

# Summary of Hurricane Maria NCST Investigation Progress

*NCST Advisory Committee Meeting*

June 8, 2022

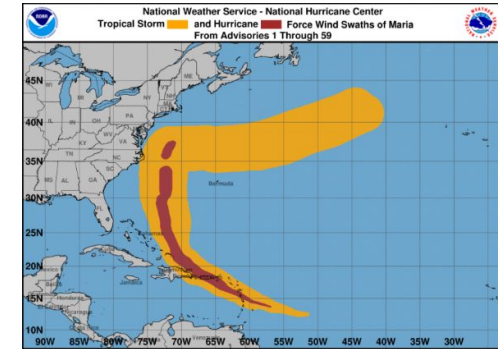
Joseph Main

*Team Lead, Hurricane Maria NCST  
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), larger with topographic speedup effects; rainfall up to 40" (100 cm), extensive flooding, landslides
- **Exposed Population:** Entire Commonwealth (~3.3M people)
- **Mortality:** Challenges in attributing hurricane-related deaths; official death toll of 2,975 (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



Source: NOAA



Source: FEMA



Source: NIST

# NCST Investigation Projects

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

**Project Leaders:** DongHun Yeo, Scott Weaver

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

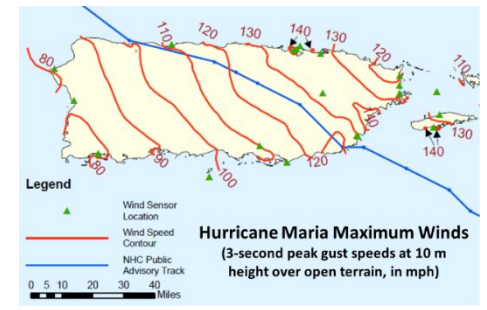
**Project Leaders:** Joseph Main, Marc Levitan

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

**Project Leader:** Katherine (Jo) Johnson

**Morbidity and Mortality:** Better understand how damaged buildings, and failures in supporting infrastructure, played a role in injuries and deaths

**Project Leaders:** Judith Mitrani-Reiser, Thomas Kirsch



Source: NIST (all photos)

# NWIRP Research Projects

**Impacts to and Recovery of Infrastructure Systems:** Evaluate 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

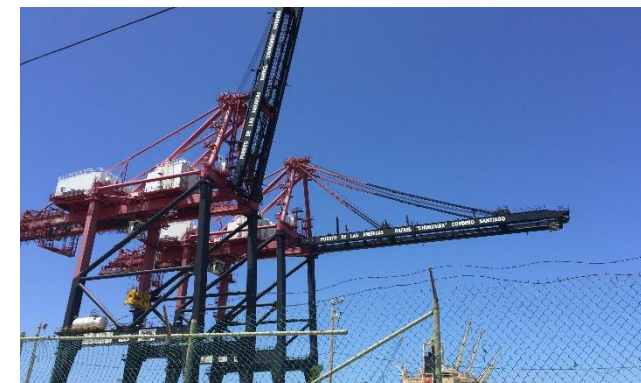
**Project Leader:** Kenneth Harrison

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

**Project Leader:** Jennifer Helgeson

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

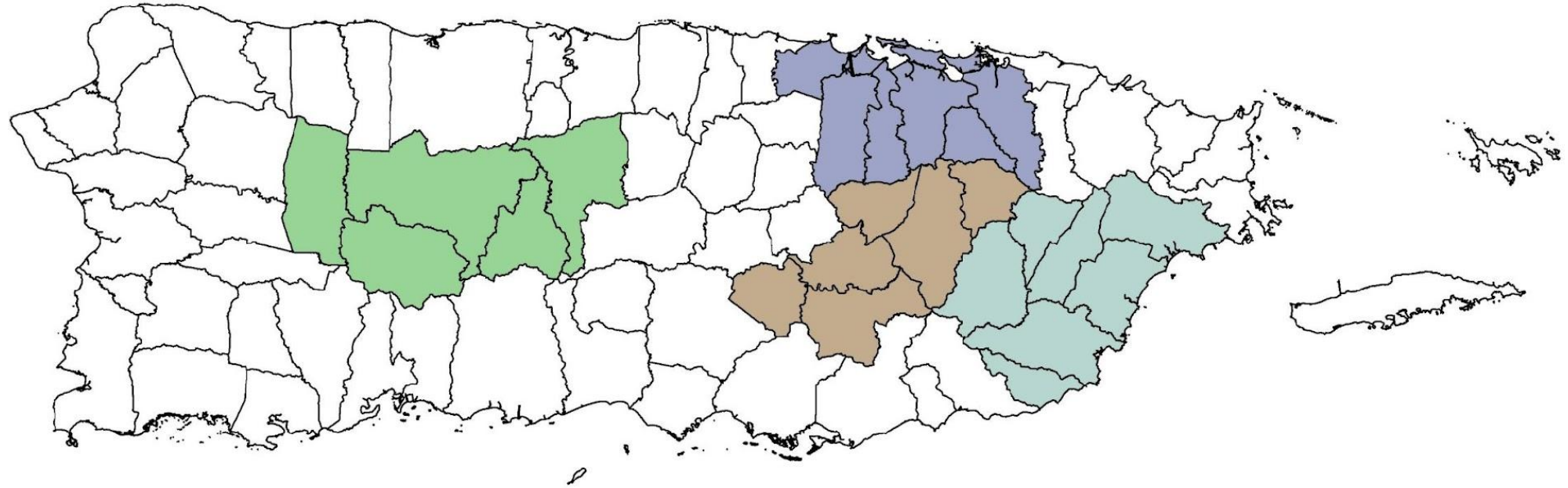
**Project Leader:** Maria Dillard







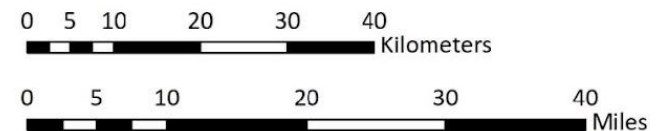
Source: NIST (all photos)

# Regions of Focus

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



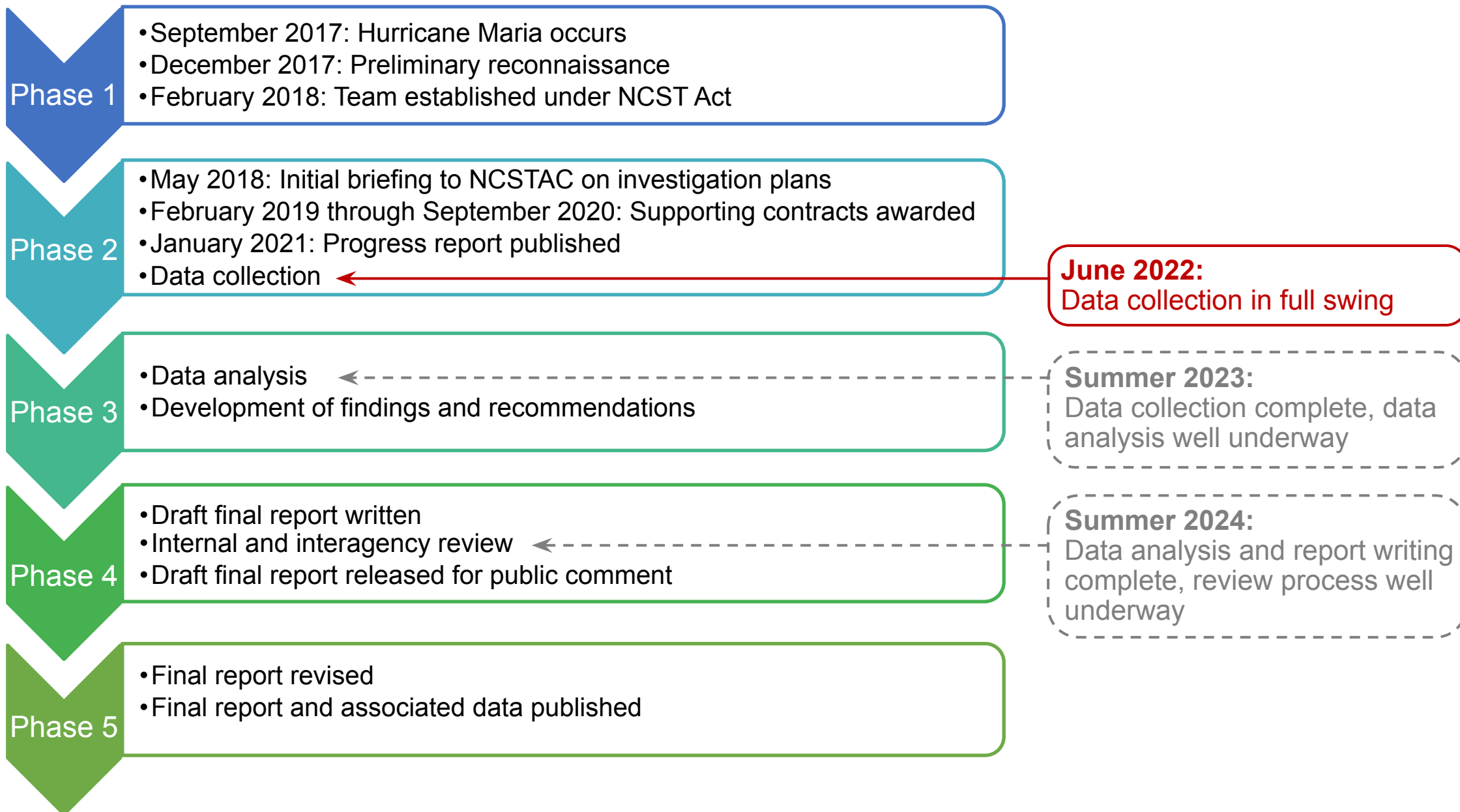
- Municipality Boundary
-  San Juan Region
-  Utuado Region
-  Caguas Region
-  Humacao Region



# Supporting Contracts

Contract	Contractor(s)	Project(s) Supported
Wind Field Modeling	Applied Research Associates	<ul style="list-style-type: none"> <li>• Hazard Characterization</li> <li>• Critical Buildings</li> </ul>
Wind Tunnel Testing and Field Measurement of Winds	University of Florida <ul style="list-style-type: none"> <li>• WeatherFlow, Inc.</li> </ul>	<ul style="list-style-type: none"> <li>• Hazard Characterization</li> <li>• Critical Buildings</li> </ul>
Engineering Services to Evaluate Critical Building Performance	Stantec Consulting Services, Inc. <ul style="list-style-type: none"> <li>• Virella Crespo &amp; Associates (Mayagüez)</li> <li>• University of Puerto Rico at Mayagüez</li> </ul>	<ul style="list-style-type: none"> <li>• Critical Buildings</li> </ul>
Social Science Data Collection	Horsley Witten Group, Inc. <ul style="list-style-type: none"> <li>• Eastern Research Group</li> <li>• Issues and Answers</li> <li>• Albizu University (San Juan)</li> </ul>	<ul style="list-style-type: none"> <li>• Emergency Communications</li> <li>• Recovery of Business</li> <li>• Recovery of Social Functions</li> <li>• Infrastructure Systems</li> </ul>
Morbidity and Mortality Assessment	Milken Institute School of Public Health at George Washington University <ul style="list-style-type: none"> <li>• University of Puerto Rico Graduate School of Public Health</li> <li>• University of Washington</li> </ul>	<ul style="list-style-type: none"> <li>• Morbidity and Mortality</li> </ul>

# Expected Timeline: Hurricane Maria NCST Investigation



# Stakeholder Outreach & Other Agency Coordination

- Briefings this year for PR government agencies and others included:
  - PR Dept of Health: January
  - PR Federal Affairs Administration: February
  - Staff of PR Resident Commissioner/Congresswoman, Jenniffer González-Colón: February
  - Resources for Communities and People (RCAP) Solutions: March
  - Central Office for Recovery, Reconstruction, and Resiliency (COR3): April
- Additional outreach for information and data requests included:
  - RAND Corporation
  - HHS Office of the Assistant Secretary for Preparedness & Response
  - FEMA
- PR Department of Education extended its approval of investigation and study projects involving public schools for another year in March



# Staffing and Support

- New NIST Associates (Professional Research Experience Program):
  - **Dr. Alizabeth M. Sánchez-López:** Supporting the *Recovery of Business and Supply Chain* project
  - **Dr. Yunjae Hwang:** Supporting the *Hazard Characterization* project
- New support by NIST colleagues from the Statistical Engineering Division:
  - Dr. Adam Pintar
  - Dr. Gregory Haber
  - Dr. Jack Prothero



**Dr. Sánchez-López**



**Dr. Yunjae Hwang**

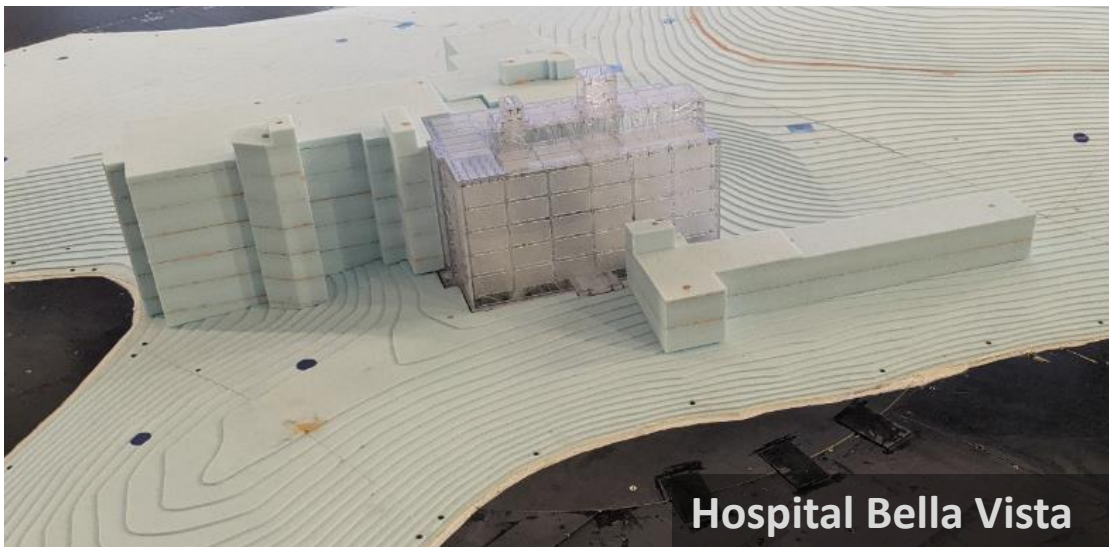
# Paperwork Reduction Act Approvals for Data Collection

Project	Instrument	Approval Date	Review Length
Emergency Communications	Household Interview	June 2021	< 2 weeks
Morbidity and Mortality	Final Verbal Autopsy Socio-Environmental Interview Instrument	September 2021	< 2 weeks
Recovery of Business and Supply Chain	Shipping and Transportation Interview Guide	April 2022	< 1 week
Recovery of Social Functions	School Recovery Interview Guide	March 2022	< 1 week
	Hospital Recovery Interview Guide	March 2022	< 1 week

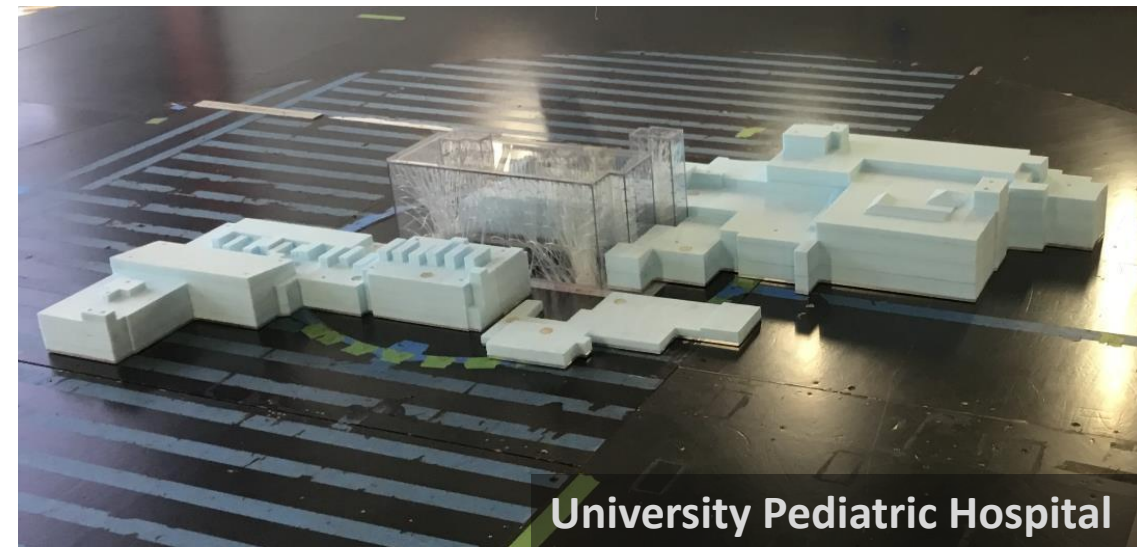
- Office of Management (OMB) Paperwork Reduction Act (PRA) reviews have been extremely timely – our record is < 24 hours for approval; in part due to a generic clearance
- The OMB PRA Community Resilience Generic Clearance expires July 2022 and is being submitted for renewal through 2025
- Both NCST and NWIRP data and information collections use this clearance

# Data Collection: Wind Tunnel Testing

- University of Florida contractor team completed model fabrication and testing for two hospital facilities
- Objectives: evaluate wind loads sustained during Hurricane Maria, including effects of local topography and surrounding buildings, and to evaluate adequacy of existing standard provisions to capture these effects
- Data processing and curation underway



Source: University of Florida (Contract 1333ND19PNB730233)



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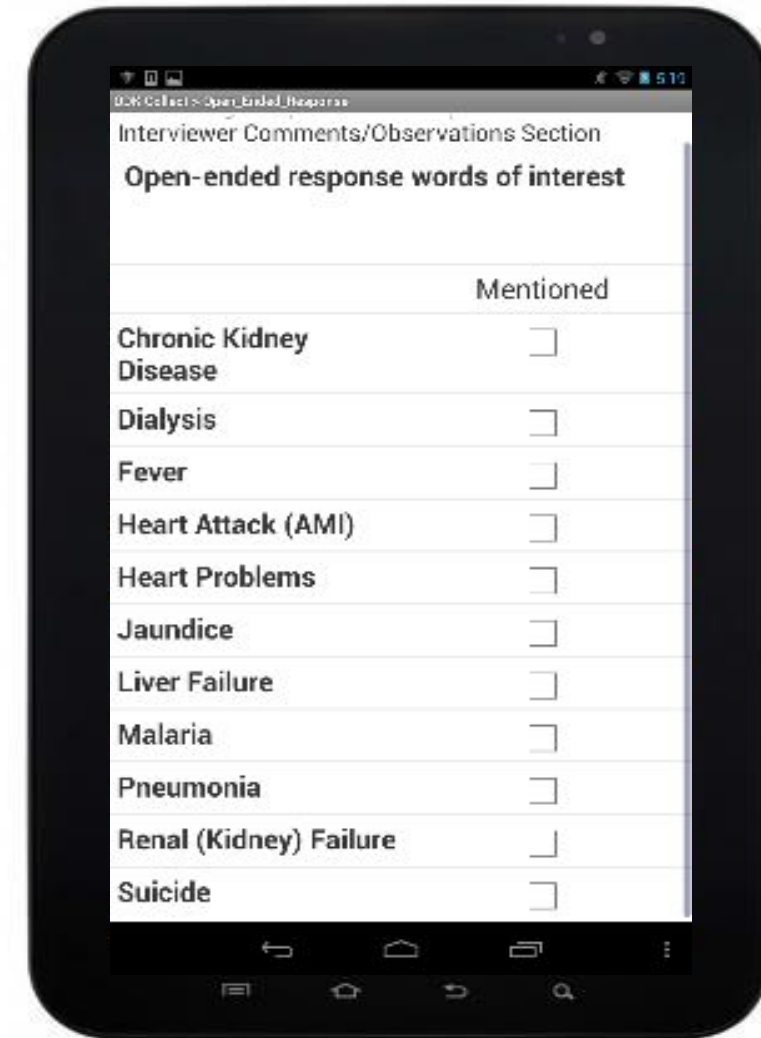
# Data Collection: Emergency Communications Household Survey

- Horsley Witten contractor team completed 78% of 1,500 surveys as of May 31, 2022
- Household survey is focused on risk awareness, access to information channels and sources, and factors for evacuation decision-making
- Data collectors are completing the vast majority of surveys in person; minimal online survey completion
- Response rates are highest on weekends



# Data Collection: Verbal Autopsy Study

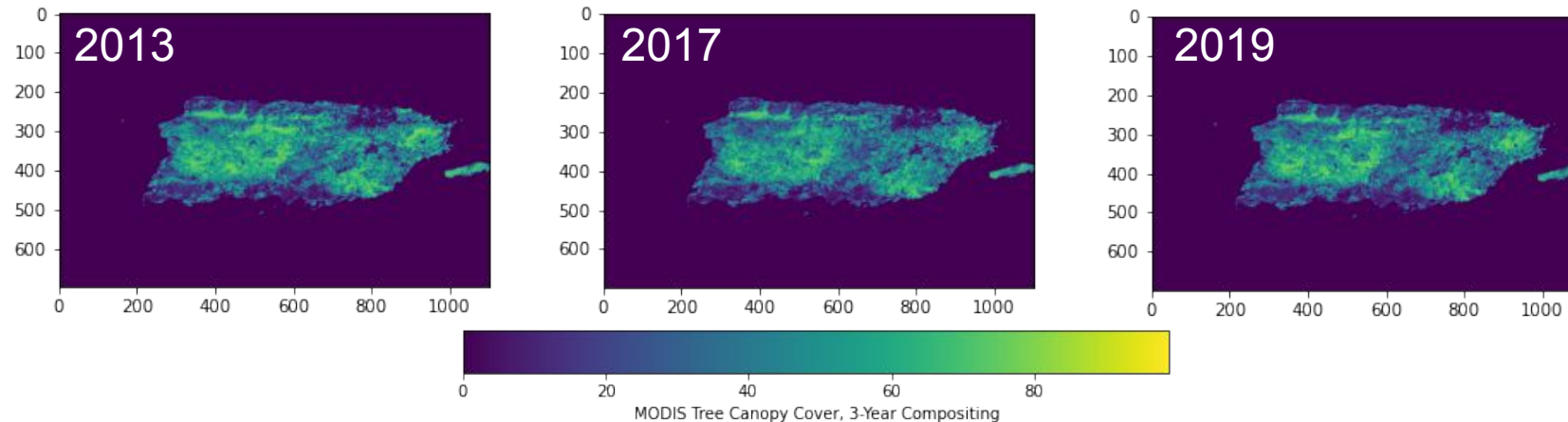
- University of Puerto Rico contractor team completed 368 interviews as of May 31, 2022
- Next of kin and key informants are being interviewed for a population of 1,804 people who died within 14 days after landfall
- Objectives are to ascertain cause of deaths and identify socio-environmental contextual factors that could be related to the deaths
- Of the individuals who were contacted, 62% agreed to participate
- Contract modification awarded to support additional efforts to contact remaining next of kin and key informants



Source: Bernardo Hernández Prado  
(with permission)

# Data Collection: NWIRP Research Projects

- Data collection is complete for surveys of manufacturing and retail service businesses
- Data collection is underway with surveys of schools and hospitals
- Interviews are slated to begin Summer 2022 for school and hospital administrators, as well as shipping and transportation sector representatives
- Vegetation remote sensing work now includes new data products to capture temporal variation of tree cover; these data products inform understanding of impacts to the transportation and power systems and benefit the Hazard Characterization Project's wind modeling work



# NCST Technical Investigation of Hurricane Maria (Puerto Rico)

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[www.nist.gov/disaster-failure-studies/hurricane-maria](http://www.nist.gov/disaster-failure-studies/hurricane-maria)