UNDERSTANDING FLOOD SCENARIOS: A ROADMAP TO RESILIENCE CHATHAM COUNTY, GA

PROJECT REPORT 2025-001

WWW.IN-CORE.ORG

JANUARY 2025

Understanding Flood Scenarios: A Roadmap to Resilience for Chatham County, GA

Project Report 2025-001

www.in-core.org

This report was prepared by the Project IN-CORE Team as part of the Geos Institute's Climate Ready America Southeast Navigator Network with funding from the Walmart Foundation to analyze future flood hazard scenarios and implement risk reduction and resilience planning strategies.

January 2025

Credits and Acknowledgements

Project IN-CORE Team
Project IN-CORE is a fiscally sponsored project of Community Initiatives, a non-profit dedicated to helping communities thrive. Project IN-CORE's objective is to apply IN-CORE capabilities to provide technical assistance and scenario-based modeling to develop resilience strategies for future flood hazards.

Project IN-CORE Chatham County Report Authorship
John W. van de Lindt, Ph.D., Director
Jamie Kruse, Ph.D., Associate Director

Melina Matos, Ph.D., Planner
Hwayoung Jeon, Ph.D., Economist
Blythe Johnston, B.S., Civil Engineer
Omar Nofal, Ph.D., Civil Engineer
Katie Skakel, Community Engagement Specialist

Geos Institute's Navigator
The Geos Institute's Navigator program supports communities in building climate resilience by providing access to funding, capacity-building resources, and technical assistance. Through its Southeast Navigator Network, the program fosters collaboration across Florida, Georgia, North Carolina, and South Carolina, focusing on Community Disaster Resilience Zones.

A special thank you to *Navigator* Courtney Reich, The Georgia Conservancy.

Data Acknowledgements

The mapped flood depths used in these analyses have been developed from climate projections generated by Argonne National Laboratories in collaboration with the AT&T Foundation and provided to Project IN-CORE by the AT&T Foundation for the development of use cases of the climate data available on the Climate Risk and Resilience Portal (ClimRR). A version of this data will be available on the ClimRR portal.

Funding Acknowledgements

This report was prepared by the Project IN-CORE Team as part of the Geos Institute's Climate Ready America Southeast Navigator Network with funding from the Walmart Foundation to analyze future flood hazard scenarios and implement risk reduction and resilience planning strategies. The findings, conclusions, and recommendations presented in this report are those of the authors alone and do not necessarily reflect the opinions of the Walmart Foundation.

Table of Contents

1. Purpose and Objective

This study presents a comprehensive flood resilience analysis for Chatham County, Georgia, to inform policy decisions and guide resilience planning strategies. The analysis evaluates future flood hazard scenarios, identifying areas within the community vulnerable to current and mid-century flooding. Considering the increasing frequency and intensity of precipitation, the study highlights evolving risks to help policymakers and stakeholders plan effectively for climate impacts. The overarching goal of this report is to support the County's capacity to navigate urban growth and flood risk uncertainties, fostering a resilient and adaptive community.

The analysis was conducted using the IN-CORE platform (www.in-core.org), incorporating its Flood Damage Analysis model, Population Dislocation Model, and Computable General Equilibrium (CGE) model. To account for mid-century climate conditions, flood data from the Climate Risk and Resilience Portal (ClimRR) was integrated, providing a comprehensive assessment of climate projections and future risks.

2. Background

Chatham County, GA, located along the southeastern U.S. coast, is the most populous county outside the Atlanta region, home to approximately 303,655 residents (Census, 2023). Anchored by Savannah (147,845 residents), the County encompasses seven other cities (Figure 1): Pooler (27,007 residents), Garden City (10,348 residents), Bloomingdale (2,870 residents), Tybee Island (3,093 residents), Vernonburg (139 residents), Thunderbolt (2,526 residents), and Port Wentworth (11,770 residents). Chatham is a key economic, cultural, and governmental hub for a six-county, bi-state region, which includes the Georgia counties of Bryan, Effingham, Liberty, and Bulloch, as well as Jasper and Beaufort counties in South Carolina. Collectively, these counties form an integrated area that collaborates on various economic and infrastructural initiatives, with Chatham County acting as the focal point for regional development and coordination. However, Chatham County faces unique flood risks from storm surges, tidal inundation, and extreme precipitation. Leveraging recent funding initiatives and its history of proactive engagement, Chatham County strives to enhance its capacity to mitigate, adapt to, and recover from flooding hazards, safeguarding its communities and economic vitality.

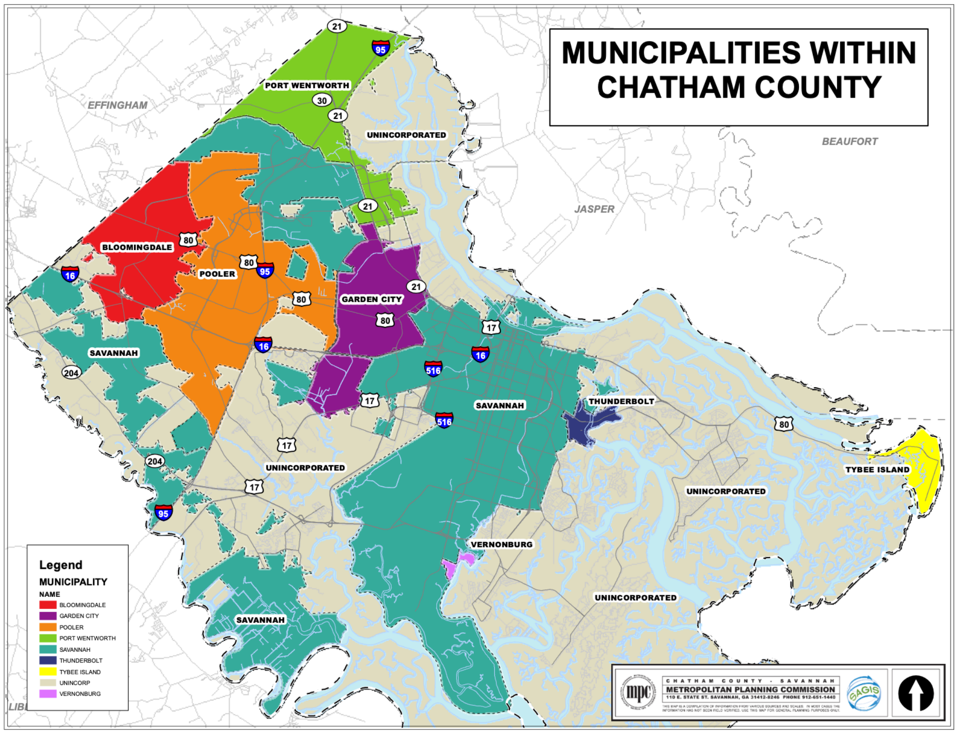

Figure 1. Municipalities within Chatham County
Source: Metropolitan Planning Commission

3. Future Flood Hazard Scenarios and Impacts

This section was developed using the Interdependent Networked Community Resilience Modeling Environment (IN-CORE) and ClimRR flood hazard data. IN-CORE is a powerful computational tool designed to help communities model natural hazards, assess risks, and develop strategies to enhance resilience and recovery. ClimRR (Climate Risk and Resilience Portal) is an online platform that provides detailed climate data and future flood projections to help communities prepare for climate-related risks. It was developed by Argonne National Laboratories and shared by Project IN-CORE's collaboration with the AT&T Foundation.

To run IN-CORE, we used building data inventory from the National Structures Inventory (NSI). The details on the methodology are provided in Appendix A. The flood scenarios in this report are based on mid-century climate projections (2045–2054) from ClimRR. These scenarios include a 100-year coastal flood, which accounts for rising sea levels and storm surges from hurricanes and tropical storms, and a 50-year inland flooding event caused by heavy rainfall (pluvial flood). This approach helps capture the increasing intensity of future storms and rainfall patterns.

The information in the current report is useful for understanding potential future flooding conditions. However, they do not include river flooding or municipal stormwater systems information. For river flooding, FEMA flood maps are still a reliable source. For urban flooding, a more detailed analysis of stormwater systems may be needed. The results presented should be interpreted considering these limitations.

3.1. Flood Damage Analysis

The building damage analysis estimates damage levels by considering building categories and simulated flood scenarios across the region, as detailed in the methodology in Appendix A. In this analysis, the term Damage State (DS) is used to represent different levels of damage, which are explained below:

- **DS 0 (No Damage or Slight Damage)**: The building experiences no visible damage from flooding. All structural and non-structural elements remain intact, with no repair required. Or there are minor impacts from flooding, such as superficial water staining, damp walls, or minimal seepage into basements or ground floors. Repairs are light and typically involve cleaning or cosmetic fixes.
- **DS 1 (Moderate Damage):** Floodwaters cause more significant damage, such as partial inundation of ground floors, damage to finishes like flooring and drywall, and minor effects on electrical or plumbing systems. Repairs are required, but the structural integrity remains intact.
- **DS 2 (Severe Damage):** Substantial flooding leads to significant structural impacts, such as prolonged submersion of key components, damage to load-bearing walls, or failure of essential systems (e.g., electrical, HVAC). The building may be uninhabitable until extensive repairs are completed.
- **DS 3 (Complete Damage):** The building is fully inundated or structurally compromised, resulting in total loss. Repairs are not feasible, and the structure may need to be demolished and rebuilt.

Table 1 summarizes the results of the building damage analysis, highlighting that while low-level damage (Damage State 1) is expected for approximately 6.48% of buildings, only around 230 buildings are likely to experience moderate to severe damage (Damage States 2 or 3). The results highlight only buildings with a probability greater than 50% of being damaged within each category. Figure 2 and Figure 3 show the areas in which those buildings are concentrated, which can also be accessed in this link. The flood depths used in our modeling represent realistic events that the local community is likely to encounter and should be prepared to repeatedly withstand in the coming years rather than a worst-case scenario. Appendix A provides more details on the methodology.

Table 1: Summary of the building damage analysis – Chatham County

Damage State	Building Count	% of Buildings
Damage State 0	103043	93.32%
Damage State 1	7150	6.48%
Damage State 2	220	0.20%
Damage State 3	11	0.01%

Source: IN-CORE

Figure 2 highlights the priority areas where buildings are at significant risk of severe damage (DS2) or complete damage (DS3). The highest concentration of vulnerable buildings is in Tybee Island, Thunderbolt, unincorporated areas, and parts of Savannah. The flood depth in this region varies from 3 to 15 feet for some structures, which is higher than most other areas in the county. To mitigate risks, it is further recommended that new construction in these regions be restricted to elevated structures having as reference the projected flood depths indicated in the flood depth raster layer available in the [Chatham County IN-CORE Analysis app](#).

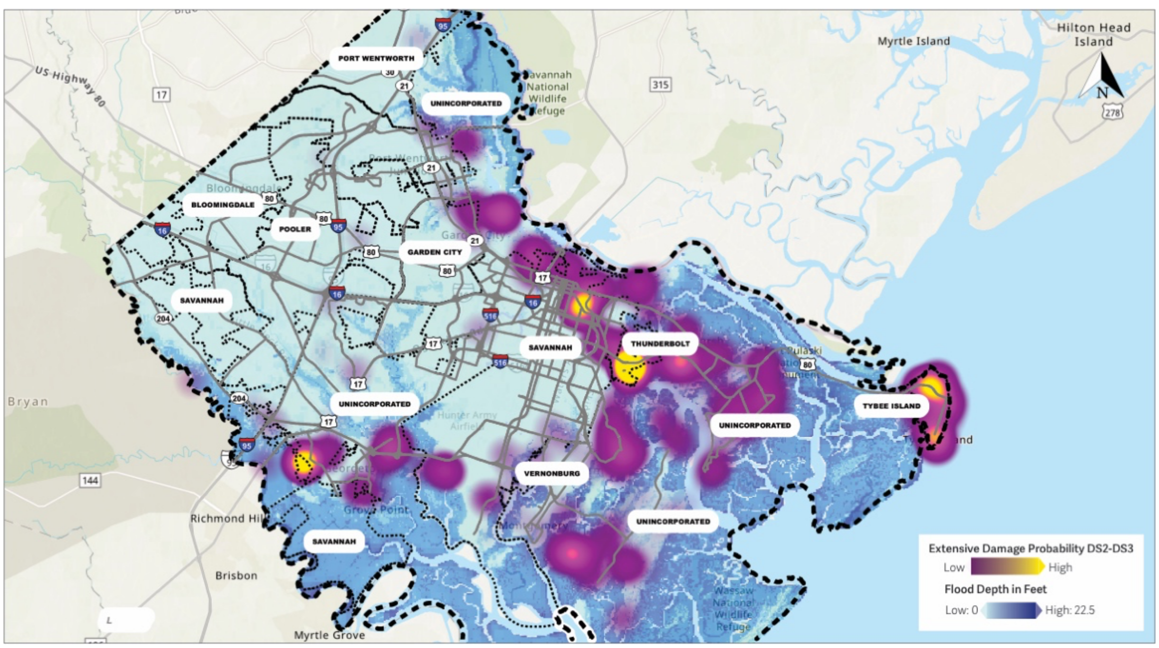

Figure 2. Areas with the probability of experiencing Damage State 2 and 3
Source: [Chatham County IN-CORE Analysis app](#)

While DS 1 represents moderate damage, the immediate priority in a single flood would be structures with a greater than 50% probability of reaching DS 2 or 3. However, global climate models indicate that flooding events described in this report will likely become more frequent as the century progresses. With repeated flood events, structures currently in DS 1 should also be a concern, as ongoing exposure could gradually compromise the functionality and structural integrity of a larger portion of the building stock over time (Figure 3).

For areas expected to experience lower-level damage, it is recommended to implement proactive flood management strategies. These include avoiding utility installation in flood-prone crawlspaces, installing sump pumps where low-level flooding is projected to be more common, landscaping to divert heavy precipitation away from the base of the building, and nature-based solutions to allow for greater infiltration of precipitation and erosion prevention along rivers, streams, and coastlines. These measures can help mitigate cumulative impacts and improve long-term resilience.

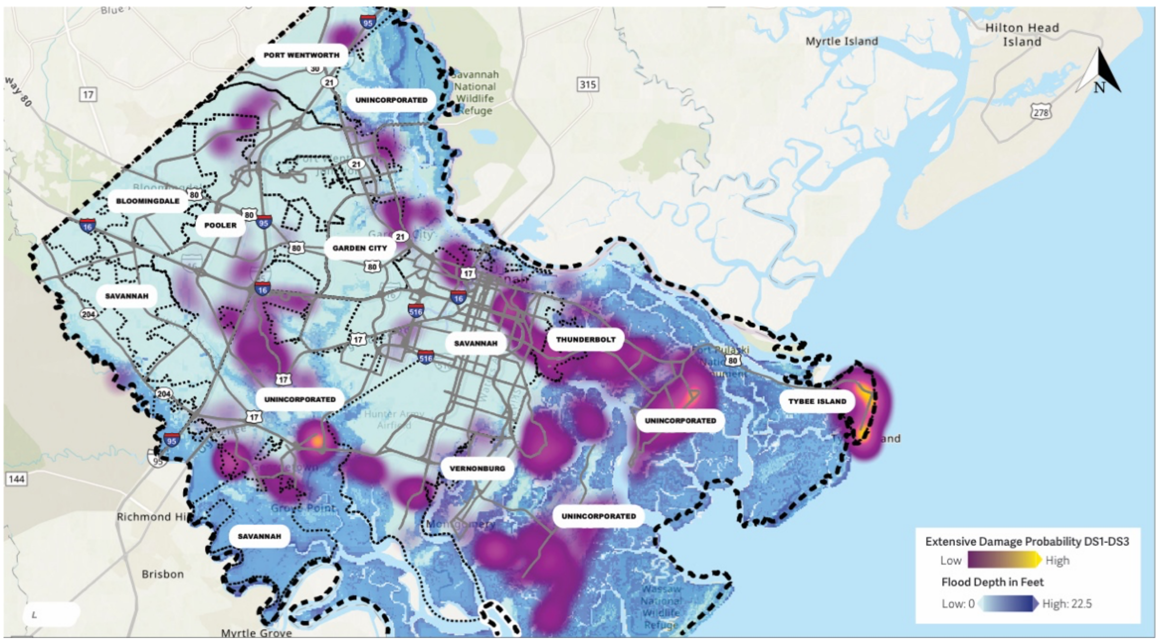

Figure 3. Areas with the probability of experiencing Damage State 1 to 3
Source: [Chatham County IN-CORE Analysis app]

3.2. Population Dislocation

Population dislocation refers to the displacement or temporary relocation of individuals due to disasters (Oliver-Smith, 2018). While people are the cornerstone of community resilience planning, existing models prioritize buildings and infrastructure over human-centered considerations. This repository addresses this gap by integrating people into community resilience models and linking population dynamics with building data.

The dislocation model relies on data about both people and structures. A specialized Python package, **Pyncoda**, developed under the Center of Excellence for Risk-Based Community Resilience Planning, is utilized to allocate population data to housing units. This tool synthetically assigns households to housing units, enabling a more comprehensive understanding of community resilience. A detailed explanation of the methodology is provided in Appendix B. The demographic characteristics of the synthetic population match the characteristics at the Census block group level. This work is described as follows by Pyncoda's README file on GitHub authored by Nathanael Rosenheim (Rosenheim, 2021).

Once a housing unit allocation has been generated, then the damage result for each building can be combined with the social data for each household, such as tenure status, race, and household income, to determine whether a household is likely to temporarily relocate due to a hazard event, in this case, flood. The results of a population dislocation analysis can be analyzed further to understand the equity impacts of such hazards. Figure 4 shows dislocated households in Chatham County after a simulated hazard event. This analysis yielded a dislocation of approximately 7140 households, representing about 6% of the household census data. Details of this procedure can be found in the population dislocation methodology section. Minimizing damaged areas will also minimize population dislocation.

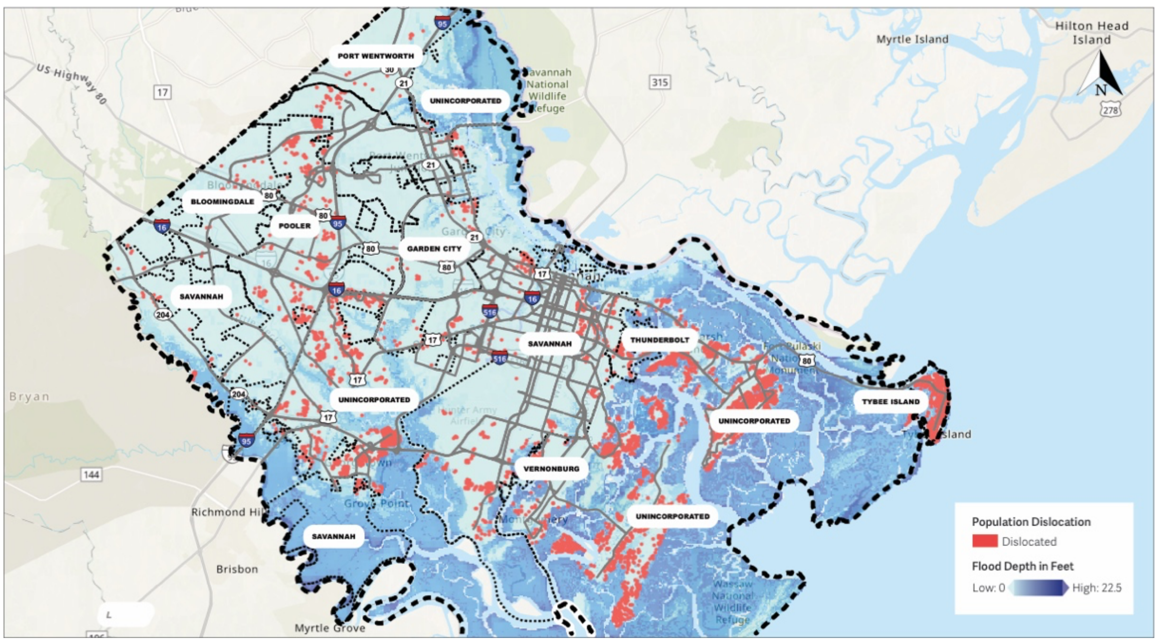

Figure 4. Population Dislocation
Source: [Chatham County IN-CORE Analysis app]

3.3. Economic Impacts

Flood events disrupt local economies, damage infrastructure, and reduce productivity. These impacts can ripple across sectors, affecting not only directly impacted industries but also supply chains and consumer behavior. To analyze such effects comprehensively, we used Computable General Equilibrium (CGE) models to simulate the interdependencies of economic sectors within Chatham County, capturing the systemic effects. A CGE model represents the economic relationships among producers, households, and the government, using economic theory to demonstrate the effects of economic changes on these entities. These models are centered on a

Social Accounting Matrix (SAM), which tracks the transactions and income flows between households, firms, and government agents. A more in-depth explanation of CGE models is available in Appendix C.

The dominant industries in Chatham County (Figure 5) are Commercial (22%), Retail (15%), Leisure & Hospitality (13%), and Health (13%). The Commercial sector encompasses wholesale trade, finance and insurance, real estate, professional services, management, and administrative support.

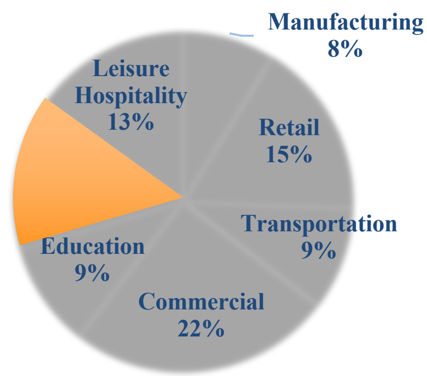

Figure 5. Employment share distribution across major economic sectors, 2022
Source: U.S. Bureau of Labor Statistics

The distribution of workers by race and ethnicity across four key economic sectors (Figure 6) reveals distinct patterns. The Commercial sector employs the highest number of White workers, particularly in the top income group (over $70,000), with nearly 7,000 workers. Retail stands out for employing many lower-income Black workers, while Manufacturing features prominently in both the highest income group for White workers and the lower income group for Black workers. Leisure & Hospitality is concentrated in lower income brackets, with significant employment across all racial and ethnic groups. Among the Other racial group, employment is more evenly distributed, with the Commercial sector leading in the $15,000–$40,000 income range. Overall, the Commercial sector employs the most workers across most racial groups, followed by Retail and Leisure & Hospitality, reflecting sectoral differences in workforce distribution by race and income. More detailed analysis of the workforce across income levels, racial and ethnic groups, and economic sectors can be found in Appendix C.

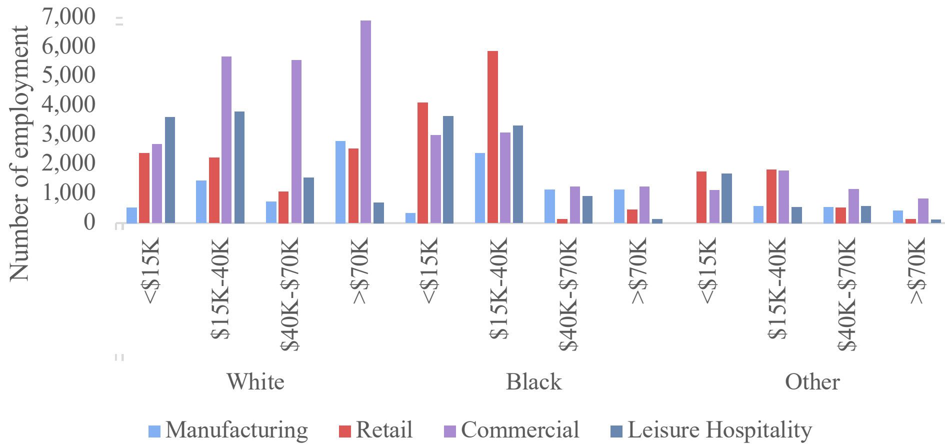

Figure 6. Distribution of workers by race and ethnicity across selected economic sectors, 2022
Source: U.S. Bureau of Labor Statistics

Regarding labor movement in and out of Chatham County, Figure 7 shows that 44.5% of the local workforce lives outside the county, making Chatham County a major employment hub for nearby areas. Conversely, over 31,000 residents commute out of the County for work, which impacts household wage income within the county.

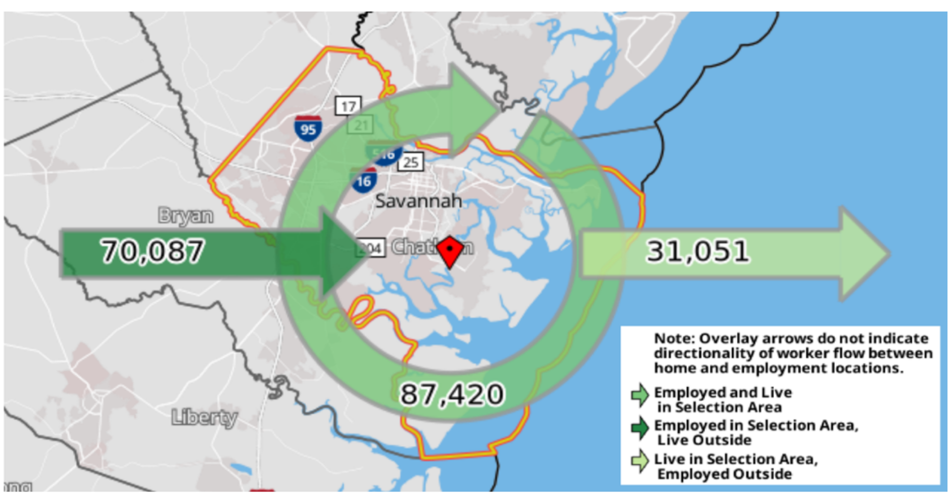

Figure 7. Inflow/Outflow analysis, Chatham County
Source: U.S. Census Bureau, 2021

The process of estimating economic damage using a CGE model is outlined in Figure 8. The process begins with engineers assessing how likely buildings are to become non-functional during a hazard. These probabilities are then used to estimate the loss in property value or "capital stock" within each economic sector by averaging the damage across buildings. This loss is treated as an external shock in the CGE model, which calculates the broader economic impact. The losses to capital stock (represented as delta K) lead to a decline in economic output (delta Y). As output drops, businesses may need fewer workers, causing employment to decrease. This reduction in employment impacts household income, both from wages and returns on investments. In essence, the loss of capital stock triggers a chain reaction affecting the local economy.

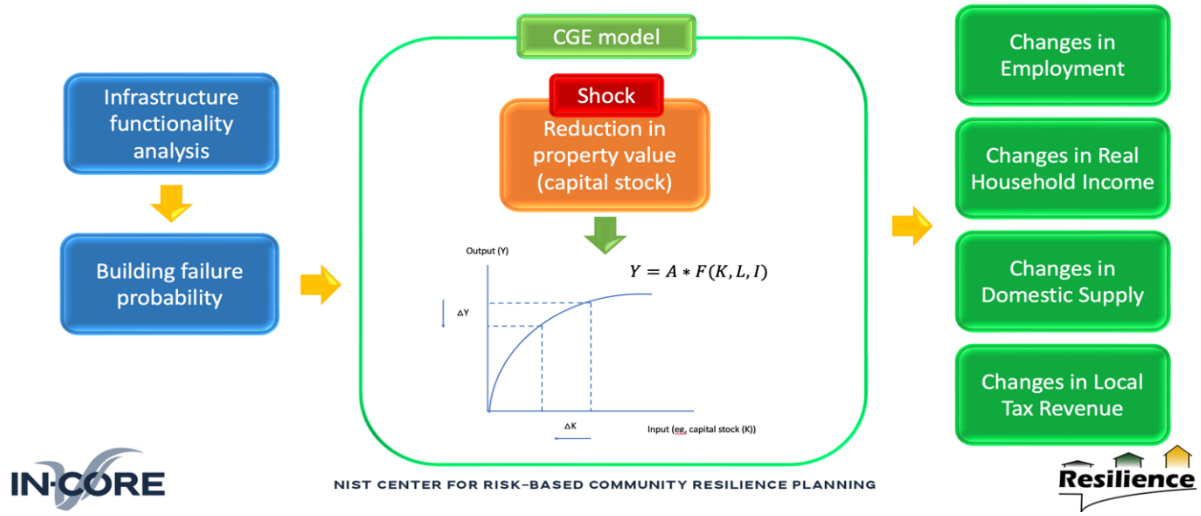

Figure 8. Integrating damage analysis into the CGE model

Figure 9 shows the analysis of two scenarios. The first, the DS2 threshold, defines failure as DS2 (severe damage) or higher (complete damage), focusing on structures impacted by one-time severe flooding. The second, the DS1 threshold, sets failure at DS1 (moderate damage) or higher (severe and complete damage), capturing structures more prone to frequent, lower-level flooding.

Under the DS2 threshold, the effects on real household income are relatively mild, yet the most significant decreases occur in households earning between \$30,000 and \$60,000. This trend is largely due to escalating housing costs that have a more pronounced impact on these income groups, even amid only moderate employment reductions across all labor categories. Lower-income households typically spend a higher percentage of their income on housing-related expenses, such as rent. While the damage to the lowest valued housing units was slight, at just 0.1%, middle-valued units suffered more extensive damage at 0.3%. This suggests that middle-income households endure greater increases in housing service costs, which in turn diminish their real household income. Under the DS1 threshold, losses are markedly greater, particularly among higher-income households making over \$60,000, affecting all racial groups with significant declines. High-income Black and Other households experience the most severe reductions, with losses approaching or exceeding 3.5%. These losses are driven by significant job cuts in higher-income brackets within the most affected sectors, alongside extensive damage to high-value properties. High-income earners generally own more property and rely more heavily on capital income rather than wages. Consequently, damage to housing units leads to significant reductions in their capital income, a more pronounced effect than what is experienced by lower-income groups.

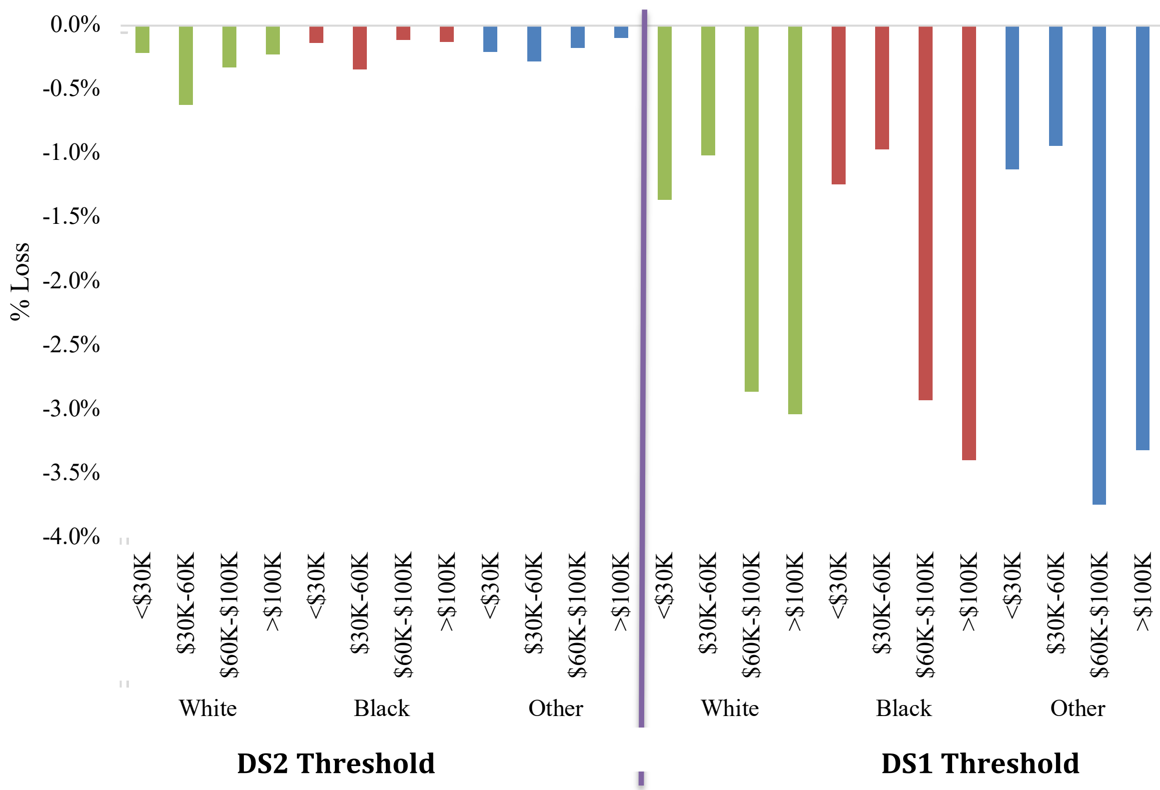

Figure 9. Effects on distribution of real household income

Table 2 provides an overview of property damage from flooding across various economic sectors, evaluated at two different thresholds. At the DS2 threshold, the damage is minimal, with total property losses amounting to $382 million, representing less than 1% of the overall property value. The Manufacturing and Commercial sectors are the hardest hit, experiencing damage to 2.3% and 2.1% of their properties, respectively. At the DS1 threshold, total property damage increases to $3.03 billion, representing almost 8% of the overall property value. Within this, the Housing Services sector, which holds the highest property values, incurs the greatest percentage of loss, followed by the Manufacturing and Commercial sectors.

Table 2. Property damage impacts of flooding

Economic sector	Total property value (millions of $)	DS2 Threshold		DS1 Threshold	
		Property damage (millions of $)	% loss	Property damage (millions of $)	% loss
Mining Utility	68.5	-0.1	-0.1%	-4.8	-7.0%
Construction	532.1	-5.3	-1.0%	-30.7	-5.8%
Manufacturing	2,215.2	-51.6	-2.3%	-210.0	-9.5%
Retail	2,135.2	-32.8	-1.5%	-119.2	-5.6%
Commercial	8,315.7	-173.3	-2.1%	-624.8	-7.5%
Transportation	89.6	-1.0	-1.1%	-4.0	-4.5%
Education	1,284.3	-5.9	-0.5%	-27.2	-2.1%
Health	1,031.1	-1.8	-0.2%	-33.6	-3.3%
Leisure Hospitality	2,019.6	-35.7	-1.8%	-144.9	-7.2%
HS1<10K	953.8	-1.4	-0.1%	-22.6	-2.4%
10K≤ HS2<20K	6,025.8	-17.8	-0.3%	-317.4	-5.3%
20K≤ HS3<40K	8,804.8	-25.2	-0.3%	-756.2	-8.6%
40K ≥HS4	6,459.1	-30.5	-0.5%	-739.8	-11.5%
Total	39,934.9	-382.35	-1.0%	-3,034.9	-7.6%

4. Current Planning Initiatives for Flood Resilience

Chatham County has proactively committed to enhancing flood resilience through comprehensive planning and management initiatives that address current and future challenges. As an active participant in the National Flood Insurance Program's (NFIP) Community Rating System (CRS), the County has achieved a Class 5 Rating, which provides a 25% discount on flood insurance premiums for properties in Special Flood Hazard Areas (SFHAs) and a 10% discount for properties outside these areas. To maintain and improve this rating, many of the County's plans focus on strategies that strengthen its CRS standing. This section reviews key plans and ordinances related to flood resilience across the County and specific cities, emphasizing areas identified as risk in future flood hazard analyses.

2018 Chatham County Natural Floodplain Functions Plan

The Chatham County Natural Floodplain Functions Plan outlines a comprehensive approach to managing floodplains to mitigate flood risks while preserving and enhancing their natural functions in the unincorporated areas of the County. The document emphasizes the ecological, hydrological, and socio-economic values of floodplains, which include floodwater storage, water quality maintenance, groundwater recharge, and wildlife habitat provision. It underscores the balance between human development and natural processes, aiming to protect floodplain resources from degradation caused by urbanization. The County benefits from reduced insurance premiums by participating in the CRS while promoting awareness and proactive floodplain management strategies.

The plan addresses flood mitigation through a combination of strategies, including the preservation of natural floodplain functions, implementation of green infrastructure, and regulatory measures like setbacks and zoning adjustments to limit development in high-risk areas. It highlights the role of wetlands and barrier islands in reducing storm surges and erosion. These strategies are important mainly in the unincorporated areas in the Southeast of the County (Figure 3, page 7).

2018 Repetitive Loss Area Analysis (RLAA) for Chatham County, Georgia

The 2018 RLAA focuses on identifying and mitigating flood risks associated with the repetitive loss of properties within the unincorporated areas of Chatham County. Highlighting the significant financial burden these properties place on the NFIP, which has paid nearly $9 billion to repetitive loss properties since its inception, the report notes that in 2017, Chatham County had 40 unmitigated and 4 mitigated repetitive loss properties. The RLAA identifies each repetitive loss area, assesses vulnerabilities, and recommends mitigation measures such as property acquisition, elevation, floodproofing, and drainage improvements. Additionally, it emphasizes public education and coordination with state and federal agencies to enhance community resilience. By prioritizing actions based on risk severity and cost-effectiveness, the report ensures targeted mitigation for high-impact areas, aiming to reduce long-term flood risks and financial losses.

Figure 3 (page 7) highlights areas with a probability of experiencing moderate flood damage. Given predictions that flooding events will become more frequent and severe as the century progresses, structures in these areas, if not adequately mitigated, are at risk of evolving into repetitive loss properties. This underscores the importance of proactive mitigation efforts to safeguard these structures and prevent further financial and community impacts.

2021 Chatham County Sea Level Rise Study

The 2021 Chatham County Sea Level Rise (SLR) study aims to assess the potential impacts of sea level rise on critical infrastructure, stormwater systems, and roadways in Chatham County. This study evaluates vulnerabilities under current and projected sea level rise scenarios and identifies strategies to mitigate future risks. By integrating the study's findings into planning and mitigation frameworks, the County seeks to enhance its resilience to climate change-related flooding while complying with FEMA's Community Rating System (CRS) standards.

The plan proposes recommendations for infrastructure improvements, such as updating drainage capital improvement programs, integrating green infrastructure upstream of vulnerable systems, and incorporating tide gates and pump stations. The study also suggests prioritizing nature-based solutions and revising local policies to adapt to changing conditions.

2020 Chatham County Multi-Jurisdictional Pre-Disaster Hazard Mitigation Plan

The 2020 Chatham County Multi-Jurisdictional Pre-Disaster Hazard Mitigation Plan focuses on reducing vulnerability to flood hazards and other disasters across Chatham County and its municipalities. The goal of the report is to identify potential risks, assess vulnerabilities, and implement strategies to protect life, property, and critical infrastructure from flood hazards, hurricanes, and other natural disasters. The plan aligns with FEMA and Georgia Emergency Management Agency (GEMA) guidelines to maintain grant eligibility and reduce disaster recovery costs. The plan recommends a multi-faceted approach to address mitigation, including structural measures like drainage system upgrades and non-structural strategies such as public education, floodplain management, and improved building codes. Proposed actions include implementing green infrastructure solutions, preserving natural floodplain functions, and integrating climate adaptation strategies into local policies.

The current report is important for the County Multi-Jurisdictional HMP since it provides actionable data for prioritizing mitigation measures, offering more refined, localized data to support targeted decision-making and tailored strategies that address specific flood vulnerabilities.

2021 Comprehensive Plan 2040

The 2021 Comprehensive Plan 2040 for Chatham County and Savannah outlines a long-term strategy to enhance flood resilience in the region, reflecting the community's priorities and challenges. The plan emphasizes the need to protect natural resources, manage stormwater effectively, and adapt to climate change, including rising sea levels. Public engagement revealed significant concerns about flooding and drainage issues across neighborhoods. The goal is to integrate sustainable infrastructure and policies to address these vulnerabilities while fostering economic growth and maintaining community well-being.

Key recommendations include enhancing drainage infrastructure, preserving wetlands, and implementing green stormwater management systems. The plan also proposes interconnecting trail systems and improving maintenance for parks to increase community resilience. Furthermore, policies are suggested to strengthen zoning and development codes, ensuring new construction adheres to flood-resistant designs.

2023 Flood Mitigation Study for the Chatham County-Savannah Metropolitan Planning Commission (MPC)

The 2023 Flood Mitigation Study for the Chatham County-Savannah Metropolitan Planning Commission (MPC) provides an in-depth analysis of vulnerabilities in the region's stormwater infrastructure and transportation systems. The report aims to enhance the resilience of the transportation network by incorporating advanced flood modeling tools that address rainfall events, tidal flooding, and projected sea level rise (SLR) scenarios up to 2100. This study emphasizes integrating stormwater management, roadway vulnerability assessments, and social vulnerability analysis to prioritize and optimize infrastructure investments equitably.

Key findings highlight the susceptibility of the transportation system to present and future flooding conditions, with significant risks identified under projected SLR scenarios and storm events. Recommendations include the implementation of nature-based solutions, such as green infrastructure, to enhance stormwater capacity, installation of backflow preventers, and the elevation of vulnerable roadways. The study also proposes a comprehensive Project Prioritization Tool, integrating geographic information system (GIS) layers, social vulnerability data, and environmental factors to guide decision-making and resource allocation.

2024 Chatham County Floodplain Management Plan

The 2024 Chatham County Floodplain Management Plan (FMP) aims to reduce risks to people and property from flood hazards while preserving the natural functions of floodplains in the unincorporated areas of the County. Developed under FEMA and CRS guidelines, the plan evaluates the county's vulnerability to climate change, sea level rise, and stormwater flooding. Through a participatory process led by the Floodplain Management Planning Committee (FMPC), the report identifies key risk factors, sets mitigation goals, and proposes 16 prioritized actions to enhance flood resilience. These include acquiring and demolishing high-risk structures, updating stormwater systems, and implementing higher regulatory standards to protect existing and future development.

The current report is important for the 2024 Chatham County FMP as it provides refined, data-driven insights into properties with a high probability of experiencing moderate, severe, or complete damage from flooding, particularly in climate model forecast increase in intensity and frequency of precipitation by mid-century. This detailed analysis aids in prioritizing mitigation measures, enabling more informed and targeted decision-making.

2015 Stormwater Master Plan for Garden City

The 2015 Stormwater Master Plan for Garden City aims to address the city's vulnerabilities to flooding and stormwater impacts, particularly in light of anticipated urban growth and environmental challenges. The primary objective of the report is to provide a strategic framework for managing stormwater through engineering studies, policy updates, and infrastructure investments. The plan focuses on four major drainage basins identified as high-priority areas and outlines strategies to mitigate flooding risks and enhance water quality. By leveraging hydrologic and hydraulic modeling, the report identifies deficiencies in the existing drainage system and provides actionable recommendations for capital improvement projects and policy amendments.

The plan indicates that Garden City's current stormwater infrastructure is aged, undersized, and insufficient to manage increasing runoff, especially in high-risk basins like Talmadge, Smith, Chatham City, and Heidt-Telfair. The plan proposes targeted measures, including upgrading drainage systems, implementing stormwater detention facilities, and developing basin-specific management standards. It also recommends adopting non-structural best practices, such as creating "Special Drainage Districts" to reduce runoff volume and pollutant loads.

2021 Savannah Flood Mitigation Plan

The 2021 Savannah Flood Mitigation Plan aims to reduce flood risks to people, property, and the environment while enhancing community resilience to climate change and other flood-related hazards. Developed collaboratively by the Floodplain Mitigation Planning Committee (FMPC), the plan identifies vulnerabilities, assesses risks, and sets goals to guide mitigation efforts. It integrates a comprehensive risk assessment of hazards, including climate change, sea level rise, and storm surge. It aligns with federal and state requirements to maintain Savannah's eligibility for disaster assistance and Community Rating System credits.

The plan highlights Savannah's susceptibility to flooding due to its low-lying topography, increasing storm intensity, and aging drainage infrastructure. The plan recommends 32 mitigation actions, emphasizing infrastructure upgrades, public education, and land-use policies. Specific measures include improving drainage systems, acquiring flood-prone properties, promoting green infrastructure like permeable pavements, and implementing stricter development codes to protect floodplains. The current report is vital to the 2021 Savannah Flood Mitigation Plan as it offers detailed, data-driven insights into properties with probability of high risk of moderate, severe, or complete flood damage, particularly in light of climate model projections indicating an increase in the intensity and frequency of precipitation by mid-century.

2021 Repetitive Loss Area Analysis (RLAA) for Savannah

The 2021 RLAA for Savannah aims to address chronic flooding issues by analyzing repetitive loss areas and proposing actionable flood mitigation strategies. This report focuses on identifying areas with multiple flood insurance claims, understanding the causes of flooding, and prioritizing mitigation efforts to enhance community resilience while meeting the requirements of the NFIP and the Community Rating System. The analysis is divided into three general areas—Downtown/Historic/Midtown, Southcentral, and South City/Sound—each with distinct flooding patterns and infrastructure challenges.

The plan reveals that Savannah's repetitive loss areas are impacted by a combination of tidal flooding, poor stormwater drainage, and aging infrastructure, exacerbated by the city's low-lying coastal geography. Recommendations include structural solutions such as elevating buildings and infrastructure, improving drainage systems, and constructing flood barriers. Non-structural measures like public education on floodproofing, promoting flood insurance, and adopting stricter zoning and land-use regulations are also emphasized. Additionally, the acquisition and demolition of high-risk properties, along with enhanced maintenance of stormwater systems, are proposed to reduce repetitive flooding and safeguard community assets. The current report is important for the 2021 RLAA Savannah since it highlights areas with a probability of experiencing moderate flood damage. Given predictions that flooding events will become more frequent and severe as the century progresses, structures in these areas, if not adequately mitigated, are at risk of evolving into repetitive loss properties.

Flood Damage Prevention Ordinance

This section focuses exclusively on reviewing the Flood Damage Prevention Ordinances for areas within Chatham County with a high probability of experiencing moderate to complete flood damage.

Unincorporated Areas of Chatham County

The 2021 Flood Damage Prevention Ordinance for Chatham County mandates that new constructions within Areas of Special Flood Hazards must be designed to minimize flood damage. These structures must be securely anchored and constructed with materials resistant to flood impacts. Additionally, the ordinance stipulates a minimum of 3 feet of freeboard above the Base Flood Elevation (BFE). It requires critical systems such as water, sewer, HVAC, and power to be strategically designed and located to prevent flood-related damage.

City of Savannah

On October 24, 2024, the City of Savannah adopted a new regulation requiring a two-foot freeboard above the BFE for all new and substantially improved structures within the 100-year floodplain, as identified by NFIP's Flood Insurance Rate Maps and local basin flood studies. This regulation, effective January 1, 2025, builds on the city's previous one-foot freeboard standard established in 2008. The ordinance also requires critical systems such as water, sewer, HVAC, and power to be strategically designed and located to prevent flood-related damage.

City of Tybee Island

According to Tybee Island's building code, new construction in Special Flood Hazard Areas without established base flood elevation data must be elevated to at least three feet above the highest adjacent grade at the building site. Additionally, in A-Zone areas where a limited detailed study has been conducted, the building code requires the lowest floor to be elevated at least one foot above the estimated BFE.

City of Thunderbolt

According to Thunderbolt's building code, for new construction where base flood elevation data are available, construction must be elevated by no lower than two (2) feet above the base flood elevation. The ordinance also requires critical systems such as water, sewer, HVAC, and power to be strategically designed and located to prevent flood-related damage.

Future Land Use

By analyzing the future land use maps proposed by the County and its municipalities, alongside the data from this report identifying areas with a high probability of moderate to severe flood damage, the following observations emerge:

- In the City of Tybee Island, most affected areas are designated for future residential and commercial land use.
- In the City of Savannah, the impacted areas are primarily residential but close to a zone with the potential for a transit-oriented community (TOC).
- In the City of Thunderbolt, the currently affected areas are designated as mixed-use and commercial, with future land use emphasizing industrial and commercial development.
- In the unincorporated areas of Chatham County, the vulnerable zones are primarily established as residential suburban single-family neighborhoods.

5. Recommended Actions

The IN-CORE analysis provides valuable insights into identifying areas at risk and assessing the severity of impacts, enabling more effective protection strategies. Preventing development in high-risk areas is often more cost-effective than implementing mitigation measures. Therefore, integrating risk assessments into planning processes is crucial. To address these challenges, we recommend the actions presented in Table 3. Below is a list of potential funding sources available at various levels.

Federal Level

- **HMGP – FEMA Hazard Mitigation Grant Program:** This program provides funding for projects that reduce risks from natural disasters, including retrofitting high-risk structures:
- **FMA—FEMA Flood Mitigation Assistance:** This program offers grants for flood mitigation activities, including elevation, acquisition, and floodproofing of buildings.
- **BRIC – Building Resilient Infrastructure and Communities:** This program offers Funds to proactive community resilience projects, including retrofitting vulnerable properties.

- **USDA Rural Development Water and Environmental Programs:** This program provides funding for stormwater-related projects in rural and unincorporated areas that could complement building retrofits.
- **NOAA Coastal Resilience Grants:** This program supports flood mitigation projects in coastal areas

State Level

- **GEMA/HS – Georgia Emergency Management and Homeland Security Agency:** This program administers FEMA's HMGP and BRIC funding at the state level and provides technical assistance to local governments.
- **GEFA – Georgia Environmental Finance Authority:** This program offers grants and low-interest loans for projects that improve environmental resilience, including stormwater management and building retrofits.
- **CIGP—Georgia Coastal Incentive Grant Program:** This program provides funding for coastal resilience projects, including flood mitigation and retrofitting in coastal communities.
- **CDBG – Georgia Community Development Block Grants:** Administered by the Georgia Department of Community Affairs, these funds can be used for resilience-focused improvements, including retrofitting structures in low- and moderate-income communities.
- **Georgia Department of Natural Resources (DNR) Coastal Resources Division Grants:** Supports projects that mitigate flooding impacts in coastal areas, including retrofitting vulnerable properties.

Table 3. Recommended Strategies

Action	Description	Potential Funding Source	Priority	Timeline
Use this current study to establish base flood elevation standards in building codes and floodplain damage prevention ordinance	Actively using the results of the current study to establish and enforce base flood elevation data for new construction, considering the impacts of climate change. By taking this approach, cities can directly address flood risks, promote safer building practices, and enhance resilience in flood-prone areas. The data flood depth raster layer available in the Chatham County IN-CORE Analysis app.	Local funds	High	Short-term
Building retrofit at high-risk of complete damage	This initiative focuses on retrofitting buildings identified as having a high probability of complete damage due to flooding (DS 3). The goal is to strengthen these structures through elevation, floodproofing, buyout or other resilience measures to mitigate flood risks, protect property, and enhance occupant safety. The data flood depth raster layer available in the Chatham County IN-CORE Analysis app.	HMGP / FMA / BRIC / USDA / NOAA / GEMA / GEFA / CIGP /CDBG / Georgia DNR /	High	Short-term
Building retrofit at high-risk of severe damage	This initiative focuses on retrofitting buildings (through elevation, floodproofing, and other resilience measures) identified as having a high probability of severe damage due to flooding (DS 2). The data flood depth raster layer available in the Chatham County IN-CORE Analysis app.		Moderate	Medium-term
Building retrofit at high-risk of moderate damage	This initiative focuses on retrofitting buildings (through elevation, floodproofing, and other resilience measures) identified as having a high probability of moderate damage due to flooding (DS 1). The data flood depth raster layer available in the Chatham County IN-CORE Analysis app.		Low	Long-term

Action	Description	Potential Funding Source	Priority	Timeline
Use the current report to enhance CRS rating	This action focuses on utilizing the current report to improve the County's Community Rating System (CRS) rating by optimizing flood damage reduction activities. The report can assist in earning additional CRS credits through Activity 320 – Map Information Service and Activity 440 – Flood Data Maintenance	Local funds	Moderate	Medium-term
Revise Future Land Use for High-Risk Areas in Unincorporated Chatham County, Savannah, Thunderbolt and Tybee Island	This action focuses on revising the future land use plans for unincorporated areas of Chatham County, Savannah, Thunderbolt and Tybee Island to account for zones with a high probability of complete or severe flood damage. By incorporating data from the current report, this initiative aims to ensure that land use designations reflect flood risks and prioritize resilience. The reassessment will emphasize directing development away from high-risk areas, preserving natural floodplain functions, and integrating flood mitigation strategies into planning policies.	Local funds	High	Short-term
Discourage Development in High-Risk Areas	The flood depth in certain areas of Chatham County ranges from 3 to 15 feet. Flood depths of **6 feet or more** are generally considered extremely hazardous for construction, as they pose significant risks to life safety, structural integrity, and emergency access. Therefore, the County and its municipalities should strongly discourage development in regions where flood depths exceed 6 feet. The data flood depth raster layer available in the Chatham County IN-CORE Analysis app	Local funds	High	Short-term

References

Amini, M., Jeon, H., Sanderson, D. R., Cox, D. T., Barbosa, A. R., & Cutler, H. (2023). Integrated Engineering–Economic Analysis for Multihazard Damage and Loss Assessment. *Journal of Infrastructure Systems*, 29(4), 04023031.

Argonne National Laboratory. (2024). Climate Risk and Resilience Portal (ClimRR). https://climrr.anl.gov/

Georgia Tech Geospatial Research and Applications. (2010). *GIS data: LIDAR and shoreline change data*. Retrieved from https://geospatial.gatech.edu/G-WRAP/

Georgia Tech Geospatial Research and Applications. (2010). *LIDAR DEM*. Retrieved from https://geospatial.gatech.edu/G-WRAP/

NOAA Fisheries. (2018–2019). *LIDAR dataset*. Retrieved from https://www.fisheries.noaa.gov/inport/item/67264

Nofal, Omar M., and John W. van de Lindt. (2020). Minimal Building Flood Fragility and Loss Function Portfolio for Resilience Analysis at the Community Level. **Water.** 12(8), 2277. https://doi.org/10.3390/w12082277

Oliver-Smith, A. (2018). Disasters and large-scale population dislocations: International and national responses. In *Oxford research encyclopedia of natural hazard science*.

Rosenheim, Nathanael, Roberto Guidotti, Paolo Gardoni & Walter Gillis Peacock. (2021). Integration of detailed household and housing unit characteristic data with critical infrastructure for post-hazard resilience modeling. **Sustainable and Resilient Infrastructure**. 6(6), 385-401. https://doi.org/10.1080/23789689.2019.1681821

Rosenheim, Nathanael. (2022). "Detailed Household and Housing Unit Characteristics: Data and Replication Code." [Version 2] **DesignSafe-CI**. https://doi.org/10.17603/ds2-jwf6-s535

SAGIS. (n.d.). *Data available: Building footprints, stormwater infrastructure, roadways, future land use*. Retrieved from http://www.sagis.org

Savannah Metropolitan Planning Commission (MPC). (n.d.). *Flood modeling: Depth grid for transportation networks under different SLR projections*. Retrieved from https://www.thempc.org/Core/Ufm#gsc.tab=0

U.S. Census Bureau. (2023). *Census data*. Retrieved from https://www.census.gov

Appendices

Appendix A. IN-CORE Methodology

In order to run an IN-CORE building damage analysis, information about the local building stock is required. To build this dataset, the publicly available data from the National Structures Inventory (NSI) is typically utilized. This data has information on the structure type and size, foundation type and height, and number of stories. This data is used to determine the most appropriate building flood archetype for each structure. Some uncertainty arises at this stage as the NSI makes necessary assumptions to populate missing records. The quality of this dataset at the local level should always be considered. The flood archetype assignment process bins all buildings into one of 15 possible building archetypes (Table 4), which are assumed to behave similarly under hazard loading. In the case of flood, these archetypes were developed in order to effectively predict the structural and non-structural damage caused by a given flood depth on different types of buildings. The full list of building archetypes and their defining characteristics was put forth in the work of Omar Nofal and John W. van de Lindt in the peer-reviewed paper Minimal Building Flood Fragility and Loss Function Portfolio for Resilience Analysis at the Community Level (2020) and has been referenced in several subsequent publications.

Table 4. A reproduction of the tabulated archetypes

Building Archetype	Building Description
F1	One-story single-family residential building on a crawlspace foundation
F2	One-story multi-family residential building on a slab-on-grade foundation
F3	Two-story single-family residential building on a crawlspace foundation
F4	Two-story multi-family residential building on a slab-on-grade foundation
F5	Small grocery store/Gas station with a convenience store
F6	Multi-unit retail building (strip mall)
F7	Small multi-unit commercial building
F8	Super retail center
F9	Industrial building
F10	One-story school
F11	Two-story school
F12	Hospital/Clinic
F13	Community center (place of worship)
F14	Office building
F15	Warehouse (small/large box)

Source: Nofal and van de Lindt (2020)

With buildings sorted into the most appropriate archetype category and archetypical building damage determined by flood depth, a flooding scenario in the form of mapped flood depths is the final element that required to run a building damage analysis with IN-CORE. The mapped flood depths used in these analyses have been developed from mid-century climate projections generated by Argonne National Laboratories, purchased by AT&T, and provided to Project IN-CORE by AT&T for the development of use cases of the climate data available on the Climate Risk and Resilience Portal (ClimRR). A version of this data will be available in short order on the ClimRR portal. The flood depths shown for this analysis represent a 100-year flood depth along the coastline and a 50-year pluvial flooding event inland in the mid-century decade of 2045-2054. The coastal flood dataset captures the increase in storm surge under sea-level rise scenarios compounded by hurricane and tropical storm events. Meanwhile, the inland pluvial flooding dataset captures the non-stationarity of intense rainfall events across the United States.

ClimRR provides peer-reviewed climate datasets in a nontechnical format and puts high-resolution, forward-looking climate data into the hands of those who need them most. Community leaders and public safety officials can now understand how changing climate risks will affect the populations they serve. Access to this information will assist leaders as they strategically invest in infrastructure and response capabilities to protect communities for future generations. ClimRR has been made publicly available at no cost by Argonne, AT&T, and FEMA in order to enable greater climate resilience among local communities.

These datasets are immensely helpful in understanding possible future flooding conditions; however, it is worth noting that these datasets do not reflect riverine flooding, nor do they capture municipal stormwater systems. For fluvial (riverine) flooding information, FEMA flood maps remain a good source of information. Meanwhile, for urban flooding, it may be necessary to engage in a more in-depth stormwater analysis. The results below are provided within this understanding of the bounds of the analysis.

Building the Damage Analysis: Running the Model and Obtaining Results

As described above, the building damage analysis is run by taking a set of buildings, binning them into 15 archetypical building categories, simulating a flood across the region of interest, and then determining the predicted damage level in accordance with these input factors. Upon running this analysis, you will note the term Damage State (DS) is used to denote varying levels of damage. In the latest version of IN-CORE, damage states are defined as DS0, DS1, DS2, and DS3. This is not in direct alignment with previously mentioned work and the figures shown below. This is because the most up-to-date version of IN-CORE has simplified the damage state prediction by grouping the slight damage category of “DS1” with the insignificant damage category of “DS0.” Thus, in Figure 10, the original table of anticipated functionality from Nofal and van de Lindt (2020) has been annotated to show the new damage states and how they map to the original ones.

	DS Level	Functionality	Damage Scale	Loss Ratio
DS0	DS0	Operational	Insignificant	0.00–0.03
	DS1	Limited Occupancy	Slight	0.03–0.15
DS1	DS2	Restricted Occupancy	Moderate	0.15–0.50
DS2	DS3	Restricted Use	Extensive	0.50–0.70
DS3	DS4	Restricted Entry	Complete	0.70–1.00

Figure 10. Anticipated functionality by damage state according to Nofal and van de Lindt (2020) and augmented to align with the outputs of up-to-date IN-CORE models

Building Functionality Analysis: Defining Damage Probabilities

If the community only has to experience this event a single time, then we would primarily be concerned with those structures that have surpassed of 50% probability of being in a Damage State 2 or 3. This would represent an impactful result for those structures with only a single occurrence of the modeled hazard event. However, global climate models suggest that the flooding event shown in this report will occur with greater frequency as we progress through this century. Thus, there becomes a greater level of concern with not only buildings in the DS2 and DS3 levels but also buildings in the DS1 level that will see a wearing down of their functionality as similar events become more common. As such, we have highlighted two scenarios. The first is the scenario where this event happens a single time, and the second is where this event happens frequently enough to degrade a larger portion of the building stock through repeated exposure. We have chosen to provide both of these scenarios because the flood depths we used for modeling do not represent a worst-case scenario for the local community, but rather an event that the community should be very much expected to experience and successfully withstand in the coming years and possibly on multiple occasions. These two thresholds are superimposed onto Archetype 1's set of fragility curves in Figure 11 below. Thus, the following damage probability values do not represent damage probabilities due to separate events but rather serve to explore the possibility of how the flooding event described above would have varied impact if it occurred habitually versus a single time. The reality will likely be somewhere between these two scenarios.

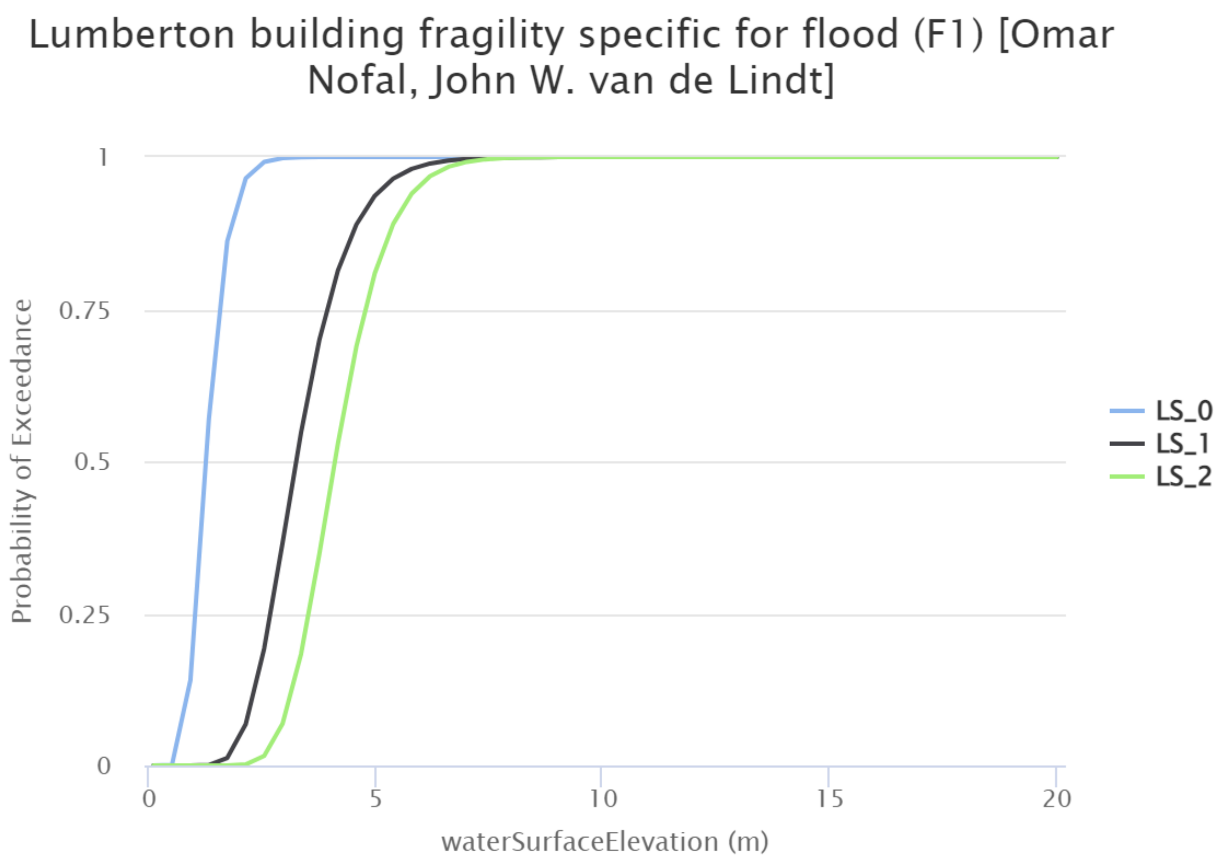

Figure 11. An example set of fragility curves to demonstrate the failure thresholds defined for this analysis
Source: Nofal and van de Lindt (2020)

Appendix B. Sourcing the Necessary Data to Run an IN-CORE Population Dislocation Analysis

The dislocation model requires data on people as well as on structures. To generate the housing unit population allocation, a separate python package called Pyncoda developed as part of the Center of Excellence for Risk-Based Community Resilience Planning, is used to synthetically allocate households to housing units. The demographic characteristics of the synthetic population matches the characteristics at the Census block group level. This work is described as follows by Pyncoda's README file on GitHub authored by Nathanael Rosenheim:

People are the most important part of community resilience planning. However, models for community resilience planning tend to focus on buildings and infrastructure. This repository provides a solution that connects people to buildings for community resilience models. The housing unit inventory method transforms aggregated population data into disaggregated housing unit data that includes occupied and vacant housing unit characteristics. Detailed household characteristics include size, race, ethnicity, income, group quarters type, vacancy type, and census block. Applications use the housing unit allocation method to assign the housing unit inventory to structures within each census block through a reproducible and randomized process. The benefits of the housing unit inventory include community resilience statistics that intersect detailed population characteristics with hazard impacts on infrastructure, uncertainty propagation, and a means to identify gaps in infrastructure data such as limited building data. This repository includes all of the Python code files. Python is an open-source programming language, and the code files provide future users with the tools to generate a 2010 housing unit inventory for any county in the United States. Applications of the method are reproducible in IN-CORE (Interdependent Networked Community Resilience Modeling Environment).

Population Dislocation Analysis: Running the Model and Obtaining Results

Once a housing unit allocation has been generated, then the damage result for each building can be combined with the social data for each household, such as tenure status, race, and household income, to determine whether a household is likely to temporarily relocate due to a hazard event, in this case a flood. The results of a population dislocation analysis can be analyzed further to understand the equity impacts of such hazards.

Appendix C. The Computable General Equilibrium Model (CGE) for Chatham County

Chatham County has a diverse employment distribution across income levels, racial and ethnic groups, and economic sectors. A Computable General Equilibrium (CGE) model represents the economic relationships among producers, households, and the government, using economic theory to demonstrate the effects of economic changes on these entities. These models are centered on a Social Accounting Matrix (SAM), which tracks the transactions and income flows between households, firms, and government agents. The SAM documents the resource flows shown in Figure 12, utilizing data from multiple sources

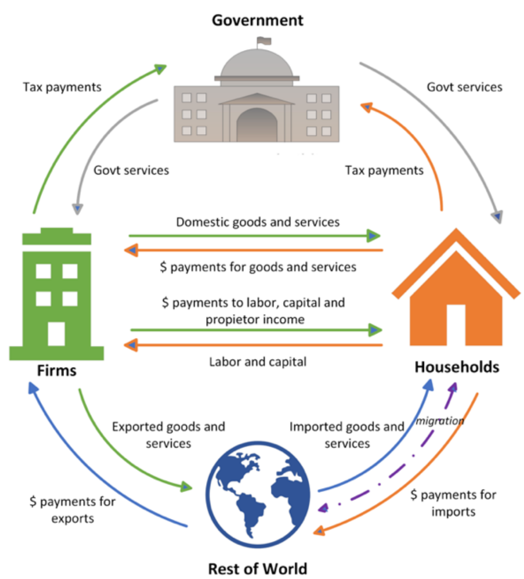

Figure 12. Structure of Computable General Equilibrium Model
Source: Amini et al. (2023)

Figure 12 illustrates the fundamental modeling framework using a circular flow diagram. Households contribute labor, entrepreneurship, and capital, earning income through wages, profits, and returns on investments. This income is then distributed among consumption, taxes, and savings. Profit-oriented firms produce and sell goods and services, utilizing both local and imported inputs such as labor, capital, and intermediate goods. Governments, in turn, use tax revenue collected from households and firms to provide various public goods and services. Source: Amini et al. (2023). The CGE model also accounts for trade between a community and other places which we call "Rest of the World".

Figure 13 illustrates a visual representation of the Chatham County SAM, along with brief descriptions of its key components.

	Economic sector	Labor groups	Capital	Households	Housing services	Taxes	Government	ROW
Economic sector	Intermediate purchases			Household expenditure			Government expenditure	Export
Labor groups	Wage payments by fimrs						Wage payments by government	
Capital	Capital payments				Capital payments			
Households		Wage transfer to households						
Housing services				Housing expenditure				
Taxes	Tax payments			Tax payments				
Government						Tax transfer to government		
ROW	Imports							

Figure 13. Detailed Chatham County SAM

The demand for intermediate inputs is derived from input-output coefficients for two-digit North American Industry Classification System (NAICS) sectors, determined by IMPLAN (Economic Impact Analysis Software) data. Employment is estimated by race and ethnicity across four wage groups and is aggregated into two-digit NAICS sectors using the Census Longitudinal Employer-Household Dynamics dataset (LEHD) and PUMS (Public Use Microdata Sample). The wage payments by firms and government matrices are constructed from worker incomes obtained from the U.S. Census Bureau's PUMS, which are then aggregated by sector. Wage transfers to households refer to the distribution of wage payments from labor groups to their respective household groups. Household and income data are sourced from PUMS, while household spending patterns are estimated using IMPLAN values adjusted with the Bureau of Labor Statistics' Consumer Expenditure Survey. Capital stock values for buildings are estimated based on data from the National Structure Inventory (NSI) provided by the U.S. Army Corps of Engineers, which includes detailed information on property types, building values, and spatial coordinates. Government tax revenue and expenditures are drawn from Chatham County's Annual Comprehensive Financial Report. The import and export matrices outline the payments made by sectors and households in Chatham County to sectors in other regions and vice versa. From a microeconomic standpoint, a household's income and expenditures must balance within its budget constraint, meaning total income should equal total expenditures, including consumption, taxes, and savings. A reduction in real household income due to factors like job losses or inflation can lead to economic downturns. On the macroeconomic level, transactions between sectors and economic agents must conform to standard aggregate accounting identities, such as Chatham

County's GDP equating to the sum of consumption, investment, government spending, and net exports.

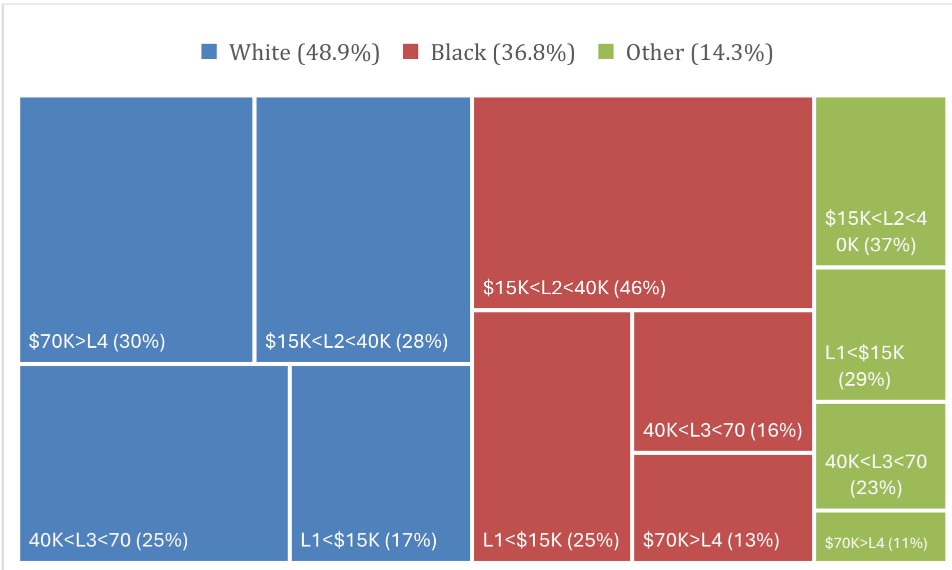

Figure 14. Distribution of workers by race and ethnicity across different income groups, 2022
Source: U.S. Bureau of Labor Statistics

As shown in Figure 14, White workers make up nearly 49% of the workforce, with the majority (30%) earning over $70,000 annually. In contrast, Black workers represent 36.8% of the workforce, with more than 75% earning less than $40,000. Workers from other racial groups, comprising 14.3% of the workforce, have a higher proportion (34%) earning over $40,000 compared to Black workers.

Figure 15. Employment share distribution across major economic sectors, 2022
Source: U.S. Bureau of Labor Statistics

Figure 15, a pie chart, highlights the key economic sectors driving employment. The dominant industries are Commercial (22%), Retail (15%), Leisure & Hospitality (13%), and Health (13%). Note that the Commercial sector encompasses wholesale trade, finance and insurance, real estate, professional services, management, and administrative support.

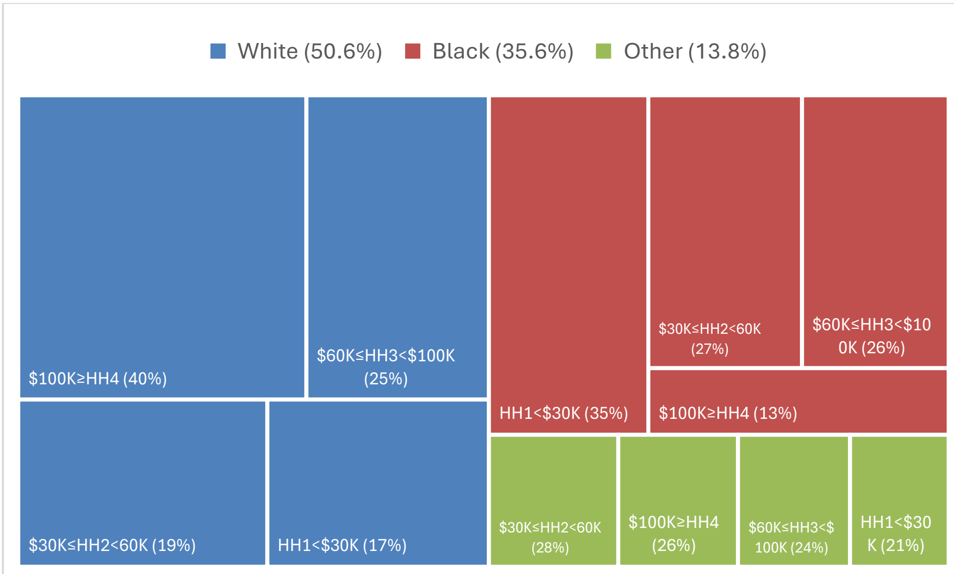

Figure 16. Distribution of households by race and ethnicity across different income groups, 2022
Source: U.S. Bureau of Labor Statistics

In Figure 16 White households make up 50.6% of the total, with 40% earning over $100,000 annually, while 17% fall into the lowest income bracket. Black households account for 35.6% of the total, with the largest share (35%) earning less than $30,000, and only 13% earning more than $100,000. Households from other racial/ethnic groups comprise 13.8% of the total, with a more even distribution across income levels. This data highlights racial and economic disparities in Chatham County, where White households tend to have higher incomes, while Black households are more concentrated in lower income brackets.

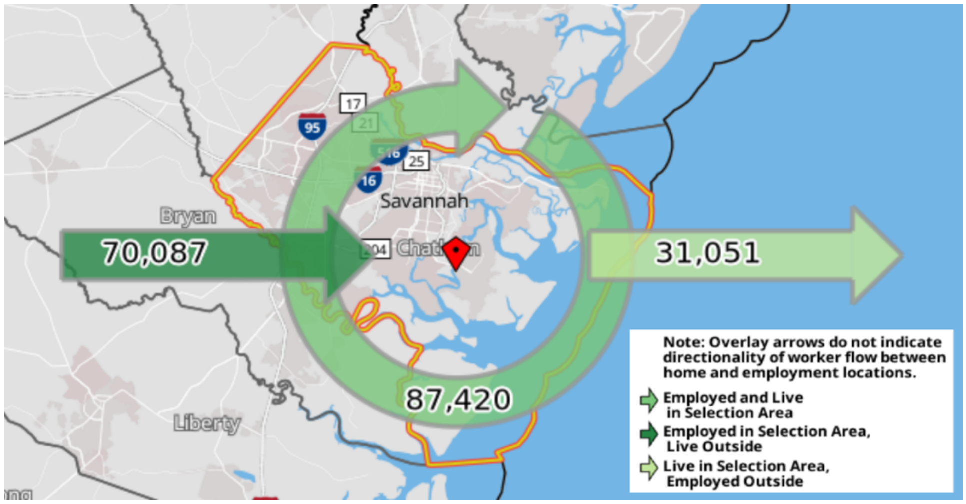

Figure 17. Inflow/Outflow Analysis for the Chatham County
Source: U.S. Census Bureau, 2021

Figure 17 shows the labor movement in and out of Chatham County, revealing significant worker flows. Notably, 44.5% of the local workforce resides outside the county but commutes in for employment, indicating that Chatham County serves as a major employment hub for surrounding regions. Conversely, over 31,000 county residents commute elsewhere for work, which has a considerable impact on household wage income within the county.

Economic Impact Channels

Civil engineers evaluate damage across a range of building types, such as commercial, industrial, and residential structures. This damage, whether to structural, non-structural (architectural), or content components, is represented as a decline in the region's overall capital stock. The resulting changes in residential and commercial capital stock are aggregated at the sector level and expressed as a percentage decrease in total capital stock within the region.

A decrease in capital stock in commercial and industrial sectors has two primary effects on domestic supply. First, reduced production capacity lowers firms' output. Second, as capital becomes scarcer, its price rises, prompting firms to reduce demand for it and increase reliance on substitutes such as labor. These shifts ultimately raise production costs, weakening a business's ability to remain competitive both nationally and globally.

The effects of reductions in housing capital can be modeled in a similar way. Housing serves two primary purposes: providing shelter and generating income through property appreciation. Damage to housing capital has a direct negative impact on household income, which is composed of labor income and capital income. In this case, it is assumed that households own a substantial share of firms in Chatham County. Consequently, when commercial capital is damaged, capital income declines, resulting in a drop in household income. Furthermore, damage to residential properties decreases the equity in homes, further diminishing household income. Note that for clarity, property value will be consistently referred to as capital stock throughout this document.

Changes in domestic supply

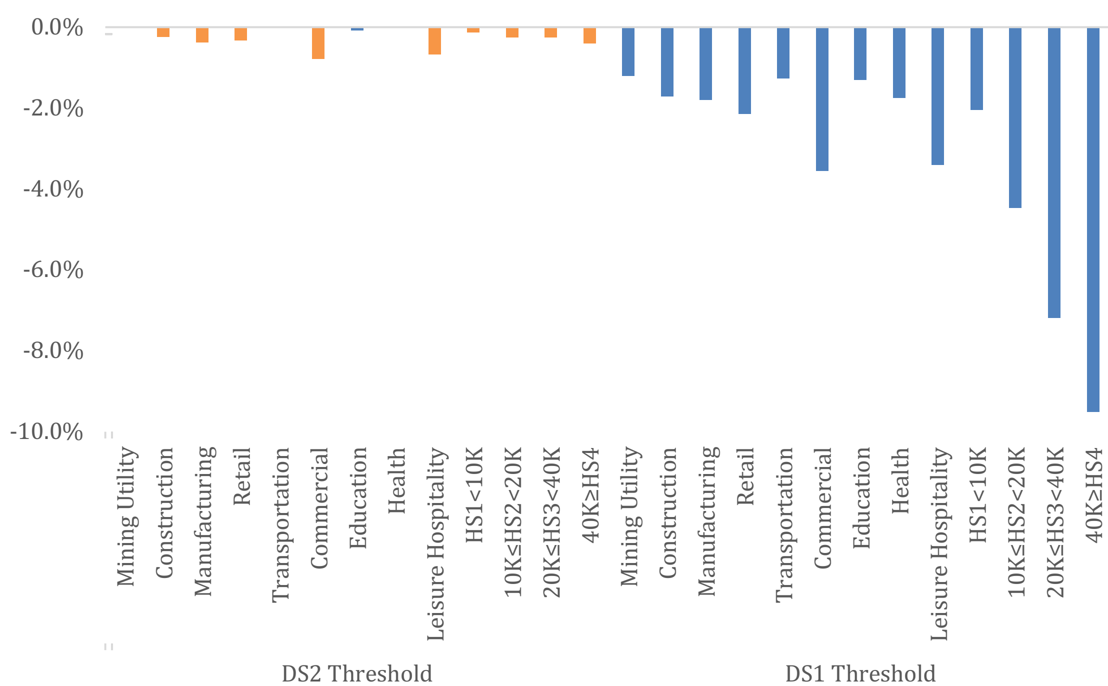

Figure 18. Effects on sectoral domestic supply

Figure 18 displays the effects of flooding on sectoral domestic supply across various economic sectors. Under the DS2 threshold, most sectors experience moderate declines in supply, with the largest impacts seen in the Commercial and Leisure & Hospitality sectors. These declines generally remain below 1%. However, under the DS1 threshold, the reductions become much more severe, particularly in the Housing Services sector, where losses approach 10%. Other sectors such as Commercial and Leisure & Hospitality also see notable reductions, with losses at 3.5%. These findings indicate that while the DS2 threshold represents a more manageable impact, the DS1 scenario could lead to severe disruptions in key sectors, especially in housing and commercial supply. It suggests that sectors heavily reliant on physical infrastructure and services, particularly housing service sectors, are the most vulnerable to the disruptive impacts of flooding during more frequent instances of moderate flooding.

Changes in local tax revenues

Figure 19. Effects on local tax revenues

In terms of local tax revenues (Figure 19), under the DS2 threshold, all local tax revenues experience minor declines, less than 0.1%. However, under the DS1 threshold, the negative effects are more severe, with income tax revenues experiencing the most substantial drop of over 1% across all categories. As shown above, flooding disrupts employment and business activity, reduces economic output, and causes population displacement, all of which contribute to a decline in income tax revenue for local governments. Sales tax and property tax also experience considerable reductions, with losses nearing 0.4%. These findings reflect Chatham County's dependence on tourism as a key source of sales tax revenue. Flooding discourages tourists from visiting, adversely affecting revenue from hotels, restaurants, retail stores, and other businesses reliant on tourist spending, thereby directly diminishing sales tax revenue.

This report presents the predicted ex-post economic consequences of flooding events in Chatham County. The analysis provides the expected costs of flooding, including the distributional impacts across all three racial and ethnic groups and economic sectors. The findings highlighted that lower-level flooding disproportionately affects both business and residential properties. Notably, the most significant damage was observed in the higher-valued housing sectors, as well as in the Manufacturing and Commercial, followed by the Leisure and Hospitality sectors. The destruction of housing units led to increased housing expenses, which, in turn, decreased real household income and triggered outmigration. Alongside, damage to business sectors caused unemployment, affecting not only local households but also those living outside the county who commute for work. These reductions in household income led to decreased spending on goods and services within the county, contributing to a cumulative local economic downturn. Therefore, retrofitting both high-value housing units and business sectors could significantly mitigate losses in real household income and unemployment, thus lessening the severity of flood damage and expediting the county's recovery time.

It is important to recognize that our analysis considers only a limited set of economic and distributional impacts. While our findings indicate that more frequent, lower-level flooding can lead to larger negative economic consequences, these results must be evaluated alongside the environmental and health-related costs that accumulate under each scenario. For instance, flooding can cause environmental issues such as water contamination, habitat loss, and coastal erosion, all of which contribute to substantial economic, health, and ecological costs. Additionally, it is crucial to acknowledge that our economic modeling is based on damage estimates, which are inherently uncertain. The model also relies on simplifying assumptions that may not fully capture the complexity of human behavior and economic interactions. Therefore, the results should not be interpreted as definitive predictions, but rather as approximations of potential outcomes based on the current available data.