Summary of Hurricane Maria NCST Investigation Progress

NCST Advisory Committee Meeting

June 14, 2023

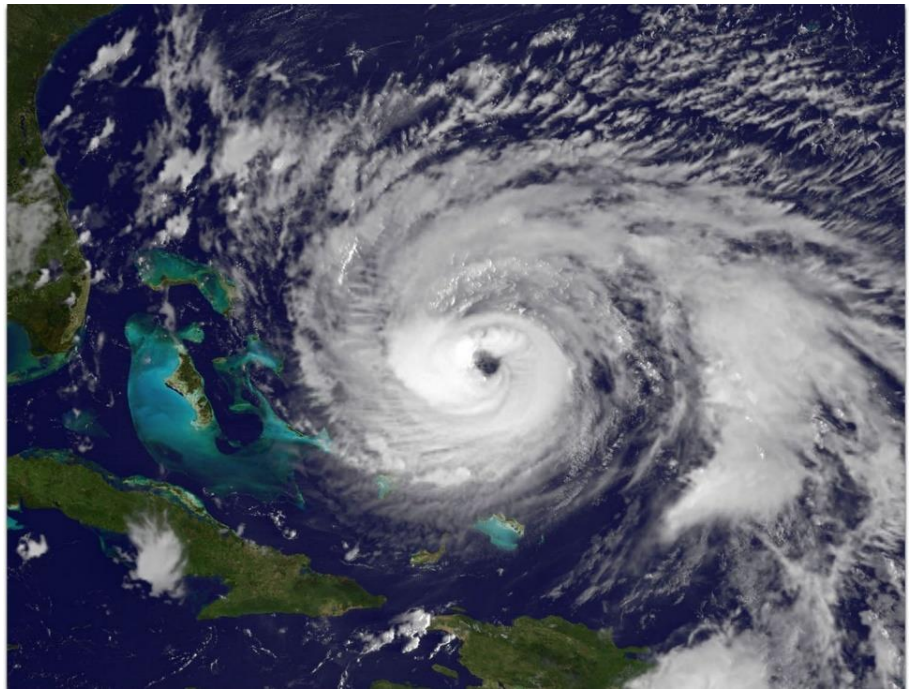
Joseph Main

Team Lead

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

NIST Hurricane Maria Program

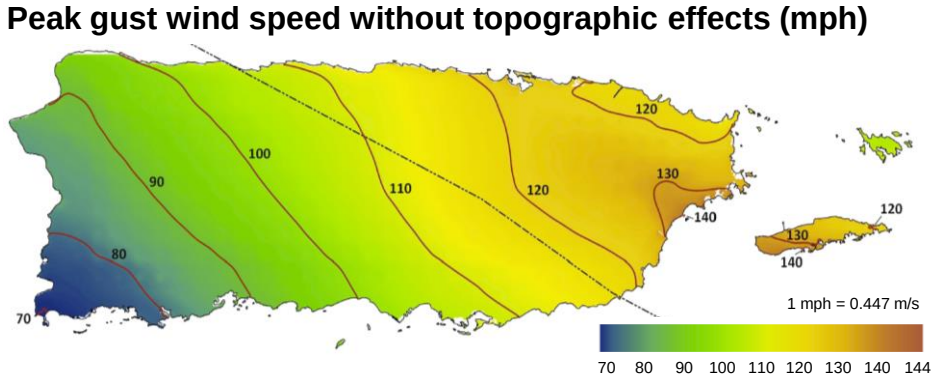
- **NIST is studying** Hurricane Maria's effects on Puerto Rico and subsequent recovery
- **Goal:** Recommend improved building codes, standards, and practices to help communities in Puerto Rico and across U.S. to be more resilient
- Launched February 2018; authorized by:
  - National Construction Safety Team Act
  - National Windstorm Impact Reduction Act



Credit: NOAA

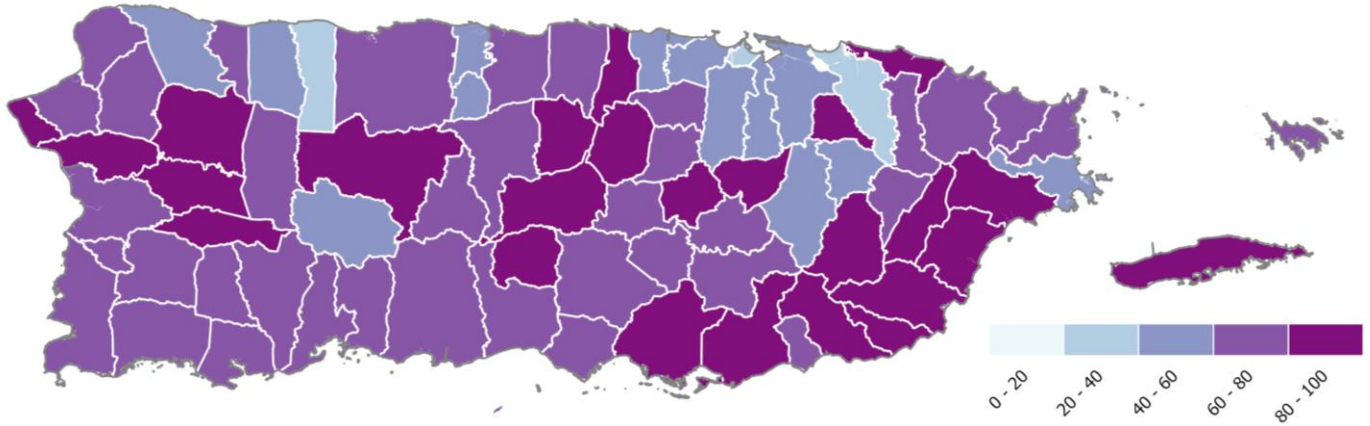
Hurricane Maria's Impacts on Puerto Rico

- **Hazard Exposure:** Strong Category 4 hurricane, peak gusts near 140 mph (greater with topographic speedup), up to 40" rain, extensive flooding, landslides
- **Exposed Population:** Entire Commonwealth (~3.3M people)
- **Mortality:** Challenges attributing hurricane-related deaths; excess mortality est: 2,975
- **Engineered Buildings:** Extensive nonstructural damage, rainwater intrusion, loss of function
- **Emergency Response:** Challenges with rescues in flooded areas, complicated by loss of communications for extended periods



Impacts on Infrastructure and Recovery

- **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:** Impacts on recovery due to power loss, non-structural building damage, generator failures, road closures



Wireless communications status at 1 month
Percent cell service sites out-of-service – 10/24/2017

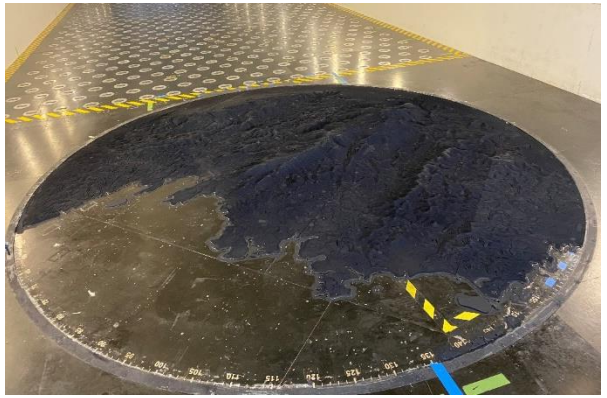
NCST Investigation Goals and Projects

Goals: *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*

Projects:

Hazard Characterization	Performance of Critical Buildings	Public Response to Emergency Communications	Morbidity & Mortality



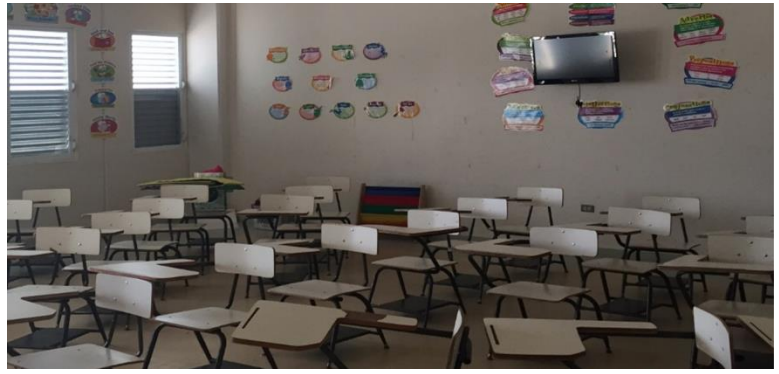
NWIRP Research Study Goals and Projects

Goals: *To characterize the impacts to and recovery of:*

1. *small and medium-sized manufacturers, businesses in retail and service industries, and supply chains*
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*

Projects:

Recovery of Business & Supply Chains	Recovery of Social Functions	Impacts to & Recovery of Infrastructure Systems



Supporting Contracts

Contract	Contractor(s)	Project(s) Supported
Wind Field Modeling	Applied Research Associates	• Hazard Characterization • Critical Buildings
Wind Tunnel Testing and Field Measurement of Winds	University of Florida • WeatherFlow, Inc.	• Hazard Characterization • Critical Buildings
Engineering Services to Evaluate Critical Building Performance	Stantec Consulting Services, Inc. • Virella Crespo & Associates (Mayagüez) • University of Puerto Rico at Mayagüez	• Critical Buildings
Social Science Data Collection	Horsley Witten Group, Inc. • Eastern Research Group • Issues and Answers • Albizu University (San Juan)	• Emergency Communications • Recovery of Business • Recovery of Social Functions • Infrastructure Systems
Morbidity and Mortality Assessment	Milken Institute School of Public Health at George Washington University • University of Puerto Rico Graduate School of Public Health • University of Washington	• Morbidity and Mortality

Collaborating & Coordinating Agencies

Federal

Federal Emergency Management Agency
NOAA's National Weather Service
U.S. Army Corps of Engineers
Nat'l Ctr for Disaster Medicine and Public Health
U.S. Geological Survey
Small Business Administration
Dept of Health & Human Services

Puerto Rico

Depts of Education, Health, Housing, Transportation & Public Works, Economic Development & Commerce
PR Ports Authority, PR Energy and Power Authority
PR Aqueduct & Sewer Authority, Emergency Management
Central Office for Recovery, Reconstruction & Resiliency
Municipalities, universities, businesses, nonprofits
Governor's Federal Affairs Administration
Resident Commissioner's Office

Collaborate
Coordinate
Cooperate

NIST Engineering Laboratory

Disaster & Failure Studies Program
Community Resilience Group
Structures Group
Earthquake Engineering Group
Applied Economics Office
Data, Security, Technology Group

Other NIST Units

Public Affairs
Office of Chief Counsel
Congressional & Legislative Affairs
Program Coordination
Management & Organization
Acquisition & Agreements Mgt
Statistical Engineering Division of ITL
Research Protections

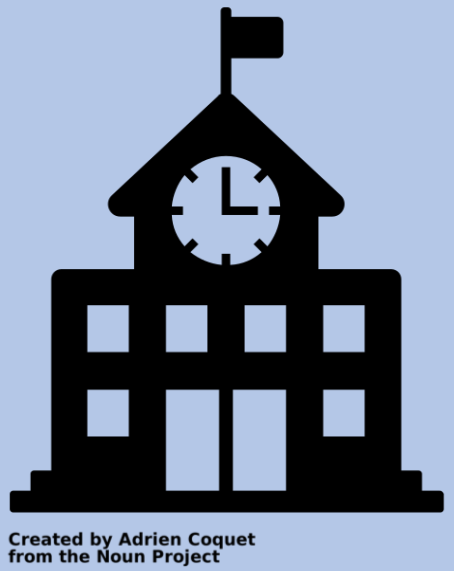
Panel Presentation Themes

Subsequent panel presentations are organized around these cross-cutting themes:

Theme 1: *Hospitals*

DongHun Yeo, Joseph Main, Judith Mitrani-Reiser

Theme 2: *Sheltering*



Marc Levitan, Katherine Johnson, Maria Dillard

Theme 3: *Infrastructure Dependencies*

Ken Harrison, Jennifer Helgeson, Maria Dillard

Outline of Hurricane Maria Presentations

- ***Summary of Hurricane Maria Investigation Progress*** – Joseph Main
  - Overview of goals and projects
  - Highlights of recent progress
  - Updates on stakeholder outreach and staffing
- ***Cross-Project Panel Theme 1: Hospitals***
- ***Cross-Project Panel Theme 2: Sheltering***
- ***Cross-Project Panel Theme 1: Infrastructure Dependencies***
- ***Conclusion and Update on Hurricane Fiona*** – Maria Dillard
  - Data collection status by project
  - Update on expected timeline
  - Update on plans and progress related to Hurricane Fiona

Presentation of Preliminary Data & Analysis

⚠ IMPORTANT: ALL DATA ARE PRELIMINARY

- These presentations describe preliminary data gathered to date as well as preliminary analyses of these data. Data and analyses are subject to change.
- Once all data are finalized and analyzed, they will inform a broader understanding of Hurricane Maria's effects on Puerto Rico and subsequent recovery – and NIST's findings and recommendations.
- Data and analyses in these presentations should not be used to form recommendations at this time.

Highlights of Data Collection Completed

1500+

HOUSEHOLD SURVEYS

ON PUBLIC RESPONSE TO EMERGENCY COMMS

300+

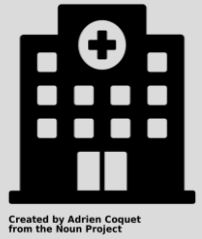
SCHOOL SURVEYS

ON RECOVERY OF SOCIAL FUNCTIONS

60

HOUSEHOLD INTERVIEWS

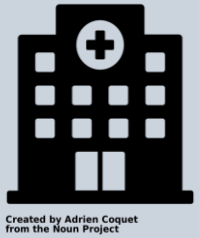
ON PUBLIC RESPONSE TO EMERGENCY COMMS



16

HOSPITALS SURVEYS

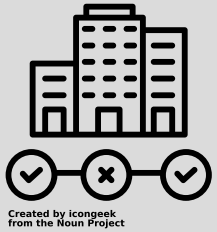
ON RECOVERY OF SOCIAL FUNCTIONS



30

HOSPITAL STAFF INTERVIEWS

ON HOSPITAL FUNCTIONS FOR MORTALITY ASSESSMENT



450+

BUSINESS SURVEYS

ON HURRICANE IMPACTS AND RECOVERY

400+

NEXT-OF-KIN INTERVIEWS

ON MORTALITY CAUSES & SURROUNDING CONDITIONS

30

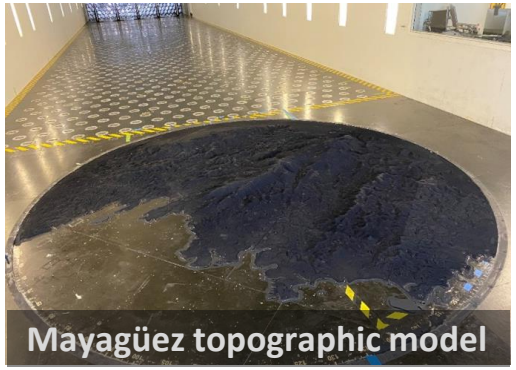
SHIPPING & TRANSPORT INTERVIEWS

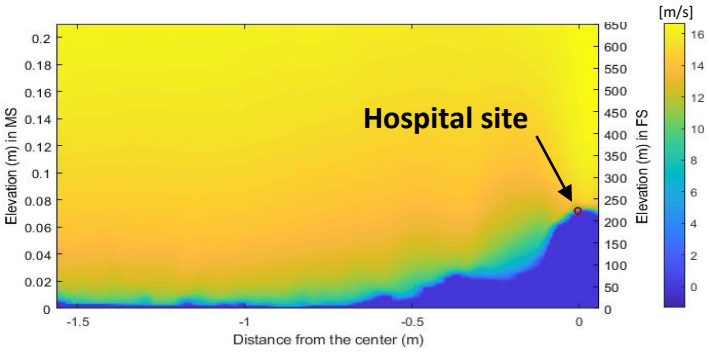
ON PREPAREDNESS, IMPACTS, AND RECOVERY

Processed Wind Tunnel Datasets Delivered

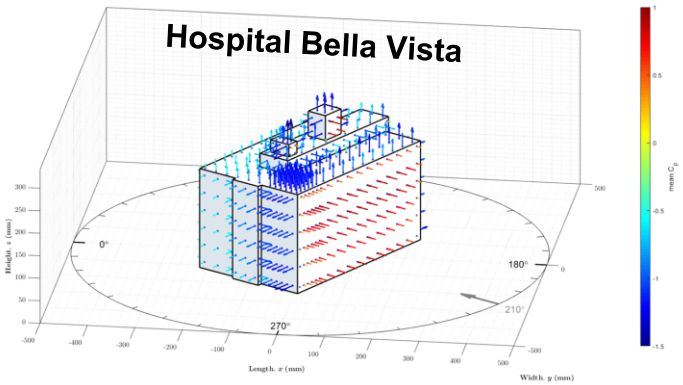
University of Florida contractor team delivered processed datasets from wind tunnel testing of building and topographic models

- Topographic models (1:3100 scale):
  - Yabucoa and Mayagüez regions, generic ridge and plateau models
  - Velocity field measurements from PIV, profiles from velocity probes
- Building Models (1:100 scale):
  - Two selected hospitals: Hospital Bella Vista and University Pediatric
  - Pressure tap, load cell, and velocity probe measurements





Flow field measurements from Particle Image Velocimetry (PIV)

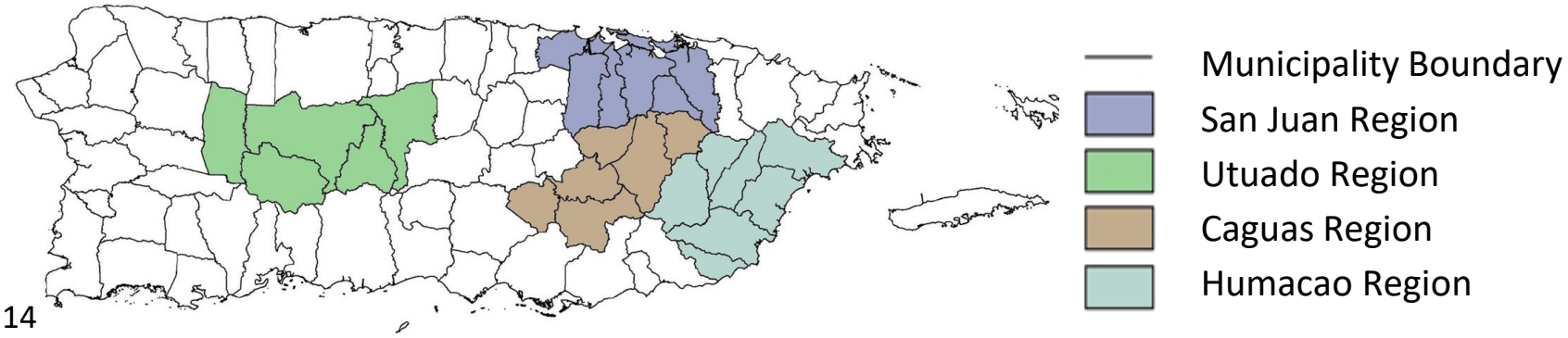


Mean pressure coefficients

Household Surveys and Interviews Completed

Albizu University contractors solicited responses from households across 4 study regions:

- >1500 households surveyed
- 60 follow-on interviews conducted
- ~95% of interviews were in-person, although alternatives were provided
- Data provide detailed, household-level information on:
  - Receipt of emergency communications
  - Evacuation behavior and decision-making

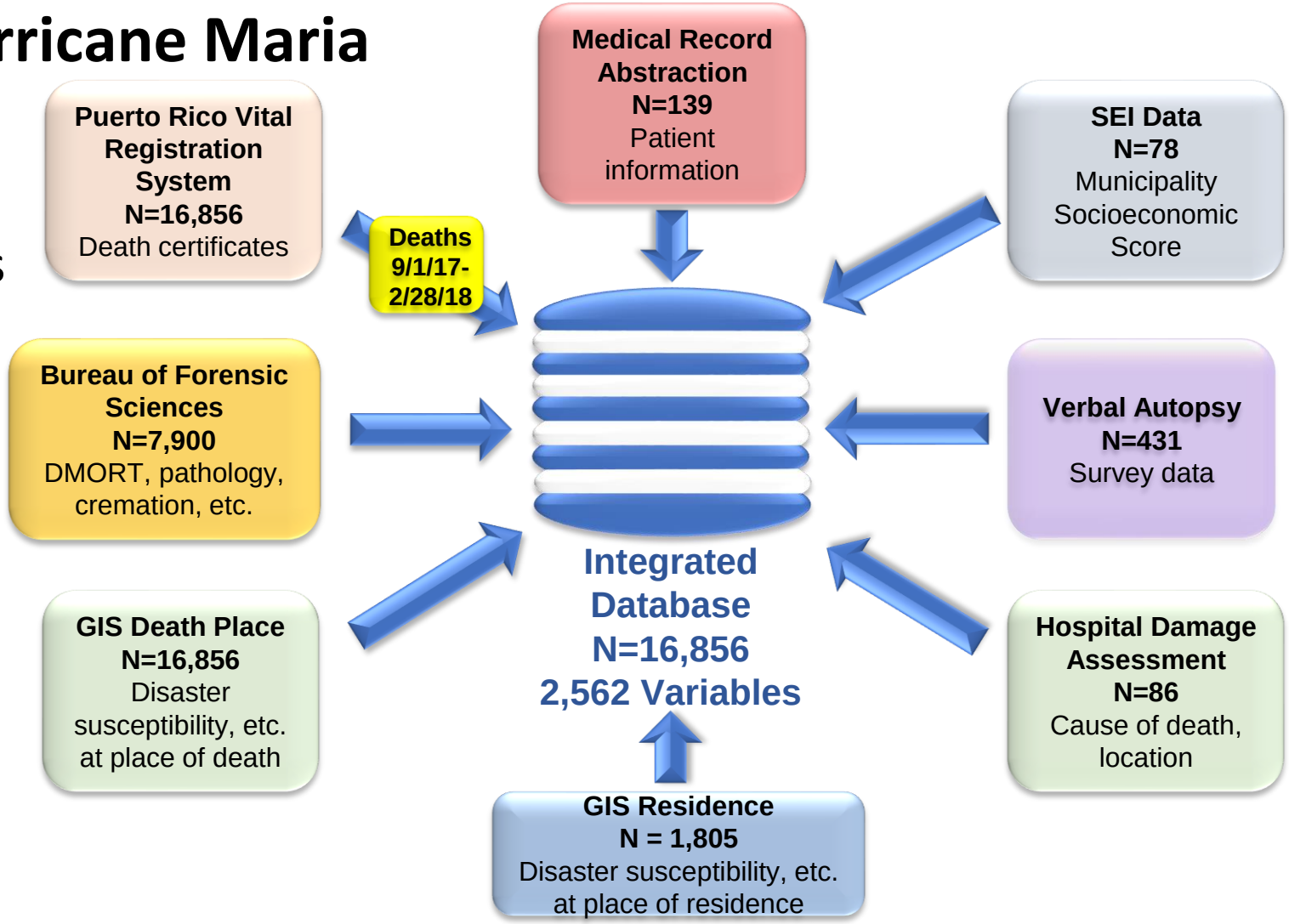


Integrated Mortality Database Delivered

GW/UPR contractor team transmitted de-identified dataset of deaths in Puerto Rico surrounding Hurricane Maria

Database includes:

- decedents' demographic information, medical conditions and surrounding information
- geographic conditions
- socio-economic conditions
- verbal autopsy data
- medical records abstraction data
- hospital functionality data



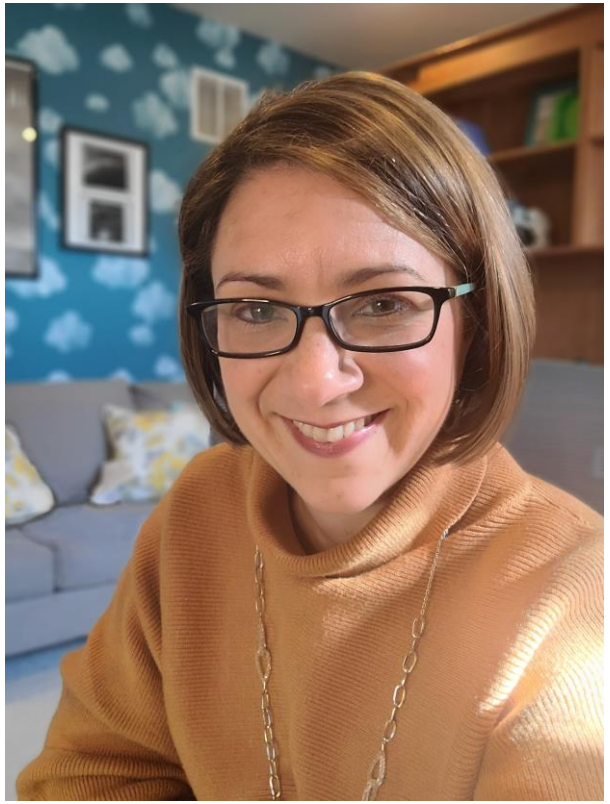
Stakeholder Outreach & Puerto Rico Travel

- Support for infrastructure-sector interviews has resulted from coordination with PR agencies and organizations:
  - Transportation (DTOP): Letter of support provided by Secretary Vélez following in-person meeting (December 2022); contact list also provided
  - Power (LUMA/PREPA): Updated contact lists provided
  - PRASA: Contact lists provided, engagement with regional managers facilitated
- PR Department of Education extended its approval of data collection activities involving public schools for another year (March 2023)
- Team members traveled to meetings in PR (October, December 2022)

Disrupting the Disaster Cycle
Forum at UPR Río Piedras
October 26, 2022

NIST-GW-UPR Workshop
UPR Medical Sciences Campus
December 1-2, 2022

Staffing Updates



Gina Eosco

- **Dr. Gina Eosco** of NOAA appointed as NCST member to provide expertise in risk communication, especially for the Emergency Communications Project
- **Nathan McKinney** hired to provide GIS expertise across the Hurricane Maria Program
- Term extensions approved by DOC and OPM for three NIST staff supporting the HM program

Nathan McKinney

Questions?

Joseph Main, Ph.D.
Team Lead
joseph.main@nist.gov

Maria Dillard, Ph.D.
Associate Team Lead
maria.dillard@nist.gov

www.nist.gov/topics/disaster-failure-studies/hurricane-maria