Identifying Obstacles to Equitable Flood Mitigation Funding

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Abstract

As damages from floods, fires, and other climate extremes mount, public investments in risk reduction have also grown. In the US, public spending on risk reduction efforts totaled over $X in 2024, and demand for such funds regularly exceeds available funding. Evidence suggests that in this competitive landscape for funding, urban and whiter communities have fared better at obtaining funding but are often spending it on more disadvantaged neighborhoods within them. However, the reasons for this trend are unclear: complexities in the application process, cost-benefit analysis requirements, and flood damage may all play a role in driving the uneven funding patterns. Here, using a novel dataset tracking properties from flood exposure to application to funding receipt, we identify how each hurdle in the mitigation process shapes the properties that ultimately benefit. Our findings suggest that application for federal flood mitigation assistance serves as a pinch point where homeowners in less-white neighborhoods and more affordable homes relative to their neighbors apply. This trend deepens for those who ultimately receive funding, while higher flood-exposure has minimal correlation, implying that funding may not reach all who need it or may be interested.

Keywords: Flood mitigation, Climate resilience

1. Introduction

Impacts from natural hazards in the United States are increasing in cost and frequency (NOAA National Centers for Environmental Information, 2024).

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While demand and funding for climate resilience measures has grown significantly in recent years, there are widespread concerns about access to those funds and the extent to which they perpetuate or mitigate existing inequities (FEMA, 2023; Junod, 2021; Miller, 2023). Evidence suggests that while vulnerable groups including mobile home residents and racial minorities are overrepresented in flood hotspots, wealthier and whiter communities have received more federal funds to adapt to and recover from floods (**?**Tate et al., 2021). Several explanations for this disparity have been proposed, including federal cost-benefit analysis requirements, limited local government capacity to apply for grants, and lack of household awareness about funding opportunities. However, research to pinpoint funding obstacles has been constrained by only observing who ultimately receives funding, not who is eligible or who applies for funding.As a result, it is unclear what the barriers are, and therefore which policy or procedural changes would most improve access to climate resilience funds.

Here, we combine novel datasets on over two decades of flood exposure and applications for federal funding in North Carolina to examine the full process: who floods, who applies for mitigation funding, and who receives it. This flooded-to-funded pipeline (Fig. 1) is critical for understanding the process by which households experience the Hazard Mitigation Assistance (HMA) process. By analyzing the household- and neighborhood-level characteristics at each stage of the process, we provide new evidence regarding how the application process shapes the distribution of funding. For example, if households located in marginalized communities rarely submit applications, the primary issue may be lack of awareness or resources for applying. In contrast, if they are applying but not being funded, the selection criteria may be driving disproportionate access.

Our initial results demonstrate that the application stage is crucial for understanding the mitigation funding pipeline. 67.5% of properties that experience flooding are eligible for public assistance, and 61% are in communities where local governments have submitted applications for assistance. However, only 2.3% of all flooded properties apply and ~1% are funded. Properties that apply are significantly more likely to have experienced more than one flooding event over the period. Compared to the population of flooded properties, properties that apply for funding have lower property values (58th percentile to 42nd percentile) and come from census block groups with a lower share of white residents (74% to 64%). Among properties receiving funding, property values and the share of white residents in the block group are even lower. These results are consistent with some nationwide findings, where wealthier and whiter communities have been linked to mitigation access [mach2019; Elliot 2020], however we add fidelity in that applying and funded properties are also lower-in-value than their flooded neighbors. Notably, these trends emerge at the newly-visible application stage and widen for those ultimately funded. We are the first to demonstrate that unpacking and examining this stage is pivotal to understanding potential obstacles to equitable mitigation funding.

2. Bibliography styles

With this template using elsevier class, natbib will be used. Three bibliographic style files (*.bst) are provided and their use controled by `cite-style` option:

- `citestyle: number` (default) will use `elsarticle-num.bst` - can be used for the numbered scheme
- `citestyle: numbername` will use `elsarticle-num-names.bst` - can be used for numbered with new options of natbib.sty
- `citestyle: authoryear` will use `elsarticle-harv.bst` — can be used for author year scheme

This `citestyle` will insert the right `.bst` and set the correct `classoption` for `elsarticle` document class.

Using `natbiboptions` variable in YAML header, you can set more options for `natbib` itself . Example

```
natbiboptions: longnamesfirst,angle,semicolon
```

2.1. Using CSL

If `cite-method` is set to `citeproc` in `elsevier_article()`, then pandoc is used for citations instead of `natbib`. In this case, the `csl` option is used to format the references. By default, this template will provide an appropriate style, but alternative `csl` files are available from https://www.zotero.org/styles?q=elsevier. These can be downloaded and stored locally, or the url can be used as in the example header.

3. Equations

Here is an equation:

$$f_X(x) = \left(\frac{\alpha}{\beta}\right)\left(\frac{x}{\beta}\right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^{\alpha}}; \alpha, \beta, x > 0.$$

Inline equations work as well: $\sum_{i=2}^{\infty}\{\alpha_i^{\beta}\}$

4. Figures and tables

Figure 1 is generated using an R chunk.

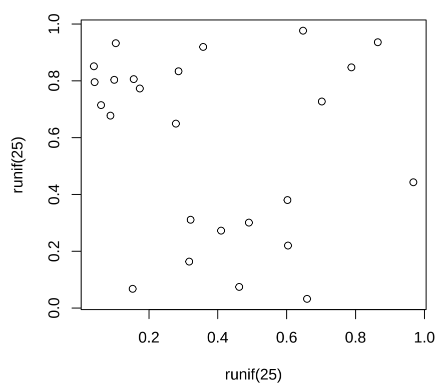

Figure 1: A meaningless scatterplot

Source: Article Notebook

5. Tables coming from R

Tables can also be generated using R chunks, as shown in Table 1 example.

```
knitr::kable(head(mtcars)[,1:4])
```

Table 1: Caption centered above table

	mpg	cyl	disp	hp
Mazda RX4	21.0	6	160	110
Mazda RX4 Wag	21.0	6	160	110
Datsun 710	22.8	4	108	93
Hornet 4 Drive	21.4	6	258	110
Hornet Sportabout	18.7	8	360	175
Valiant	18.1	6	225	105

Source: Article Notebook

References

FEMA, 2023. OpenFEMA Dataset: Hazard Mitigation Assistance Mitigated Properties – v3. URL: https://www.fema.gov/openfema-data-page/hazard-mitigation-assistance-mitigated-properties-v3.

Junod, A.N., 2021. Equitable Investments in Resilience. Technical Report. Urban Institute. URL: https://www.urban.org/research/publication/equitable-investments-resilience.

Miller, B.M., 2023. The Cost of Cost-Effectiveness: Expanding Equity in Federal Emergency Management Agency Hazard Mitigation Grants. Technical Report. RAND Corporation. URL: https://www.rand.org/pubs/research_reports/RRA2171-1.html.

NOAA National Centers for Environmental Information, 2024. U.S. Billion-Dollar Weather and Climate Disasters. URL: https://www.ncei.noaa.gov/access/billions/, doi:10.25921/stkw-7w73.

Tate, E., Rahman, M.A., Emrich, C.T., 2021. Flood Exposure and Social Vulnerability in the United States. Natural Hazards 106, 435–457. doi:10.1007/s11069-020-04470-2.