Flooding Odds During 2016 Flood in the Amite River Basin, Baton Rouge, Louisiana

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 flood exposure and FEMA flood risk were independent of each other through a chi square test, visualization, conditional probability and odds ratio . All of these 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 in addition two other variables such as flood factor category and median income level.

1. 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 risk indicators 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). This indicates that people are not fully aware of their risk. Aside from the FEMA SFHA, other flood risk models may address this need. The purpose of this study is to determine whether the FEMA Special Flood Hazard Area (SFHA) location of the property (whether the property inside the SFHA or not), Median Income (for this study only lower and middle-class income level groups have been used), flood factor (for this study, only minor, minimal and moderate levels have been used) were statistically significant in affecting flooding.

2. Dataset Description

The dataset used for this project was aggregated from different sources of data. The property level flood data was prepared by taking the flood depth and first-floor foundation height for each of them. If the flood depth is greater than the height that property is considered as flooded, if not then that property was considered as not flooded. Based on the block group level median income for the property, they were classified as lower, middle, and median-income groups. Since the previous studies show that the areas outside the FEMA-SFHA were flooded in fact higher for disadvantaged people, for this study I chose to use the lower and middle-income groups. Another category was to use the property location in terms of the FEMA flood risk indicator, FEMA-SFHA. If the property was located inside the FEMA-SFHA, then that property was considered as in, and if not, then the property was classified as out. Flood factor categories were also used for this study, another flood risk indicator to understand how statistically significant these two flood risk indicators were in flooding, in other words how well they predicted flooding during 2016 for people to be aware of their property's flood risk.

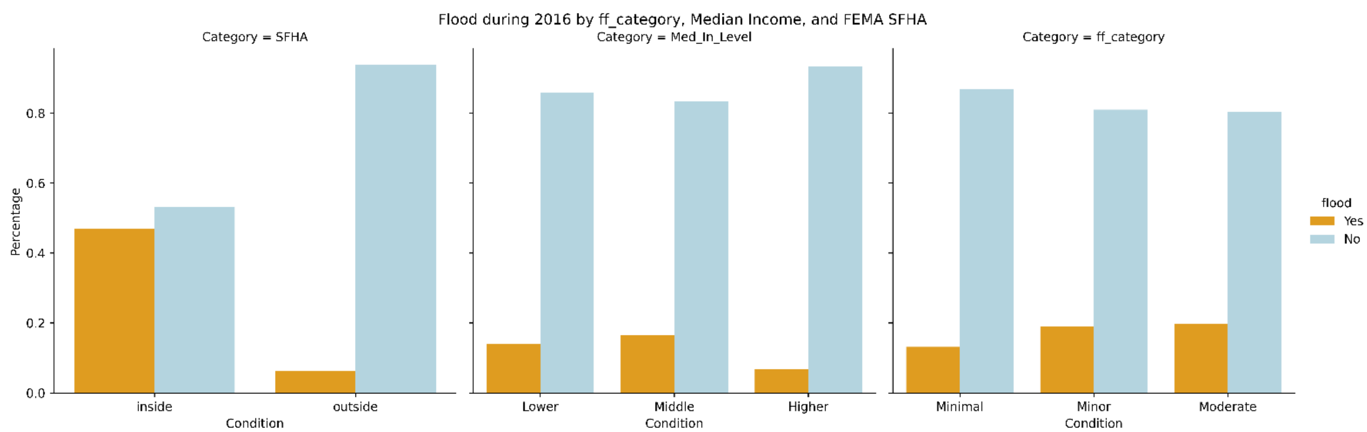

Fig 01: Flooding percentage by FEMA-SFHA, Flood Factor and Median Income Level

The figure illustrates the distribution of flooding during the 2016 event across three categories: FEMA Special Flood Hazard Area (SFHA) status, Median Income Levels, and Flood Factor Categories. Each subplot represents one category, with the x-axis indicating specific conditions within that category and the y-axis showing the percentage of properties flooded (Yes) and not flooded (No).For SFHA, the two conditions, inside and outside, indicate whether properties are located within or outside the FEMA-designated flood zones. Properties inside the SFHA have a higher percentage of flooding compared to those outside. However, most properties, even within the SFHA, did not flood, as reflected by the predominance of the light blue (No) bars.

For median income category, the subplot categorizes properties into Lower, Middle, and Higher income levels. Lower-income areas have a slightly higher proportion of flooded properties (Yes) than middle and higher-income areas, where flooding is minimal. This pattern suggests some socioeconomic vulnerability in lower-income areas. For flood factor category, This subplot examines the flooding likelihood based on flood risk levels: Minimal, Minor, and Moderate. Properties in the Minimal category rarely experienced flooding, as the No percentage is dominant. Flooding becomes more common in Minor and Moderate risk categories, although the majority of properties in these categories also did not flood.

3. Method and Statistical Analysis

The chi-square test is a statistical test used to examine relationships between categorical variables. It evaluates whether the observed frequencies (counts) in a contingency table differ significantly from what would be expected under the assumption of independence or homogeneity. I used the chi-square test of independence to determine the effects of three variables (SFHA, Flood Factor Category, and Median Income) on flooding individually. I created a contingency for each of the three variables. Then the test was run on each of the tables to produce the expected values of the flooding of each group if the variables were independent from each other. The null hypothesis for each chi-square test was that the variables were independent of each other, and the alternative hypothesis was that the variables were not independent. A chi-square value is calculated from the difference between the observed and expected flooding, which has an associated p-value. The p-value was compared to the alpha value of 0.05 which is my rejection region, and the null hypothesis was rejected if the p-value was lower than the alpha level. Then I created a table to show the observed and expected values. After the chi-square test was done, a mosaic plot was produced for each of the variable groups to show the graphical representation of the frequencies from the contingency table. The shading on the mosaic plot determines the Pearson residuals, which is an assessment of the relative contribution of each box in the mosaic plot to the chi-square statistic. The odds ratio (OR) is a measure used to assess the strength of the association between two variables, particularly in the context of categorical data. It compares the odds of an event occurring in one group with the odds of the same event occurring in another group.

$$\frac{P(Flood|Variable\ Category/P(Not\ Flooded|Variable\ Category}{P(Flooded|Variable/\ P(Not\ Flooded|Variable\ Category}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

4. Results

4.1 SFHA flood risk communication during 2016 flood events

Table 01: Contingency table of observed and expected values from the chi-square test of independence

Observed			
SFHA Status	Not Flooded(No)	Flooded(Yes)	Total
In SFHA	14,199	16,415	30,614
Out SFHA	7,575	99,359	106,934
Total	21,774	115774	137,548
Expected			

SFHA Status	Not Flooded(No)	Flooded(Yes)	Total
In SFHA	4,846.23	25,767.77	30,614
Out SFHA	16,927.77	90,006.23	106,934
Total	21,774.00	115,774.00	137,548

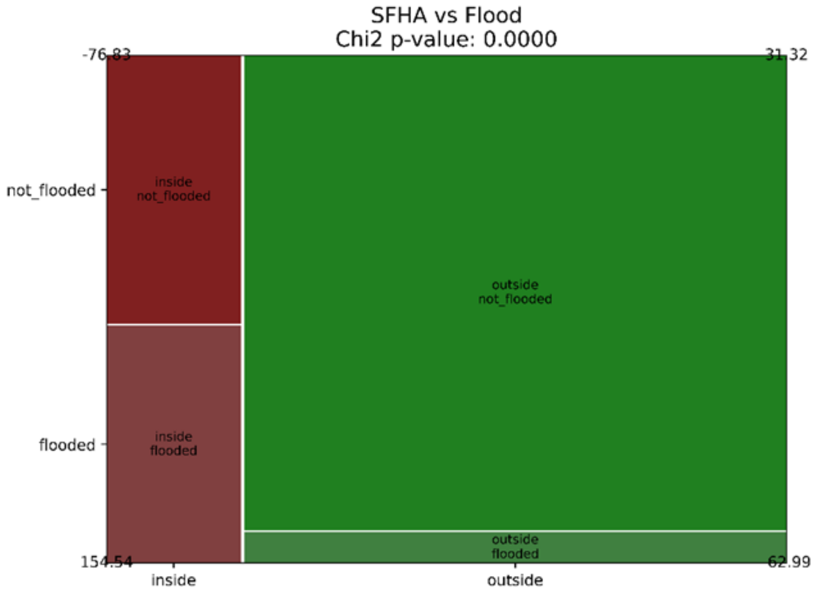

Fig 02: Mosaic plot by FEMA-SFHA and flooding status

This mosaic plot is a graphical representation of the relationship between two categorical variables: whether a property is located inside or outside the Special Flood Hazard Area (SFHA) and whether it experienced flooding or not. The layout divides the x-axis into two main categories, "inside" and "outside," indicating whether the property lies within the boundaries of the FEMA-designated SFHA. The y-axis is split into "flooded" and "not_flooded," showing whether the property experienced flooding during the event in question. The size of each rectangle in the plot reflects the number of observations that fall into the corresponding category. For example, the green area, which dominates the plot, represents properties that are outside the SFHA and did not flood, highlighting that a substantial portion of properties outside the FEMA-designated zone avoided flooding. Conversely, the smaller red areas represent properties inside the SFHA, divided into flooded and not_flooded subcategories, showing the relative proportions of flooding within the designated high-risk area.

The color coding visually emphasizes the distribution of observations. Darker shades represents a higher frequency of properties within those categories. For instance, the green rectangle is much larger than the others, underscoring the fact that many properties outside the SFHA did not flood, while the smaller rectangles inside the SFHA indicate higher concentrations of flooding within the zone but still show that flooding did not occur universally. Besides the plot indicates the statistical significance of the relationship between the two variables, as calculated by a Chi-square test. A p-value of 0.0000 suggests a very strong association between SFHA designation and flooding. In practical terms, this means that the likelihood of this pattern occurring by random chance is extremely low. This strong association could indicate that properties inside the SFHA are at higher risk of flooding, as the FEMA designation intends, but the presence of a large number of flooded areas outside the SFHA also raises questions about the adequacy of the SFHA in predicting flood-prone areas.This visualization provides a compelling way to assess the predictive power of SFHA designations compared to actual flooding events. It also highlights discrepancies, such as flooded properties outside the SFHA, which may suggest limitations in

FEMA's mapping or the need for updated models to account for unforeseen factors like extreme rainfall or insufficient drainage.

Table 02: Conditional probability by SFHA location and Flooding Status

	Observed	Expected
In SFHA - No	0.46380741	0.1583011
In SFHA - Yes	0.07083809	0.1583011
Out SFHA - No	0.53619259	0.8416989
Out SFHA - Yes	0.92916191	0.8416989

This table presents the conditional probabilities of flooding in relation to whether an area is inside or outside the Special Flood Hazard Area (SFHA), with the values categorized as Not Flooded (No) and Flooded (Yes). In the row for In SFHA - No Flooded, the observed probability is 0.4638, which means that, in areas inside the SFHA that did not experience flooding, the likelihood of no flooding is about 46.4%. The expected probability for this group is 0.1583, indicating that the model expects a much lower probability of no flooding in SFHA areas. This suggests that the observed value is significantly higher than expected, implying that flood-prone areas inside SFHA may have experienced lower-than-expected flooding, or there may be other factors affecting flood risk that are not captured in the model. For In SFHA - Flooded, the observed probability is 0.0708, meaning that in areas inside the SFHA, the likelihood of flooding is about 7.1%, while the expected probability is 0.1583. The observed probability of flooding here is much lower than expected, which could indicate that the SFHA areas may not have experienced as much flooding as anticipated, potentially due to improved flood mitigation or other local factors. For the Out SFHA - No Flooded category, the observed probability is 0.5362, meaning that in areas outside the SFHA that did not flood, the likelihood of no flooding is about 53.6%, while the expected probability is 0.8417. This large discrepancy shows that the probability of no flooding in areas outside the SFHA is far lower than expected. This suggests that areas outside the SFHA may be experiencing more frequent flooding than the model anticipates, which could be due to localized flooding patterns, such as flash floods or issues not captured by the SFHA designation. Lastly, in the Out SFHA - Flooded category, the observed probability is 0.9292, indicating that in areas outside the SFHA that flooded, the probability of flooding is 92.9%, while the expected probability is 0.8417. Here, the observed probability is slightly higher than expected, showing that areas outside the SFHA experience flooding more often than anticipated by the model. Overall, this table suggests that the current SFHA designations may not fully capture the actual risk of flooding, especially in areas outside the SFHA, where the observed probabilities of flooding and non-flooding diverge significantly from expected values. It highlights the need for further investigation into local flood risk factors that might not be accounted for by the SFHA alone.

4.2 Flood factor category risk communication during 2016 flood events:

Table 03: Contingency table of observed and expected values from the chi-square test of independence for flood factor category of flood risk

Observed			
Flood Factor	Not Flooded(No)	Flooded(Yes)	Total
Minimum	16,984	98,875	115,859
Minor	929	3,716	4,645
Moderate	3,861	13,183	17,044
Total	21,774	115,774	137,548
Expected			
Flood Factor	Not Flooded(No)	Flooded(Yes)	Total
Minimum	18,340.61	97,518.39	115,859
Minor	735.31	3,909.69	4,645
Moderate	2,698.08	14,345.92	17,044
Total	21,774.00	115,774.00	137,548

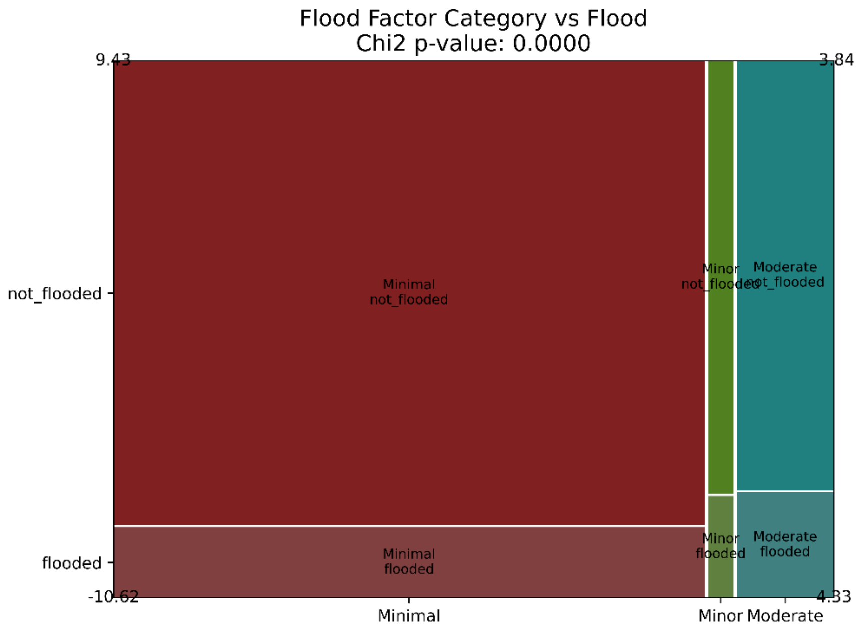

Fig 03: Mosaic plot by flood factor category and flooding status

The mosaic plot illustrates the relationship between Flood Factor Category and Flood Status (Flooded vs. Not Flooded). Along the horizontal axis, the Flood Factor Categories, such as Minimal, Minor, and Moderate, are displayed. Each category is subdivided by flood status, represented on the vertical axis as flooded and not flooded. The size of each tile corresponds to the frequency of observations for each combination of Flood Factor Category and Flood Status. Tiles are colored based on Pearson residuals from the Chi-squared test of independence. Dark red tiles indicate cells with observed counts significantly higher than expected, while dark blue or green tiles indicate cells with observed counts significantly lower than expected. The intensity of the colors reflects the strength of the deviation, with a color-bar on the side providing a scale for interpreting the residuals. The p-value from the Chi-squared test is displayed, confirming a statistically significant relationship between the variables. The plot highlights that Minimal Flood Factor is predominantly associated with not flooded cases, as evidenced by the strong red tile. Conversely, Minor and Moderate Flood Factors show higher proportions of flooded cases, with deviations in these categories captured by the respective tile colors.

Table 04: Conditional probability by flood factor category and Flooding Status

	Observed	Expected
Minimum - No Flood	0.146592	0.158301
Minimum - Flood	0.853408	0.841699
Minor - No Flood	0.200000	0.158301
Minor - Flood	0.800000	0.841699
Moderate - No Flood	0.226531	0.158301
Moderate - Flood	0.773469	0.841699

The table compares observed and expected conditional probabilities for each combination of flood factor category and flood status. The rows represent each category of Flood Factor (Minimum, Minor, Moderate) paired with the flood status ("No Flood" and "Flood"), and the columns show the probabilities derived from observed data and expected frequencies. For the Minimum Flood Factor, the observed probability of not being flooded is 0.1466, slightly lower than the expected probability of 0.1583. Conversely, the observed probability of being flooded is 0.8534, which is slightly higher than the expected probability of 0.8417. This indicates that, for the Minimum Flood Factor, flooding occurs more often than what would be expected under the assumption of independence. For the Minor Flood Factor, the observed probability of not being flooded is 0.2000, which is notably higher than the expected probability of 0.1583. However, the observed probability of being flooded is 0.8000, lower than the expected probability of 0.84. This suggests that flooding happens less frequently than expected for the Minor Flood Factor, while non-flooding occurs more frequently. For the Moderate Flood Factor, the observed probability of not being flooded is 0.2265, which is higher than the expected probability of 0.1583. On the other hand, the observed probability of being flooded is 0.7735, which is lower than the expected 0.8417. This indicates that for the Moderate Flood Factor, flooding is less frequent, and non-flooding is more frequent than expected. Overall, the deviations between observed and expected probabilities highlight potential patterns in the data. For both Minor and Moderate Flood Factors, non-flooding occurs more often than expected, while flooding occurs less often. Conversely, the Minimum Flood Factor shows the opposite trend, where flooding is more frequent than anticipated. These patterns suggest that the relationship between flood factors and flood status may not be uniform and is influenced by the level of flood risk indicated by the flood factor category.

4.3 Median income level category affecting flooding during 2016 flood events

Table 05: Contingency table of observed and expected values from the chi-square test of independence for variable median income

Observed			
Median Income	Not Flooded(No)	Flooded(Yes)	Total
Middle	6,110	36,808	42,918
Lower	15,664	78,966	94,630
Total	21,774	115,774	137,548
Expected			
Median Income	Not Flooded(No)	Flooded(Yes)	Total
Middle	6,793.97	36,124.03	42,918
Lower	14,980.03	79,649.97	94,630
Total	21,774.00	115,774.00	137,548

.

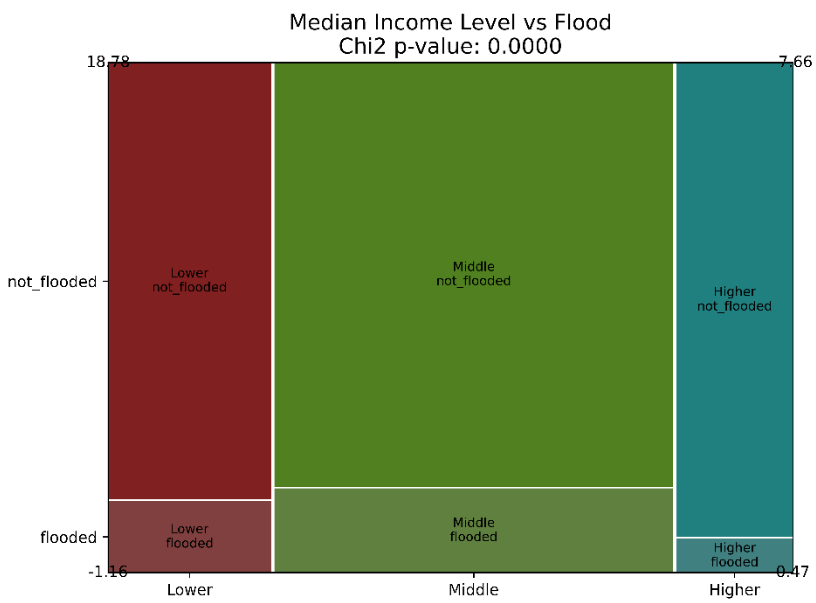

Fig 03: Mosaic plot by median income and flooding status

This mosaic plot visualizes the relationship between median income levels (categorized as Lower, Middle, and Higher) and flood status (flooded or not flooded). The horizontal axis represents the income levels, while the vertical axis represents the flood status. The size of each tile reflects the number of observations for each combination of income level and flood status.

The tiles are colored based on Pearson residuals, indicating how much the observed frequencies deviate from the expected frequencies under the assumption of independence. Dark red tiles represent combinations where observed values significantly exceed expected values, while dark green or blue tiles show combinations where observed values fall significantly below expected values. A color scale on the plot helps interpret the residuals. For households with a Lower income level, the "not flooded" category is prominently dark red, suggesting these households are significantly more likely to remain unaffected by flooding than expected. However, the corresponding "flooded" category is a less intense shade, indicating a smaller but noticeable trend of fewer flooding cases than anticipated. For households with a Middle income level, the "not flooded" tile is strongly green, indicating significantly fewer unaffected cases than expected. Meanwhile, the "flooded" category is less prominent but follows the opposite trend, with slightly more flooding cases than anticipated. Households with a Higher income level show contrasting patterns. The "not flooded" tile is blue, indicating fewer unaffected cases than expected. However, the "flooded" category displays a weak red shade, reflecting a slightly higher-than-expected likelihood of flooding in these areas. The chi-squared p-value of 0.0000 indicates a statistically significant relationship between income level and flood status, suggesting that flood risk is not distributed uniformly across income groups. This plot provides insight into how socio-economic factors, such as income, correlate with flood exposure, with lower-income groups being less affected by flooding than higher-income ones. However, the pattern may also highlight geographic or structural inequalities in flood mitigation and risk exposure.

Table 06: Conditional probability by median income category and Flooding Status

	Observed	Expected
Middle - Not Flooded	0.142365	0.158301
Middle - Flooded	0.857635	0.841699
Lower - Not Flooded	0.165529	0.158301
Lower - Flooded	0.834471	0.841699

The table presents the observed and expected conditional probabilities for two income groups—Middle and Lower—across the flood status categories of "Not Flooded" and "Flooded." These probabilities help to interpret the likelihood of flooding (or lack thereof) within each income group. For the Middle-income group, the observed probability of being "Not Flooded" is 0.142, which is slightly lower than the expected probability of 0.158 under the assumption of independence. Conversely, the observed probability of being "Flooded" is 0.858, slightly higher than the expected value of 0.842. This indicates that the Middle-income group experiences flooding at a slightly greater frequency than anticipated, with fewer households remaining unaffected compared to expectations. In the case of the Lower-income group, the observed probability of being "Not Flooded" is 0.166, which is marginally higher than the expected value of 0.158. Meanwhile, the observed probability of being "Flooded" is 0.834, slightly lower than the expected value of 0.842. This suggests that the Lower-income group is marginally more likely to remain unaffected by flooding than predicted, with fewer households experiencing flooding compared to the statistical expectation. Overall, the deviations between observed and expected probabilities are subtle, reflecting minor differences between actual and anticipated flood exposure across income groups. The trends align with the idea that socio-economic factors may influence flood outcomes, though the variations here are not extreme.

4.4 Odds Ratio

The odds ratios provide a way to understand the relative likelihood of an event (in this case, flooding) occurring under different conditions or categories. Each odds ratio compares the odds of flooding in one category to the odds in another, helping to determine how the likelihood of flooding changes across different flood factors, income levels, and SFHA designations.

For the comparison between In SFHA (Special Flood Hazard Area) and Out SFHA, the odds ratio of 0.088 suggests that the odds of flooding are much lower for areas Inside SFHA compared to those Outside SFHA. In other words, being outside the SFHA significantly increases the odds of flooding, indicating that areas not designated as high-risk flood zones are more prone to flooding compared to those within the designated zones. This may seem counterintuitive but could be due to various factors such as localized flood risk or other environmental or socio-economic factors not captured by the SFHA alone. In the comparison between Middle Income and Lower Income, the odds ratio of 1.195 implies that the odds of flooding in areas with Middle Income are about 1.19 times higher than in areas with Lower Income. This suggests that, despite the differences in income levels, the likelihood of flooding is slightly greater in middle-income areas compared to lower-income areas, although the difference is relatively small. This could reflect other variables influencing flood risk, such as geography, infrastructure, or urbanization patterns in these income brackets. For the flood factor categories, the odds ratio between Minimum and Minor flood risks is 1.455, indicating that areas with Minimum flood risk have about 1.46 times higher odds of flooding than areas with Minor flood risk. Similarly, the odds ratio of 1.705 between Minimum and Moderate flood risks shows that areas with Minimum flood risk have about 1.71 times higher odds of flooding than areas with Moderate flood risk. This implies that areas categorized as having a Minimum flood risk are significantly more prone to flooding compared to those in the Moderate and Minor categories. Lastly, the odds ratio of 1.172 between Minor and Moderate flood risks indicates that areas with Minor flood risk are 1.17 times more likely to experience flooding than those with Moderate flood risk**,** but the difference is less pronounced than the other comparisons. This suggests a moderate increase in flood likelihood from Moderate to Minor flood risk categories. In summary, these odds ratios reveal patterns of flood risk across different regions based on their SFHA designation, income levels, and flood factor categories. Areas outside SFHA and those with Minimum and Minor flood factors tend to have higher odds of flooding compared to others. The comparison between income levels shows that middle-income areas have slightly higher odds of flooding than lower-income areas, though the difference is not large.

5. Discussion and Conclusion

The first section analyzes the association between the Special Flood Hazard Area (SFHA) designation and flooding. The contingency table shows observed and expected values for areas inside and outside the SFHA. The chi-square test indicates a statistically significant relationship, with a p-value of 0.0000. This suggests that properties inside the SFHA are more likely to flood, as expected, but interestingly, there are a significant number of flooded properties outside the SFHA as well. A mosaic plot illustrates this relationship, with the color coding highlighting the distribution of flooding events. Notably, a large proportion of properties outside the SFHA did not flood, while areas inside the SFHA, although more prone to flooding, did not universally flood, indicating some limitations of the SFHA in accurately predicting flood risk.

Conditional probabilities for flooding in the SFHA zones show a discrepancy between observed and expected flooding. For example, areas inside the SFHA had a lower-than-expected probability of flooding, suggesting the model might not capture all flood risk factors. Conversely, areas outside the SFHA had a higher-than-expected probability of flooding, pointing to possible issues with the SFHA's ability to account for all factors influencing flood risk. In the next section, the relationship between flood risk, categorized by flood factors (Minimum, Minor, Moderate), and flooding is assessed. The chi-square test again reveals a statistically significant association. A mosaic plot shows that areas with a "Minimum" flood factor were predominantly "Not Flooded," while "Minor" and "Moderate" flood factors had higher proportions of flooding. The observed conditional probabilities further reinforce these findings. For example, for areas categorized with a "Minimum" flood factor, the probability of flooding was slightly higher than expected, suggesting that this category might not fully capture the actual risk. The final section explores the relationship between median income levels and flooding. A mosaic plot visualizes the distribution of flooding across different income groups. The chi-square test again indicates a statistically significant relationship. Interestingly, lower-income households were more likely to avoid flooding, contrary to the expectation that flood risk would be more severe in lower-income areas. In contrast, middle-income households experienced slightly more flooding than expected. The conditional probabilities suggest that income levels may influence the likelihood of flooding, though these differences are less pronounced than in the SFHA and flood factor categories. The odds ratios provide an additional perspective on the relative likelihood of flooding under different conditions. The odds ratio for the SFHA designation shows that areas outside the SFHA have significantly higher odds of flooding, despite not being classified as high-risk zones. This could indicate the need for improved flood risk models or more localized flood data. The odds ratio for income suggests that middle-income areas are slightly more prone to flooding than lower-income areas, though the difference is modest.

In summary, the analysis shows significant relationships between flood risk, SFHA designation, flood factor categories, and income levels. However, it also highlights some discrepancies, such as the higher-than-expected flooding outside the SFHA and the unexpected patterns in income levels, suggesting that flood risk prediction models may need to account for a wider range of local factors.

Reference:

Alipour, A., Ahmadalipour, A., & Moradkhani, H. (2020). Assessing flash flood hazard and damages in the southeast United States. *Journal of Flood Risk Management*, *13*(2), e12605.

Delong, M. D., Whitledge, G. W., Theiling, C. H., & Lamer, J. T. (2023). Upper mississippi river basin. In *Rivers of North America* (pp. 314-361). Elsevier.

Guin, A. (2023). *Comparing Flood Models From Federal Emergency Management Agency (FEMA), First Street Foundation's Flood Factor, and a Multi-Criteria Decision Analysis (MCDA) to Evaluate Flood Risk in the Rouge River Watershed*

Hettiarachchi, S., Wasko, C., & Sharma, A. (2018). Increase in flood risk resulting from climate change in a developed urban watershed–the role of storm temporal patterns. *Hydrology and Earth System Sciences*, *22*(3), 2041-2056.

Masozera, M., Bailey, M., & Kerchner, C. (2007). Distribution of impacts of natural disasters across income groups: A case study of New Orleans. *Ecological economics*, *63*(2-3), 299-306.

Michaud, J. D., Hirschboeck, K. K., & Winchell, M. (2001). Regional variations in small-basin floods in the United States. *Water Resources Research*, *37*(5), 1405-1416.

Pace, N. L. (2017). Unaware, Unprepared, and Unexpectedly Flooded: Improving Louisiana's Capacity to Respond to Flood Hazards. *LSU J. Energy L. & Resources*, *6*, 121.

Wing, O. E., Lehman, W., Bates, P. D., Sampson, C. C., Quinn, N., Smith, A. M., Neal, J. C., Porter, J. R., & Kousky, C. (2022). Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change*, *12*(2), 156-162.

Appendix:

Github Repository Link:
https://github.com/chsharrison/Sci_comp_F24/blob/main/Israt_Tama/Final_Project.ipynb