rico](#) and subsequent recovery processes. Further details are provided at the following links:

- [News update on release of Progress Report](#)
- [PDF version of Progress Report in English/ Spanish](#)

Advisory Committee Updates

NIST provides regular updates on its Hurricane Maria projects to the [National Construction Safety Team Advisory Committee](#). The following is a listing of presentations to the Advisory Committee that provide details on the preliminary reconnaissance, plans, and progress of the Hurricane Maria Program. Links to the full presentations are provided.

- [Hurricane Maria Preliminary Reconnaissance](#) (February 2018)
- [Summary of NIST's Efforts to Investigate and Study Hurricane Maria's Impacts on Puerto Rico](#) (September 2019)
- [Summary of Hurricane Maria NCST Investigation Progress](#) (June 2020)

1566 total downloads (as of 5/23/21)
888 English / 678 Spanish

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LEARNING from
HURRICANE MARIA'S IMPACTS
on
PUERTO RICO

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<https://www.nist.gov/topics/disaster-failure-studies/hurricane-maria/progress>

COVID-19 Pandemic Updates

- NIST continues to operate on a maximum telework policy with all HM work and meetings conducted remotely
- Evaluation of critical buildings supported by Stantec contractor team:
 - Virtual meetings conducted with hospital staff in support of Phase 1 data collection
 - Some local travel by PR-based contractors to collect documents shared by hospitals
- Surveys and interviews supported by Horsley Witten contractor team:

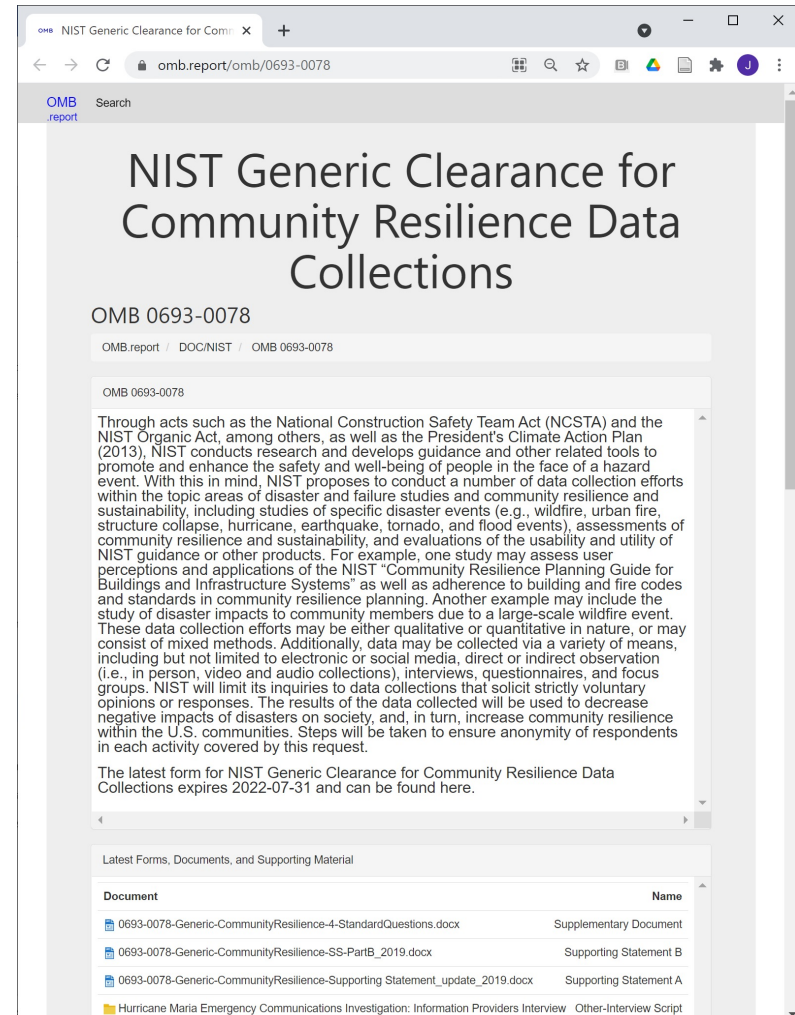
(Emergency Communications and three NWIRP Projects: Recovery of Business and Supply Chain, Recovery of Social Functions, Recovery of Critical Infrastructure)

 - Online and/or telephone-based modes of data collection being used rather than in-person
 - Pandemic training conducted and safety protocols in place to support data collection in office settings and field teams traveling within study area to distribute information sheets to households being recruited for survey
- Mortality-related surveys supported by GWUPR contractor team:
 - Survey data collection for pilot study is being conducted by telephone
 - Extensive training conducted to familiarize interviewers with survey procedures and tablet-based questionnaire and to facilitate team-building in this telework context

Review and Approval of Project Plans

Paperwork Reduction Act (PRA) review by Office of Management and Budget:

- Clearances under the NIST Generic Clearance for Community Resilience Data Collections, OMB Control Number #0693-0078
 - Household Survey (*Emergency Communications*): Pilot survey approved November 2020;
 - Information Provider Interviews (*Emergency Communications*): approved December 2020
 - Verbal Autopsy and Socio-Environmental Interviews (*Morbidity and Mortality*): approved March 2021
 - Household Survey (*Emergency Communications*): Full survey approved April 2021



<https://omb.report/omb/0693-0078>

Review and Approval of Project Plans

NIST Institutional Review Board (IRB) review of NCST and NWIRP project plans:

- NCST projects: Non-research exemption granted July 2020
- NWIRP projects: Data collection protocols and pilot instruments approved December 2020
 - Hospital Recovery Survey (*Recovery of Social Functions*); Manufacturing Business Continuity Survey/Interview (*Recovery of Business and Supply Chain*)
- NWIRP projects: Amendment for changes to protocol and instruments following pilot studies approved May 2021
 - School Recovery Survey (*Recovery of Social Functions*); Retail/Service Business Continuity Survey and Interview (*Recovery of Business and Supply Chain*)

Puerto Rico Department of Education review of project plans and data collection instruments involving public schools:

- *Performance of Critical Buildings* (NCST project): approved March 2021
- *Recovery of Social Functions* (NWIRP project): approved March 2021

Staffing, Contracts, and Other Agency Coordination

Staffing

- Staff hired to support *Emergency Communications* project, with expertise in risk and crisis communication: Dr. Emina Herović (photo at right)
- Guest Researcher hired to support *Hazard Characterization* project, with expertise in Computational Fluid Dynamics: Dr. Rameche Somassoundirame



Contract Support

- Subcontract through Stantec established with University of Puerto Rico at Mayagüez to support evaluation of critical buildings
- Contract option exercised on GWUPR contract for expert panel to retrieve and review additional data in cases of death identified as potentially due to building failures

Other Agency Coordination

- Data Use Agreements established with Demographic Registry at the Puerto Rico Department of Health and the Institute for Forensic Sciences for sharing of datasets to support mortality assessment by the GWUPR contractor team
- Ongoing coordination with FEMA, HHS on additional data requests

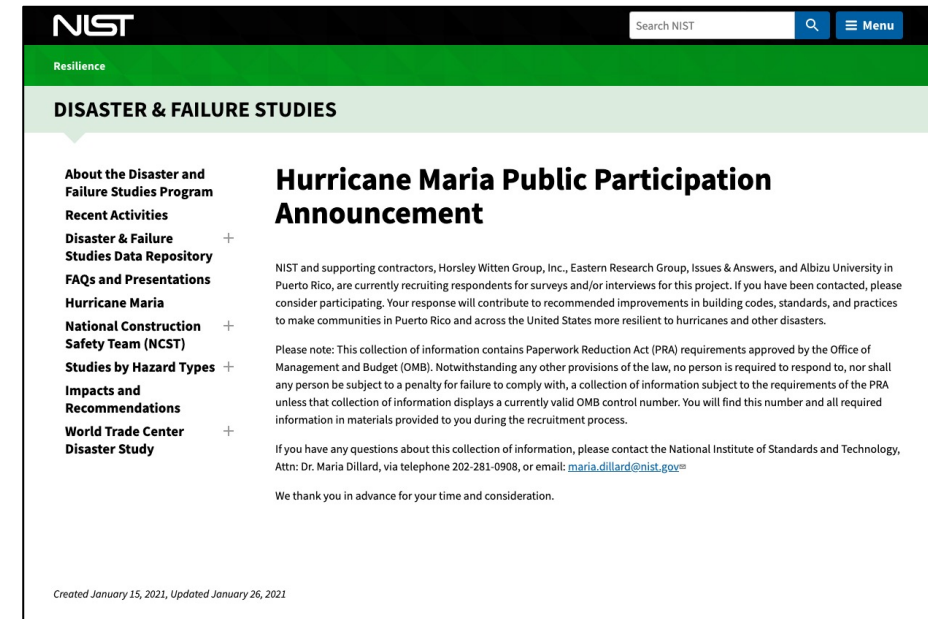
Progress of Survey and Interview Data Collection

NCST Projects:

- Household Survey (*Emergency Communications*): pilot testing completed Dec 2020
- Information Provider Interviews (*Emergency Communications*): in progress
- Verbal Autopsy and Socio-Environmental Interviews (*Morbidity and Mortality*): pilot testing in progress

NWIRP Projects:

- Hospital Recovery Survey (*Recovery of Social Functions*): pilot testing completed Feb 2020
- Manufacturer Business Continuity Survey and Interview (*Recovery of Business and Supply Chain*): pilot testing completed Feb 2020
- School Recovery Survey (*Recovery of Social Functions*): pilot testing in progress
- Retail/Service Business Continuity Survey and Interview (*Recovery of Business and Supply Chain*): pilot testing in progress



HM web content for potential respondents



Landing page for school pilot survey

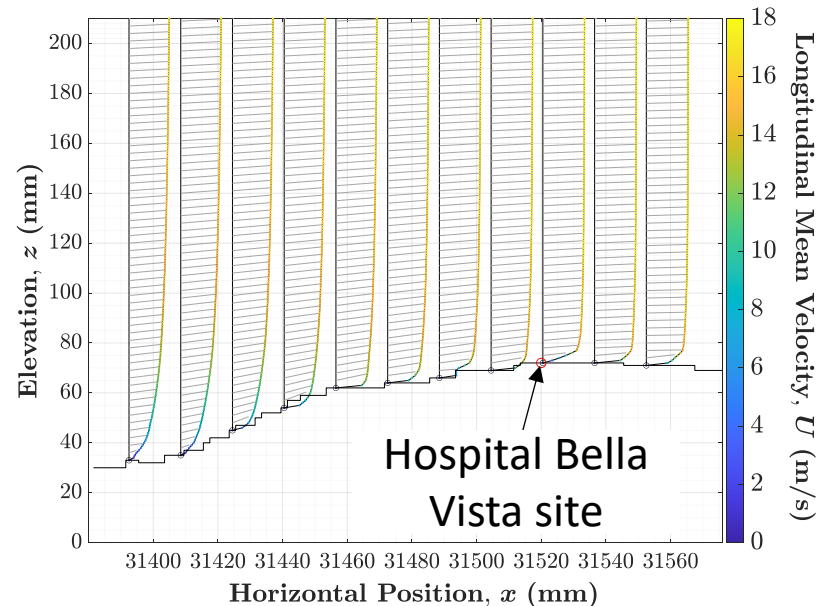
Evaluation of Topographic Effects on Wind Loads

Coordination Between *Hazard Characterization* and *Critical Buildings* Projects:

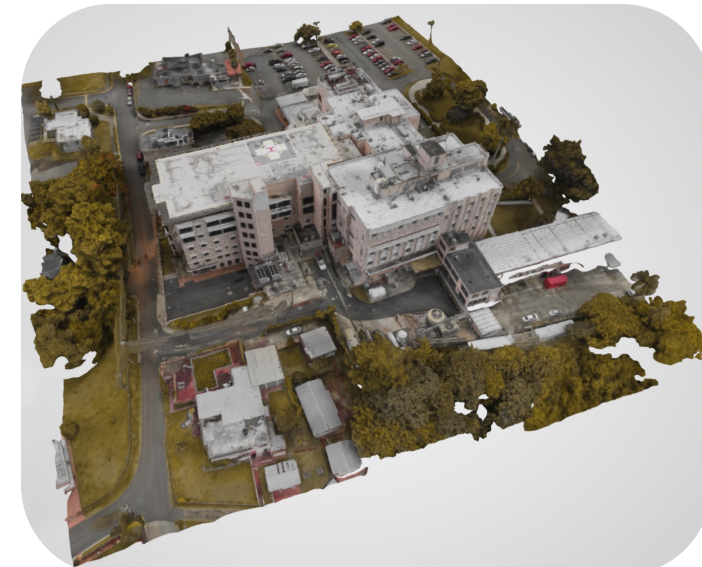
- Completed wind tunnel testing of topographic models of Mayagüez and Yabucoa regions (1:3100 scale) using Particle Image Velocimetry (PIV) measurement system
- Obtained PIV measurements of approach flow profiles at Hospital Bella Vista site, which will be used for wind tunnel testing of a scale model of the hospital buildings
- Completed the design of a wind tunnel model of Hospital Bella Vista (1:125 scale) using point cloud data obtained from drone photography
- Measurements will enable evaluation of topographic effects on wind loads, including evaluation of the adequacy of provisions in current standards and codes



Topographic Model of Mayagüez



PIV Approach Flow Measurements

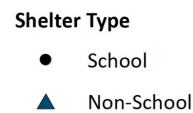
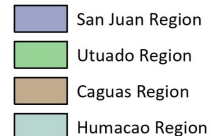
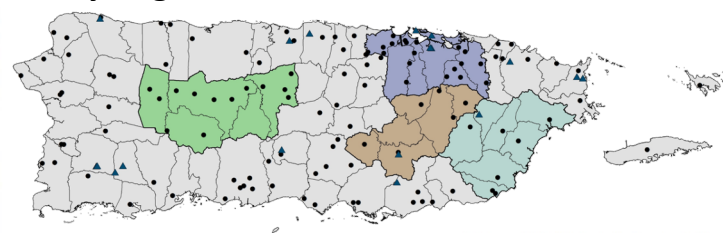


Point Cloud Model of Hospital

Cross-Project Coordination

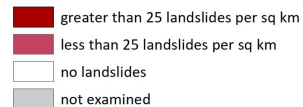
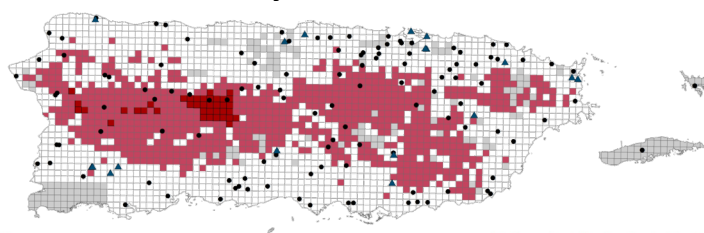
- Collaboration on survey questions related to building damage:
 - Damage matrix developed to capture degrees of damage to building components
 - Survey questions developed across multiple projects with linkages to damage matrix
 - Pilot data used to evaluate the mapping of survey responses to damage states
 - Damage information from surveys for larger sample of buildings will provide valuable context for damages observed from detailed evaluations of selected critical buildings
- Online library with bibliography developed for sharing literature across the program
- GIS datasets from across the program being compiled, documented, and maintained by a dedicated GIS staff member:
 - Ongoing coordination with GWUPR’s GIS team to support analysis and visualization
 - Ongoing efforts to implement U.S. National Grid standard for map products

Study Regions



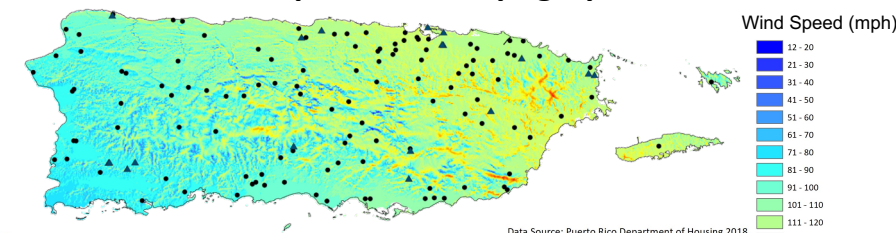
Data Source: FEMA 2017, Puerto Rico Department of Housing 2018, US Census Bureau TIGER/Line 2016
 Developed: NIST 2020; using ESRI software
 Coordinate System: GCS NAD 1983
 Datum: NAD 1983

Landslide Density

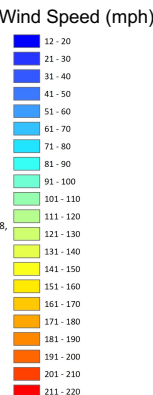


Data Source: Puerto Rico Department of Housing 2018, United States Geological Survey (USGS) 2019
 Developed: NIST 2020; using ESRI software
 Coordinate System: GCS NAD 1983
 Datum: NAD 1983

Peak Gust Wind Speed with Topographic Effects



Data Source: Puerto Rico Department of Housing 2018, United States Geological Survey (USGS) 2019
 Developed: NIST 2020; using ESRI software
 Coordinate System: GCS NAD 1983
 Datum: NAD 1983



NCST Technical Investigation of Hurricane Maria (Puerto Rico)

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Questions?

 Please 'raise your hand' using the Blue Jeans Participant window and unmute your audio and video