

# Summary of Progress: Hurricane Maria NCST Investigation

*National Construction Safety Team Advisory Committee Meeting*

June 30, 2020

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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:** Hurricane Maria made landfall in Puerto Rico on Sept. 20, 2017 as a strong Category 4 storm.
- **Exposed Population:** Entire Commonwealth (~3.3 M people)
- **Mortality:** Excess mortality estimated to be 2,975\*
- **Engineered Buildings:** Extensive nonstructural damage 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 of due to power loss, non-structural building damage, generator failures, and road closures

\* The George Washington University Project Report: *Ascertainment of the Estimated Excess Mortality from Hurricane Maria in Puerto Rico*

<https://publichealth.gwu.edu/sites/default/files/downloads/projects/PRstudy/Acertainment%20of%20the%20Estimated%20Excess%20Mortality%20from%20Hurricane%20Maria%20in%20Puerto%20Rico.pdf>



# NCST Technical Investigation of Hurricane Maria

Under the NCST Act\*, on February 21, 2018, the NIST Director established a 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*

\*Public Law 107-231: <https://www.congress.gov/107/plaws/publ231/PLAW-107publ231.pdf>

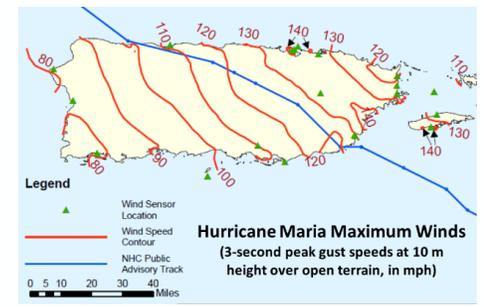
# NCST Investigation Projects

**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 how emergency communications systems performed and the public's response to those communications – focusing on communications in disaster response (during and immediately after the hurricane)

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



# NWIRP Research Study of Hurricane Maria

Complementary to the NCST Technical Investigation, NIST is conducting a research study under the National Windstorm Impact Reduction Act\* focused on post-hurricane recovery processes

Goals of the NWIRP research study are to characterize:

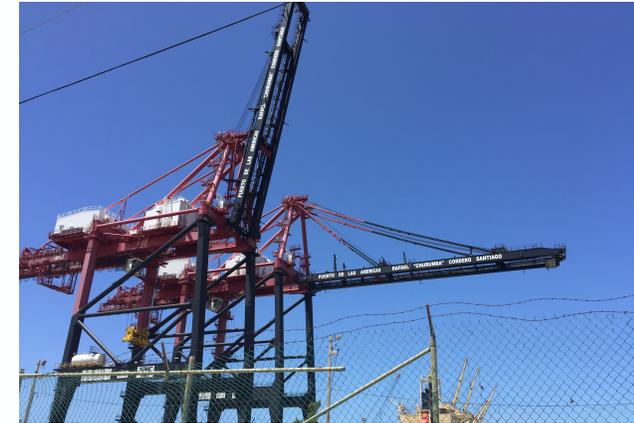
- 1. the impacts to and recovery of small and medium-sized manufacturers, as well as businesses in retail and service industries*
- 2. the impacts to and recovery of education and healthcare services*
- 3. the impacts to and recovery of infrastructure systems in Puerto Rico, with a focus on infrastructure that supports the functioning of 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:** Understand 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



# Updates to HM National Construction Safety Team

## Leadership Changes

*Effective February 13, 2020*

- Dr. Joseph Main (NIST): Lead Investigator (formerly Associate Lead)
- Dr. Maria Dillard (NIST): Associate Lead Investigator

## New Team Members

*Appointed September 8, 2019*

- Dr. DongHun Yeo (NIST): Project Leader, Hazard Characterization
- Mr. Joel Cline: Tropical Program Coordinator, National Weather Service, NOAA

*Appointed June 1, 2020*

- Dr. Katherine Johnson (NIST): Project Leader, Emergency Communications
- Dr. Luis Aponte-Bermúdez: Professor, University of Puerto Rico at Mayagüez and Federal Contractor through Stantec Consulting

# Impacts of Recent Disruptions

## Seismic Events

- Heaviest direct damage was outside of the study areas where our technical projects are concentrated
- Earthquake sequence highlights the importance of seismic considerations in future recommendations from our investigation and study
- Our team includes seismic engineering experts who are considering Puerto Rico's multi-hazard environment

## COVID-19 Pandemic

- Wind tunnel testing work, anemometer installation at tower sites delayed
- Outreach to hospital staff postponed due to the role of hospitals in pandemic response
- During NIST campus closure, NIST has maintained high-performance computing facilities, which allow the computational studies of topographic effects to continue
- Meetings of NIST team and contractors have continued remotely
- Projects have been developing alternative approaches for data collection that will still allow us to achieve our goals (e.g., conducting surveys and interviews remotely)

# Highlights of Recent Progress

- The following slides highlight three areas of recent progress
- Further details will be provided in the subsequent project presentations

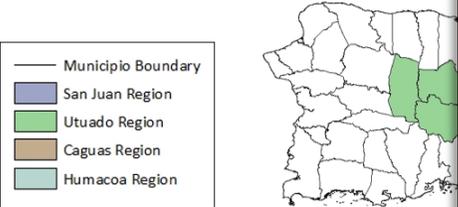
## Stakeholder Outreach, Information Sharing Agreements, and Supporting Contracts

- Meetings with senior Puerto Rico program and request needed information
  - Subsequent follow-up with key stakeholders
  - Communications with key staff members
- Memorandums of Agreement with schools and hospitals (November)
- Major contracts awarded to support
  - Horsley Witten Group – Social science
  - Stantec Consulting Services – Evaluation

## Coordination Across Projects: Areas of Focus and Sampling Strategies

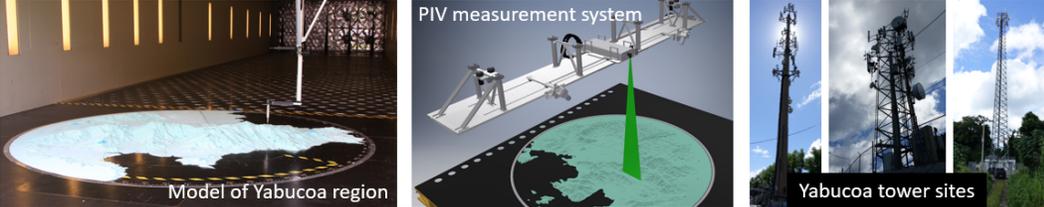
To facilitate coordination across NCST and NWIRP projects, four regions of focus were selected, considering hazard exposure.

- To ensure representative findings, sampling strategies have been developed for social science communications, recovery of small schools and hospitals.
- Development of sampling frames and evaluation and wind tunnel testing were



## Wind Tunnel and Field Measurements to Characterize Topographic Effects on Winds

- Models fabricated and testing initiated for evaluation of topographic effects on winds in Puerto Rico at the University of Florida Boundary Layer Wind Tunnel
- Detailed measurements of turbulent flow fields performed using Particle Image Velocimetry (PIV) in conjunction with discrete Cobra probe measurements
- Partnerships established and plans completed for deployment of anemometers at three cellular tower sites in Yabucoa for field measurement of topographic effects
- Wind tunnel and field measurements will provide data to validate Computational Fluid Dynamic models for evaluation of topographic effects
- A subsequent phase of wind tunnel testing will evaluate wind loads on buildings



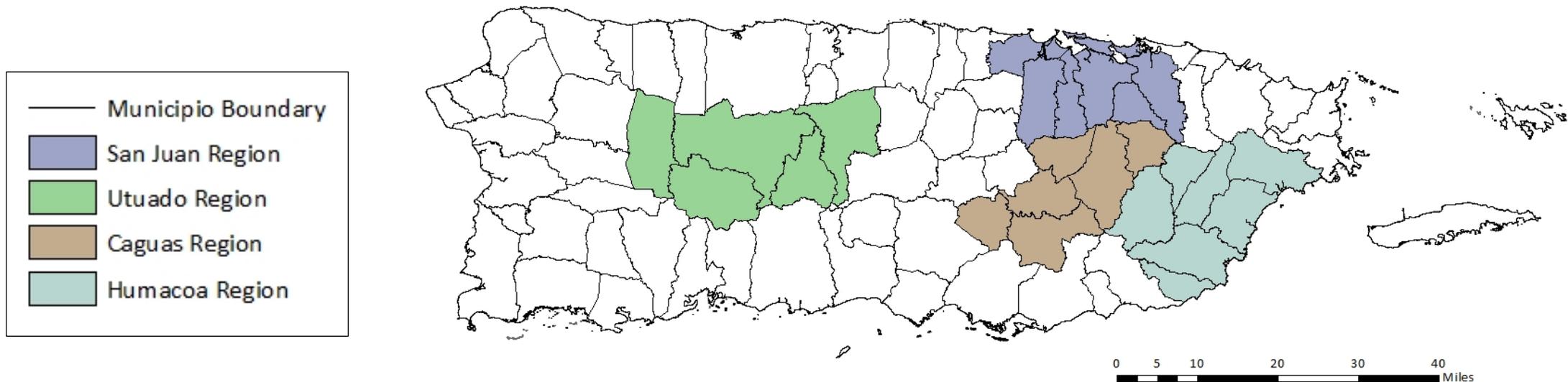
# Stakeholder Outreach, Information Sharing Agreements, and Supporting Contracts

- Meetings with senior Puerto Rico government officials to review NIST program and request needed information
  - Subsequent follow-up with key staff having relevant information
  - Communications with key staff maintained even with turnover of senior officials
- Memorandums of Agreement with FEMA for sharing information on damage to schools and hospitals (November 2019, March 2020)
- Major contracts awarded to support data collection efforts in Puerto Rico
  - Horsley Witten Group – Social science data collection (January 2020)
  - Stantec Consulting Services – Evaluation of critical buildings (March 2020)

# Coordination Across Projects: Areas of Focus and Sampling Strategies

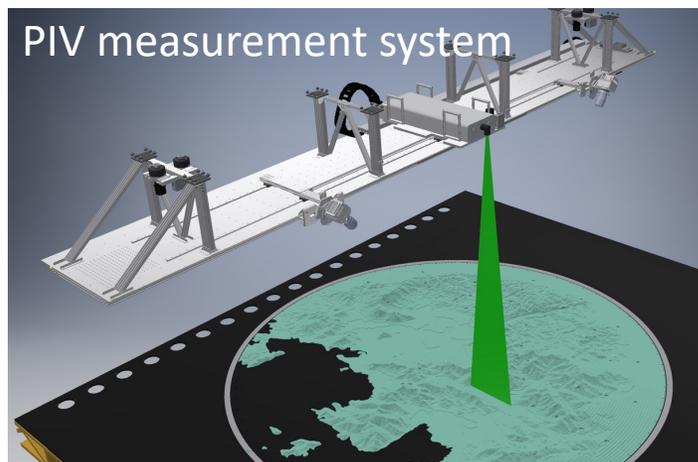
To facilitate coordination across NCST and NWIRP projects, four regions of focus were selected, considering hazard exposure, geography, and socioeconomic factors.

- To ensure representative findings, sampling frames drawing from multiple datasets have been developed for social science data collection focused on emergency communications, recovery of small and medium sized businesses, and recovery of schools and hospitals.
- Development of sampling frames and selection of critical buildings for engineering evaluation and wind tunnel testing were coordinated, giving priority to the four regions.



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# Questions?

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

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