

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

Recovery of Business and Supply Chains Post-Hurricane Maria

Project Leader: Jennifer Helgeson

Objective:

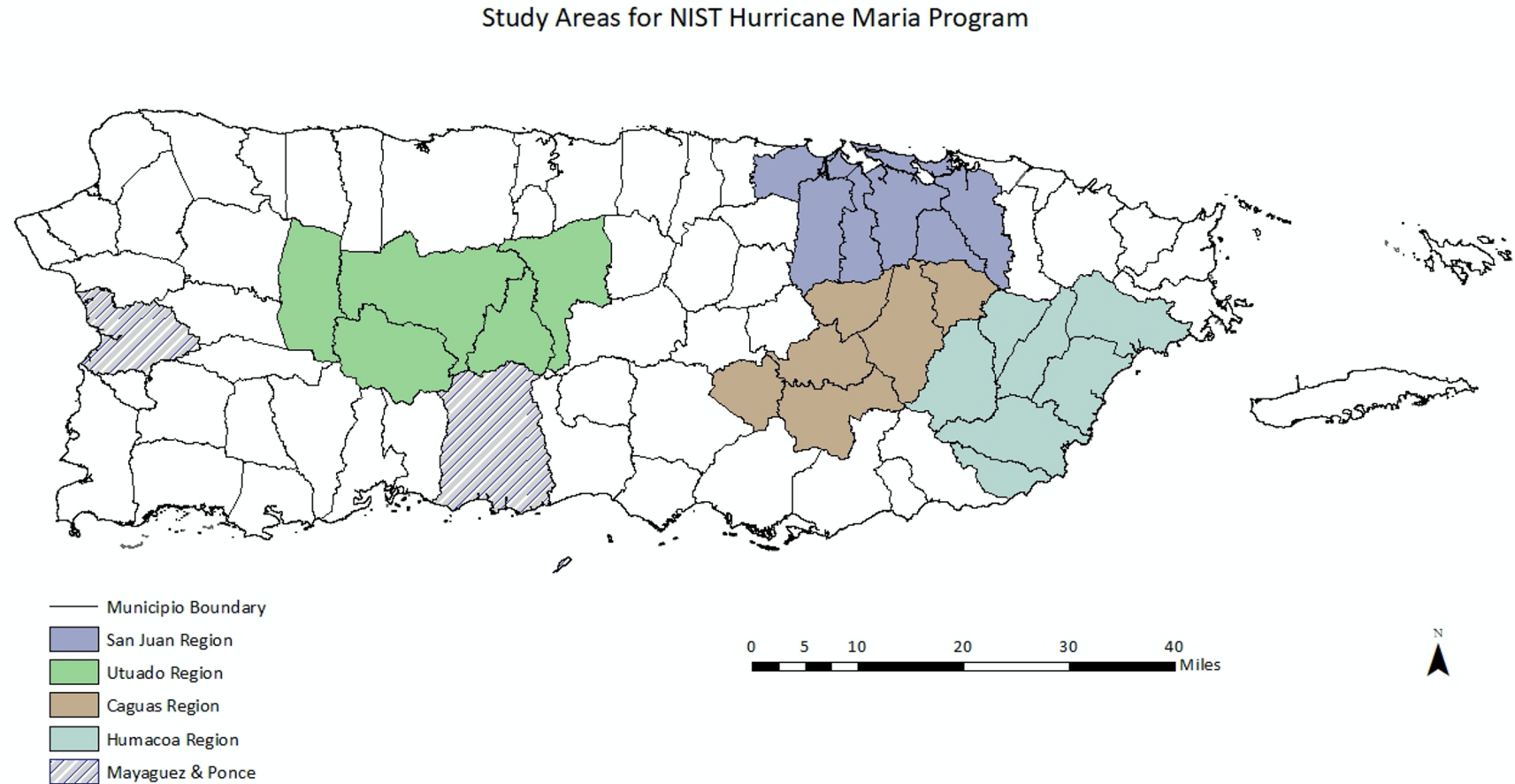
- Identify the underlying characteristics and conditions associated with recovery of supply chains from Hurricane Maria in Puerto Rico.
- Examine the recovery trajectories of sampled small- and medium-sized businesses, including manufacturing, retail, and service sectors in Puerto Rico, to provide greater understanding of business continuity resilience planning and supply chain continuity and how these may differ between industries/affected regions.

Project Goal

The goal of this project is: To characterize the recovery of small- and medium-sized businesses, including manufacturing, retail, and service sectors in Puerto Rico to provide greater understanding of business continuity resilience planning and supply chain continuity and how these may differ between industries/affected regions.

Regions Selected for NIST Study

- Municipios (municipalities) selected as the study unit
- Municipios selected within the six shaded regions shown below
 - Four common across all NIST projects
 - Addition of Mayaguez and Ponce (concentration manufacturers)



Data Source: US Census Bureau TIGER/Line 2016, FEMA 2017
 Developed: NIST 2020; using ESRI software
 Coordinate System: GCS NAD 1983
 Datum: NAD 1983
 Scale: 1:700,000

Project Plan – Overview

Two-part plan and analysis outcomes:

1. Sampling and Surveying individual small- and medium-sized enterprises (SMEs):
 - Small- and medium-size manufacturers (SMMs) and
 - Small- and medium-sized businesses in the retail and services sectors (e.g., grocery, clothing, and restaurants)

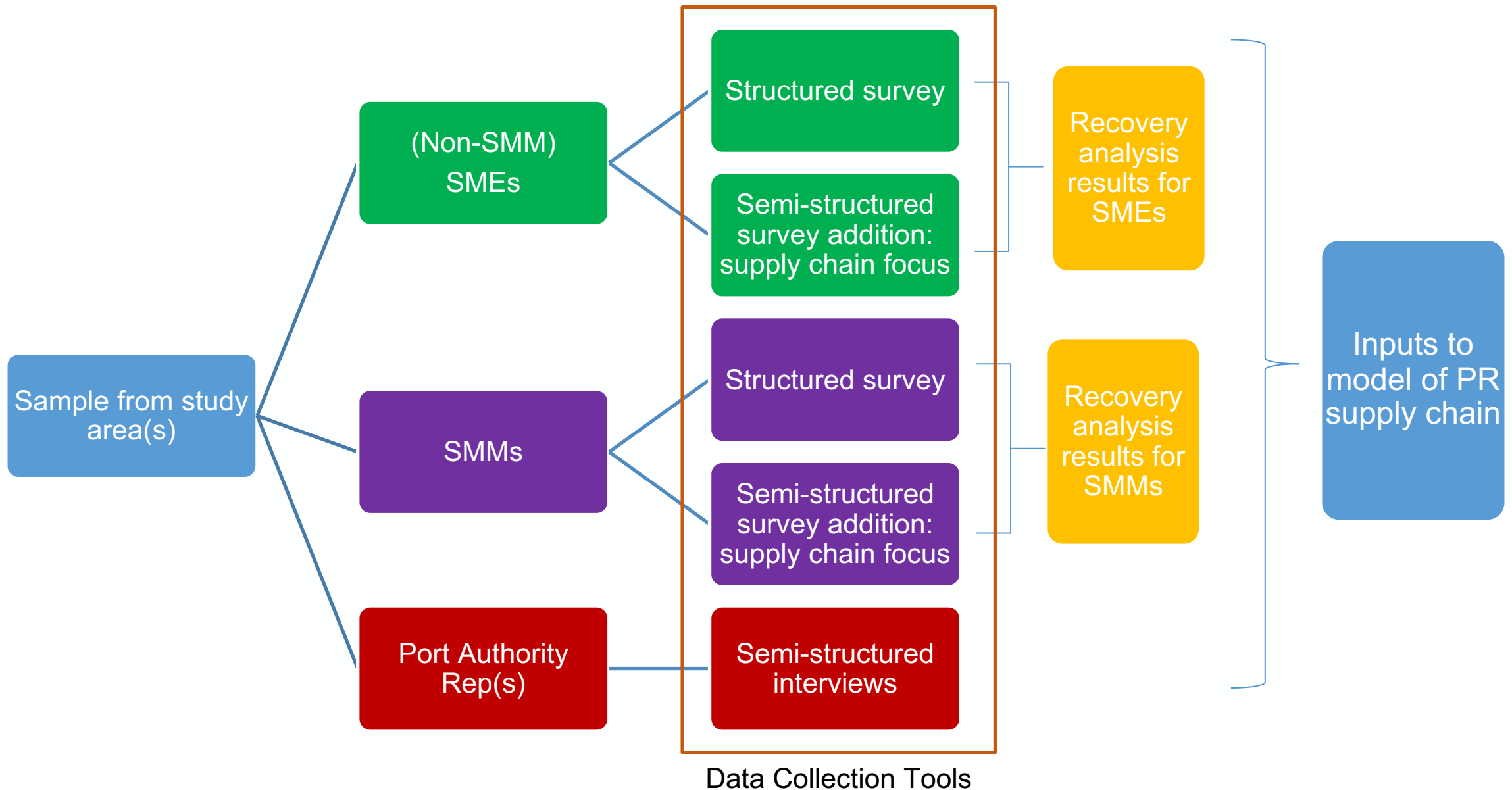
(contractor supported effort, in progress)

2. Full supply chain modeling (based upon infrastructure) for key Puerto Rico-based industries:

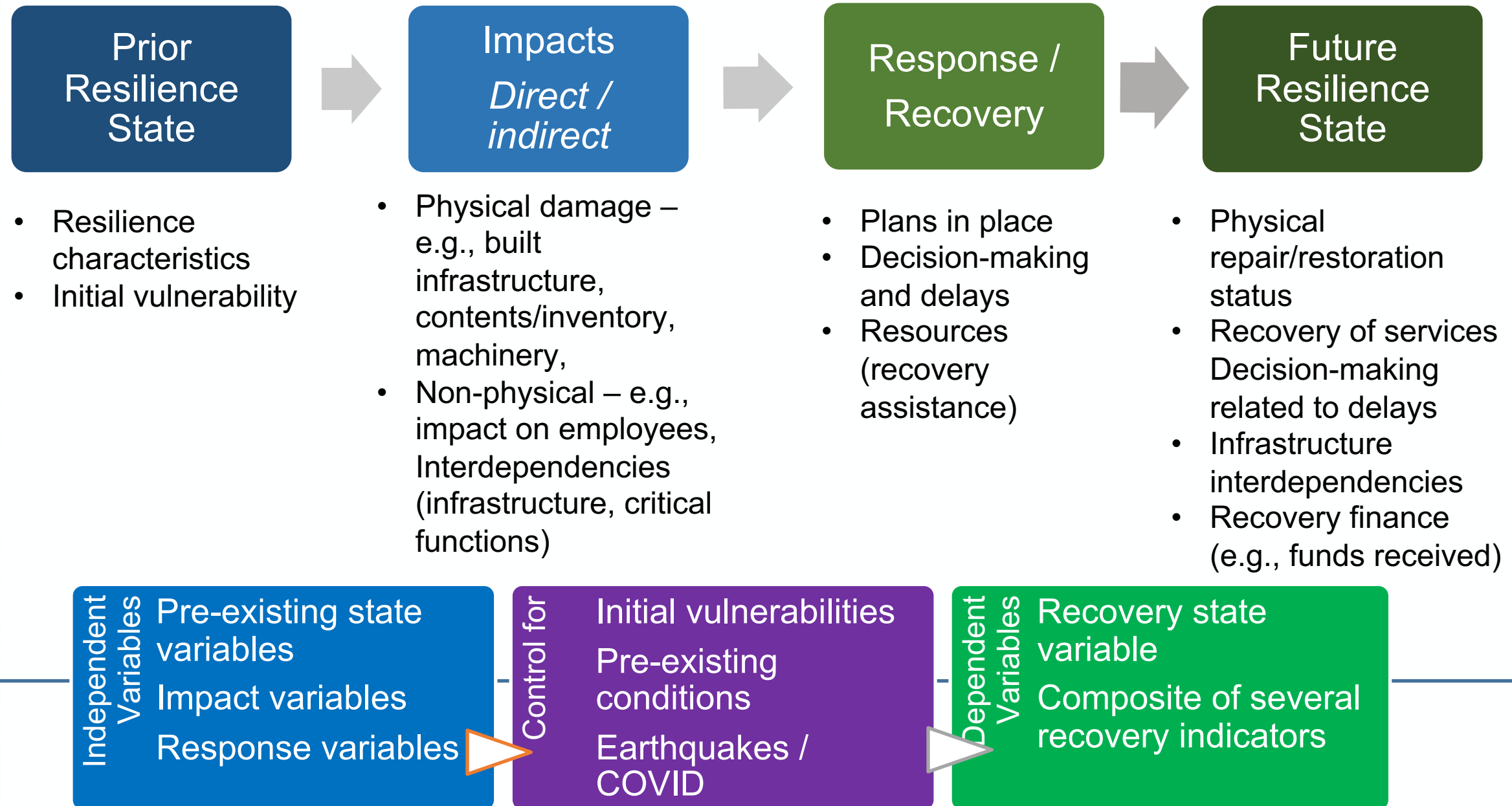
- Medical Device Manufacturing
- Food Preparation Manufacturing



Sampling and Surveying individual SMEs: Overview



Sampling and Surveying Individual SMEs: Overview



Recent Progress – Summary (1/2)

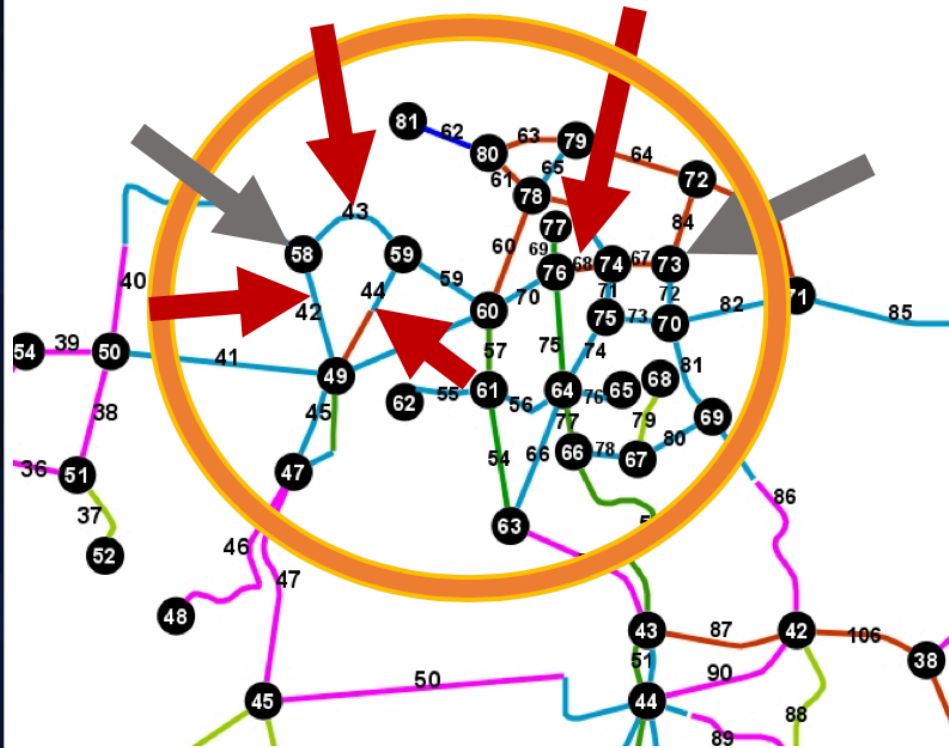
- Travel to Puerto Rico in FY20 Q1 for meetings:
 - PR Ports Authority – import / export information
 - Additional meetings for context and understanding interdependencies with PREPA (Power)
- Contract awarded for survey and interview collections (FY20 Q1); Kick-off meeting (FY20 Q2)
- Identified study areas, drafted data collection instruments, and developed sample frame
- Continued contact with PRiMEX* and additional contact with sector-specific Puerto Rican agencies/associations

*PRiMEX: The Puerto Rico Manufacturing Extension Inc. (PRiMEX) is a private non-profit organization, organized in 1996 through the initiative of Puerto Rico Industrial Development Company (PRIDCO) and the Manufacturing Extension Partnership (MEP), a program under the National Institute of Standards and Technology (NIST).

Recent Progress – Summary (2/2)

- Completed preliminary models for two key sectors using information from company discussions and manufacturing facility tours:
 - Medical Device Manufacturing
 - Food Preparation Manufacturing
- Using two modeling methods:
 - Complex Network Theory (CNT) – classifying the network structure (with a focus on roadways and ports) using the nodal and link degree distribution
 - Discrete Event Simulation (DES) – a simulation process that is used to model event-based systems. DES is a technique to understand how a specific system works in the real world, and how its different components will act under different conditions.
- These preliminary models allows for better question and sample frame development for the data collection instruments focused on individual-level recovery

Recent Progress – CNT Preliminary Findings

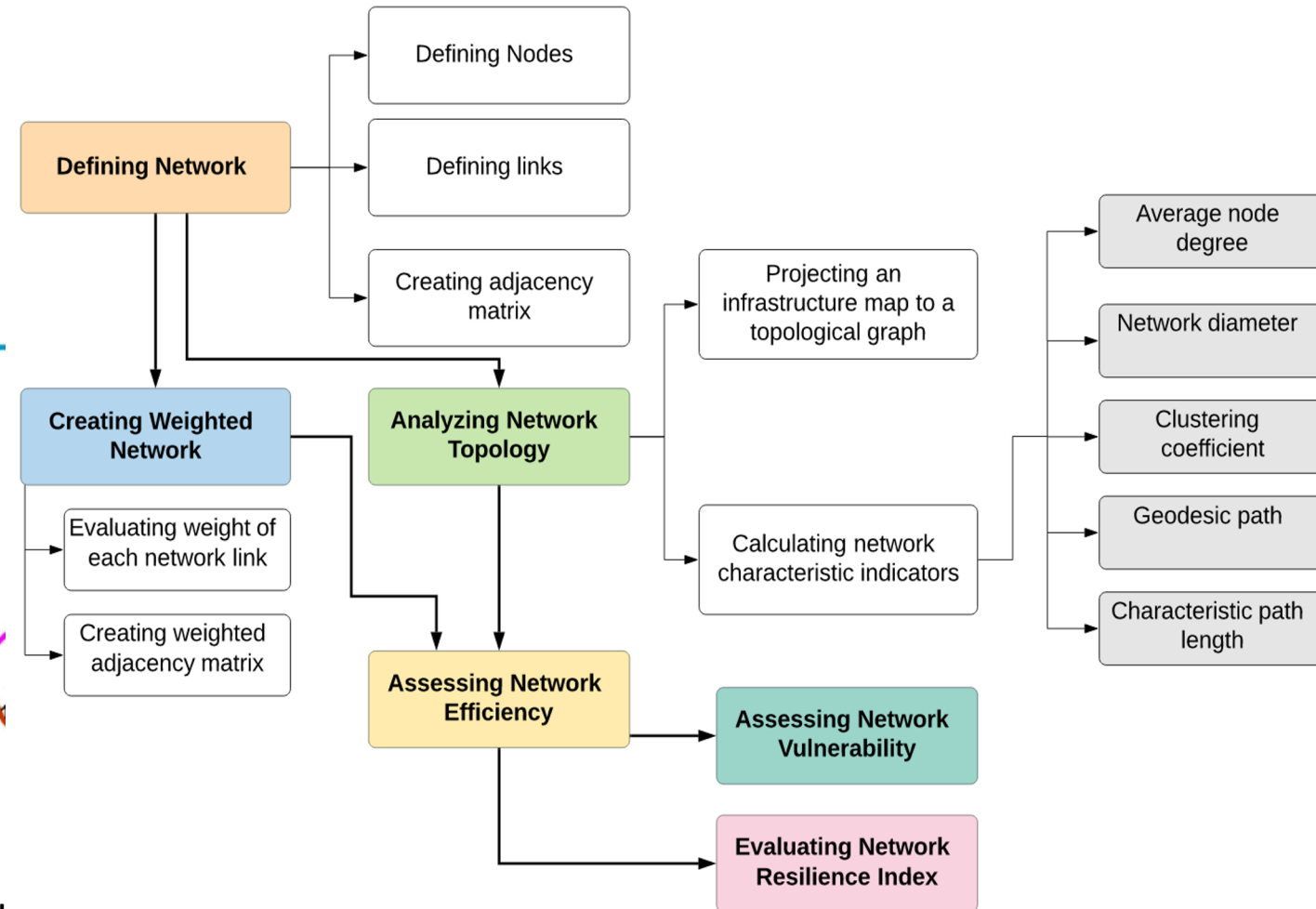


San Juan, PR

Weighted by:
Road type, Population density, Business density

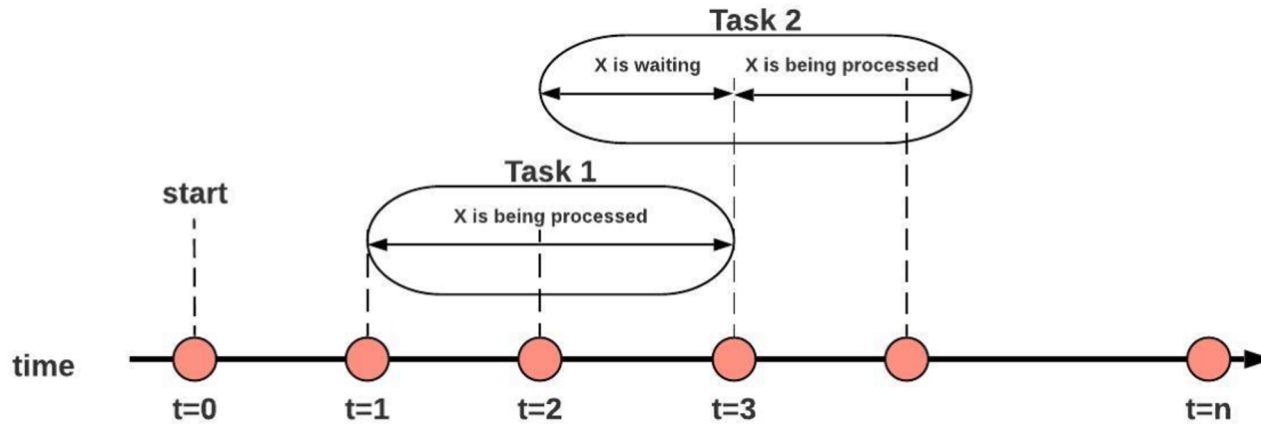
Helgeson, Saadat,
Ayyub (2020)

Most robust nodes
Most robust links

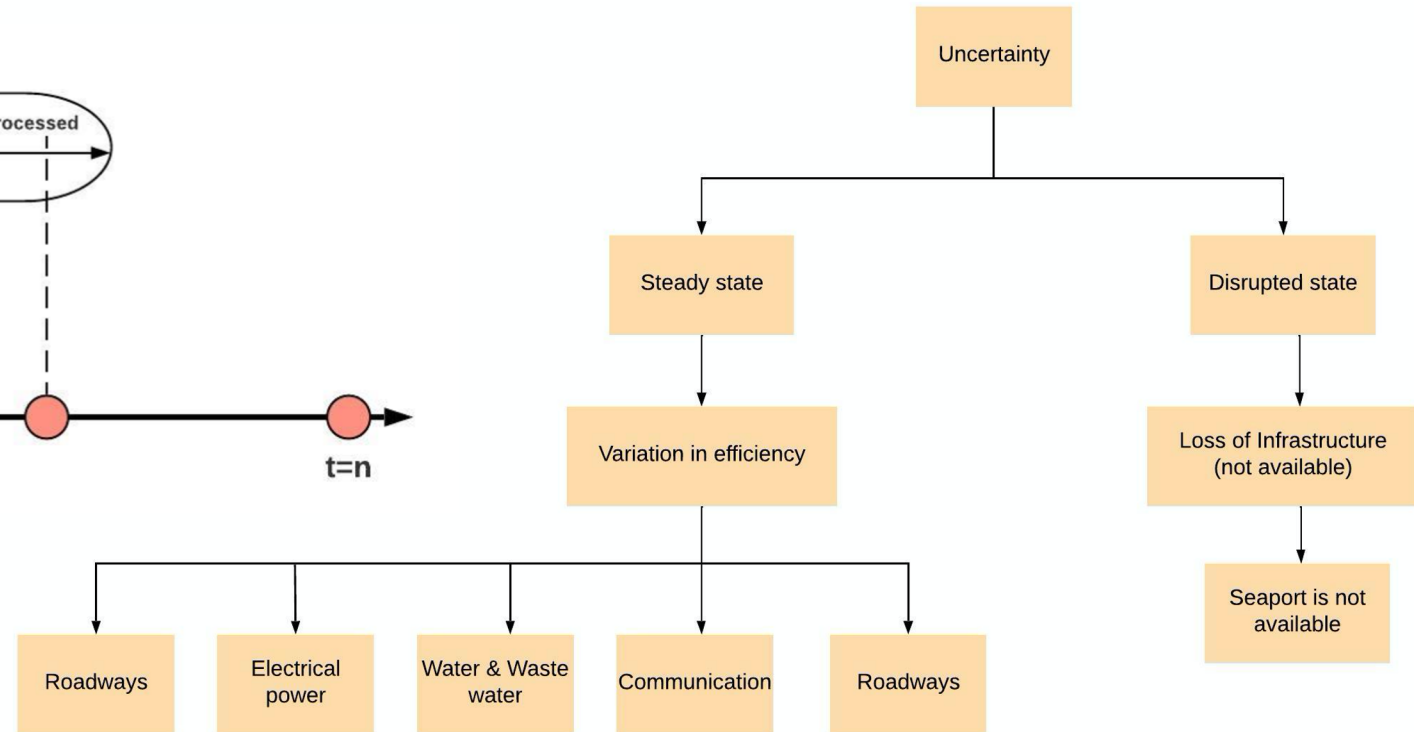


Helgeson, Saadat,
Ayyub (2020)

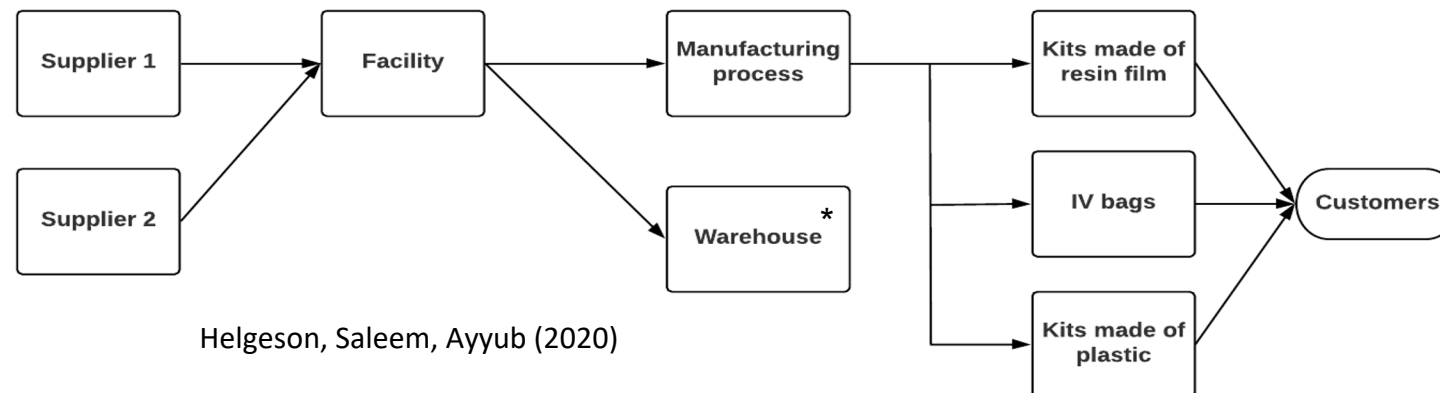
Recent Progress – DES Preliminary Findings



Helgeson, Saleem, Ayyub (2020)



Helgeson, Saleem, Ayyub (2020)



* Warehouse stores overflow supplies from Suppliers 1 and 2

Helgeson, Saleem, Ayyub (2020)

Planned Next Steps

- Complete all data collection instruments
 - Obtain Institutional Review Board (IRB) and Paperwork Reduction Act (PRA) approvals
 - Account for connections to other NWIRP data collections on recovery of social functions and recovery of infrastructure
 - Pilot survey and interview instruments
- Finalize sample of businesses and determine best mode of contact with owners or managers
- Outline econometric and agent-based models for data analysis
 - Property damage and business interruption
 - Business recovery and business information
 - Employee-related recovery
 - Resilience tactics (employed, planned)
 - Recovery finance
 - Control questions: Earthquake-related / COVID-related