

NWIRP Research Study of Recovery from Hurricane Maria's Impacts on Puerto Rico

Evaluation of Infrastructure Support of Critical Buildings and Emergency Communications

Project Leader: Ken Harrison

Objective: From a study of power, water, and transportation infrastructure impacts, recovery, and decision-making, make recommendations for increasing resilience through changes to codes, standards and practice.



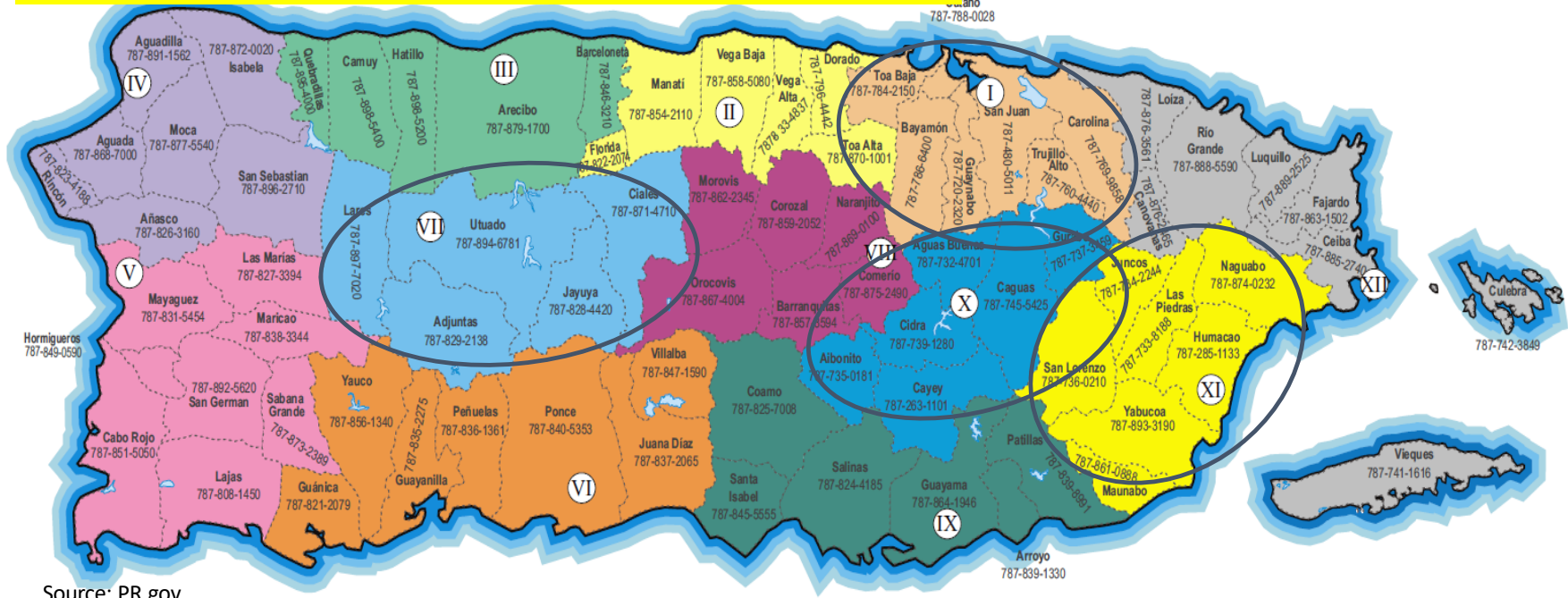
Goals and Authorities of NWIRP Study

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 goals 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.*

Regions Selected for NIST Study

- Includes Emergency Regions: I, VII, X, and XI – Common across all NIST projects in the Hurricane Maria Program.
- Selection of “infrastructure study areas” within these regions are being coordinated with selection of hospitals for the buildings project.

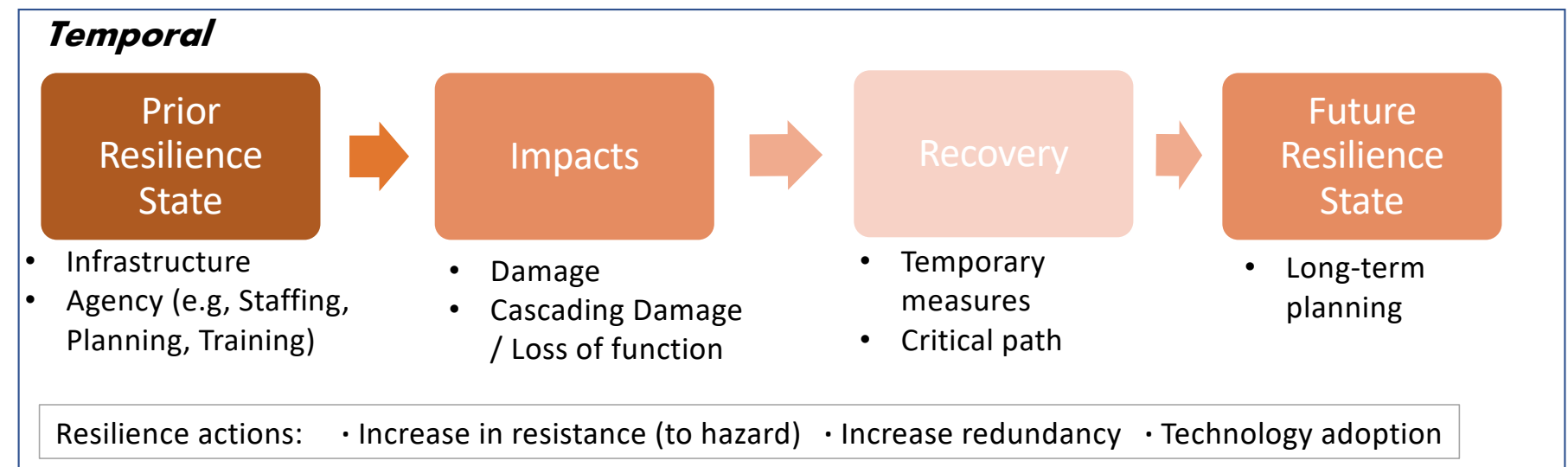
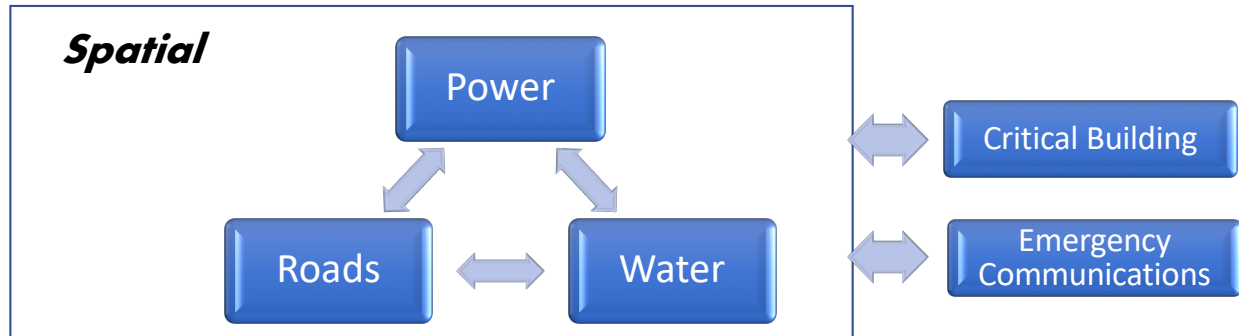


Source: PR.gov

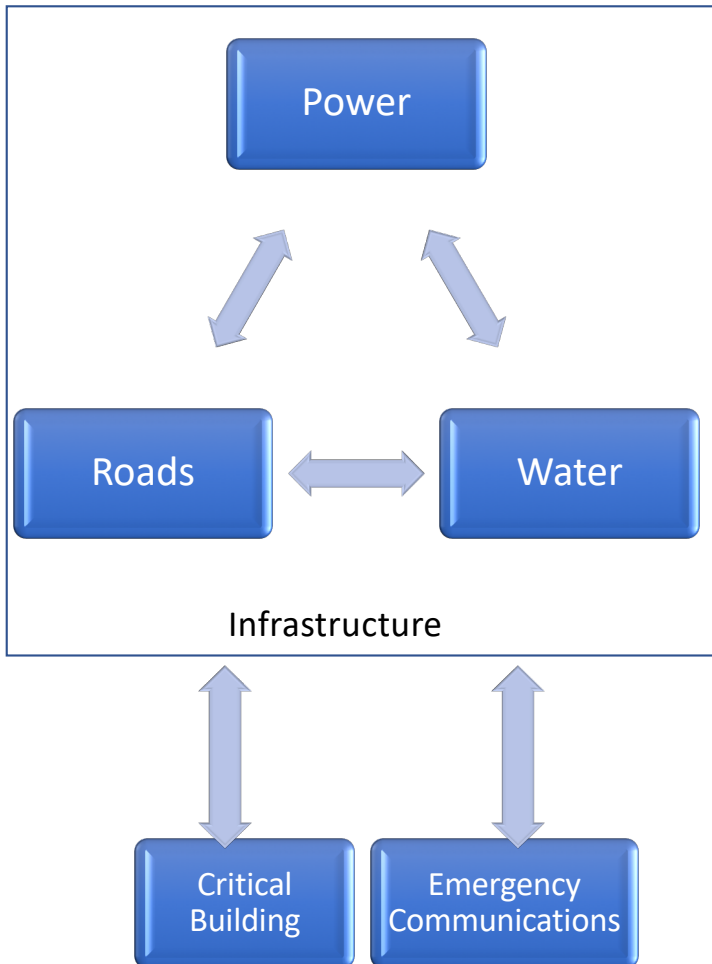
<http://prfaa.pr.gov/wp-content/uploads/2017/09/Oficinas-Regionales.pdf>

Hurricane Maria NWIRP Research Study

Project Study Scope

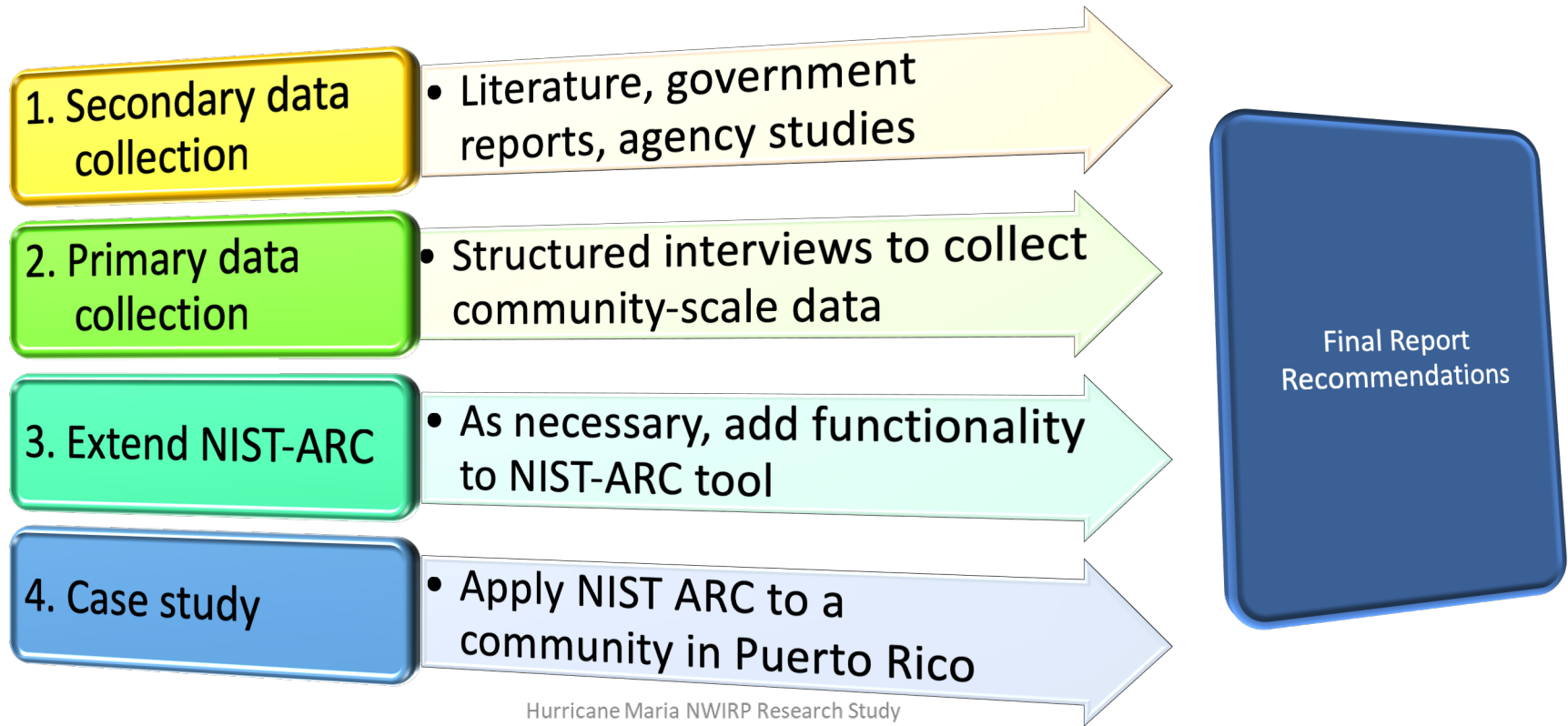
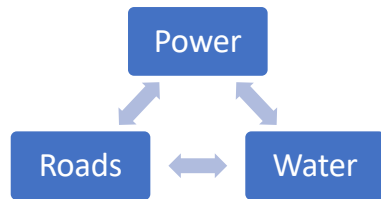


Dependency example



Long line of power generators and fuel tankers on parked trucks with container cranes overhead, arriving to the port of San Juan, Puerto Rico. Source: FEMA

Project Plan

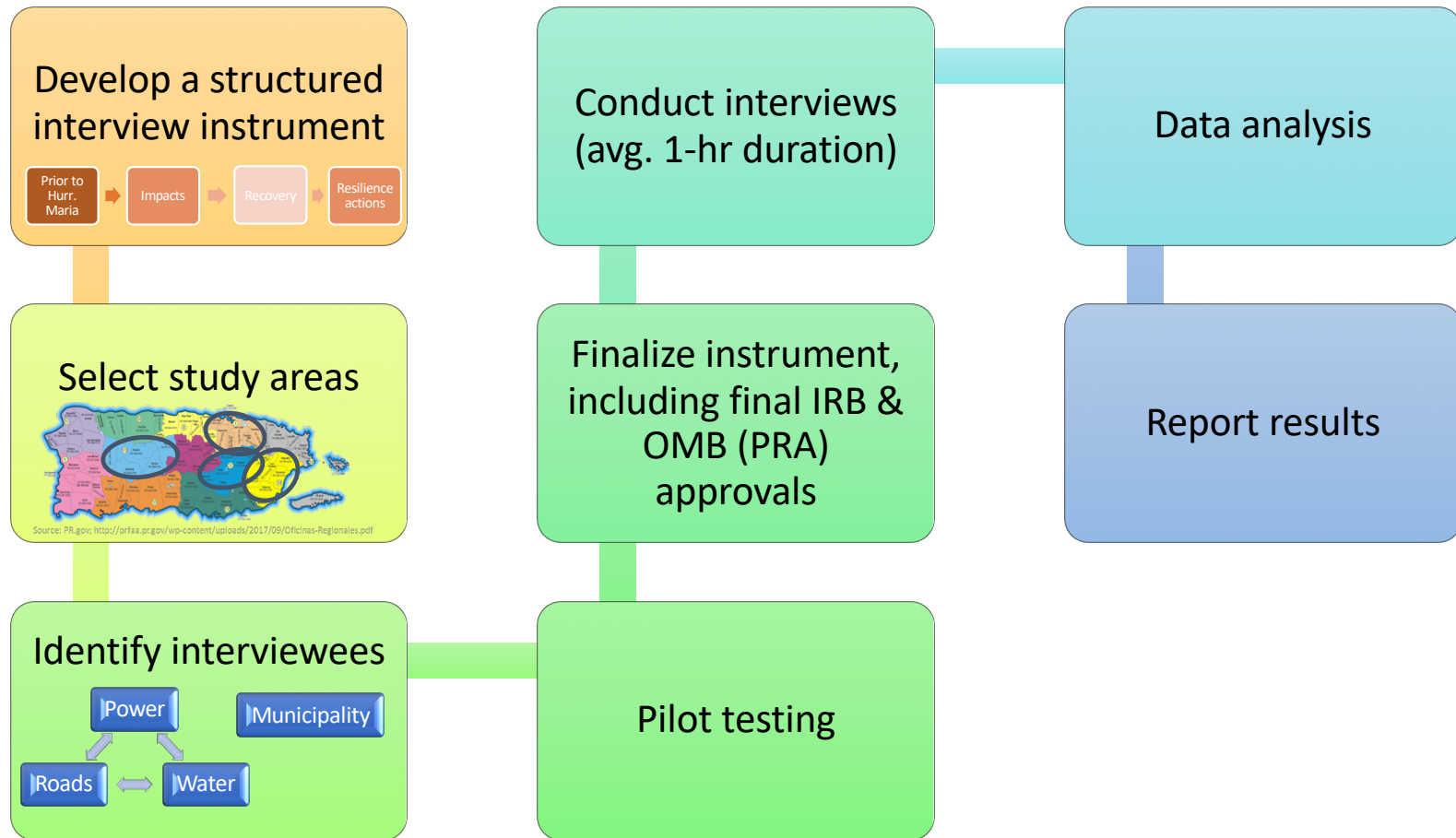




1. Secondary data collection

- Example sources
 - Federal agencies (FEMA after-action reports, DOE, GAO, USEPA)
 - Puerto Rico agencies presentations/reports (e.g, PREPA, PRASA, DTOP)
 - Professional society documents (e.g., Institute of Transportation Engineers (ITE))
 - Journal articles

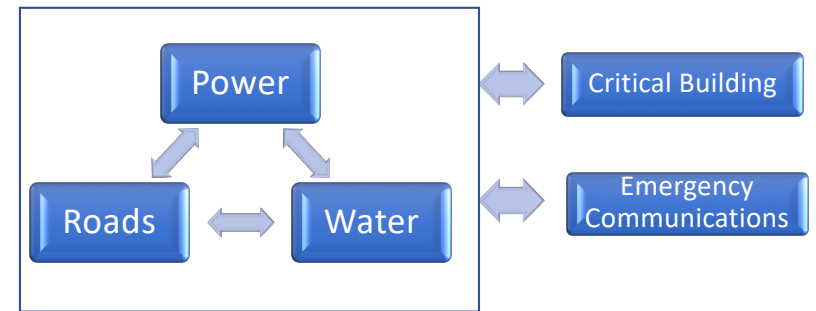
2. Primary data collection



3. Extend NIST Alternatives for Resilient Communities (ARC) tool

NIST-ARC is a new (alpha) interactive tool for developing alternative sets of actions meeting community resilience and cost goals, given hazard and interdependency information, and socio-economic data.

Assists with the process of developing viable alternatives for stakeholder consideration.



4. Case study



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

- Coordinating with the other projects, identify case study centered on one community
- Apply NIST-ARC tool as demonstration of incorporating dependencies into the decision-making process

FY19 Progress Updates

1. Secondary data collection

- Complete through August 2019
- Have general knowledge of range of prior infrastructure state, impacts, recovery and resilience decision-making

2. Primary data collection

- Framework in place, consisting of common sets of questions for water, power, and transportation
- Lists of potential responses are informed by secondary data (Step 1)

3. Extend NIST-ARC

- Changes made that improve recovery model validity:
 - Use of generators (delivery, fuel, backup capacity)
 - Startup time (e.g., flushing water distribution systems)

4. Case study

- To start in 2021

Next Steps

1. Secondary data collection

- Update as new information is made available
- Through outreach, obtain new data from Puerto Rican agencies (PRASA, PREPA, DTOP)

2. Primary data collection

- Award the contract
- Complete the interview instrument
- Gain final IRB and OMB approvals for instrument

3. Extend NIST-ARC

- Extensions that support improved modeling of the transportation system and the movement of goods

4. Case study

- To start in 2021



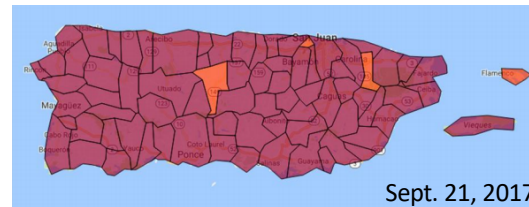
Project: Physical Performance of Wireless Communications Systems during Hurricane Maria

Project Objective:

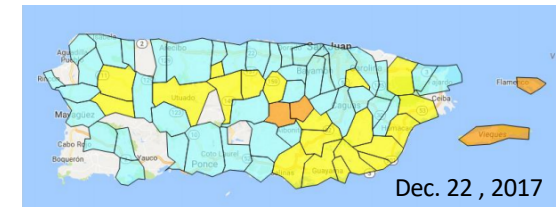
- To investigate causes of the loss of functionality and extended-duration outage of the wireless communication system in Puerto Rico following Hurricane Maria.

Cell Sites Out-of-Service, by County (%)

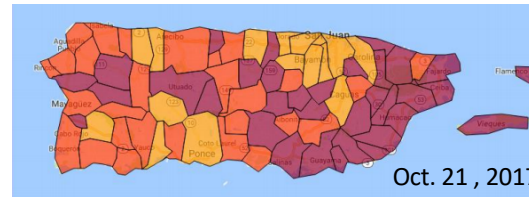
1 - 20 21 - 40 41 - 60 61 - 80 81 - 100



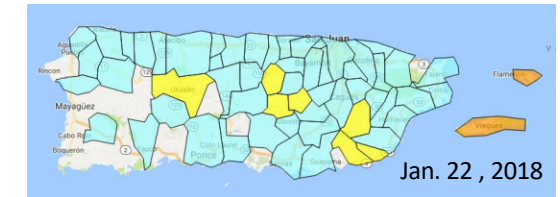
Sept. 21, 2017



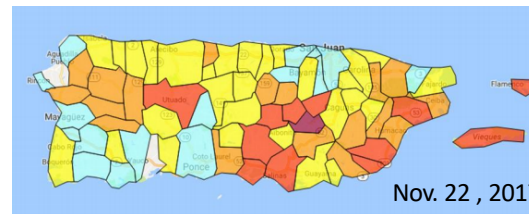
Dec. 22, 2017



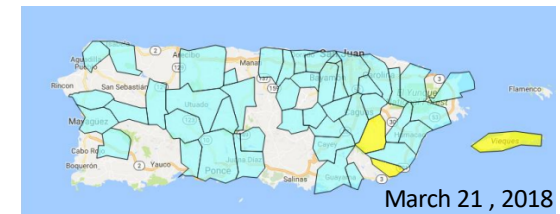
Oct. 21, 2017



Jan. 22, 2018



Nov. 22, 2017



March 21, 2018

Source: FCC

Hurricane Maria NWIRP Research Study

Investigation Plan

- Collect data on damage caused by Hurricane Maria to cell towers, equipment, cabling, and related components of wireless communications systems, from regulatory agencies, telecommunications companies, and telecommunications support industries
- Collect data on other causes of service outages, including loss of power and damage to backhaul
- Collect information on codes, standards and regulations governing the design and construction of cell towers and wireless communication equipment
- Determine the hazard levels experienced at cell site locations using information from the Hazard Characterization project
- Evaluate tower and equipment performance with respect to the hazard levels experienced at each site and code design requirements

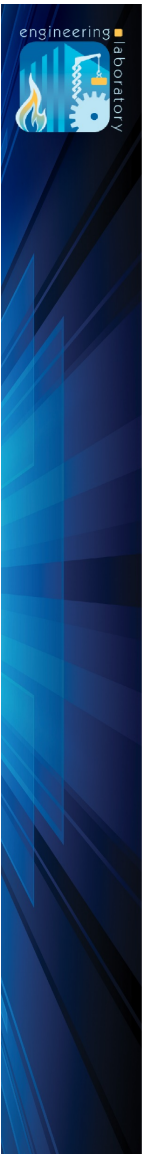


Progress Updates

- Held several meetings with the Federal Communications Commission (FCC)
 - Obtained information on the overall performance and recovery of the wireless telecommunications system in Puerto Rico
- Held multiple meetings with a leading provider of wireless telecommunications infrastructure
 - While damage to their towers was limited, wind damage to cabling and antennas on towers may be an issue
- Program leadership team met with the President of Junta Reglamentadora de Telecomunicaciones de Puerto Rico (JRT – the Regulatory Board of Telecommunications of Puerto Rico)
 - Gathered information on the causes of communications outages and on the recovery efforts
- Met with the Chair of the Telecommunications Industry Association (TIA) TR-14 Committee that maintains the *ANSI/TIA 222 Standard For Antennas and the Supporting Structures For Antennas And Small Wind Turbines*
 - Wind loads on cabling and antennas are not fully covered in existing standards
- Confirmed (from the sources above) our preliminary assessment (which were based on media reports, telecommunications company press releases, and NIST analysis of aerial post-storm imagery) that very few towers collapsed



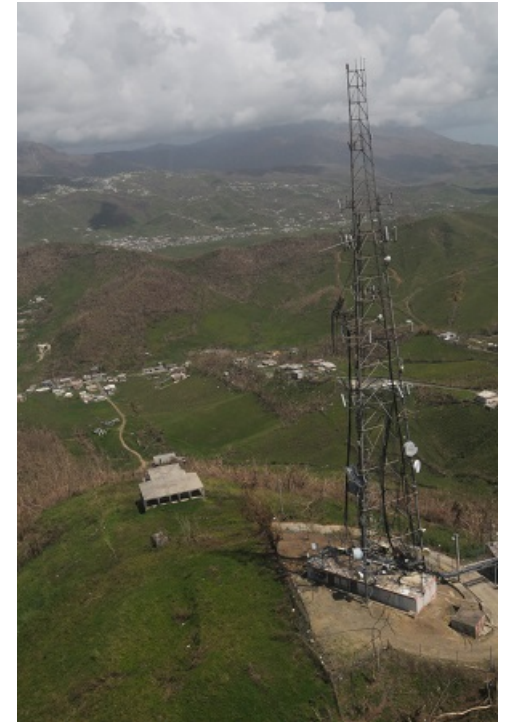
Source: FEMA



Next Steps

- Planning for Fall 2019 data collection trip to Puerto Rico, including potential meetings and site visits with
 - JRT
 - FEMA Joint Recovery Office
 - Wireless communications service providers
 - Wireless communications infrastructure providers
 - Wireless equipment installation and repair providers
 - Cell site locations (towers, building rooftops, other structures)
- Continue identification of codes, standards, regulations and practices governing the wind load design and construction of communications towers and the equipment such towers support, as well as any design requirements for other hurricane-related hazards

A severely damaged cellular tower remains on a hillside in Puerto Rico after Hurricane Maria October 8, 2017



Source: U.S. Army