

Summary of Hurricane Maria NCST Investigation Progress

NCST Advisory Committee Meeting

September 12, 2024

Joseph Main

Team Lead

Maria Dillard

Associate Team Lead

Presentation Outline

1. Program Overview

2. Timeline

3. Contracting Updates

4. Staffing Updates

6. Hurricane Fiona Updates

7. Next Steps

1. Program Overview

2. Timeline

3. Contracting Updates

4. Staffing Updates

6. Hurricane Fiona Updates

7. Next Steps

Hurricane Maria Program



Event Impacts



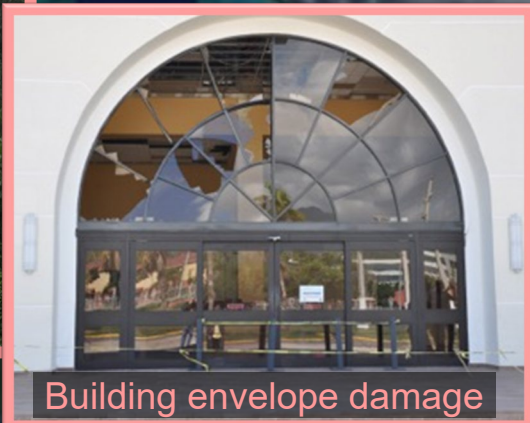
Landslides, road damage



Failure of power & communications



Heavy rain, flooding



Building envelope damage



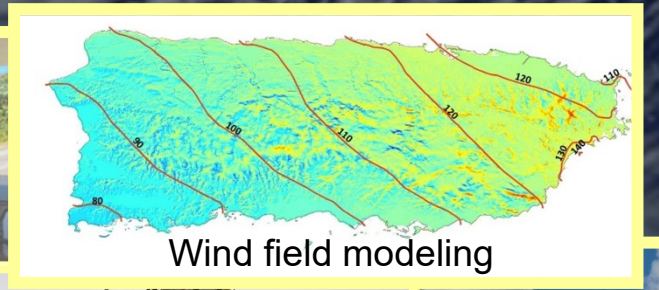
Rainwater intrusion in buildings



Recommendations



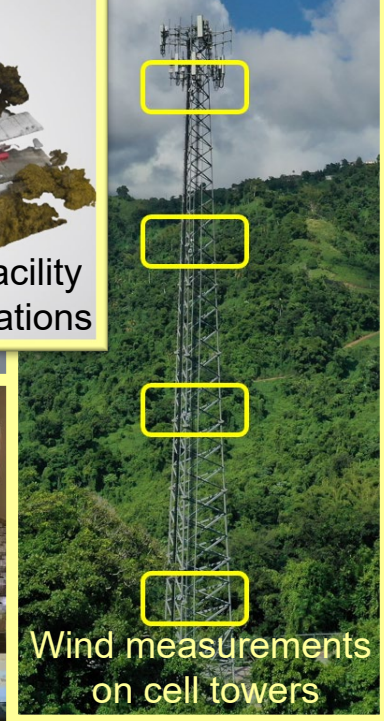
Surveys & interviews



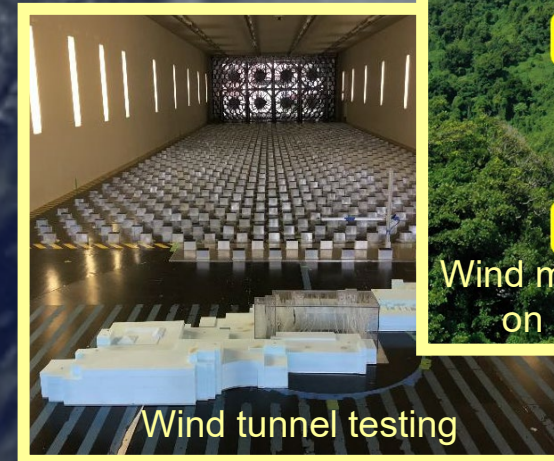
Wind field modeling



Facility evaluations



Wind measurements on cell towers



Wind tunnel testing

Investigation



2 Program Components

NCST Investigation

NWIRP* Research Study

7 Technical Projects

Hazard
Characterization

Performance of
Critical Buildings

Public Response
to Emergency
Communications

Morbidity &
Mortality

Impacts to and Recovery
of Infrastructure
Systems

Recovery of Business
and Supply Chain

Recovery of Social
Functions

5 Major Contracts

Applied Research Associates

University of Florida

Stantec Consulting

George Washington
University

Horsley Witten Group

Multiple Collaborating and Coordinating Agencies

FEMA

NOAA

HHS

USGS

NCDMHP

PRDOH

PRDOE

PRDTOP

PRASA

PRFAA

Many others...

1 Coordinated Program

*National Windstorm Impact Reduction Program

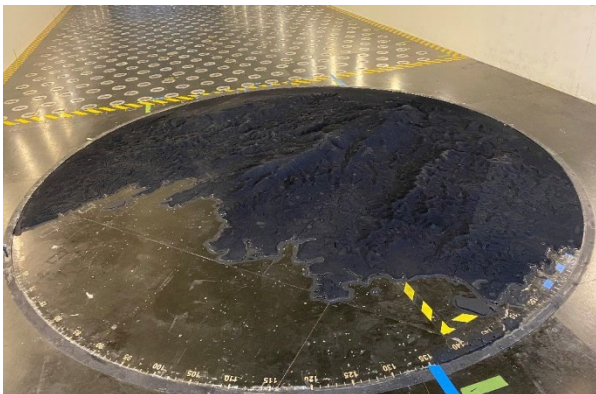
NCST Investigation Goals and Projects

Goals 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; and*
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**



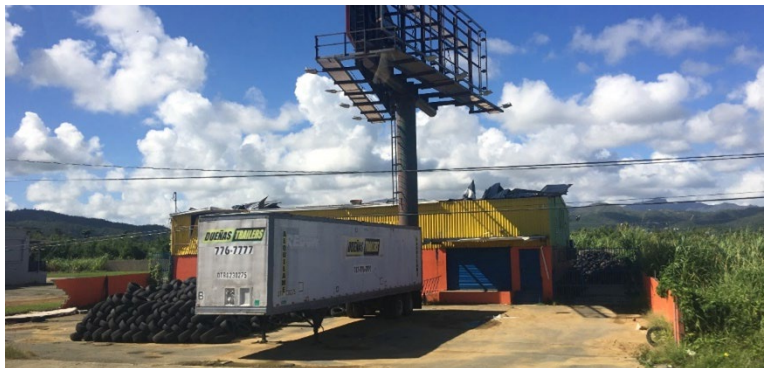
NWIRP Research Study Goals and Projects

Goals are 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; and*
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



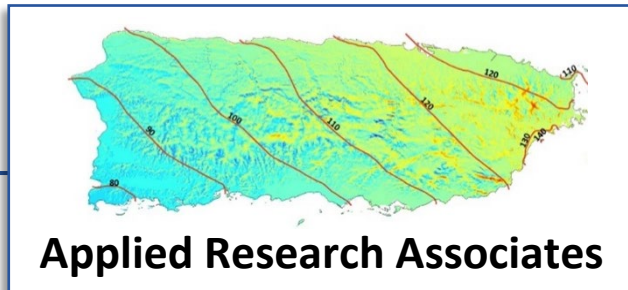
Impacts to & Recovery of Infrastructure Systems



Supporting Contracts

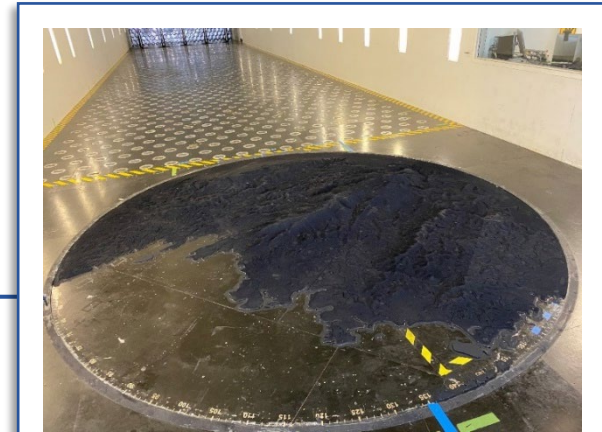
Contract

Wind Field Modeling



Applied Research Associates

Wind Tunnel Testing and Field Measurement of Winds



University of Florida

Engineering Services to Evaluate Critical Building Performance



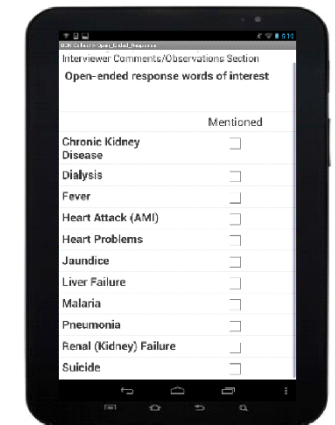
Stantec Consulting

Social Science Data Collection



Horsley Witten Group

Morbidity and Mortality Assessment



Source: Bernardo Hernández Prado

GW/UPR

Hurricane Maria Program Timeline

Sep: Hurricane Maria made landfall in PR
Dec: Preliminary reconnaissance

Feb: ARA contract awarded
Feb-Apr: Supporting contracts awarded
May: UF contract awarded
Jul: Initial wind-field model developed
Oct/Nov: Stakeholder outreach in PR
Nov: FEMA MOA established
Dec: Earthquake swarm began

Jan: Progress Report published
Feb: Drone photography of hospitals (2)
Mar: Wind tunnel testing of PR topographic models (2)
Jul: Information provider interviews (35)

Mar: Integrated mortality database
Apr: Hospital surveys (16)
Apr: Hospital interviews (30)
May: Shipping and transport interviews (30)
Jun: School surveys (300+)
Jul: Hospital (5) and shelter (5) evaluations

2017

2018

2019

2020

2021

2022

2023

2024

Feb: NCST Team established
May: Investigation plans presented to NCSTAC
Aug: Windshield survey across PR
Sep: Study regions established
Dec: Government shutdown (35 days)

Jan: HW contract awarded
Feb: New investigation leadership
Mar: Stantec contract awarded
Mar: 2nd FEMA MOA established
Mar: Start of COVID-19 lockdown
Jul: GW/UPR contract awarded
Oct: Anemometers installed on cell towers in Yabucoa

May: Business surveys (450+)
Jun: Wind tunnel testing of hospitals (2)
Sep: Household surveys (1500+)
Sep: Next-of-kin interviews (400+)
Sep: Hurricane Fiona impacts PR
Nov: Household interviews (60)

Updates on subsequent slides

⚠ 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.
- These presentations do not constitute NIST findings or recommendations.
- All survey and interview data collection included a consent process that specifies the allowable uses of data and protections of respondents.
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- Every reasonable effort has been made to identify copyright holders for content (such as photographs) appearing in these presentations.

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2. Timeline

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Highlights of Progress Since March 2024

- NCSTAC meeting
- Contractor draft reports on Hurricane Maria and Fiona wind-field models delivered

2024

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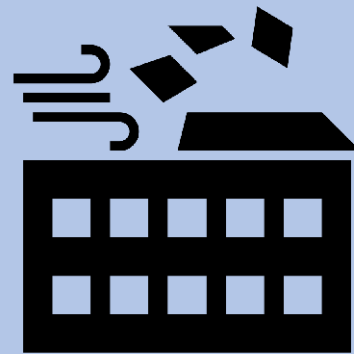
NCST Advisory Committee Meeting: March 6-7, 2024

Panel Presentation Themes



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

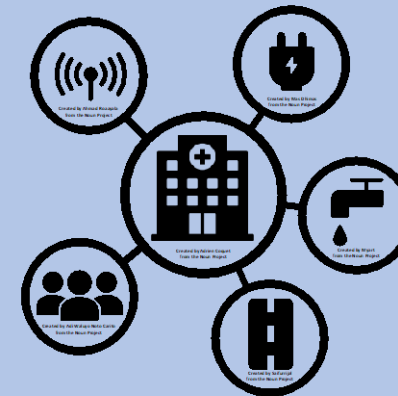
Theme 1: Hazard Exposure



Created by Arthur Shlain from the Noun Project

DongHun Yeo, Marc Levitan, Maria Dillard

Theme 2: Hospital Functionality & Infrastructure Dependencies



Maria Dillard, Joseph Main, Ken Harrison

Theme 3: Protective Action & Preparedness



Created by Good Father from Noun Project

Jennifer Helgeson, Katherine Johnson, Marc Levitan, Judith Mitrani-Reiser

Hurricane Maria Program

2 Program Components										
NCST Investigation	NWIRP* Research Study									
7 Technical Projects										
Hazard Characterization	Performance of Critical Buildings	Public Response to Emergency Communications	Morbidity & Mortality	Impacts to and Recovery of Infrastructure Systems	Recovery of Business and Supply Chain	Recovery of Social Functions				
5 Major Contracts										
Applied Research Associates	University of Florida	Stantec Consulting	George Washington University	Horsley Witten Group						
Multiple Collaborating and Coordinating Agencies										
FEMA	NOAA	HHS	USGS	NCDMHP	PRDOH	PRDOE	PRDTP	PRASA	PRFAA	Many others...
1 Coordinated Program										

*National Windstorm Impact Reduction Program

Next Steps: Completing Reports

Plan in place for report organization, writing, review, and publication – in collaboration with NIST Disaster & Failure Studies and Champlain Towers South Team, including:

- Outline of report volumes
- Identification of publication series
- Contract for report preparation (solicitation posting imminent)

Completing reports

Publishing datasets, models, and other products

Implementation, including communication and outreach for broadest dissemination

NIST PUBLIC DATA REPOSITORY 1.11.2

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Data Publication

Hurricane Maria Wind-Field Model for Puerto Rico

Lauren A. Mudd, Fangqian Liu, Peter J. Vickery, Marc L. Levitan, Nathan McKinney, DongHun Yeo, Joseph Main ▶

Contact: [Marc Levitan..](#) ▶

Identifier: [doi:10.18434/mds2-3184](https://doi.org/10.18434/mds2-3184)

Version: 1.0 First Released: 2024-02-28 Revised: 2024-02-28

Abstract

This data comes from a three-second grid of wind directions are...

Research Topics

Subject Keywords

Data Access

These data are available as:

Files

Name
HMaria_Gust_Flat_CV.tif
HMaria_Gust_Flat_PR.tif
HMaria_Gust_Topo_CV.tif
HMaria_Gust_Topo_PR.tif
HMaria_WindFieldModel.csv
HurricaneMariaWindField-README.txt

Wind-Field Model Dataset

- Published just prior to previous NCSTAC meeting
- 68 dataset downloads (as of 9/11/24)

Dataset Metrics

Hurricane Maria Wind-Field Model for Puerto Rico
Metrics Since Mar 4, 2024

Download Metrics Download Graphics

Dataset Summary

Total file downloads	102
Total dataset downloads	68
Total bytes downloaded	1.23 GB
Total unique users	66
Last downloaded	Sep 6, 2024

Total Downloads by File

Ascending Descending Original

File Name	Downloads
HMaria_Gust_Flat_CV.tif	31
HMaria_Gust_Flat_PR.tif	12
HMaria_Gust_Topo_CV.tif	9
HMaria_Gust_Topo_PR.tif	11
HMaria_WindFieldModel.csv	24
HurricaneMariaWindField-README.txt	15

Name	Downloads	File Size
HMaria_Gust_Flat_CV.tif	31	1.18 MB
HMaria_Gust_Flat_PR.tif	12	11.80 MB
HMaria_Gust_Topo_CV.tif	9	1.18 MB
HMaria_Gust_Topo_PR.tif	11	11.80 MB
HMaria_WindFieldModel.csv	24	37.91 MB
HurricaneMariaWindField-README.txt	15	9.15 KB

Total No. files: 6, Total dataset size: 63.88 MB

Highlights of Progress Since March 2024

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2024

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Contractor Reports Delivered

DEVELOPMENT OF WIND SPEED CONTOURS FOR 2017 HURRICANE MARIA

March 25, 2024

Development of Wind Speed Contours for Hurricane Fiona (2022)

Draft Report
March 25, 2024

Contract No.
1333ND19PN8730060

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

Prepared by:
APPLIED RESEARCH ASSOCIATES, INC.
Lauren A. Mudd, Ph.D., P.E.
Peter J. Vickers, Ph.D., P.E.

IntraRisk Group
8537 Six Forks Road, Suite 600
Raleigh, NC 27615

Final Report

Wind Tunnel Testing and Field Measurement of Winds for the NCST Investigation of Hurricane Maria's Impacts on Puerto Rico

DRAFT

HURRICANE MARIA SURVEY RESEARCH SERVICES

RECOVERY OF BUSINESS AND SUPPLY CHAINS

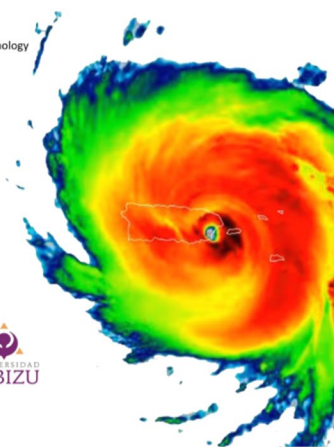
FINAL REPORT

April 5, 2024
Data Collection: November 30, 2021 - April 30, 2023

Prepared For
National Institute of Standards and Technology

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

Prepared By:
Horsley Witten Group, Inc.
Eastern Research Group, Inc.
Logit | i+a
Dr. Domingo Marqués

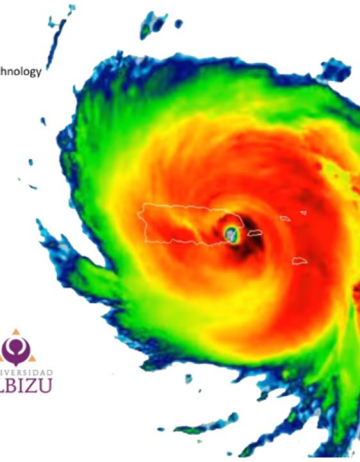


HURRICANE MARIA SURVEY RESEARCH SERVICES

PUBLIC RESPONSE TO EMERGENCY COMMUNICATIONS

FINAL REPORT

2020 - September 2022



PREDECISIONAL DRAFTS

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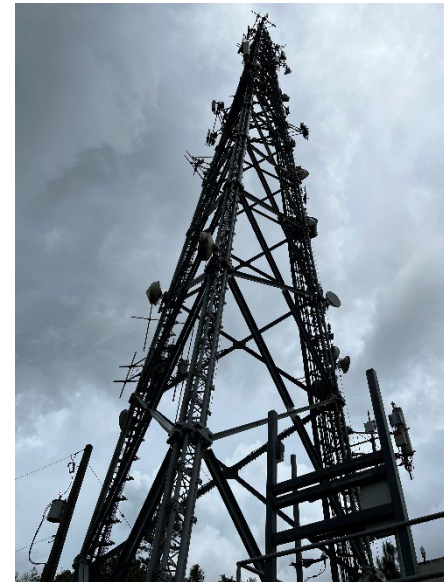
September

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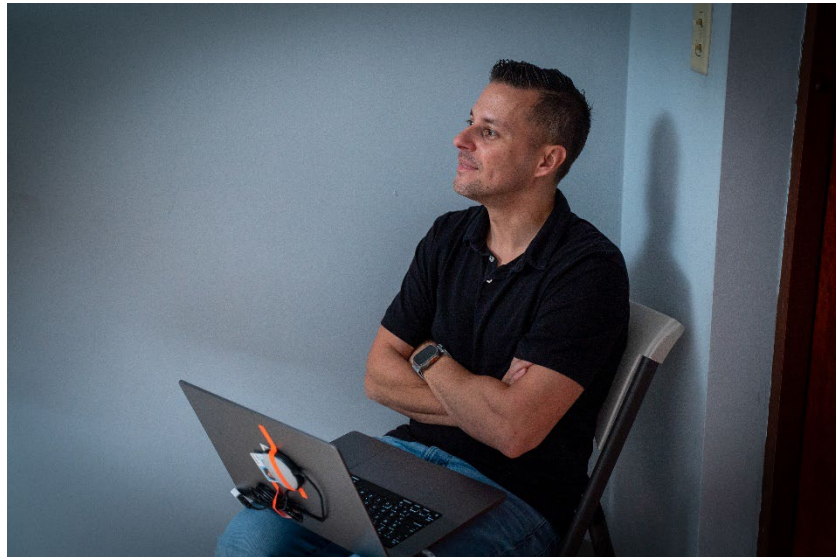
- April 29-30, University of PR- Río Piedras: NSF Rising Voices, Changing Coasts Hub Conference: Materializando la promesa de la ciencia de convergencia
- May 1-3, Joint Recovery Office, San Juan: Mitigation Framework Leadership Group Meetings and Site Visits
- May 2-3, San Juan: Puerto Rico IV Public Health Conference
- Meetings and site visits with cell tower repair companies, representatives of the Private School Association, PR Dept. of Health, and PR Dept. of Transportation and Public Works
- Interviews for documentary with NIST Video Team in Puerto Rico



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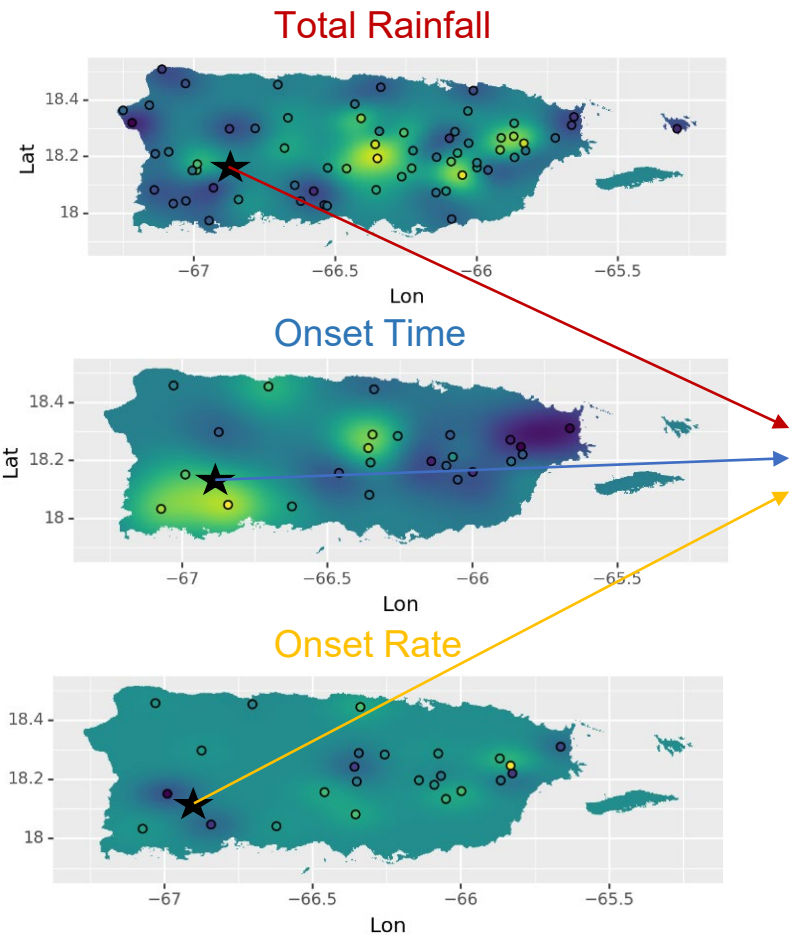
August

September

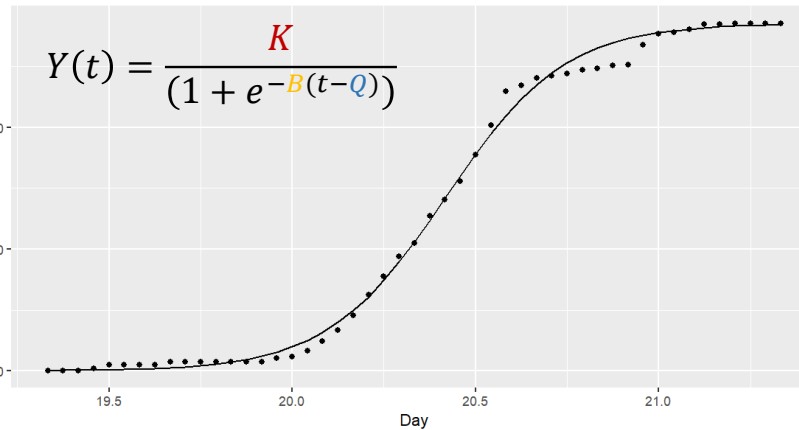
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- Social media posts on hurricane preparedness
- Extensions for PREP Associates

Time-Dependent Rainfall Model



Predicted cumulative rainfall for a given latitude/longitude



Infrastructure Interviews

Infrastructure Sector	Sample Frame	Interviews Completed
Water (PRASA)	24	4
Community Water (non-PRASA)	19	6
Power (PREPA/LUMA)	24	0
Transportation (DTOP/PRHTA)	26	1

Desplácese hacia abajo para obtener más información y leer cartas de apoyo.

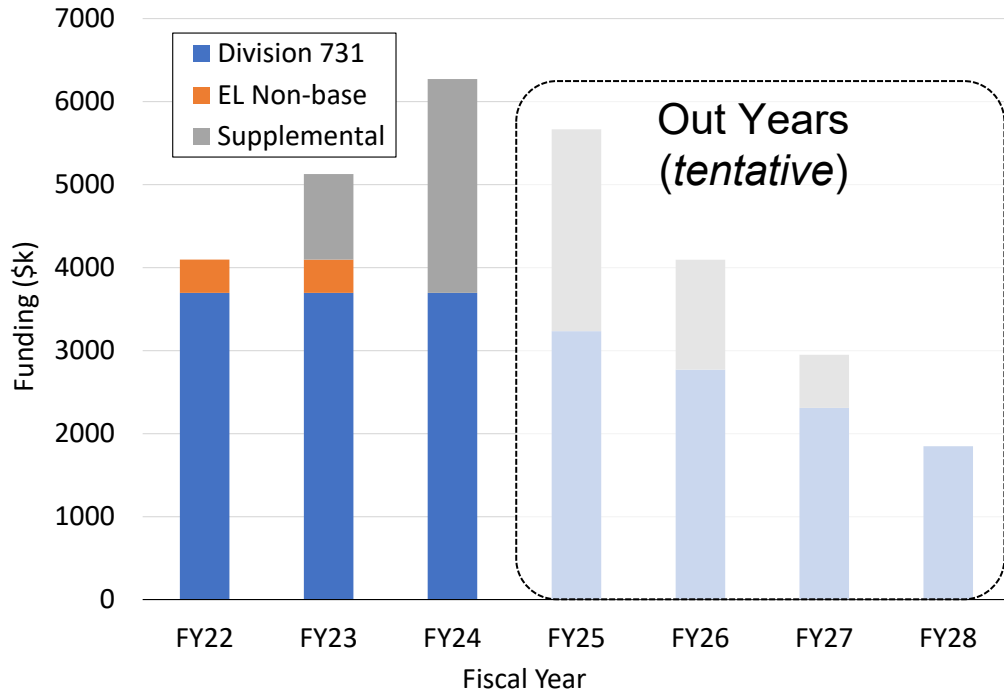
- Website used to provide respondents with study information
- Data collection began June 2024

Sectores de infraestructura de agua, energía y transporte

Se le ha pedido que participe en una entrevista para el estudio del NIST

PRELIMINARY ANALYSIS

Total Hurricane Maria/Fiona Program Budget



New NIST Technical Publication Series Approved

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NIST Series Publications

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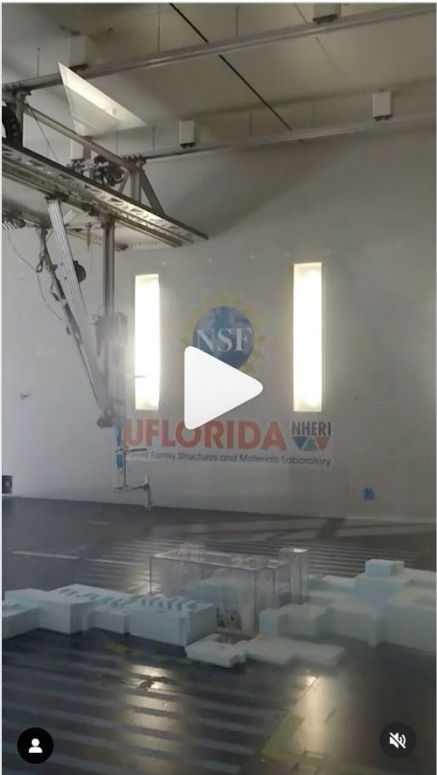
The major publication types of the National Institute of Standards and Technology (NIST). To find a specific report, search the [NIST Research Library catalog](#) or view a [full list of publications](#) that are available electronically.

- National Construction Safety Team Grant/Contract Reports (NCST GCR)
- National Windstorm Impact Reduction Program (NWIRP) Series
- National Windstorm Impact Reduction Program Grant/Contractor Reports (NWIRP GCR)

Social Media Posts Related to Hurricane Preparedness

Instagram

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nist • Follow
Original audio

nist By looking at the past, you can prepare for the future. That's what NIST researchers are doing in the area of hurricane preparedness.

Critical infrastructure, such as hospitals and storm shelters, can provide medical care and shelter during a hurricane. But it's important to make sure these buildings can handle the impact of natural disasters.

NIST researchers are doing just that by evaluating the performance of selected hospitals and shelters in Puerto Rico, known for being a highly mountainous region, as part of an ongoing study initiated in 2017 after the disastrous impact of Hurricane Maria.

252 likes
June 13

Log in to like or comment.

facebook.com

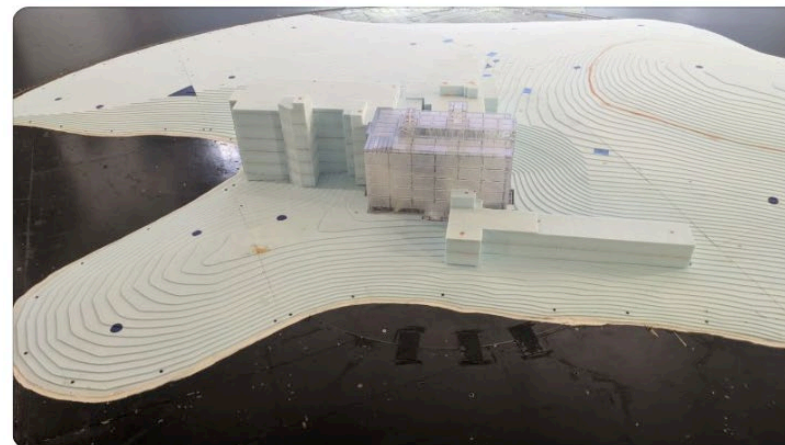
National Institute of Standards and Technology (NIST)

Communities can prepare for extreme weather and climate-induced disasters, such as hurricanes, in a number of ways. For example, certain buildings, such as storm shelters and hospitals, can serve as...

linkedin.com

[How hurricanes affect buildings in Puerto Rico | National Institute of Standards and Technology \(NIST\) posted on the topic | LinkedIn](#)

Extreme weather and climate-induced disasters, such as hurricanes, can have tremendous impacts. Hurricanes generate sustained wind speeds ranging from 74 miles... (49 kB)



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- Conference presentations
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- July 14-17, Broomfield, CO: Panel on sheltering guidance at 2024 Natural Hazards Workshop
- July 30, University of Birmingham, UK: Presentation on uncertainty quantification for CFD simulations at 9th International Colloquium on Bluff Body Aerodynamics and Applications
- Interviews in Puerto Rico for documentary with NIST Video Team



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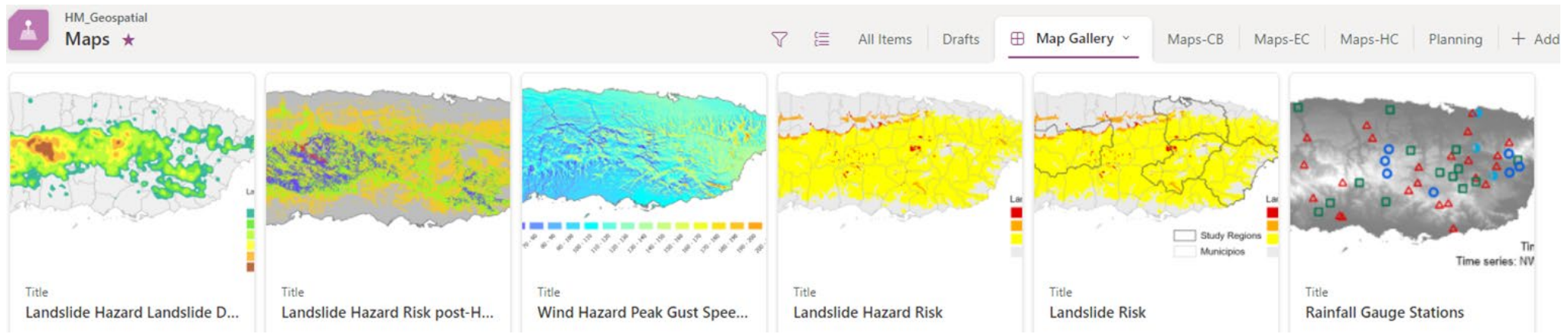
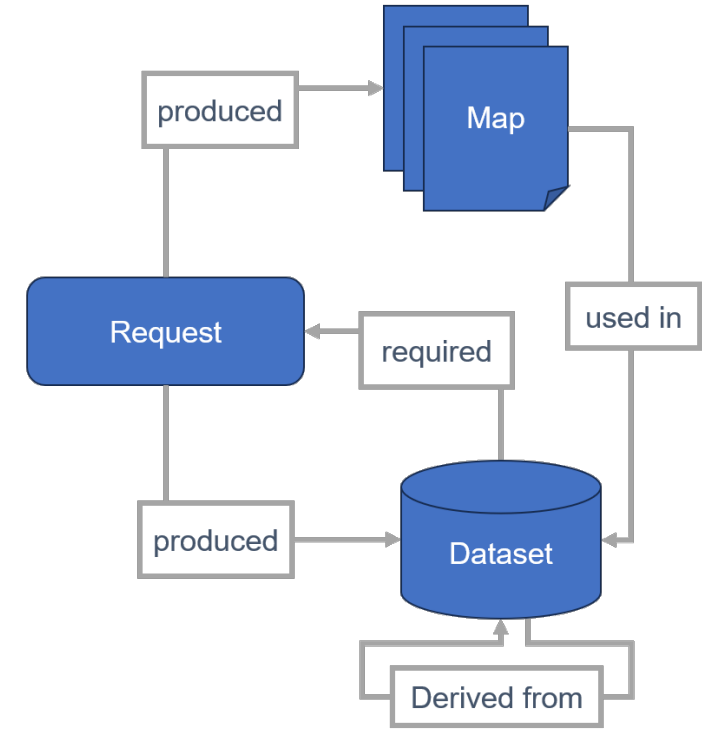
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- Contractor delivered hazard data linked to survey responses
- GIS integration plan presented
- Stakeholder outreach plan for video products developed
- Emergency communications household survey data analysis completed
- Tropical Storm Ernesto impacts PR

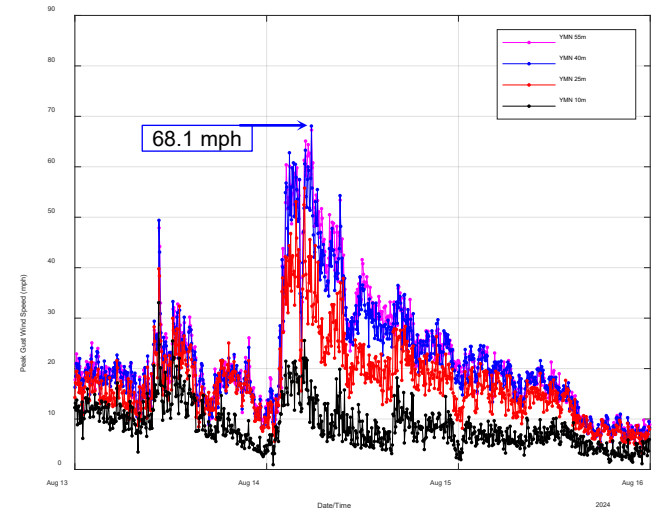
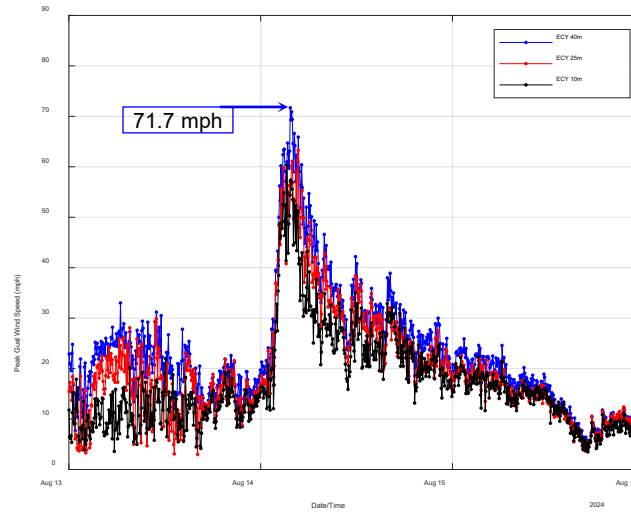
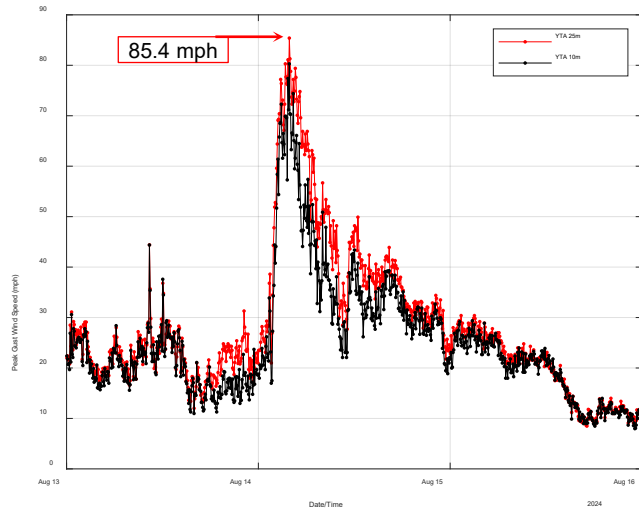
Geospatial Integration Plan

1. Organize Needs identify overlap
2. Populate Lists maps, data, requests
3. Annotate Lists questions, links, metadata
4. Identify significant work items data development, analysis,
5. Dependent data HC & RI datasets, boundary
6. Create map drafts rough w/ missing data noted, comment for revisions
7. Finalize templates / styles update drafts > feedback > revisions
8. Finalize data update drafts > feedback > revisions
9. Finalize maps / report products revisions on revisions
10. Supporting products summary report, web & story maps

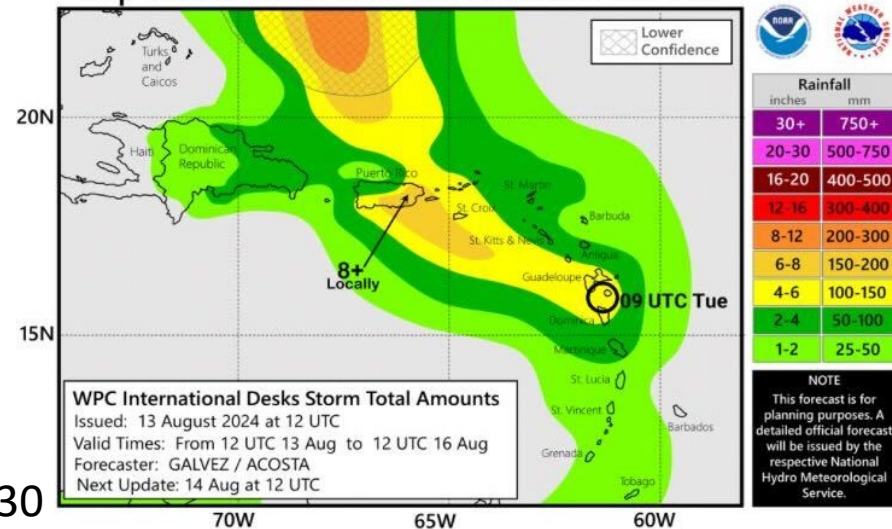


Tropical Storm Ernesto impacts Puerto Rico

Wind measurements at Yabucoa cell towers:



Tropical Storm Ernesto Total Forecast Rainfall



PRELIMINARY ANALYSIS

Source: NOAA National Weather Service

“...Ernesto caused damage in Puerto Rico and the U.S. Virgin Islands as it passed north of the region as a tropical storm, managing to knock out power to hundreds of thousands of residents. At one point, 23 hospitals were operating on generators. Schools and numerous roads were also closed. At the outage's peak, 750,000 customers were without power, with rivers across Puerto Rico swollen after nearly 10 inches of rain.” Aug 22, 2024, NOAA NESDIS

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- Multiple contracts awarded
- Data for Wave 2 school and hospital surveys delivered
- Dataset from building wind load analysis delivered

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Supporting Contracts: Updates



Status	Contract	Contractor(s)	Project(s) Supported
Modifications (3/2024, 8/2024)	Engineering Services to Evaluate Critical Building Performance	Stantec Consulting Services, Inc.	<ul style="list-style-type: none"> • Critical Buildings
Modification (5/2024)	Social Science Data Collection	Horsley Witten Group, Inc. <ul style="list-style-type: none"> • Eastern Research Group • Issues and Answers • Albizu University (San Juan) 	<ul style="list-style-type: none"> • Emergency Communications & all projects of NWIRP Research Study
New Contract (6/2024)	Continuation of Wind Measurements in Yabucoa	WeatherFlow	<ul style="list-style-type: none"> • Hazard Characterization
New Contract (8/2024)	Stakeholder Outreach Support	Strativia, LLC	<ul style="list-style-type: none"> • All projects of NCST Investigation & NWIRP Research Study
New Contract (9/2024)	Local Translation and Interpretation Services	Lighthouse Integrated Services Corp.	<ul style="list-style-type: none"> • All projects of NCST Investigation & NWIRP Research Study
New Contract (Evaluation in progress)	Outside NCST Member Support	TBD	<ul style="list-style-type: none"> • All projects of NCST Investigation
New Contract (Award pending)	Technical Report Preparation	TBD	<ul style="list-style-type: none"> • All projects of NCST Investigation & NWIRP Research Study

1. Program Overview

2. Timeline

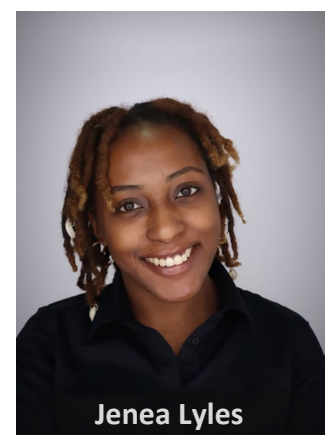
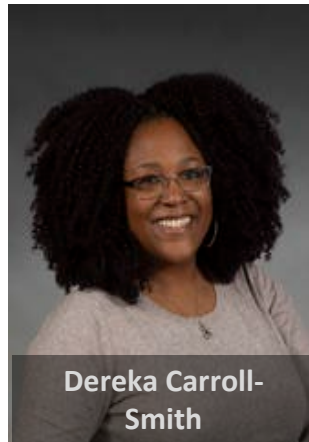
3. Contracting Updates

4. Staffing Updates

6. Hurricane Fiona Updates

7. Next Steps

- Terms extended for **NIST Associates** under Professional Research Experiences Program (PREP); new Associates selected to provide support for data analysis
- Three term employees supporting the HM Program departed NIST in the past year
- New **federal term positions** in progress for 1 Social Scientist or Engineer with GIS expertise and 3 Social Scientists to support Hurricane Maria and other NIST Engineering Laboratory Programs
- Additional staffing appointments via contract and IPA will provide continuation of subject matter expertise to support data analysis and report writing



1. Program Overview

2. Timeline

3. Contracting Updates

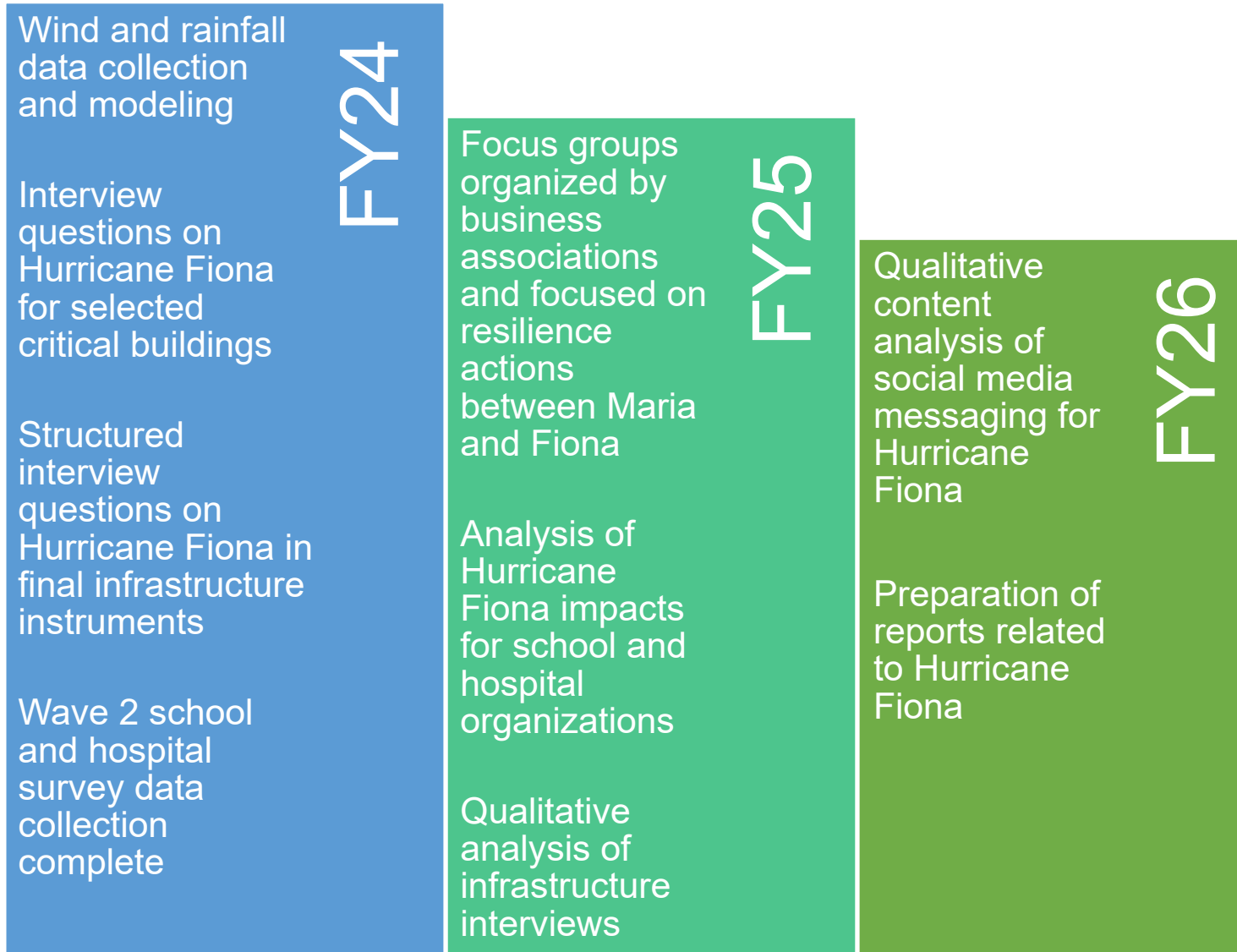
4. Staffing Updates

6. Hurricane Fiona Updates

7. Next Steps

- A portion of the \$40M in additional funding received by EL is supporting extension of the HM Program to consider impacts of Hurricane Fiona, including:
 - **Hazard Characterization:** Assessment of the hazard, specifically wind and rainfall
 - **Critical Building Performance:** Evaluation of Hurricane Fiona's impacts on hospitals and shelters selected for evaluation in the Hurricane Maria NCST Investigation
 - **Recovery of Infrastructure:** Assessment of impacts on infrastructure systems and their interdependencies (e.g., power, water, transportation)
 - **Recovery of Social Functions:** Evaluation of physical and non-physical impacts of Hurricane Fiona as well as effects on recovery from Hurricane Maria
- Supplemental funding is also planned to support implementation of recommendations from the Hurricane Maria Program

Hurricane Fiona Work



1. Program Overview

2. Timeline

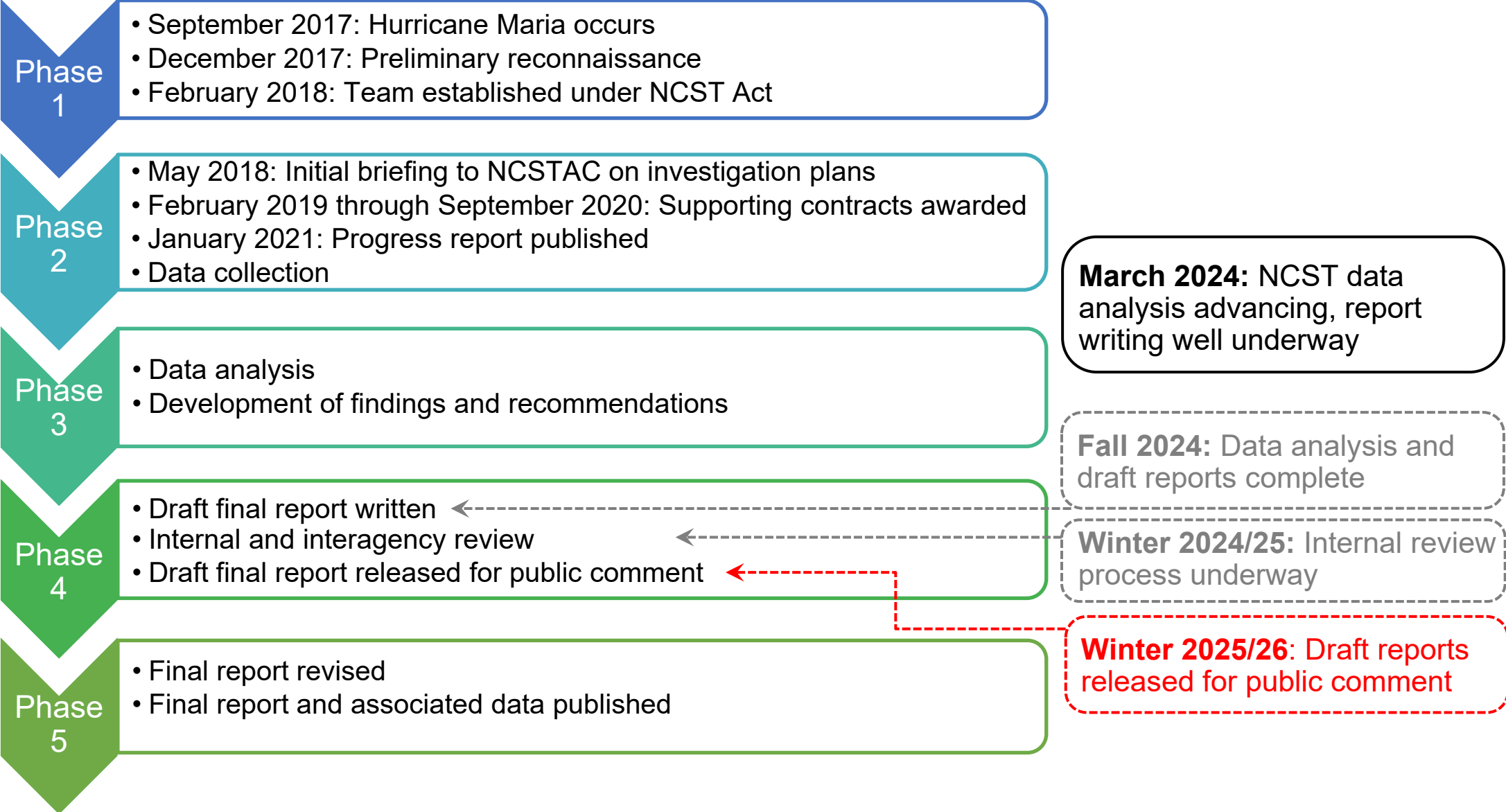
3. Contracting Updates

4. Staffing Updates

6. Hurricane Fiona Updates

7. Next Steps

Expected Timeline: September 2024 Update



Planned HM NCST Report Hierarchy

Level 1: Summary Report

NCSTAR 4

Overarching Summary Report:

- Principal findings
- Recommendations

Level 2: Project Reports

NCSTAR 4-1

Hazard Characterization

NCSTAR 4-2

Performance of Critical Buildings

NCSTAR 4-3

Public Response to Emergency Communications

NCSTAR 4-4

Morbidity and Mortality

Level 3: Supporting Documents

Examples:

Appendix to NCSTAR 4-1

NCSTAR 4-1A

NCST GCR 4-1A

The same structure is planned for NWIRP Reports.

NCSTAR: NCST Act Report

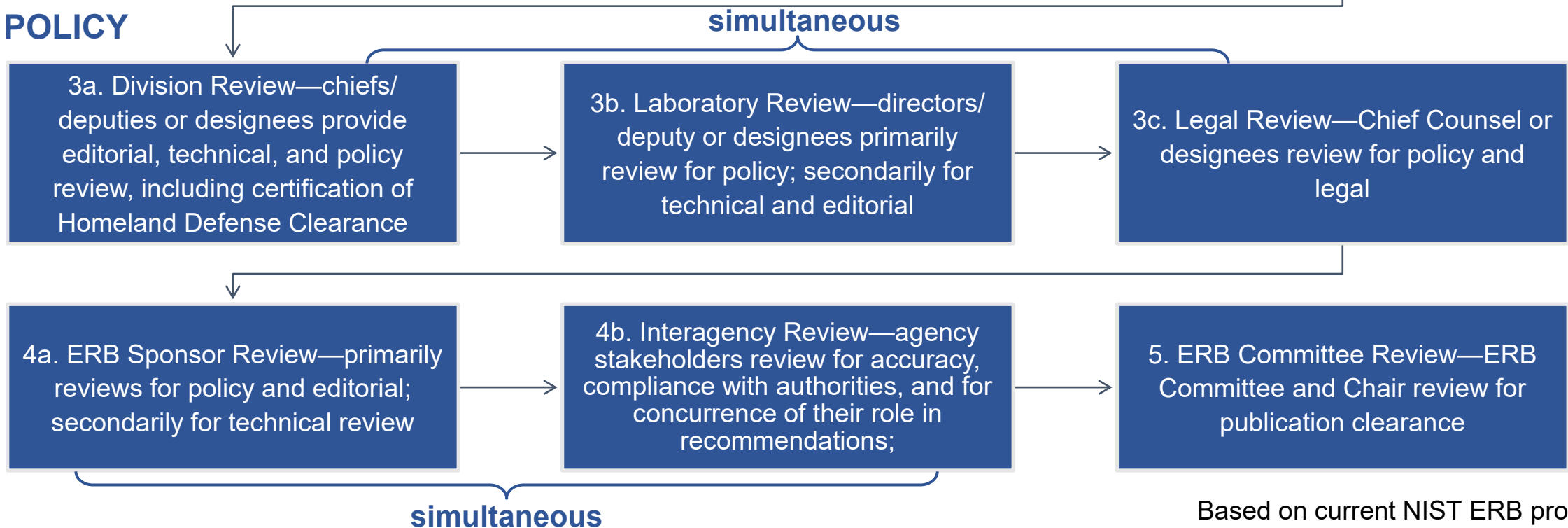
GCR: Grant/Contract Report

Report Review Process

TECHNICAL



POLICY



Anticipated HM Review Timeline

Project Reports:

Drafts complete

Technical Review

Policy Review

2024

Oct - Dec

2025

Jan - Mar

Apr - Jun

Jul - Sep

Oct - Dec

Summary Report:

Draft complete

Technical Review

Policy Review

Acknowledgements

To all those in Puerto Rico who responded to the data collection requests and shared knowledge, experiences, and lessons learned, including:

- Households
- Families and loved ones of those who lost their lives
- Emergency information providers
- Business owners and managers
- Shipping and transport operators
- Hospital administrators and staff
- School administrators and staff
- Shelter operators
- Infrastructure operators



To all those impacted by Hurricane Maria

To our dedicated team who continue to demonstrate great perseverance, including:

- NCST Members
- Technical Staff
- PREP Associates
- Contractor Teams
- Institutional Support

To our many partners in Puerto Rico who have supported our data collection efforts.

Questions?

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