Spillover Effect in Predictive Recovery Based on Hazard, Built-Environment, and Population Features

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INTRODUCTION

- The frequency and intensity of natural hazards are increasing with time. Timely population activity recovery is a key aspect of maintaining functionality of cities. Predictive recovery monitoring is an essential step to ensuring the functioning of cities return to normal.

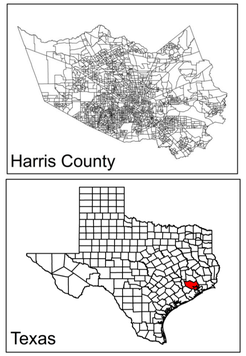

Figure 1. Case study location

- The extent to which physical vulnerability, hazard exposure, population protective actions, and population attributes affect the duration of population activity recovery at the neighborhood level is limited in the context of community recovery as a spatial process.
- Harris County, see **Figure 1**, located in Texas was chosen as a case study, primarily due to its high flood risk and exposure to hurricanes as for its vicinity to the Gulf of Mexico.

RESEARCH QUESTIONS

- The research questions which drove this study are:

(**RQ1**) Which features of the spatial areas are associated with the duration of the population essential activity recovery?;

(**RQ2**) To what extent do the features of the neighboring spatial area influence the population essential activity recovery?; and

(**RQ3**) What is the extent of spatial effects in the population activity recovery in impacted regions?

DATA

- The dependent variable in this study is the population activity recovery, while the independent variables can be categorized into three groups: hazard, built-environment, and population features, as shown in **Figure 2**.

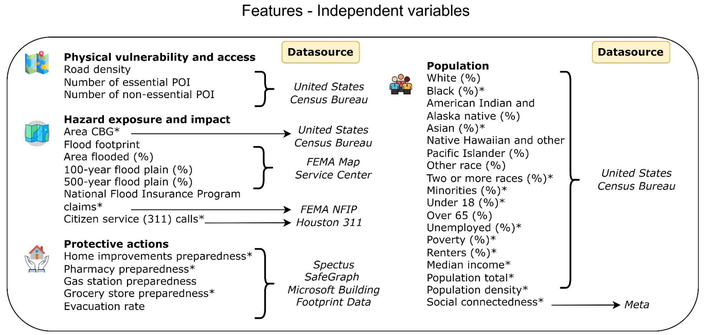

Figure 2. Independent and dependent Variables

FRAMEWORK

- The selection of features was performed using a random forest algorithm. Additionally, a spatial model was used to evaluate the dynamic effects of community recovery, as illustrated in **Figure 3**.

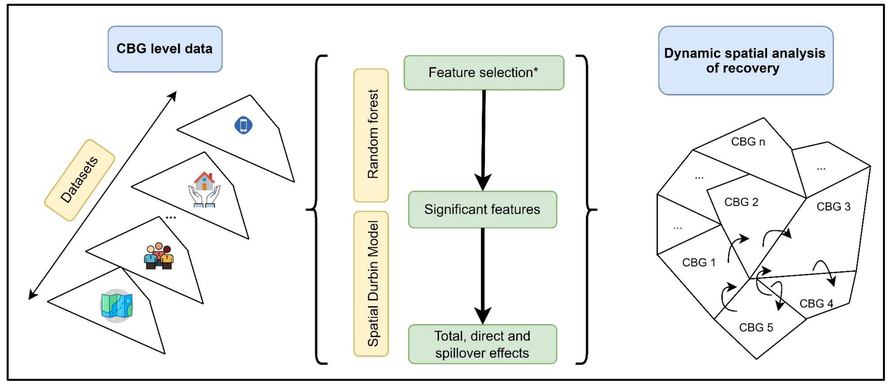

Figure 3. Research framework

METHODOLOGY

- Based on the spatial model types, two strategies were tested: forward step-wise strategy and backward step-wise strategy, as shown in **Figure 4**.
- Spatial Durbin Model (SDM) was the best fit for assessing direct, spillover, and total effects of features on population activity recovery.

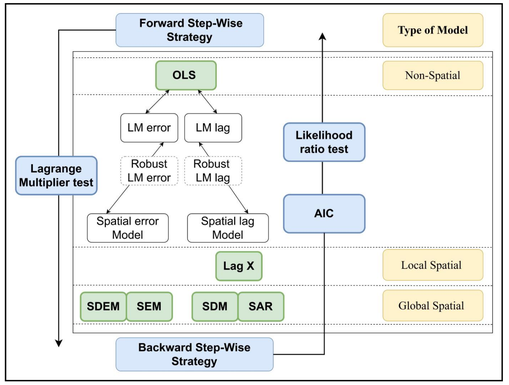

Figure 4. Best fitting model

SIGNIFICANT FINDINGS

- Better preparedness is associated with faster population activity recovery, as outlined in **Table 1.** Notably, the number of people, the proportion of minority groups, and the specific percentages of Black and Asian subpopulations are significant variables in the model for predicting the time it takes for population activity to recover.

Table 1. Results of the Spatial Durbin Model for the population essential activity-based recovery

Features	SDM					
	Simulated p-values			Impact measures		
	Direct effect	Spillover	Total effect	Direct effect	Spillover	Total effect
Physical vulnerability and access						
Road density	0.228	**0.018***	**0.001***	0.094	**0.312**	**0.407**
Number of essential POI	0.069	**0.05***	**0.013***	-0.158	**-0.429**	**-0.588**
Preparedness extent						
Home improvement preparedness	0.100	**0.013***	**0.002***	-0.134	**-0.442**	**-0.576**
Grocery store preparedness	**0.022***	0.976	0.419	**-0.210**	-0.006	-0.217
Population						
Black (%)	0.298	**0.001***	**0.001***	-0.094	**0.574**	**0.480**
Asian (%)	0.067	**0.045***	0.296	-0.133	**0.251**	0.117
Minorities (%)	0.568	**0.019***	**0.020***	0.051	**-0.329**	**-0.277**
Population total	**0.001***	0.755	**0.034***	**-0.388**	0.050	**-0.337**

Significant(*) values at p-value<=5%. Significant values in bold.

ACKNOWLEDGMENTS