



WU MIANXI
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ASSESESING HURRICANE IMPACTS AND RECOVERY USING A SYNTHETIC CONTROL MODEL AND NIGHTTIME LIGHT TIME SERIES:A CASE STUDY OF HURRICANE MARIA IN PUERTO RICO

Background

Climate-Related Disasters

The increasing frequency and intensity of hazards jeopardize the pursuit of global sustainable development, particularly impacting developing coastal areas.

Problem Statement

- Drawbacks of traditional disaster assessment approaches: Costly and time-consuming.
- Challenges of determining baseline NTL intensity have impaired the robustness of NTL analysis

Research Significance

- A leading step to combine Random Forest based Synthetic Control model and nighttime light data (NTL) for disaster analysis at sub national level
- Improving the robustness of NTL-based disaster assessments by enhancing the precision of NTL baseline determination
- Informing policymakers on resource allocation and recovery strategies.
- Extended application to other hurricane-prone coastal regions.

Research Objectives

1. To innovate disaster assessment methodologies by integrating SCM and NTL time series for subnational-level analysis.
2. To examine the spatial heterogeneity regarding impacts and recovery trajectories across 78 municipalities over extended periods.

Methodology

Nighttime Light data: Black Marble VNP46A2 product suite (2017-03 ~ 2018-05).

Predictors:Demographic, Housing, Financial Characteristics; Kernel Density of Urban Amenities

Random Forest Regression based Synthetic Control Model

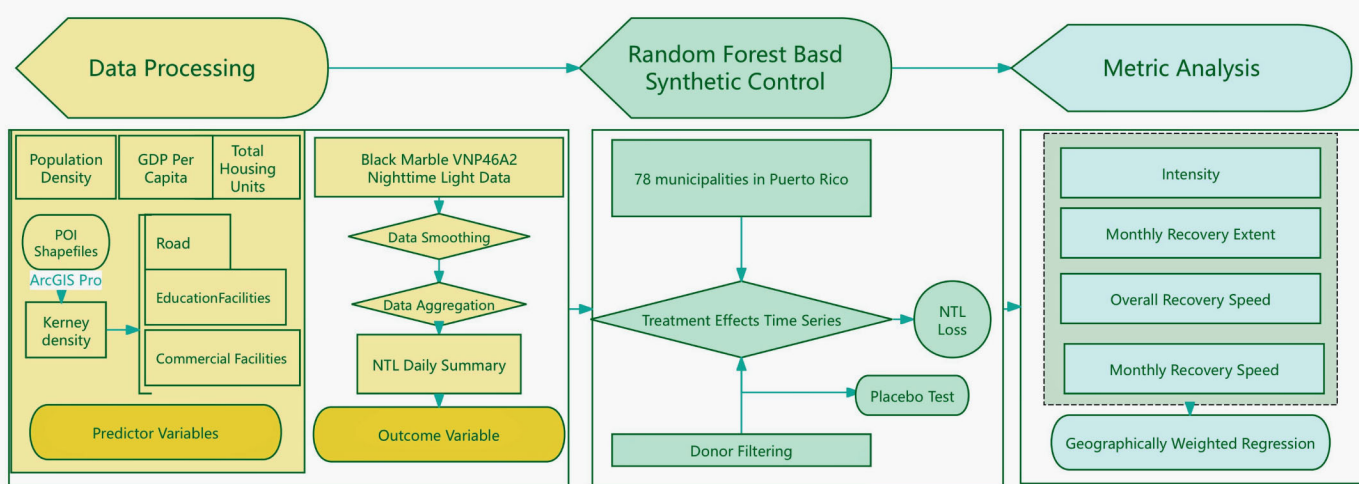
Simulates counterfactual NTL trends for municipalities in Puerto Rico using donors

Metric Analysis:

Impact intensity, Recovery Extent, Recovery Speed

Geographically Weighted Regression: identifying region-specific contributors of recovery progress

Workflow



Research Findings

Hurricane Impact Intensity

- The counties with the least NTL proportional loss had an impact intensity of over 80%.
- The counties with the most severe NTL proportional loss are predominantly situated along the movement path of Hurricane Maria with relatively high peak gust speed.
- The two lowest impact intensity values were recorded by Dorado and Quebradillas, indicating the contingency of the initial impact intensity upon the local economic base and industry structure.

Recovery Extent

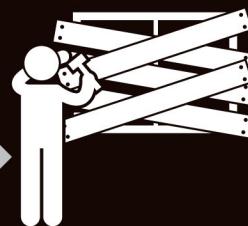
- **Three typical recovery scenarios: Rapid recovery, Slow recovery, and Volatile recovery.**
- Southeastern municipalities initially bearing the brunt of Hurricane Maria with relatively high impact intensity struggled for regaining NTL but with minor efficacy.
- Most municipalities achieved 80% NTL recovery at the end of the research period, while Humacao and Patillas struggled around 50%.
- Some counties recorded recovery levels higher than 100% in the later stages, indicating the efficacy of disaster relief efforts.
- Atypical slumps in recovery trajectories were observed in the municipalities of San Sebastián, Manatí, Toa Baja, indicating potential issues affecting local socioeconomic activities.

Recovery Speed

- The large-scale commencement of NTL recovery was recorded in Nov. 2017. Most municipalities experienced a further NTL decline in the month following the hurricane, while some southwestern municipalities showed a positive percentage change in synthetic NTL intensity.
- Coincidence between lower recovery speeds, persistent low recovery content, and high impact intensity
- Remote inland municipalities like Sabana Grande and Comerío face difficulties in NTL restoration due to geographical inaccessibility, diminished populations, and primitive infrastructure.

The advancement of RF-SC model over previous NTL-based subnational-level disaster assessments: Depicting post-disaster human activities by accounting for the interactions of confounding factors.

1. A pragmatic recovery goal centered on resuming daily life and production to an "expected level," accounting for human activities, financial constraints, and population decline.
2. Geographically heterogeneous recovery patterns across municipalities reveal region-specific disaster repercussions and challenges, highlighting the need for local planners and governors to examine disaster relief implementation effectiveness.



Recommended Adjustments for Restoration Protocols

- Shifting funding emphasis to municipalities with **aged building clusters**
- Refining the damage-assessment indicators to include the age of the facility.