FEMA Post-Flood Assistance Programs for United States Counties

An Exploratory Data Analysis of FEMA Assistance Offered by Length of Flood, Type of Flood, and Total Population Living in Poverty and with Children and Adolescents

Nicole Kingdon

2023-11-06

Table of contents

Introduction

Floods are extremely destructive storm events that can threaten one's life, business, properties, belongings, and public services and infrastructures (Flood-Impact), as well on distress, anxiety, depression, and other mental symptoms ((Foudi, Osés-Eraso, and Galarraga 2017)). Specifically, in the United States, post-flood recovery is offered through the Federal Emergency Management Agency (FEMA), which looks to mitigate risk factors resulting from natural disasters, like floods (FEMA-Support).

Post-Flood Recovery Experiences

Experiences of post-flood recovery in the United States (US) vary by neighborhood (Varela Varela 2023). Additionally, these experiences differ for low-, middle-, or high-income populations (Varela Varela 2023).

Economically Marginalized Groups

Low-income populations already have previous material and relational hardships they experience daily (Varela Varela 2023; Mijs and Roe 2021). Traumatic events, like floods, can exacerbate their hardships (Floods_Low-Income_Impact). Children and adolescents living in low-income households may experience long-term developmental impacts due to floods (Flood-Develop-Impacts).

Low-Income Children and Adolescents

Low-income children and adolescents directly and indirectly experience several material and relational hardships due to their economic status (Masarik and Conger 2017a). Traumatic events, like floods, can increase developmental impacts, such as educational attainment (Ahmed et al. 2022), depressive symptoms (Felton, Cole, and Martin 2013), and post-traumatic stress disorder (Liu et al. 2007). Each of these impacts can impede children from reaching their full potential across their development.

Family Stress Model

Figure 1 shows the Family Stress Model Framework ((Masarik and Conger 2017b)), which conceptualizes how risks, like floods, can impact low-income children. The economic hardship, like floods, is placed upon the household, which increases economic pressure. This increases parental/caregiver psychological distress, which is likely to impact relationships and parenting. Ultimately, the child may be impacted by experiencing adjustment problems across their development.

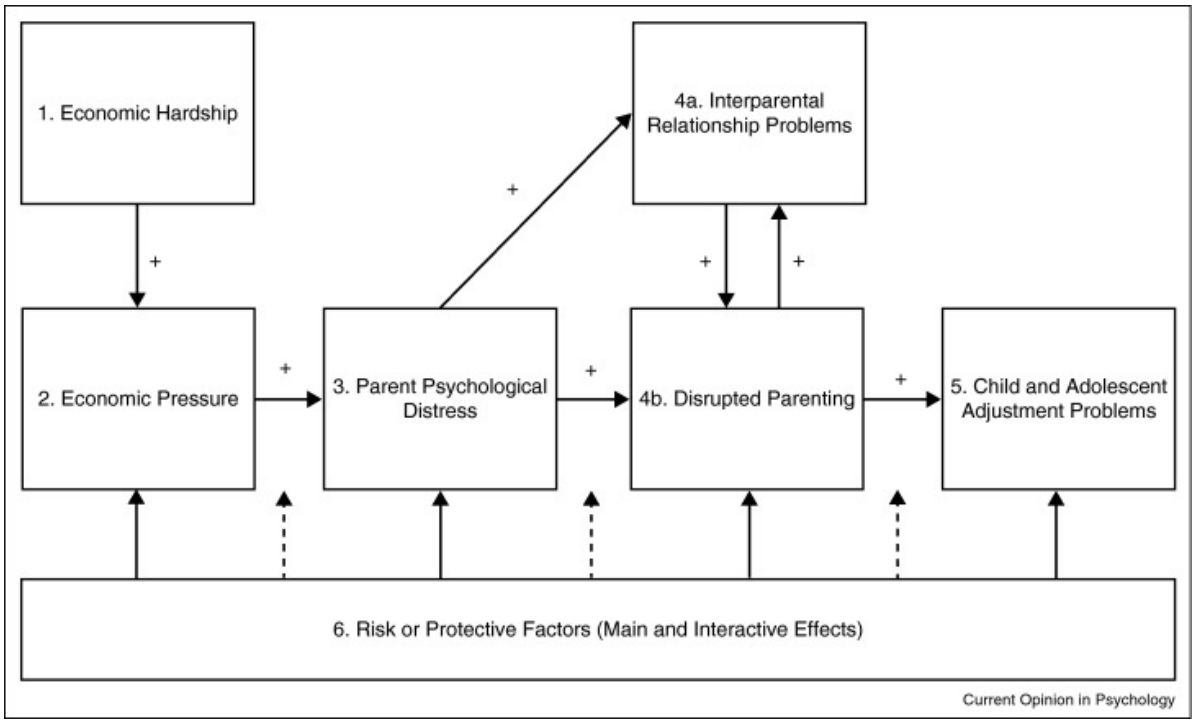


Figure 1: Family Stress Model Framework. (Masarik & Conger, 2017)

Protective Factors

Along with risk factors stemming from floods, there are protective factors implemented that can disrupt the Family Stress Model and bring resiliency into the household ((Masarik and Conger 2017a)). When protective factors, such as supports from Federal Emergency Management Agency (FEMA), are implemented to reduce economic hardships, then the family and child can be protected from the full impact of the economic hardship.

FEMA Assistance

FEMA's mission is "helping people before, during, and after disasters." (FEMA-Strategic-Plan) The specifically provide post-disaster relief, in order to reduce the hardships that tend to arise. Additionally, they look to promote resilience against disasters, such as floods (FEMA-Resilience). There are three types of assistance programs that FEMA offers: Individuals and Households (IHA), Public Assistance (PA), and Hazard Mitigation (HM) (FEMA-Declarations).

Individuals and Households Assistance Program

The IHA Program is additional support offered to uninsured and under-insured expenses and needs through financial and direct services for individuals and households who experienced a disaster-related event (FEMA-IHA). They can cover the following expenses and needs: money for temporary housing, a temporary housing unit, repairs of replacement of owner-occupied homes, and hazard mitigation to repair or rebuild stronger, more durable homes. Additionally other areas of need can be covered: damage to essential household items, clothing, clean-up items, tools and specialized clothing needed for one's job, educational materials, accessibility items, an essential vehicle, disaster-related funeral and burial expenses, disaster-related child-care expenses, medical and dental expenses, and moving and storage expenses (FEMA-IHA-Services).

Public Assistance Program

The PA program has four eligibility components: **applicant** must be a state, territory, tribe, local government, or a certain nonprofit organization; a **facility** is a building, public works system, equipment, or improved and maintained natural feature; **work** is an "emergency" or "permanent" required because of the disaster-related event; **costs** must be used for disaster-related work. Ultimately, the PA program offers grants to particular types of applicants to do particular disaster-related work for a particular period of time necessary to support post-disaster relief (FEMA-PA).

Emergency Work (Duration: 6 Months)

- Category A: Debris removal
- Category B: Emergency protective measures

Permanent Work (Duration: 18 Months)

- Category C: Roads and bridges
- Category D: Water control facilities
- Category E: Public buildings and equipment
- Category F: Public utilities
- Category G: Parks, recreational, and other facilities

Hazard Mitigation Program

The HM program offers grants to implement protective factors that will help in preventing future disaster-related risks (FEMA-HM). Home and business owners are not allowed to apply for this grant, but communities, like states and counties, can apply on their behalf.

Aim

As risks factors stemming from disasters are inevitable, it is important to delineate how post-flood recovery programs differed for counties with the lowest income populations. This Exploratory Data Analysis will focus on examining what counties were declared to receive the IHA, PA, and/or HM program, which counties had the highest total populations living in poverty, as well as the highest population of children in poverty under five and between 5-to-17 years of age. It will also examine the different lengths of the floods, as it would be perceived that longer floods would amount to more damage. Additionally, it will look at type of flood and the grant amounts offered to each county. Finally, this study aims to use a strengths-based lens, by offering suggestions on how protective factors, like FEMA assistance programs, could be bolstered for economically marginalized populations.

Data Acquisition & Assessment

There are four data sets used for this exploratory data analysis: two on Census data for all the counties in the US from 2020 and 2021, and the other two on FEMA disaster and program relief data.

The `census_2020` and `census_2021` data frames were combined to create a `census_2023` data frame, which holds both 2020 and 2021 Census data.

The `fema_disaster_dec` and `fema_web_disaster` data frames were combined to make `storm_20_21`.

Finally, `census_2023` and `storm_20_21` were combined to make a final data frame, `storm_20_21` with both Census 2020 and 2021 and FEMA 2020 and 2021 data organized by county.

In order to execute this, the following code was written and will be explained.

Data Cleaning & Organizing

Census Data Frames

To begin, I made the first row of both census data frames into the column names.

Next, I mutated a new column for each data frame, indicating the year in which the Census data was collected, stacked the data frames by finding the columns that corresponded and then binded them together. Additionally, I removed all the columns with `NA`s in the new `census_2023` data frame that held both 2020 and 2021 Census data.

Finally, I finished the initial cleaning of the `census_2023` data frame by cleaning up the column names.

FEMA Data Frames

To begin, I merged the `fema_disaster_dec` and `fema_web_disaster` data frames by `disasterNumber` and filtered out `incidentType` to be `Flood`.

Next, I prepped the data frame to be able to only hold data from 2020 and 2021. To do this, I split the `incidentBeginDate` column to reveal a single column of `incident_begin_year` to support in this step.

After that, I trimmed the `incident_begin_year` string, made the values into numeric values, and filtered out `incident_begin_year` to be `2020` or `2021`.

Storm 2020 & 2021 Data Frame

In order to prep the combination of `census_2023` and `storm_20_21` to create a complete data frame, I had to clean up the columns in both data frames with the counties in them. This was going to be the best way to match up the data.

To begin, I trimmed the strings in both data frames so that the values would be simply the county name only, as some included the word county and the state. I also renamed both columns to `county`.

Next, I merged the two data frames by county to create the complete `storm_20_21` data frame with both FEMA and Census data on floods from 2020 and 2021.

I also picked the distinct rows from the `hash.x` column, which includes individual codes to delineate different floods (FEMA-Hash-ID).

Next, I removed irrelevant columns and made some columns into numeric values that needed to be.

Finally, I duplicated the `incident_begin_year` column, and reunited the incident begin year, month, and day with "-" as the delimiter.

I also used Lubridate to make both the `incident_begin_date` and `incident_end_date` columns into dates, as well as the other columns related to dates. Additionally, I mutated a new column, `incident_length_days`, with the difference in days between the incident begin and end date.

Finally, I am going to select the columns that are necessary for the Exploratory Data Analysis.

Assumptions & Motivations

Census Data Frames

The Census data was collected as a United States nation-wide examination of different groups of populations to see where they live and what their demographic data is. This is collected every 10 years (CENSUS). It is important to understand this data to implement targeted intervention programs to areas with population that need it the most.

FEMA Data Frames

The FEMA data is collected and distributed publicly to track what natural disaster happened where and what assistance they were offered, as well as requested. This data is important to understand how FEMA assistance can be better adapted to implement a more targeted approach.

Missing Values

There are missing values throughout the Census and FEMA data - the missing values present do not disrupt the data analysis in any way.

Exploratory Data Analysis

Columns & Values

The columns used in this Exploratory Data Analysis are as follows: `county`, `declarationTitle`, `incident_begin_years`, `incident_length_days`,

`Estimate_Total_Population_for_whom_poverty_status_is_determined`,

`Estimate_Total_Population_for_whom_poverty_status_is_determined_AGE_Under_18_years_Under_5_y`

`Estimate_Total_Population_for_whom_poverty_status_is_determined_AGE_Under_18_years_5_to_17_y`

`ihProgramDeclared`, `paProgramDeclared`, `hmProgramDeclared`, `iaProgramDeclared`, `totalNumberIaApproved`, `totalAmountihpApproved`, `totalAmountHaApproved`, and `totalAmountOnaApproved`.

`county`

The following values in the `county` column are nominal variables: c("Anderson", "Apache", "Ascension", "Assumption", "Ballard", "Bell", "Bennington", "Boone", "Boyd", "Breathitt", "Buchanan", "Calcasieu", "Calloway", "Carter", "Casey", "Cass", "Chelan", "Clallam", "Clark", "Clay", "Coconino", "Columbia", "Cowlitz", "Cumberland", "Dickson", "East Baton Rouge", "Edmonson", "Elliott", "Estill", "Fayette", "Floyd", "Franklin", "Garfield", "Graves", "Grays Harbor", "Greenup", "Harlan", "Hickman", "Houston", "Humphreys", "Iberville", "Island", "Jackson", "Jefferson", "Jessamine", "Johnson", "Kenosha", "King", "Klickitat", "Knott", "Knox", "Lafayette", "Lafourche", "Laurel", "Lawrence", "Lee", "Leslie", "Letcher", "Lewis", "Lincoln", "Logan", "Madison", "Magoffin", "Marion", "Martin", "Mason", "Maui", "McIntosh", "Menifee", "Milwaukee", "Morgan", "Navajo", "Nelson", "Ohio", "Okanogan", "Owsley", "Pacific", "Perry", "Pike", "Powell", "Pulaski", "Racine", "Richland", "Rockcastle", "San Juan", "Sheridan", "Skagit", "Skamania", "Snohomish", "Steele", "Sullivan", "Thurston", "Umatilla", "Union", "Wahkiakum", "Walla Walla", "Wallowa", "Warren", "Wayne", "Wells", "Whatcom", "Whitley", "Windham", "Wolfe", "Woodford"). This describes what county exactly the flood took place in.

`declarationTitle`

The `declarationTitle` column holds the following distinct values: c("SEVERE, STORMS, FLOODING, LANDSLIDES, AND MUDSLIDES", "SEVERE STORMS AND FLOODING", "SEVERE STORMS, TORNADOES, AND FLOODING", "SEVERE STORM AND FLOODING", "FLOODING, LANDSLIDES, AND MUDSLIDES", "FLOODING", "SEVERE WINTER STORMS, SNOWSTORMS, STRAIGHT-LINE WINDS, FLOODIN", "SEVERE STORMS, STRAIGHT-LINE WINDS, FLOODING, LANDSLIDES, AND

MUDSLIDES", "SEVERE STORMS, FLOODING, LANDSLIDES, AND MUDSLIDES", "SEVERE WINTER STORM AND FLOODING", "SEVERE STORMS, FLOODING, AND LANDSLIDES"). Each values describes what type of flood occurred in the particular county for the particular date. These values are all strings, as well as are nominal variables.

`incident_begin_years`

The `incident_begin_years` has the following two values: c(2021, 2020). These are all interval variables to describe the year in which the flood event took place.

`incident_length_days`

The `incident_length_days` column holds interval variables. This is to describe the length of the flood event in days.

`Estimate_Total_Population` Columns

The three `Estimate_Total_Population` columns,

`Estimate_Total_Population_for_whom_poverty_status_is_determined`,

`Estimate_Total_Population_for_whom_poverty_status_is_determined_AGE_Under_18_years_Under_5_y`
and

`Estimate_Total_Population_for_whom_poverty_status_is_determined_AGE_Under_18_years_5_to_17_y`

each hold interval values indicating the total number of county inhabitants living below the poverty line, as well as for those under 5 and between 5 to 17 years of age.

`ProgramDeclared` Columns

The four `ProgramDeclared` columns, `ihProgramDeclared`, `paProgramDeclared`, `hmProgramDeclared`, and `iaProgramDeclared`, each hold values of `0` or `1`, with `0` indicating the program was not received and `1` indicating it was. These values are nominal variables.

`totalNumber` and `totalAmount` Approved Columns

The four columns with approved total number or amount of approved support, `totalNumberIaApproved`, `totalAmountIhpApproved`, `totalAmountHaApproved`, and `totalAmountOnaApproved`, hold interval variables with dollar amounts approved to support Individual Assistance, total amount for Individuals and Housing Assistance, Housing Assistance, and Other Needs Assistance.

Type of Flood & Grant Assistance

I prepped data frames by flood type to see the amount of grant funding provided to each county dependent on the type of flood.

`SEVERE, STORMS, FLOODING, LANDSLIDES, AND MUDSLIDES`

Counties received the following amounts for Individual Assistance: $1,136, Individuals and Housing Assistance: $10,038,254, Housing Assistance: $8,551,669, and Other Needs Assistance: $1,486,585, no matter the poverty level of the county.

`SEVERE STORMS, TORNADOES, AND FLOODING`

Counties who experienced `SEVERE STORMS, TORNADOES, AND FLOODING`received the following amounts for Individual Assistance: $2,501, Individuals and Housing Assistance: $14,032,804, Housing Assistance: $11,176,256, and Other Needs Assistance: $2,856,548. The amounts were all the same for every county, no matter the poverty level.

`SEVERE STORM AND FLOODING`

The counties that experienced `SEVERE STORM AND FLOODING` received the following amounts for Individual Assistance: $955, Individuals and Housing Assistance: $8,138,894, Housing Assistance: $6,301,770, and Other Needs Assistance: $1,837,123. All counties received the same amount for all types of assistance, and some rows held `NA` values, therefore it was not disclosed if support was offered.

`SEVERE STORMS, FLOODING, LANDSLIDES, AND MUDSLIDE`

Counties with `SEVERE STORMS, FLOODING, LANDSLIDES, AND MUDSLIDE` received the following amounts for Individual Assistance: $165, Individuals and Housing Assistance: $2,242,253, Housing Assistance: $2,069,845, and Other Needs Assistance: $172,408.40. Each county received the same amount, and some counties did not have any values to describe what they received (`NA`s).

Individual Assistance Program

Figure 2 shows the counties with the highest populations living in poverty, as well as how long their floods were and if they were offered the FEMA IA program. Figure 3 shows such for total population living in poverty under five years of age, and Figure 4 shows the same for children 5-to-17 years old. All figures show that for floods occurring in 2020 and 2021, these counties did not receive the IA program, regardless of their total population living in poverty and length of flood.

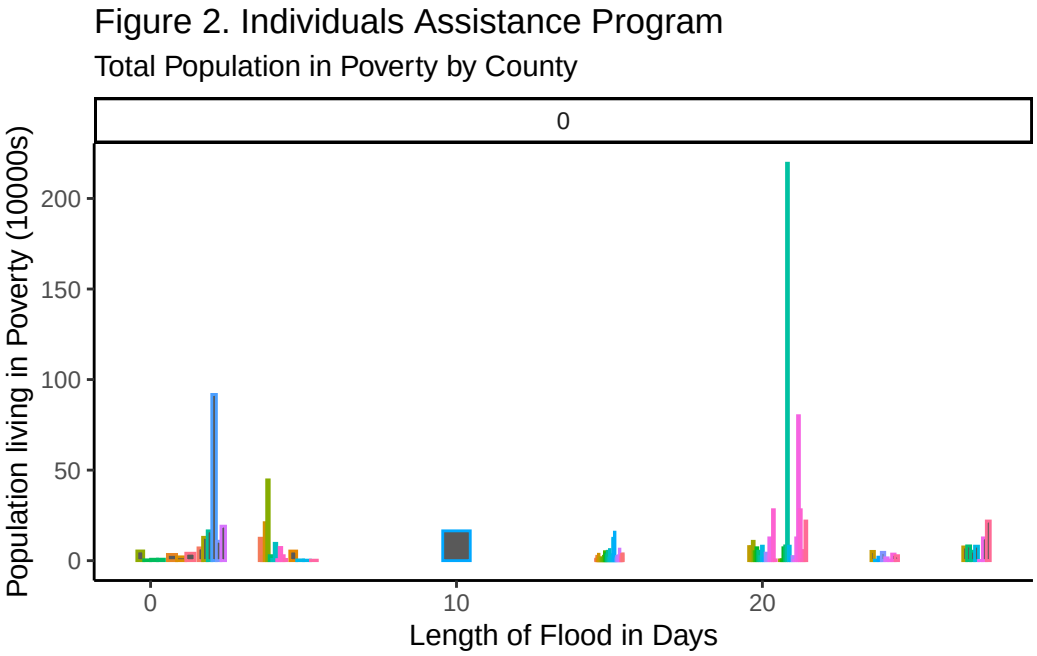


Figure 3. Individuals Assistance Program

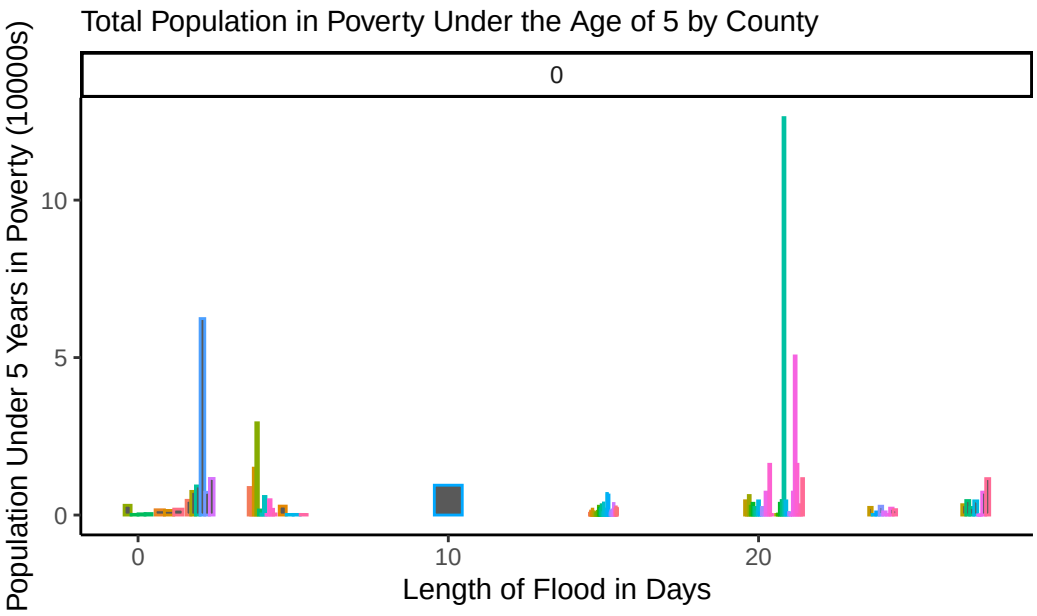
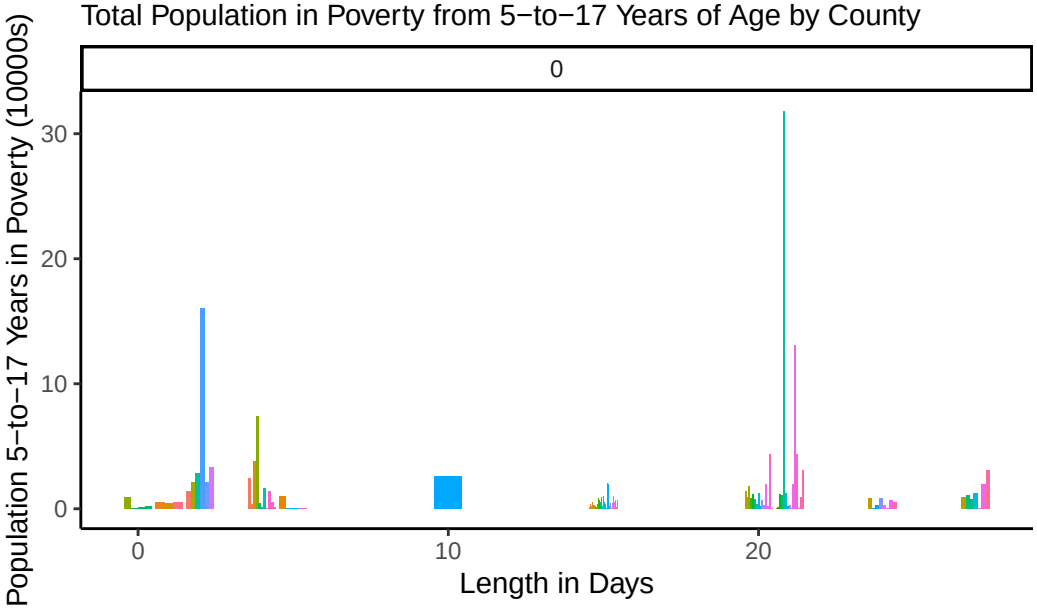


Figure 4. Individual Assistance Program



Individual and Housing Assistance Program

Figure 5 shows the total population in poverty in each county, the length of the flood, as well as if the IHA program was offered. Figure 6 shows such for populations under five years of age and Figure 7 for between 5-to-17 years old. It appears in these figures that the IHA program was not offered to the counties with the highest concentrations of populations living in poverty and who are children. Additionally, the highest total populations had the longest floods, which was not considered when declaring the IHA program for the counties.

Figure 5. Individual and Household Assistance Program

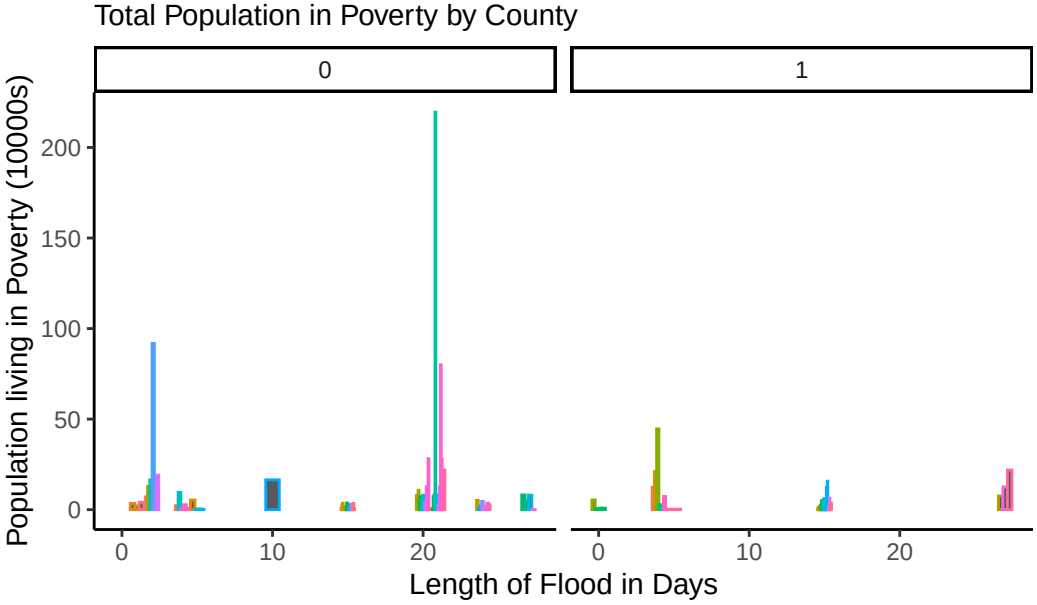


Figure 6. Individual and Household Assistance Program

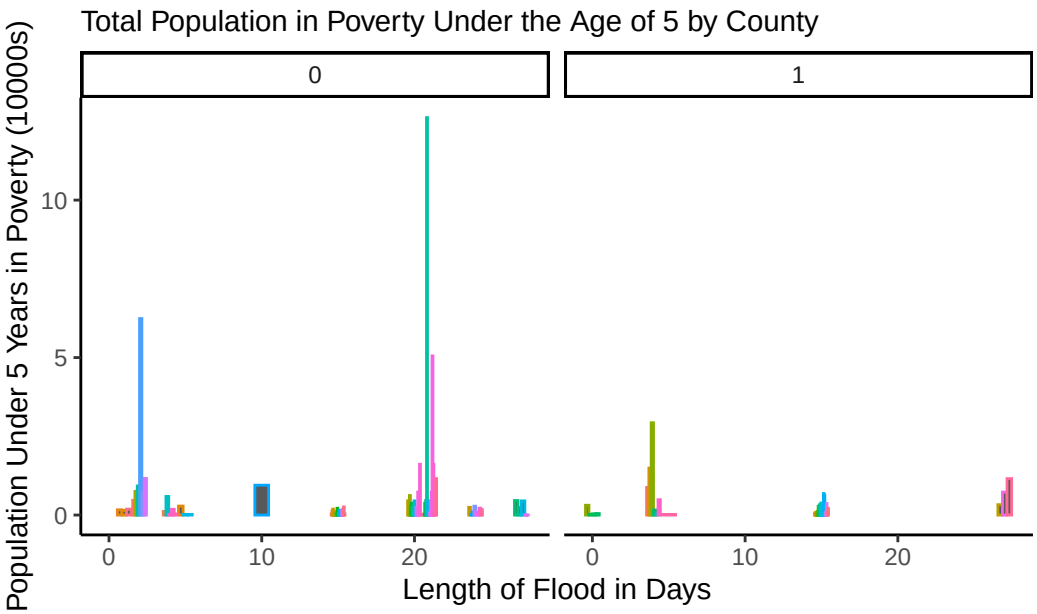
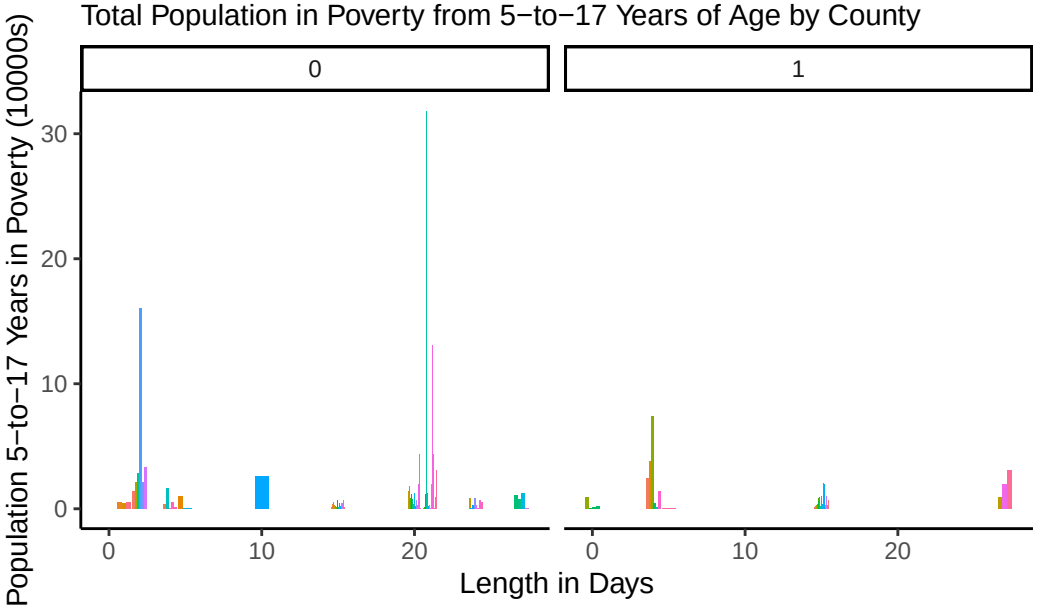


Figure 7. Individual and Household Assistance Program



Public Assistance Program

Figure 8 shows what counties were offered the PA program, the total populations living in poverty, as well as the length of the flood in days. Figure 9 shows such for populations under five, and Figure 10 represents children between 5-to-17 years. Almost all of the counties were offered PA assistance, but the one's not did not have high numbers of total populations living in poverty.

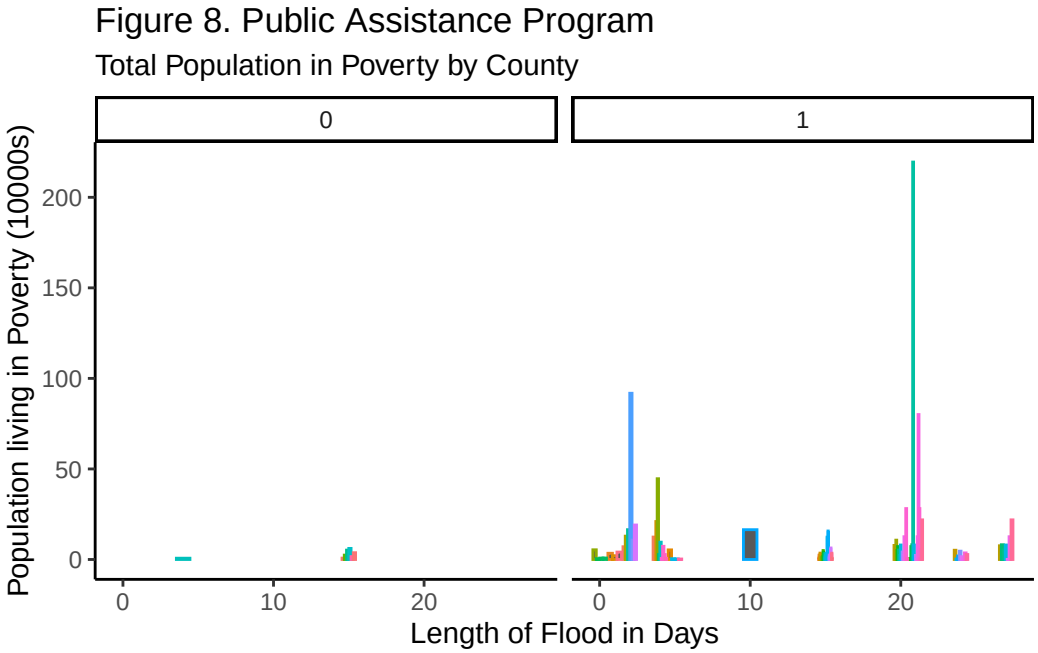


Figure 9. Public Assistance Program

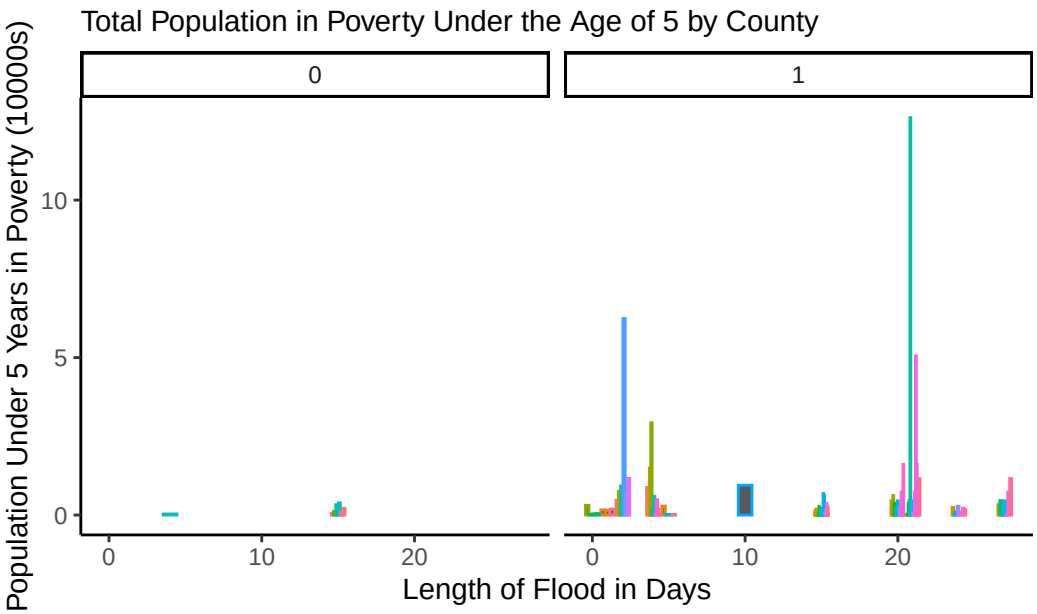
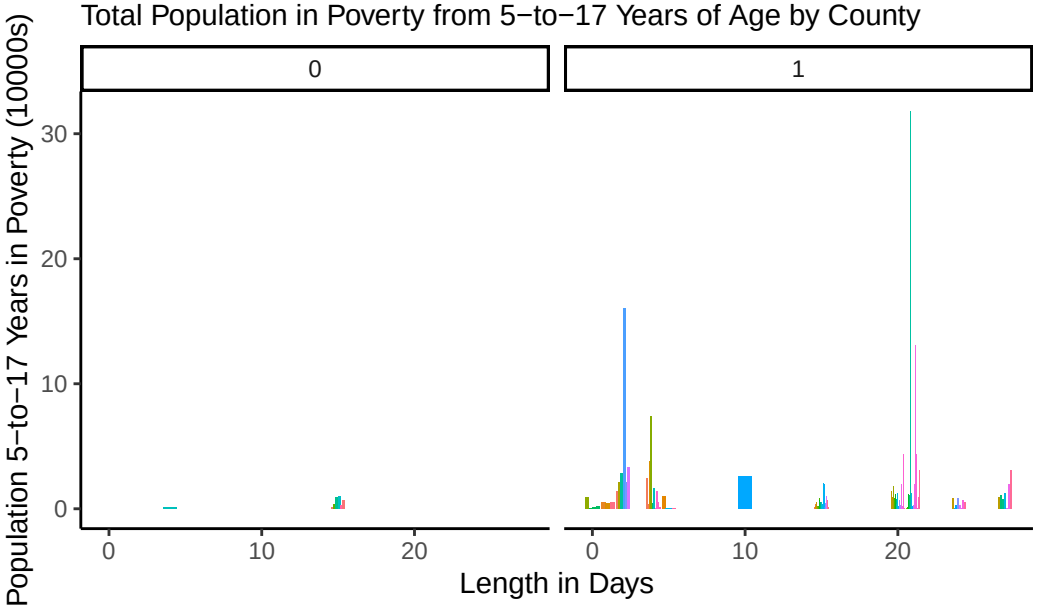


Figure 10. Public Assistance Program



Hazard Mitigation Program

The following three figures show if the HM program was declared for counties who experienced flooding, the lengths of their floods, and the populations living in poverty. Figure 11 shows all populations, Figure 12 shows populations under 5 years of age, and Figure 13 shows populations between 5-to-17 years of age. All figures show that every county was offered HM post-flood, no matter the income level and length of flood.

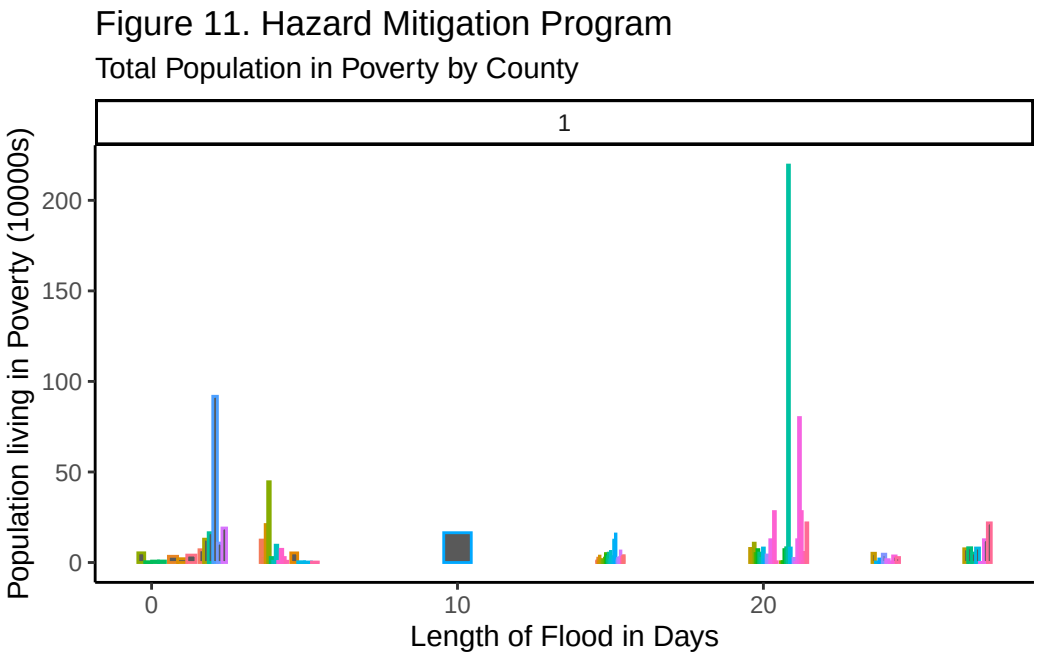


Figure 12. Hazard Mitigation Program Declaration

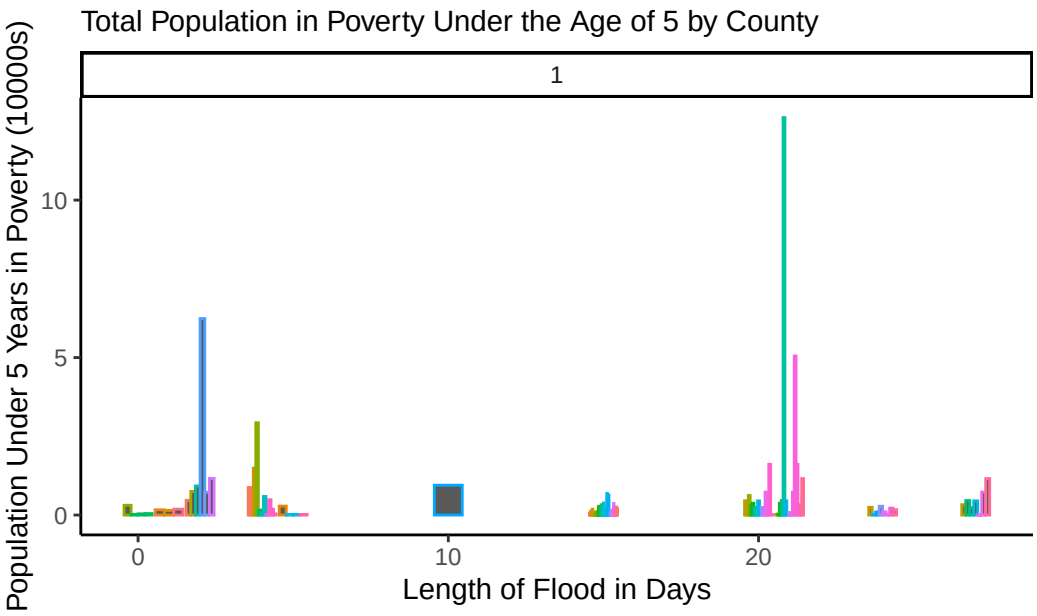
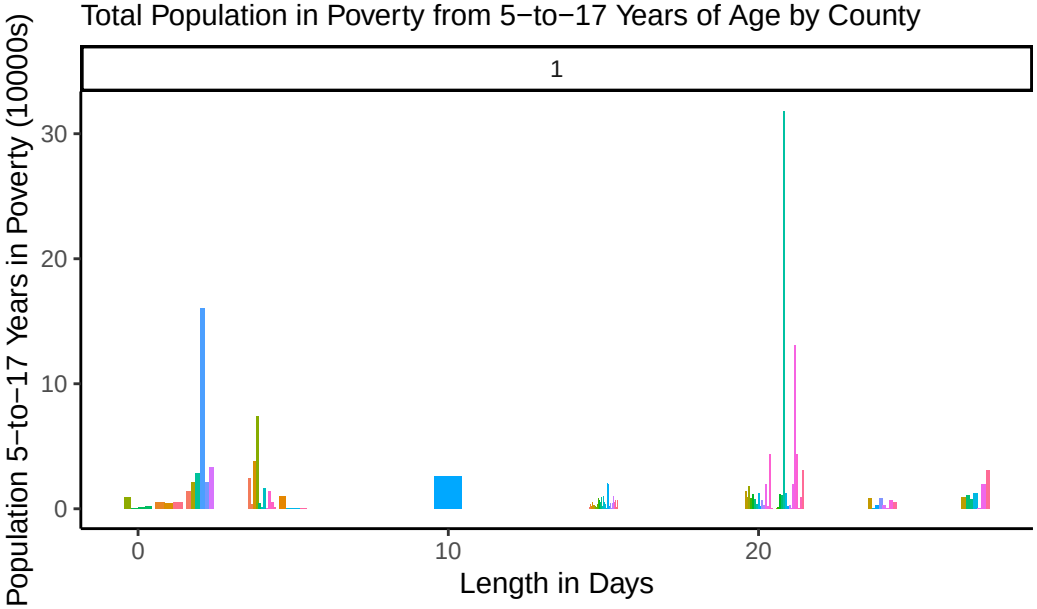


Figure 13. Hazard Mitigation Program Declaration



Findings

Taking the findings from the Census and FEMA data on floods in 2020 and 2021, it shows that FEMA does not take into account poverty level, nor length of flood, when determining assistance. There were several counties who received no assistance and had high numbers of populations in poverty and the longest floods, specifically in the IA and IHA programs. The IA and the IHA programs are designed to support the entire household, including the children. The populations with the highest number of children living in poverty are not receiving the assistance that they need the most. There needs to be further work in this area to ensure the protective factors set in place to support against post-flood risks are targeting those who need it most.

It also appears the post-flood relief of HM and PA were offered to almost, if not, all counties who needed it, not dependent on poverty level or length of flood. Additionally, the length of maximum time of PA is the same across the board (see page 5), not dependent on poverty level, length of flood, and type of flood.

Implications

There are several implications to these findings, specifically to FEMA assistance programs, as well as other areas to explore with this data. First, FEMA should determine grant support based on poverty levels in the county, as well as the length and severity of the flood. Currently, FEMA has been offering the same amount of grant money for all counties, based on declared flood type and nothing else. By distributing this money more equitably, populations living in poverty, and those who are children and adolescents, will get the protective factors they need to build resilience against post-flood risks. Next, FEMA should ensure the declared post-flood relief

Additionally, statisticians should work to build a mathematical model that will delineate how to equitably give grant funding and offer programs services to counties who need it the most. A model that accounts for total population living in poverty, especially those with children and adolescents, length of flood, and type of flood. All of these factors can find a way to equitably distribute FEMA assistance to economically vulnerable populations, especially those with the highest number of children, so they can build resiliency against post-flood risks.

Conclusion

In conclusion, it is apparent that FEMA assistance is not equitably distributed to populations who need it the most, like populations in poverty. The children and adolescents living in these populations can have extreme developmental impacts due to flood-related risks (Masarik and Conger 2017a). FEMA must work with statisticians to develop a mathematical model to

quantify how the counties with the highest amounts of populations in poverty, especially with children, can get to most targeted grant support in the IA and IHA programs, also taking into account length of flood and severity of the flood. Currently, FEMA is offering the same assistance to all counties, no matter the poverty level but instead based on the severity of the flood itself. By implementing an equity model into their assistance grant amounts, then the populations living in poverty will receive the funding they need to be protected against flood risk factors.

References

Ahmed, Riaz, Waseem Barkat, Adeel Ahmed, Muhammad Tahir, and Abdul Majid Nasir. 2022. "The Impact of Flooding on Education of Children and Adolescents: Evidence from Pakistan." *Water Economics and Policy* 08 (03). https://doi.org/10.1142/s2382624x22400094.

Felton, Julia W., David A. Cole, and Nina C. Martin. 2013. "Effects of Rumination on Child and Adolescent Depressive Reactions to a Natural Disaster: The 2010 Nashville Flood." *Journal of Abnormal Psychology* 122 (1): 64–73. https://doi.org/10.1037/a0029303.

Foudi, Sébastien, Nuria Osés-Eraso, and Ibon Galarraga. 2017. "The Effect of Flooding on Mental Health: Lessons Learned for Building Resilience." *Water Resources Research* 53 (7): 5831–44. https://doi.org/10.1002/2017wr020435.

Liu, AiZhong, Hongzhuan Tan, Jia Zhou, Shuoqi Li, Tubao Yang, Zhenqiu Sun, and Shi Wu Wen. 2007. "Brief Screening Instrument of Posttraumatic Stress Disorder for Children and Adolescents 7–15 Years of Age." *Child Psychiatry and Human Development* 38 (3): 195–202. https://doi.org/10.1007/s10578-007-0056-7.

Masarik, April S, and Rand D Conger. 2017b. "Stress and Child Development: A Review of the Family Stress Model." *Current Opinion in Psychology* 13 (February): 85–90. https://doi.org/10.1016/j.copsyc.2016.05.008.

———. 2017a. "Stress and Child Development: A Review of the Family Stress Model." *Current Opinion in Psychology* 13 (February): 85–90. https://doi.org/10.1016/j.copsyc.2016.05.008.

Mijs, Jonathan J. B., and Elizabeth L. Roe. 2021. "Is America Coming Apart? Socioeconomic Segregation in Neighborhoods, Schools, Workplaces, and Social Networks, 1970–2020." *Sociology Compass* 15 (6). https://doi.org/10.1111/soc4.12884.

Varela Varela, Ana. 2023. "Surge of Inequality: How Different Neighborhoods React to Flooding." *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4396481.