# The Resilience to Disasters & Emergencies Index (REDI)

#### A Unified Index of Resilience Capacity and Survivability

Constantine E. Kontokosta, PhD, PE, AICP, LEED AP

NYU (CUSP, Polytechnic & Schack)

With Research Assistance from: Awais Malik & Schuyler Poukish

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### BACKGROUND

#### **Project Motivation:**

- No comprehensive measure of local resilience capacity at the neighborhood level
- Govt. needs a decision-making tool for effective prioritization of resource allocation and evaluation of rebuilding investments



Services News Government

Home Overview Housing Small Business Community Reconstruction Infrastructure Communications Funding

GOVERNOR'S OFFICE OF STORM RECOVERY

TRANSLATE



"We're not just going to build what was, we're going to build to a level that never was before."

- Governor Cuomo



Governor's Office of Storm Recovery Announces \$40 Million to Create Network of Resilient Community Centers

http://stormrecovery.ny.gov/governor%E2%80%99s-office-storm-recovery-announces-40-million-create-network-resilient-community-centers-7

## PROJECT OBJECTIVES

- Develop a unified, multi-factor index of local and regional resilience capacity and vulnerability
  - The REDI Score<sup>TM</sup> combines measures of physical infrastructure, economic and social vulnerability to classify the relative resilience capacity embedded in localized urban systems
  - Use cases:
    - Benchmark local resilience capacity for spatial-temporal comparative analysis
    - Prioritize investment decisions for mitigation measures and preparedness
    - Measure and evaluate investment decision outcomes
- Create an interactive visualization of New York City highlighting the vulnerability and resilience capacity
  - Currently analyzing each Borough separately at Census tract level

## DATA SOURCES

Dept. of City Planning



- Dept. of Transportation
- Metropolitan Transit Authority
- Office of Emergency Management
- Federal Emergency Management Agency
- Dept. of Information Technology & Telecommunications
- Dept. of Finance
- United States Census Bureau













Note: All Data used is OPEN

## METHODOLOGY

#### REDI Score Composition

#### **Environmental Conditions**

- -Proximity to and extent of waterbodies (streams, rivers, lakes, ocean, etc.)
- -Topography and hydrology
- -Tree cover
- -Building density and open space

#### Social Infrastructure and Community Connectivity

- -Percent of population with incomes below poverty level
- -Percent of population over 65 years of age
- -Percent and type of subsidizedhousing
- -Voter participation rates
- -Homelessness rates
- -Health/disability indicators

#### Physical Infrastructure

- -Condition of bridges, tunnels, and other critical infrastructure
- Condition and capacity of energy networks
- Condition and capacity of water and wastewater systems
- -Condition and capacity of transit systems and roadways
- -Extent of distributed energy generation
- Access and proximity to emergency services

## REDI Score

#### Strength of Economy

- -Diversity of local industry composition
- -Growth and stability of regional economy
- -Housing affordability
- -Income equality

## METHODOLOGY

#### Defining Resilience Capacity

REDI Scores using Standardized Scores:

$$REDI_j = \left(\frac{1}{N}\right)\sum_{j=1}^n \left(w_i \times x_{ij}\right)$$

where,

 $REDI_j = RED \text{ Index for Locality } j$ 

N = Number of indicator variables

 $w_i =$  Weight for indicator i (optional)

 $x_{ij}$  = Indicator Value for indicator i for Locality j

where Indicator Value = 
$$z_{j} = \frac{x_{ij} - x_{ik}}{\sigma_{ik}}$$

where,

 $z_j$  = standard score for Locality j

 $x_{ij}$  = difference from baseline in indictor i for Locality j

 $x_{ik} =$  mean difference in indictor *i* for Region *k* 

 $\sigma_{ik}$  = standard deviation of difference in indicator *i* for Region *k* 

## INDICATOR VARIABLES

- ~ 30 variables selected for initial REDI iteration
- Indicator Variable Weights:
  - 1 = Adds Resilience
  - -1 = Adds Vulnerability
- REDI scores for each borough calculated separately
  - Normalized to 1 100 range
  - Higher score indicates greater resilience capacity

## INDICATOR VARIABLES

## Social Infrastructure & Community Connectivity

- Population Density
- Population Under 18
- Population Over 65
- Single-occupancy household density
- Households with under 18 occupants
- Vacant Housing Units
- Population Over 25 not graduated High School
- Population Over 25 with at least Bachelor's degree
- Population Over 3 not enrolled in school
- Percent Population with no Health Insurance Coverage
- Percent Families with Income below Poverty Line

#### Physical Infrastructure

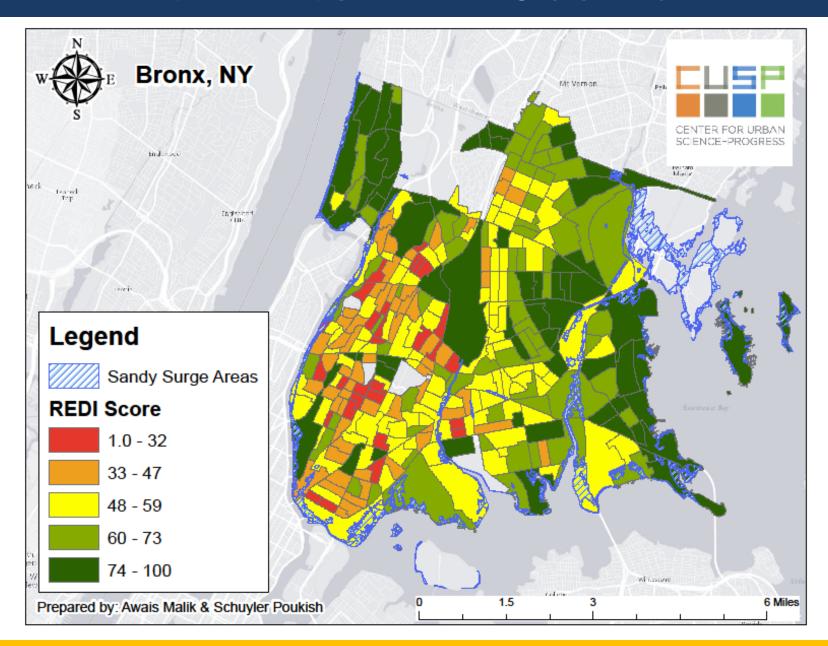
- Fire Stations
- Police Stations
- Health Services
- Libraries
- Schools
- Subway Entrances
- Adult Social Services
- Child Social Services
- Residential Developmental Disabilities Services
- OEM Evacuation Centers within 1 mile radius of Tract Center

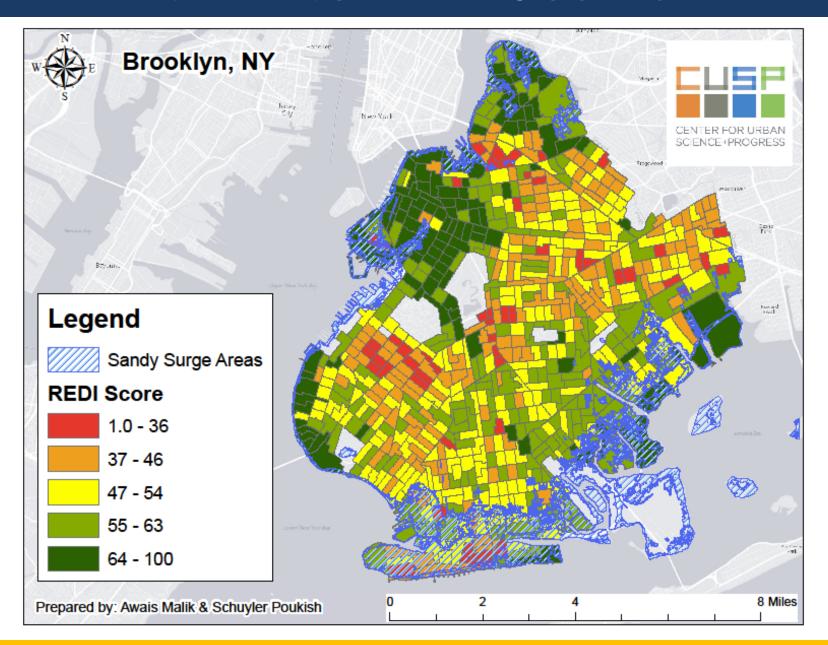
#### Strength of Economy

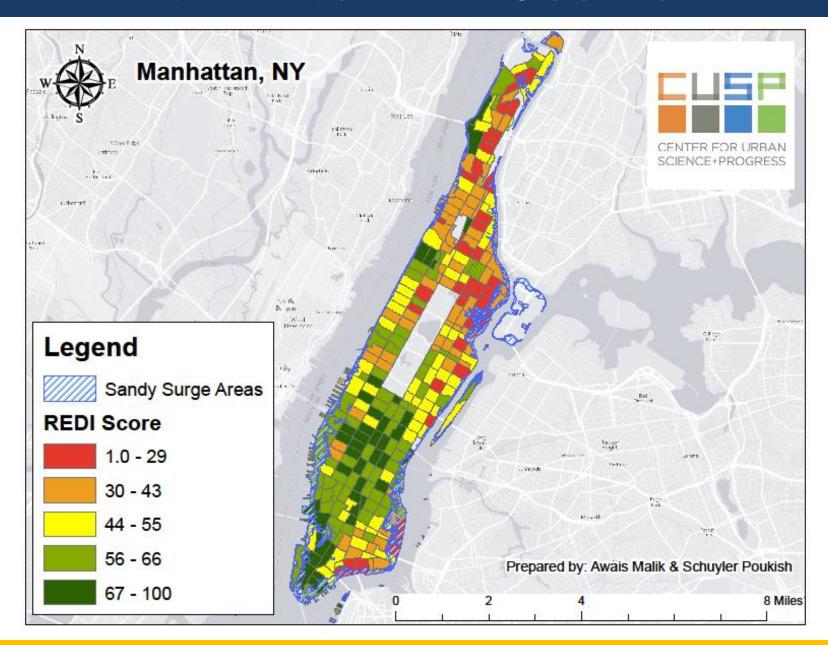
- Unemployed Population Over
   16 in Labor Force
- Gini Index for Income Inequality
- Lack of Economic Diversity (Derived Indicator)
- Median Household Income

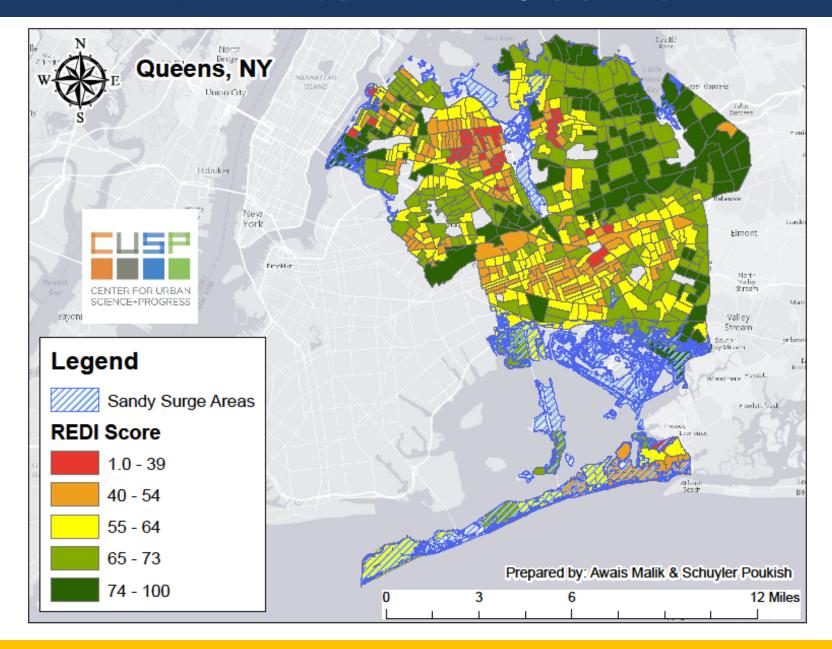
## Environmental Conditions

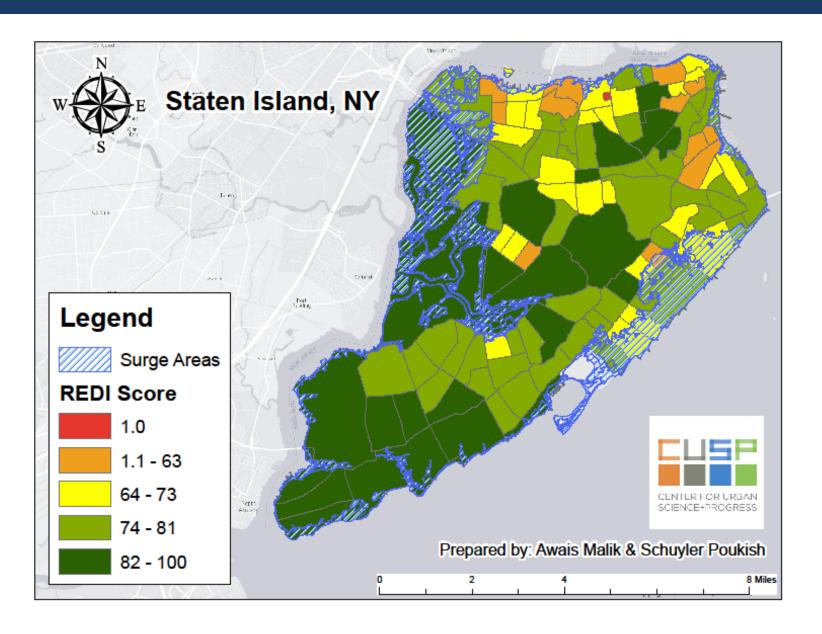
- Percent of Tract covered by Sandy
- Tree Density
- Building Density
- Percent of Tract Open Space











## NEXT STEPS

- Iteratively improve REDI scores
  - Incorporate additional indicator variables
  - Create REDI scores for each of the 4 subcategories separately
  - Combine all 5 boroughs into a single dataset
- Discuss neighborhood case studies
  - Application of REDI scores to Sandy outcomes
- Develop spatial-temporal database of critical infrastructure, built environment, social, economic variables
  - Improve GIS database platform
    - How to efficiently handle 'big' data?
- (TBC) Launch interactive visualization tool of online mapping, query,
   and analysis of REDI Scores for NYC
- (TBC) Expand to New York State