A Two-Decade Evaluation of Flood Mitigation Spending by the Federal Emergency Management Agency

Farinaz Motlagh[1], Sara Hamideh, Ph.D. [1], Eric Tate, Ph.D.[2]

[1] Stony Brook University, [2] Princeton University

Motivation

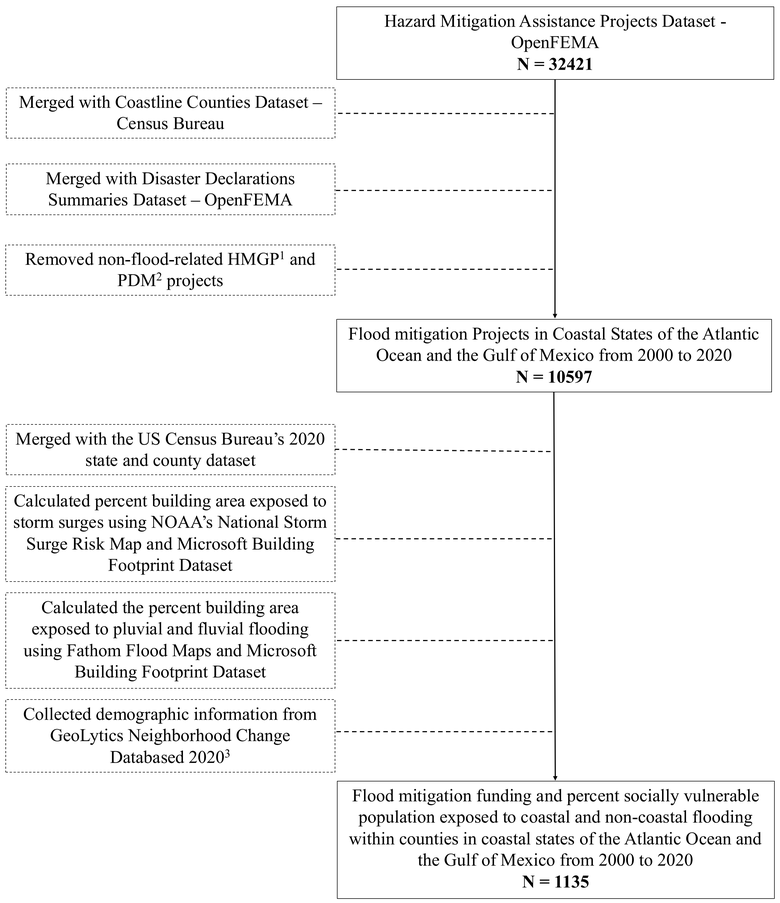
- Flood loss increase due to rapid development in high-risk areas [1,2]
- Federal mitigation programs sometimes fail to reach the socially vulnerable [3,4]
- Wealthier, non-minority areas more likely to receive hazard protection [5,6]
- Raises equity concerns in disaster mitigation program policy and design
- FEMA, the primary source of flood mitigation funding in the U.S., administers three key Hazard Mitigation Assistance (HMA) programs:
  - Hazard Mitigation Grant Program (**HMGP**) – 80% of projects and 82% of funding over two decades [7]
  - Flood Mitigation Assistance (**FMA**)
  - Pre-Disaster Mitigation (**PDM**) and Building Resilient Infrastructure and Communities (**BRIC**) – both discontinued

Objectives

- Identify spatial patterns in the distribution of HMA funding relative to flood exposure and social vulnerability.
- Analyze the factors associated with disparities in funding across counties exposed to different flood types (storm surge vs. pluvial and fluvial), using:
  - **Bivariate Local Indicators of Spatial Association (LISA)**: identifying clusters and spatial outliers of funding, social vulnerability and flood exposure.
  - **Spatial error models**: evaluating association of funding with damage, exposure, social vulnerability, and project characteristics.

Data Processing

This flow chart shows the steps we took to systematically clean our data.



[1] Non-flood-related HMGP projects are tied to the following incidents: tsunami, human cause, terrorist, toxic substances, freezing, volcano, mud/landslide, severe ice storm, tornado, fire, biological, chemical, snow, dam break, earthquake, drought, and fishing losses

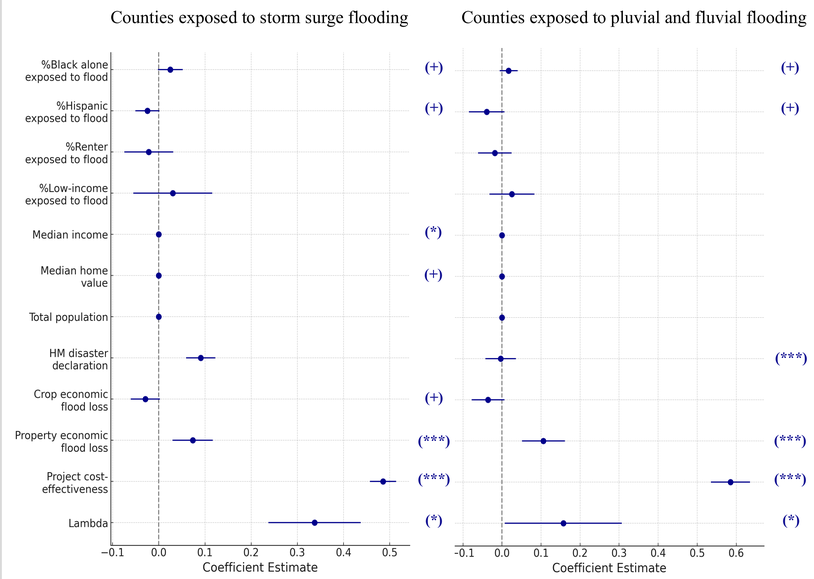
[2] Non-flood-related PDM projects are acquisition of private real property due to landslides and structural retrofitting or rehabilitating public structures due to seismic

[3] Collected demographic information: Total population, White alone, Black alone, other race alone, Hispanic/Latino, total persons below the poverty last year, and median household income last year, renters

Differences in the distribution of funds and projects

- Counties with storm surge flooding received 52% of projects and a disproportionate share of funding (78%).
- Acquisition projects dominated funding in both groups, but coastal counties received **more than double the funding** for similar project counts.
- Differences may reflect higher property values or more properties being acquired per project in coastal areas.

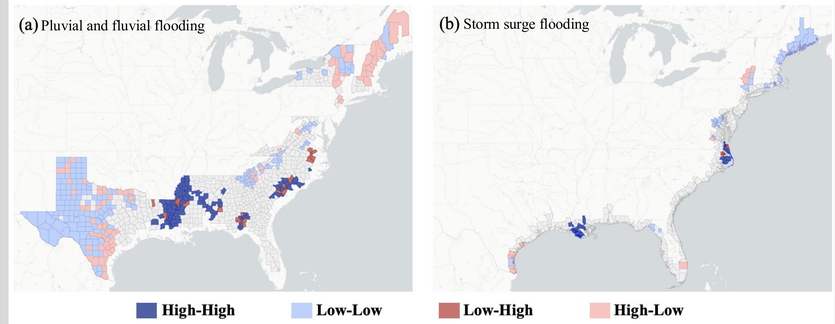
Robust Spatial Error Model



***p≤.001, **p≤.01, *p≤.05, and ⁺p≤.10

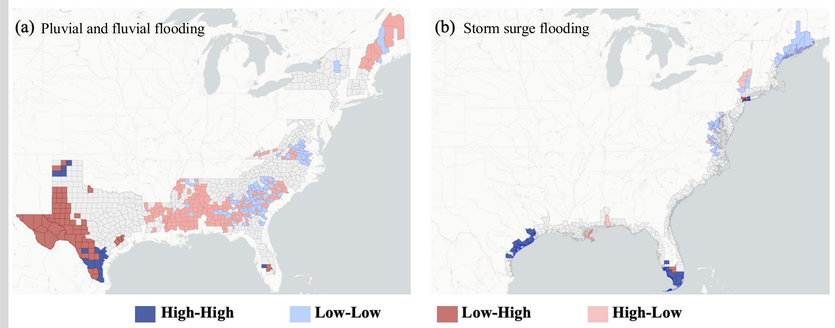
- **Flood-related property damage** is positively associated with per capita FEMA mitigation funding across both inland and coastal counties.
- **Project cost-effectiveness** has the strongest positive association with funding, especially in coastal areas.
- **Hispanic population exposure** is negatively associated with funding in both models, but **Black population exposure** shows a **marginally positive association**; other vulnerability indicators do not have a statistically significant association on per capita funding.

Local Indicators of Spatial Association of Fund and Exposed Black Population



- **High-High clusters** in **Mississippi (40%)** and **Louisiana (24%)**: high mitigation funded counties surrounded by large Black and exposed population counties.
- **Low-High outliers** in **Georgia, South Carolina, and Mississippi**: low mitigation funded counties surrounded by large Black and exposed population counties.

Local Indicators of Spatial Association of Fund and Exposed Hispanic Population



- **93% of High-High clusters** in **Texas and Florida**: high mitigation funded counties surrounded by large Hispanic and exposed population counties.
- **62 of 63 Low-High outliers** also in **Texas**: low mitigation funded counties surrounded by large Hispanic and exposed population counties.

Conclusion

- On average, HMA is allocating $254 million annually to flood mitigation projects **after disasters rather than before**. The reactive approach to hazard mitigation limits the ability of local communities to use these mitigation resources effectively.
- Global models indicate that flood mitigation funding is strongly associated with **property damage and project cost-effectiveness**, both of which are embedded in program design. However, local models show that counties with higher needs are at a disadvantage.
- In the allocation of flood mitigation funding, the HMA program must consider needs based on potential future losses by accounting for socioeconomic capacities and flood exposure, rather than solely considering historic losses and economic returns from mitigation.

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LinkedIn References

Contact:
farinaz.motlagh@stonybrook.edu

Stony Brook University