# H55V-0993: Interconnecting Networks of Social Vulnerability, Resource Access, and High-Resolution Inundation to Quantify Household Flood Impact

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## Introduction

- Previous studies indicate an **inequitable distribution of flood risks** across the country (1).
- We have further identified **wide distributions of household flood impacts** within cities and neighborhoods (2).
- Limited examinations consider how flooding affects **interconnected infrastructure networks**, which further impact an individual's flood risk (3 & 4).
- Our approach will be useful in future descriptive and prescriptive analytical frameworks by identifying **critical nodes across interconnected economical, social, hydrological, and physical networks**.

## Research Goals

1. Define a household's **holistic vulnerability to flooding in near real-time** with a multilayer network approach.
2. Determine how compound (fluvial & pluvial) inundation **disrupts a household's access to critical resources**

## Methodology

- We examine a small neighborhood in **Austin, Texas** and use compound inundation estimates from the **2015 Memorial Day Flood** as a case study (Fig. 1).
- Maximum estimated inundation **depths** were classified into ranges and **related to a given impact** on the network (Tab. 1).
- Using open-source data and a minimum cost flow algorithm (5 & 6), we **determine a household's change in travel costs to access critical resources.**

$$\min \sum_{(u,v)\in E} a(u,v) * f(u,v)$$

Where **(u,v)** is each edge in network ***E***, ***a*** is cost (travel time) across edge and ***f*** is flow across edge, subject to flow conservation and capacity constraints

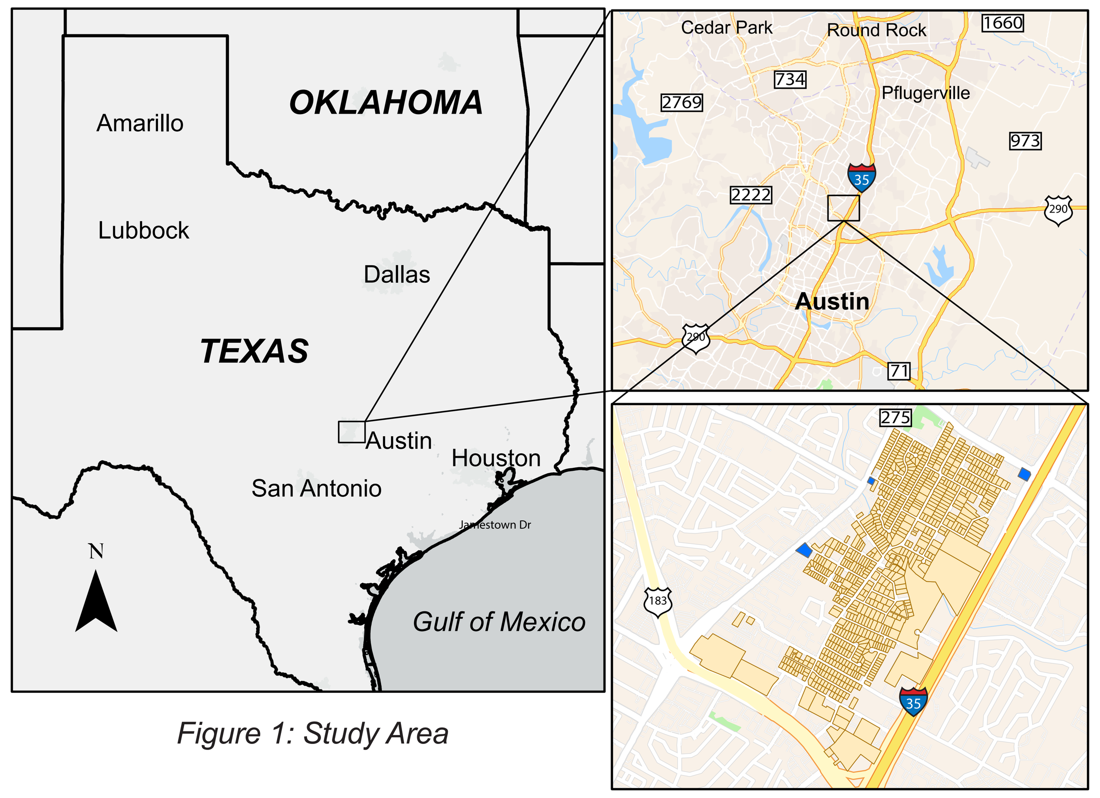



*Figure 1: Study Area*

*Table 1: Relating depth ranges to road network impact*

| Depth Range (m) | Impact |
|---|---|
| $0.01 \le d_{max} \le 0.15$ | Reduction in speed by 75% |
| $0.15 < d_{max} \le 0.29$ | Reduction in speed by 95% |
| $d_{max} > 0.29$ | Capacity reduced to 0 |

## Resource Allocation Disruption Results

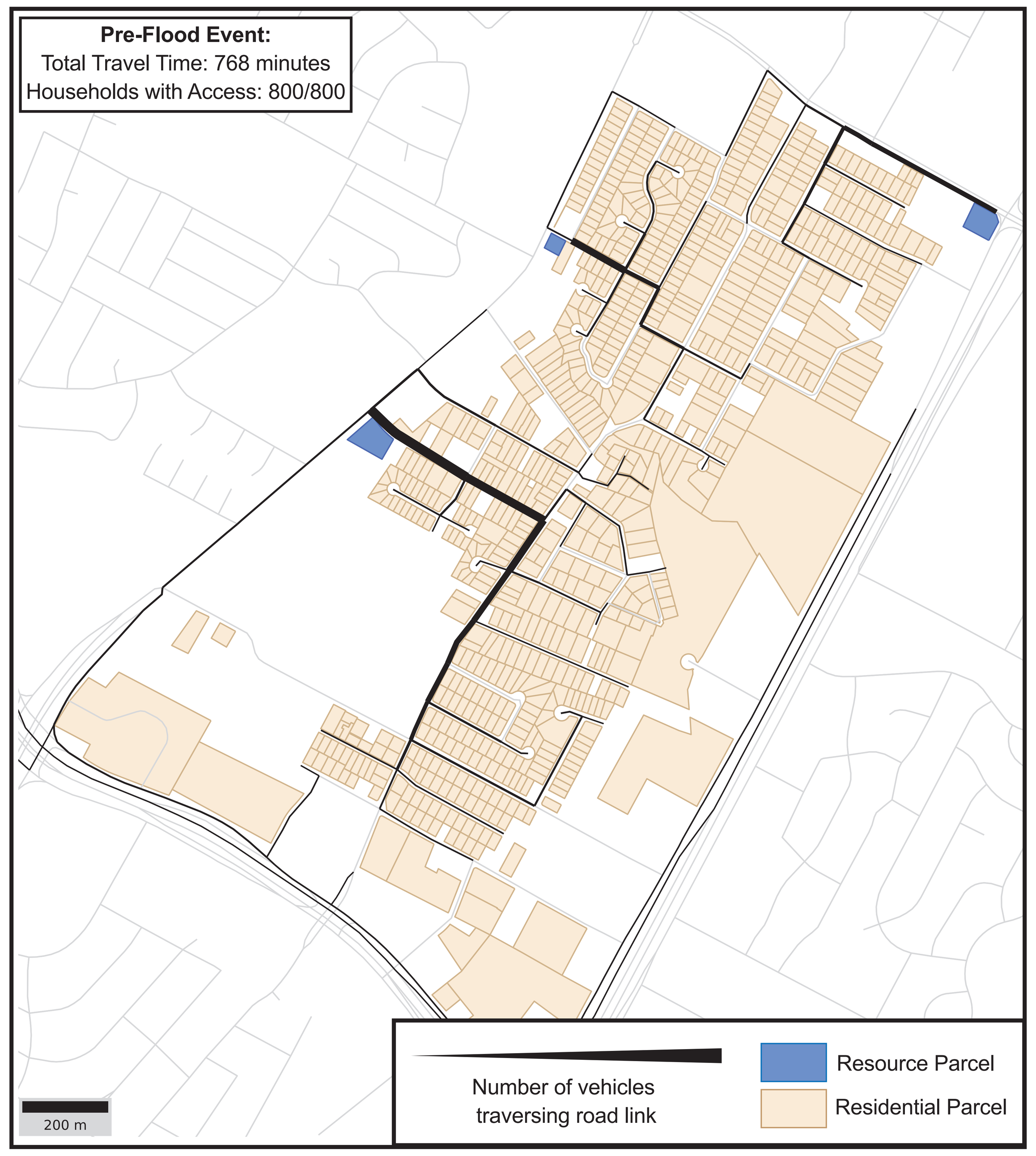



*Figure 2: Non-inundated travel. 800 residential parcels have access to 3 resource parcels (grocery stores). Thicker lines equate to more frequently traveled road links*

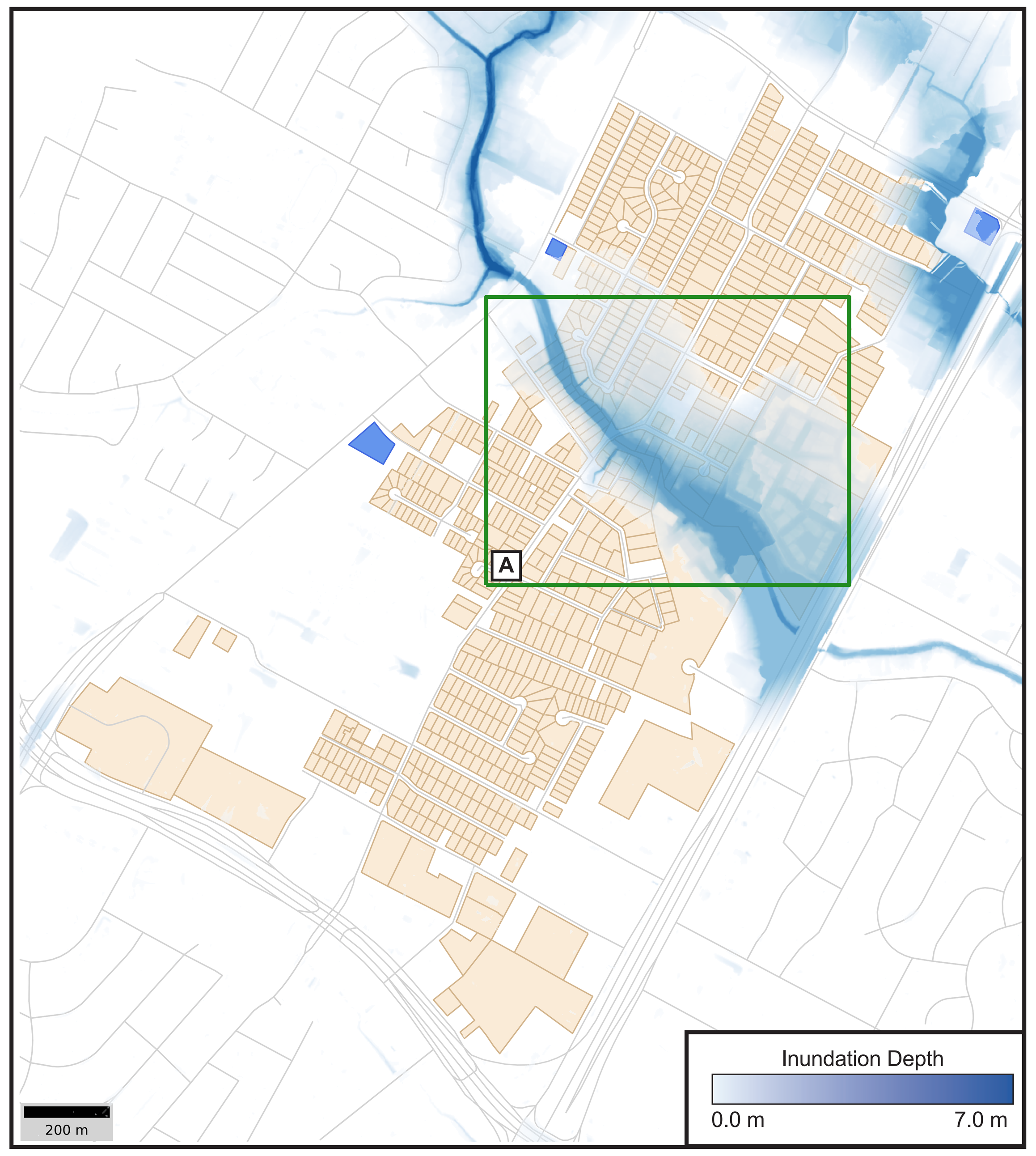



*Figure 3: Inundation estimated from the 2015 Memorial Day Flood in Austin, Texas. Flooding is coming from predominantly fluvial sources along the creek that splits the residential parcels*

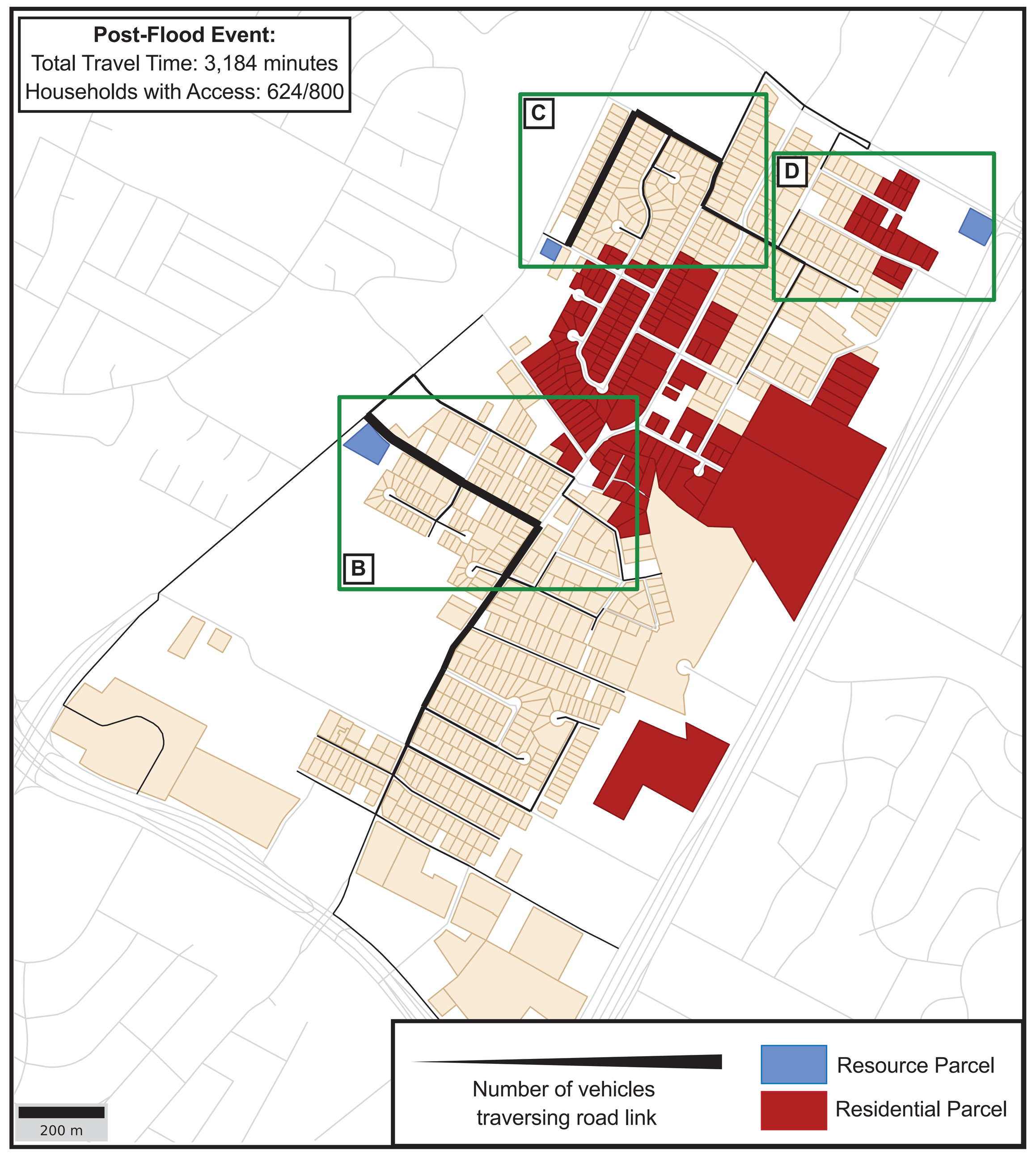
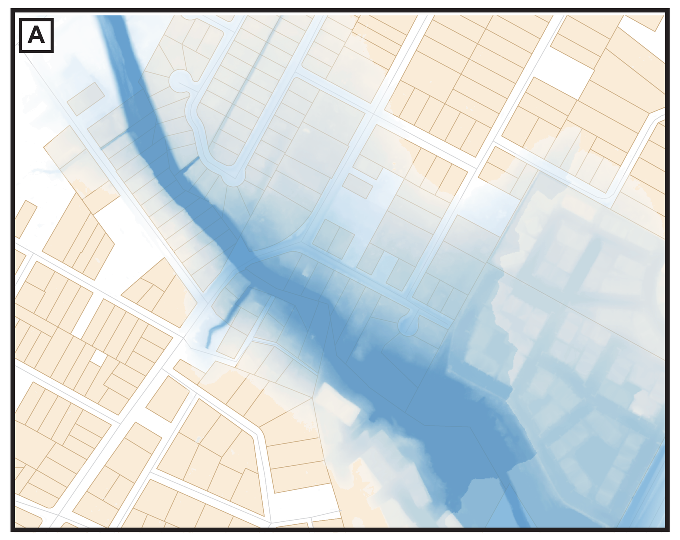
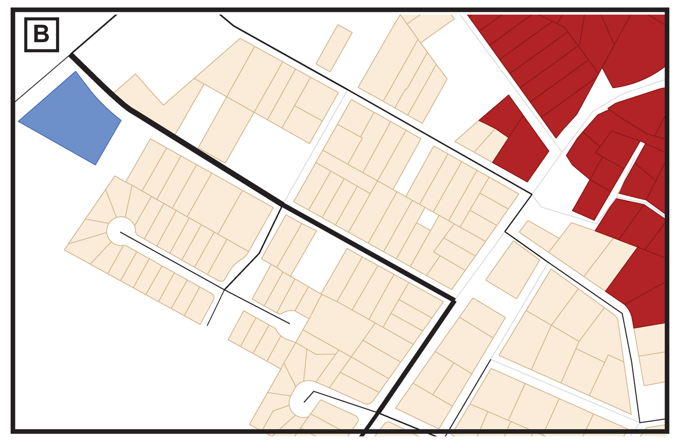


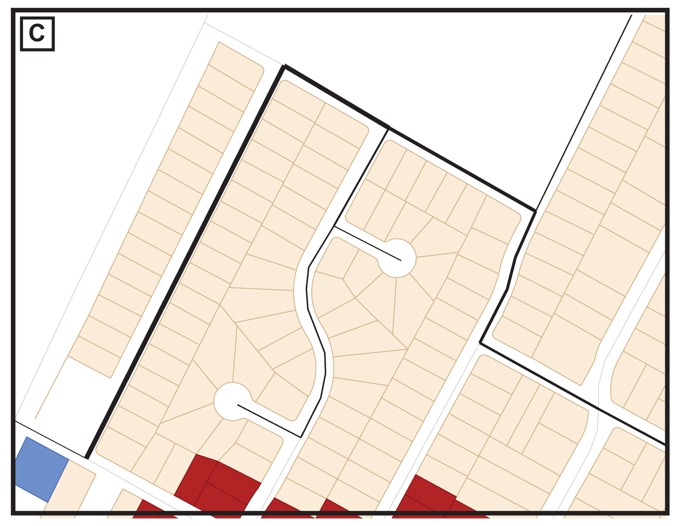

*Figure 4: Inundated travel. 624 residential parcels have access to 2 resource parcels (grocery stores). Thicker lines equate to more frequently traveled road links*



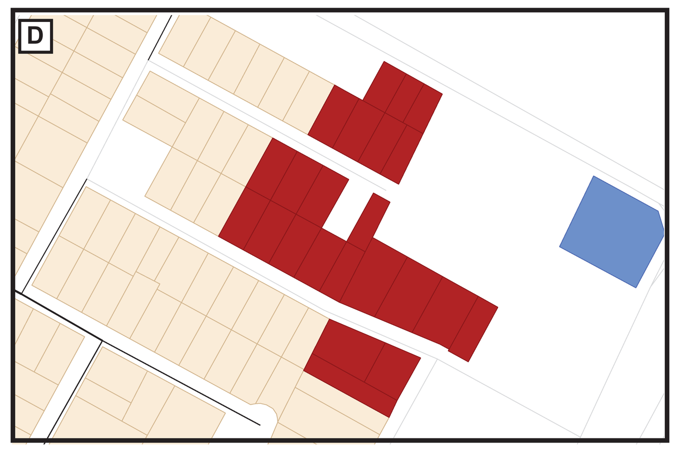

Flooding in this neighborhood is predominantly from fluvial sources along Walnut Creek. Impact of pluvial flooding is minimum in this area.




This area saw little to no change in access to grocery stores. The same roads are utilized but at reduced speeds.

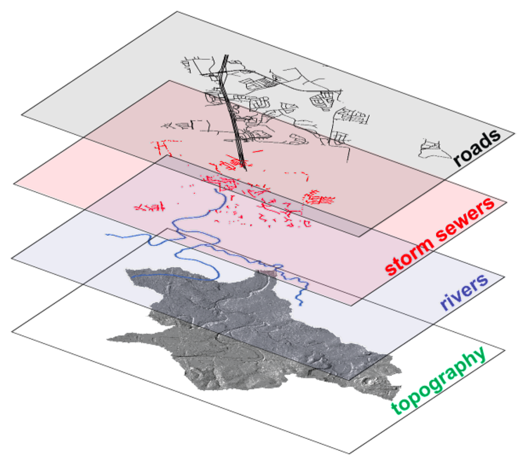



This area saw a complete change in traffic patterns. Residents are now relying on neighborhood roads instead of arterial roads.




Few residents were accessing this grocery store but have no alternative in the area post-flood and therefore lose access completely.

## Conclusions and Next Steps




Flood exposure and social vulnerability do not exist in a vacuum and interact in a variety of ways especially when considering interdependent networks. These interactions can be studied through the lens of a multiplex network to create a dynamic picture of risk in urban areas.

Future questions that will be answered through this research include:

1. How do network disruption results compare when **utilizing other flood modeling methods**?
2. How can **collaborative governance** influence interconnected networks during disruption events?
3. How are residents disconnected from the **"giant connected component" of all critical resources?**
4. How can this methodology be applied to **existing emergency response tools?**

## Acknowledgements

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## References

1. Rusca et al., 2021 *Earth's Future.* 2. Preisser et al., 2021, *Under Review.* 3. Lu et al., 2018, *Compt-aided Civl. Eng.* 4. Dong et al., 2020, *Compts., Enviro., & Urbn Systms.* 5. Boeing, 2017, *Compts., Enviro., & Urbn Systms.* 6. Hagberg et al., 2008, *SciPy2008.*