Evaluating FEMA SFHA Designation as a Predictor of Flood Exposure in the 2016 Louisiana Floods, Amite River Basin

Abstract: The FEMA SFHA illustrates flood risk through its 100-year flood plain, which is the nation's main indicator of property flood risk. Often, discrepancies exist in flood risk models, resulting in an underestimation of flood risk because recent studies have found that floods occur outside of the FEMA SFHA. This study will evaluate the relationship of flood exposure and FEMA flood risk through a logistic regression model which will be used to determine how well FEMA SFHA communicated risk or predictive of flood exposure during 2016 massive flood events in Louisiana by considering the flood depth and first floor foundation height as key components to measure whether structures was flooded or not.

Introduction: Flooding is the most common natural hazard in the USA, costing the nation billions of dollars in damages (Alipour et al., 2020). Rising sea levels, storm surges, and more frequent high tide flooding are the main causes of significant flooding in the coastal areas of the United States, especially along the East and Gulf Coast (Masozera et al., 2007; Wing et al., 2022). Major river systems like the Mississippi River in the inland areas are also prone to riverine flooding from heavy rainfall and snowmelt (Delong et al., 2023; Michaud et al., 2001). Climate change is expected to intensify the extent and impact of flooding within these regions (Hettiarachchi et al., 2018). With the acceleration of climate change impacts, flood managers need to consider regional differences in flood exposure and the predictive capacity of flood models to prioritize mitigation needs.

Studies have shown that floods often occur outside the FEMA-Special Flood Hazard Area, the nation's primary flood risk indicator for property owners(Pace, 2017). Recent analyses suggest that FEMA is underestimating the flood risk, as properties at risk of flooding have increased by 2.5 % in the FEMA 100-year floodplain and 5% in the 500-year floodplain, respectively(Guin, 2023). Inconsistencies in flood risk models may be particularly important to consider in the context of underprivileged communities. Lower socioeconomic communities may have lower ability to adapt to or mitigate their risk(Koks et al., 2015), and minority communities are frequently the most exposed and vulnerable to floods (Maantay & Maroko, 2009). This indicates that people are not fully aware of their risk and that improving predictive models is needed for a more accurate representation of flood risk in the face of climate change.

Study Area

Situated in southeast Louisiana, the United States, the Amite River Basin (ARB) extends into portions of Mississippi at its northernmost section (Figure 1). The region has a humid subtropical climate. U.S Climate Data, 2024 states that the average temperature is 68.4 ºF, with summer highs of 92ºF and winter lows of 38ºF. On average, the region gets 61.09 inches of rain annually (NOAA, 2024b). May through September is the most rainfall (Weather Spark, 2024).

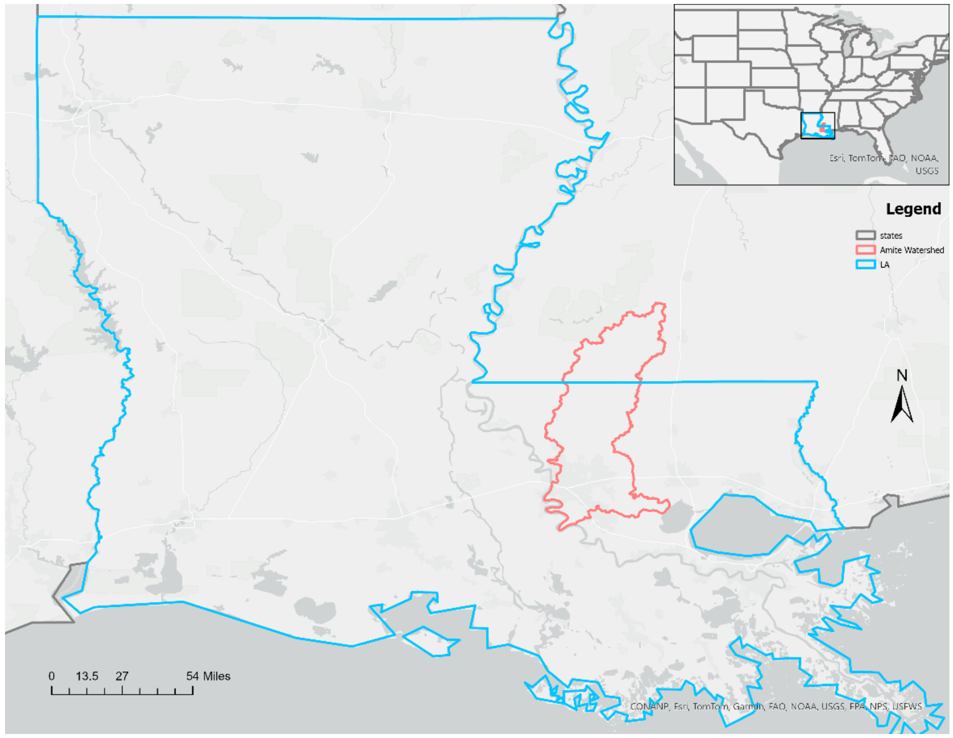

Figure 1. The Amite River Basin, in Southeast Louisiana

I selected the Amite River Basin as my study area because it was the epicenter of the 2016 Louisiana Floods, the focal research event for this study. This event took place from August 9–14, 2016, during which a low-pressure system moved slowly and stayed still for a few days, causing severe downpours that, in some places, reached up to 31 inches (LED, 2016; Watson et al., 2017).

Objective:

The objective of this study is to assess the relationship of FEMA Special Flood Hazard Area (SFHA) designation on flood exposure for structures within the Amite River Basin during the 2016 Louisiana Floods.

Methodology:

Research Question: Does FEMA Special Flood Hazard Area (SFHA) designation reliably predict flood exposure for structures in the Amite River Basin during the 2016 Louisiana Floods?

Proposed method: The analysis starts by denoting the dependent variable in a logistic regression model as a binary flood exposure, representing whether or not a structure was flooded during the 2016 flood event (1 = Flooded, 0 = Not Flooded) based on the Amite River Commission (ARBC) flood extent map. I will calculate Flood Exposure (Response) by taking the difference between the estimated flood depth in the ARBC flood inundation map for the 2016 Louisiana Floods and the first-floor foundation height of structures as estimated in a structures data set. If the flood depth is greater than the first-floor foundation height, then I will classify that structure ass flooded (Flooded=1), and if not, that structure will be regarded as not flooded (Not flooded=0). Then, I will classify each structure according to the flood risk models. I will intersect the structure with the FEMA-SFHA and classify it as either inside or outside the SFHA. The final stage of the analysis is to run a logistic regression model to have an odd ratio. In the logistic regression model, the odds ratio will help to interpret the effect of being inside or outside the FEMA Special Flood Hazard Area (SFHA) on the likelihood of a structure experiencing flooding. If the odds ratio is greater than 1, it suggests that structures inside the SFHA have higher odds of flooding compared to those outside. Conversely, if the odds ratio is less than 1, it indicates lower odds of flooding inside the SFHA.

Preliminary results or summary statistics:

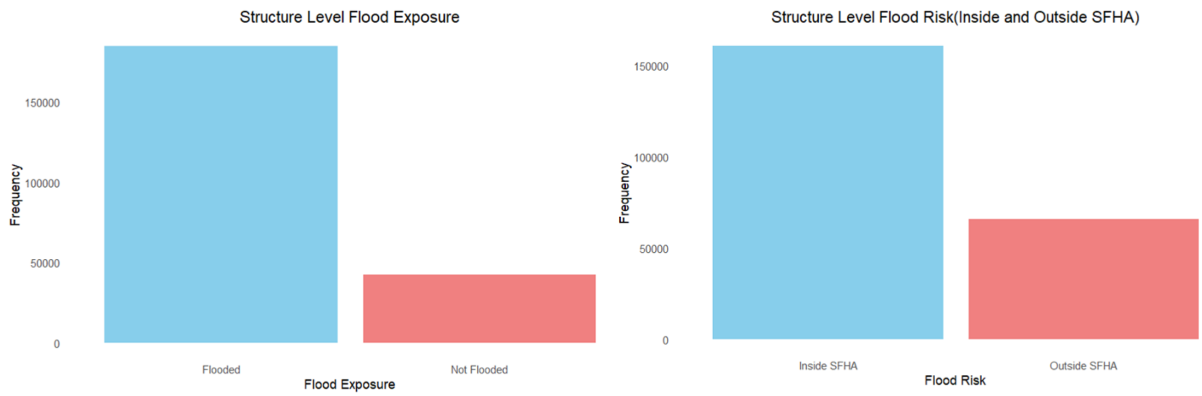

Fig 2: Structures that got flooded during 2016 flood events and structures located inside and outside Special Flood Hazard Area

Expected Contribution: Through odds ratio interpretation, this study seeks to provide actionable insights into the accuracy and reliability of FEMA's flood zone classifications in predicting real-world flood exposure, supporting improved flood risk management and mitigation efforts for vulnerable communities.

Timeline

Timeline/Task	Week 01	Week 02	Week 03	Week 04
Data Exploration	Havin a look on the data			
Data Preparation		Making data ready for the analysis		
Data Analysis			Regression Analysis	
Report Writing				Report writing and wrapping up

References

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