



engineering
laboratory

NWIRP Research Study of Hurricane Maria's Impacts on Puerto Rico Recovery of Social Functions Project

Project Leader: Maria Dillard

Objective: To examine the recovery trajectories of sampled schools and hospitals in order to identify characteristics and conditions associated with recovery of critical social functions from Hurricane Maria in Puerto Rico

Goals and Authorities of NWIRP Study

Under the National Windstorm Impact Reduction Act Reauthorization of 2015 (Public Law 114-52), NIST is conducting a scientific study of Hurricane Maria's impacts on Puerto Rico and subsequent recovery processes with the goal of characterizing:

- 1) *The impacts to and recovery of small and medium-sized manufacturers (SMMs), 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.*

Goals 1 and 2 align to NWIRP Strategic Plan Goal B: *Improve the Understanding of Windstorm Impacts on Communities*

- Objective 7: Improve understanding of economic and social factors influencing windstorm risk reduction measures
- Objective 8: Develop tools to improve post-storm impact data collection, analysis, and archival

Project Objectives

- To 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 in Puerto Rico
- To study the *interdependencies of the broader community* (e.g., infrastructure, households, businesses) *and the social functions* provided by schools and hospitals



Background

- The NIST Hurricane Maria Program[^] includes a project focused on the recovery of education and healthcare services associated with critical buildings (schools and hospitals) in Puerto Rico.
- Both education and healthcare services are an important part of understanding the impacts of Hurricane Maria, as well as the long term recovery of Puerto Rico.
- Approximately one-quarter of the schools have closed in Puerto Rico; disproportionately affecting rural communities where the majority of school closures have taken place.*
- Thus far and for Hurricane Maria alone, \$324 million in FEMA public assistance has been obligated to PR Department of Education, while approximately \$13 million has been obligated to the PR Department of Health.** Distribution of funds and planning for recovery activities are ongoing.***

[^]Under the NIST Hurricane Maria Program, NIST is conducting a NCST investigation and a NWIRP study.

*Hinojosa, Melendez and Severino Pietri, "Population Decline and School Closure in Puerto Rico" https://centropr.hunter.cuny.edu/sites/default/files/PDF_Publications/centro_rb2019-01_cor.pdf.

**The Central Office of Recovery, Reconstruction and Resiliency (COR3) Transparency Portal. Recovery Programs <https://www.recovery.pr/recovery-programs#public-assistance>

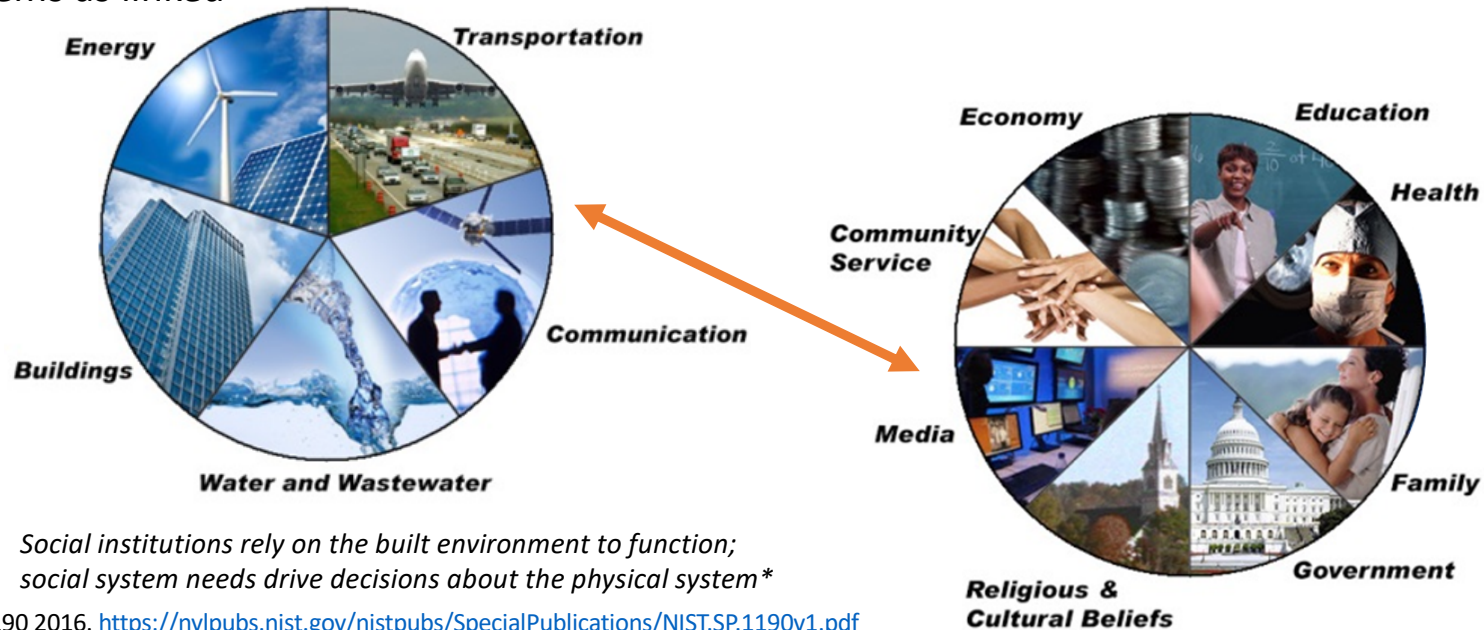
***Santiago, Leyla and Gregory Wallace, CNN. <https://www.cnn.com/2019/08/02/politics/puerto-rico-hud/index.html>



A FEMA Disaster Recovery Center in Puerto Rico

Conceptual Foundation

- This project will be used to support the development of a methodology to assess community-scale resilience
- Focuses on empirical relationships between social functions and physical systems; seeks to identify predictors of recovery outcomes
- Relies on a foundational understanding of social functions and buildings and infrastructure systems as linked



Conceptual Foundation



Current status

- Recovery is a complex concept and the process of recovery is known to include many interdependencies
- Recovery is not often quantitatively measured
- Institutional recovery is largely absent from the literature with minor exceptions for businesses



Planned research

- Systematic measurement of recovery for social institutions through structured surveys
- Supplement quantitative assessment with qualitative interviews
- Consider and account for interdependencies (businesses, infrastructure)



Outcomes

- Data collection instruments for longitudinal study of education and healthcare recovery
- Metrics for recovery
- Characteristics associated with resilience

Project Methods

Project methods include structured surveys of representatives of hospitals and school institutions within study area and semi-structured interviews with a subset of the sample

- Data collection
 - Longitudinal design for survey
 - Allows the same cases to be observed over time
 - 3 waves of data collection, approximately 6 months between each wave
 - Single time point for interviews
 - Allow in depth questioning on particular topics
 - Informs remaining waves of survey data collection
- Sampling unit: Organization
 - Schools (K-12, public and private)
 - Hospitals (public and private)
- Sample in order to assess differences in recovery
 - Geography
 - Population characteristics (e.g., hospital & school size, public/private ownership, level of staffing)
 - Degree of hazard exposure/impact

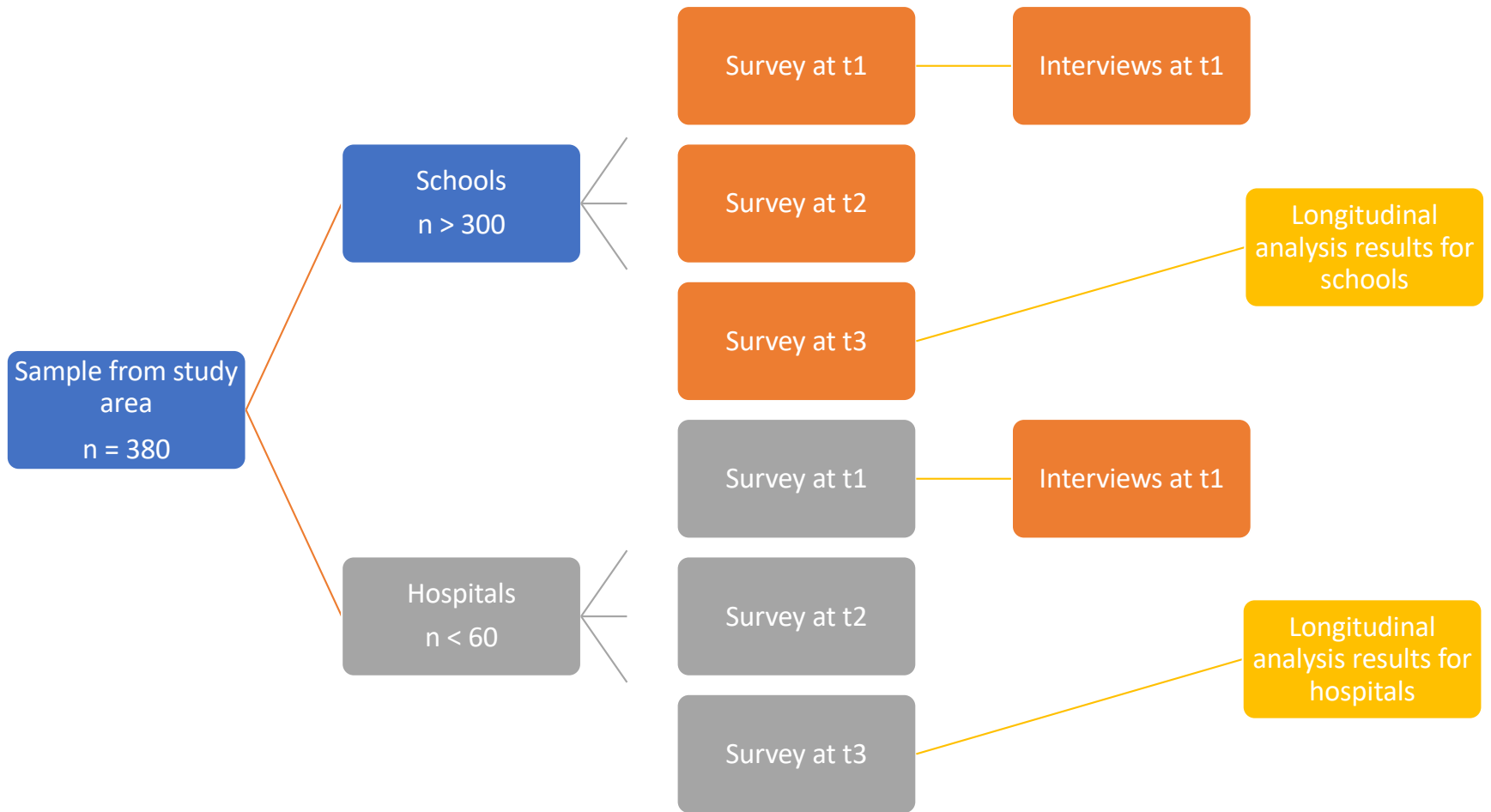


Temporary hospital facilities in Puerto Rico



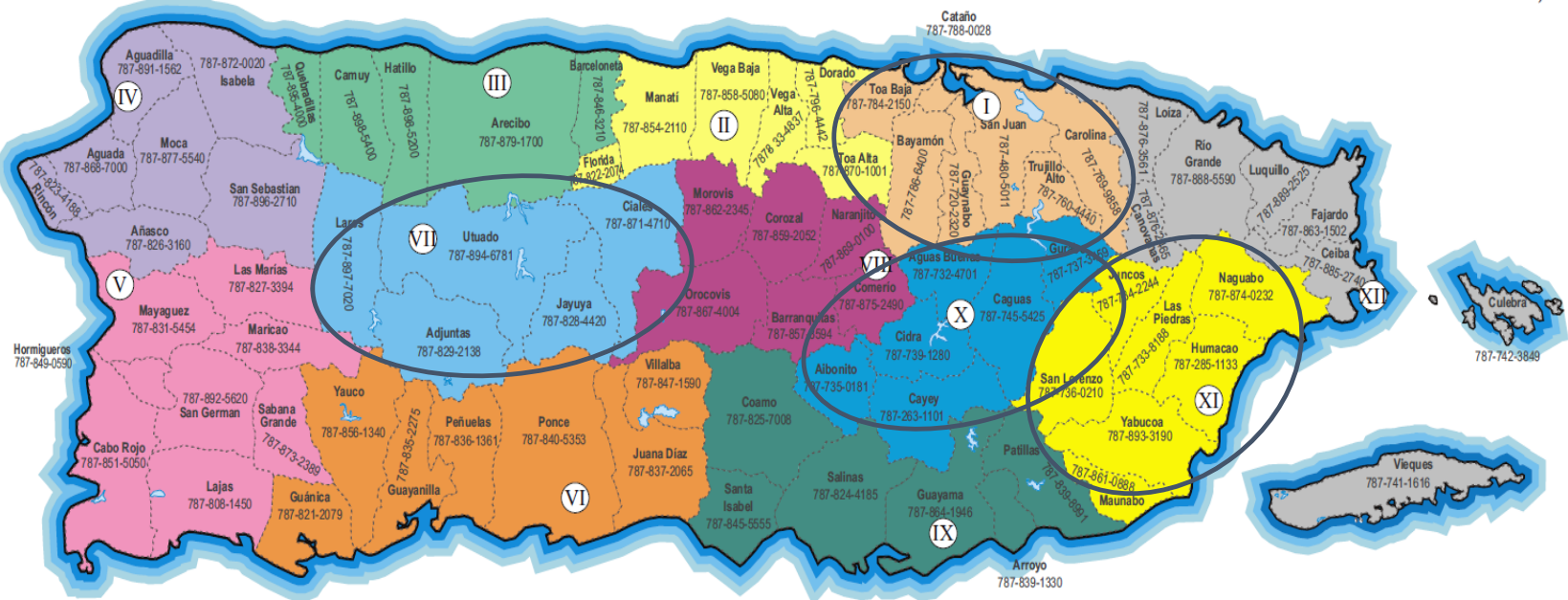
Damage to engineered building in Puerto Rico

Study Design Overview



Regions of Focus

- Includes Emergency Regions: I, VII, X, and XI – Common across all NIST Hurricane Maria Program projects
- The school sample will focus on these regions.
- The hospital sample may extend beyond these regions.



Source: PR.gov 2017. <http://prfaa.pr.gov/wp-content/uploads/2017/09/Oficinas-Regionales.pdf>

Data Collection

- Survey data collection to include:
 - Impacts of hazard on buildings and services
 - Interdependencies
 - Response
 - Recovery of services
- Interview data collection to include:
 - Decisions and processes related to institution closures
 - Decision processes for response and recovery phases
 - Use of needs assessments and associated findings
 - Observed interdependencies



Schools in Puerto Rico

Analysis

Modeling to consider the following variables:

- Pre-existing state
 - Resilience characteristics – e.g., flexible decision making structures, economic security of the institution
 - Initial vulnerability
- Impacts
 - Physical – e.g., building damage, infrastructure damage
 - Non-physical – e.g., population dislocation, impaired access, disruptions of school/work
 - Interdependencies (infrastructure, households, businesses)
- Response
 - Resources (monetary and non-monetary)
 - Plans in place
 - Policies
 - Decisions
 - Delays

- Recovery
 - Resources (monetary and non-monetary)
 - Repairs
 - Function
 - Access
 - Service provision



FY19 Progress Updates

- Evaluation of proposals for survey and interview research services contract
- Alignment of sample designs
 - Critical Buildings
 - Social Functions
- Collecting background data for schools and hospitals
 - Basic data on K-12 schools (location, public/private, damage, operational status)
 - Basic data on public and private hospitals (location, public/private, damage, operational status)
 - Collection of data on institutional characteristics (size, staffing, services provided, operating budget)
 - Damage assessments for schools, hospitals
 - Hazard exposure
 - Impact studies for education, healthcare
 - Timing and flow of recovery assistance
 - Recovery plans
- Conducted various outreach meetings in July 2019 including with the PR Departments of Education and Health

Next Steps

- Award contract for survey and interview data collection
- Finalize survey and interview instruments
- Prepare packages for data collection instrument approvals
 - PR Department of Education
 - NIST's Institutional Review Board
 - Office of Management and Budget's Paperwork Reduction Act



All photos credited to NIST unless otherwise noted.

Hospitals in Puerto Rico