RESEARCH ARTICLE

Are Underserved Populations Left Out of National Flood Mitigation Efforts and Facing Greater Impact? A Method to Assess Racial Inequality at the Census Tract Level

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ABSTRACT

Development policies have systematically relegated certain populations to undesirable locations including areas at risk of flooding. Over time many properties will no longer be inhabitable and others will see damage from significant flooding. Current U.S. federal policy funds flood risk mitigation measures, such as property acquisition, relocation, and retrofitting; however, depending on various factors at the subcounty level, these actions can in some contexts provide disproportionate benefit to higher income, mostly White areas, failing to appropriately benefit underserved and exposed populations. Here, we present an exploratory method, building off existing research on programmatic-wide and event-specific analysis to explore patterns allowing state- and county-level decision-makers to identify inequalities in federal funding, potentially supporting reprioritization. This work evaluates the National Flood Insurance Program (NFIP) claims data from 1975 to 2019 and Federal Emergency Management Agency (FEMA) mitigation efforts from 1989 to 2018 to explore the distribution of mitigation measures related to tract to county racial disproportionalities (for example, majority non-White census tracts in majority White counties). We find that for majority non-White census tracts in majority White counties, there are disproportionately fewer NFIP claims. This supports previous work, which shows lower levels of assistance in flood recovery, resilience, and preparedness in these areas.

INTRODUCTION

Economic development policies continue to lead to low-income and non-White populations living in undesirable locations in the United States (Callies & Simon, 2017; Platt, 1976; Wilson et al., 2008), including locations at higher risk of flood event occurrence and damage (Howell & Elliott, 2019; Logan, 2006). This failure to consider the gradients of impact across all affected populations has led to unsustainable development practices (Bolin & Stanford, 1991; Gaddis

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et al., 2007; Wilson, 2009). Disproportionate impact has been documented within multiple- and single-flood events (Logan, 2006), and at various spatial scales, including city (Collins et al., 2018; Montgomery & Chakraborty, 2015), county (Cutter et al., 2000), state (Zahran et al., 2008), and national levels (Longstreth, 1999). Federally funded flood insurance and buyout programs (Frazier et al., 2020; Siders, 2019a), which were developed as a response to private insurers viewing flooding as a costly, uninsurable risk (Michel-Kerjan et al., 2012), are at times perceived as a policy mechanism developed with the intention to address institutionalized injustices and minimize hardship on non-White and low-income populations at risk of flood events and damage (Anguelovski et al., 2016). However, there are outstanding questions regarding the degree to which these programs, at present, are effective (Frazier et al., 2020).

While defining what is "effective" can be complex, and subjective to some extent, even efforts to more simply assess if programs lead to positive, negative, or negligible outcomes for the populations are few (Davlasheridze & Miao, 2019; Knighton et al., 2020; Kousky & Michel-Kerjan, 2017). Elements of effectiveness, including the enabling environments that increase likelihood of effectiveness, must be better understood in order to both assess the degree to which restructuring these programs could benefit vulnerable communities (Gannon et al., 2021; Vincent et al., 2018), and to effectively design them (Hemmati et al., 2022; Vilá et al., 2022). As availability of climate and demographic data increases the understanding of both flood risk and the importance to center social justice in developing flood management policy, responsibility for implementing in a socially just way must also be prioritized (Kim & Sutley, 2021; Kraan et al., 2021). To do so, policy outcomes must not only be assessed as a snapshot at a given time, such as after a single-flood event or for a modeled-flood event, as doing so can lead to incomplete statements on spatiotemporal distribution of effectiveness, as well as introduce additional bias (Boin & Lodge, 2016; Orth et al., 2022). Ideally, analytical methods for effectiveness must be done across sufficiently long timescales, with improved data availability (Murnane et al., 2016; Luke et al., 2018)

Even if focusing only on the climatic factors that comprise flood impact, flood policies are becoming less likely to function as initially designed due to shifts in climate and climate change–related risk (Hudson & Botzen, 2019; Liu et al., 2019). For example, some residential properties are becoming uninhabitable (Burby et al., 2000; Smith et al., 2006) and others, including homes in current floodplains and property projected to be exposed in the future (O'Donnell & Thorne, 2020; Tiggeloven et al., 2020; Wing et al., 2018), are likely to suffer unprecedented damage due to more frequent and significant flooding events (Kunreuther et al., 2019; Wing et al., 2018; Wobus et al., 2017). Most flood insurance and buyout programs, however, model coverage and rates based on historical flooding patterns and fail to fully acknowledge the current and future climate risks related to expanded geographic exposure and greater frequency and intensity (Pralle, 2019). Flood policies should account for the implications of climate-induced changes to properly model rates and respond to need (White & Richards 2007; Pralle, 2019); however, significant challenges remain related to identifying (1) which properties will be subject to increased flood frequency in relation to others, (2) the timing of when certain properties may be initially exposed before others, (3) when the frequency of flooding will lead to exposed properties to be perceived to be nonfunctional, and (4) how and when shifts in the distribution of flooding impact may affect the most vulnerable populations (Carey, 2020). These and other challenges add to the complexity of design and effective implementation of flood resilience and risk-reduction programs and policies (Greiving et al., 2018; Hanna et al., 2019).

The National Flood Insurance Program (NFIP), the primary source of flood insurance, is currently facing financial losses, which may be exacerbated with an increase in climate-related flood risk and damage (Pralle, 2019). NFIP was created by the U.S. Congress under the National Flood Insurance Act of 1968 and is administered by the Federal Emergency Management Agency (FEMA) with the intention to provide regulation on federal assistance in flood-prone areas (Flood Insurance Subcommittee, 2011; Horn & Brown, 2017). Goals of NFIP include developing a mechanism for sharing of the risk from flood losses, restricting certain types of development in floodplains, and providing funds, in certain cases, for structural modifications (Brown, 2016). While the federal government backs NFIP losses, in order for a community to be eligible, they must meet certain criteria such as the requirement for communities to adopt floodplain management efforts (Burby, 2001). These stipulations can lead to additional pathways for bias in influencing both who and where is prioritized, and if there is a lack of representation and advocacy for centering the most vulnerable and underserved communities. These can become, if not acknowledged and left unchecked, factors in increasing the likelihood of scenarios whereby everyone receives some benefit, which does not allow for the gaps in the overall distribution of government-sourced wealth to be smaller than before the program was implemented. This increased benefit gap, via policy claiming to be reducing climate risk, has been identified as potentially widening the wealth gap, and if so, essentially promoting maladaptation (Atteridge & Remling, 2018). One aspect of screening climate adaptation efforts for their potential to be maladaptive is assessing what "equal benefit" means across various timescales. A multi-timescale assessment should allow for the ability to process complex scenarios of shifts in benefit over time. For example, on short timescales, actions can be taken so communities receive the same amount of benefit. However, when considering longer timescales, this may not allow for the gap between different communities to lessen, particularly where persistence of racial and socioeconomic patterns of injustice are working against the goals for a more equal distribution of risk (Magnan et al., 2016).

The Flood Disaster Protection Act of 1973 required properties with secure or federally backed mortgages in high-risk Special Flood Hazard Areas to acquire flood insurance, which led to both a significant increase in the number of properties under the program and restriction of federal assistance for flood event disasters in noncompliant areas (Arnell, 1984). While the intention of this act was at least in part to enhance "rational" approaches to flood risk management (Wilson, 1975), questions remain regarding the degree to which disproportionate negative impacts on non-White communities were considered (Anguelovski, 2013). In many areas non-White populations live with flood risk; however, there are also indications that they are more likely to accurately perceive and react to flood risk than White populations (Sung & Hanna, 1996). These actions include the consideration of taking part in buyout programs (Reeser, 2016) and purchasing flood insurance (Atreya et al., 2015; Browne & Hoyt, 2000). Differences in reaction to flood risk between non-White and White populations have been attributed to different determinants of risk perceptions, such as having recently experienced a flood event (Atreya et al., 2015; Reeser, 2016), sufficient financial assets for emergency funds, or more uncertainty about noninvestment income (Sung & Hanna, 1996). Both the privilege to tolerate risk and to elect to retain a partial perspective of climate risk can lead to a deprioritization of anticipatory actions to address such risk, such as flood risk, but this effect is also present for other climate hazards (Borie et al., 2019; Chu & Cannon, 2021; Kruczkiewicz et al., 2022). While some impacts on financial, cultural, and health systems have been described (Dannenberg et al., 2019), assessment of when, where, and to what extent consequences associated with the implementation of future flood policies is needed (Loughran & Elliott, 2019). However, this comprehensive understanding must be developed to specifically assess in what contexts and to what extent racial and socioeconomic discrepancies in flood insurance access and purchase behavior do or do not exist (Brody et al., 2017; Shao et al., 2017).

Historically, floods have influenced the prioritization of housing risks within academic research, as well as in development of national and local policy. As housing policy evolves and becomes more sensitive to climate risks, there is a responsibility to ensure that new policies do not lead to greater differences in ability to access safe and affordable housing, as well as ensuring access to risk and early warning information to allow for preparedness and anticipatory action when extreme flood events occur beyond the level of risk for which insurance coverage is designed (Nordbeck et al., 2019; Sörensen & Mobini, 2017). Safe and affordable housing is a critical element within Sustainable Development Goal 11, which identifies making cities and human settlements "inclusive, safe, resilient, and sustainable" (Aly et al., 2022; Tetteh, 2021), while access to early warning information is a primary mechanism to accelerate adaptation efforts, as announced by the UN Secretary General Guiterriez and outlined in the Early Warnings for All Executive Action Plan (World Meteorological Organization, 2022), and should therefore be integrated into policy development globally (Allen et al., 2006; Mitchell, 2020). However, even in some areas of the most developed countries adequate housing, as defined as being resilient to flooding, has proven to be lacking (Bauduceau & Jadot, 2017; Maantay & Maroko, 2009; Shao et al., 2020). There are various factors behind the motivation to both remain in an area of significant flood risk and within a housing unit that may be inadequate, with factors related to culture, identity, and tradition, as well as economic opportunity, usually part of the calculation (Loucks et al., 2008; Seebauer & Winkler, 2020; Siegrist & Gutscher, 2006). Further, even when it is acknowledged that less than adequate housing exists, the development of policy to allow for relatively safe livelihoods may not benefit those who need it the most (Tonn et al., 2021). In addition, further specificity is needed in areas that are delineated as being at risk to various flood types (Lawrence et al., 2020) and in areas where they are not officially recognized as being at sufficient levels of risk (Smiley, 2020). Improved understanding of both the programmatic outcomes and geographic distribution of NFIP claims, especially as it relates to access by vulnerable communities and areas at increased climate-related flood risk, may provide insight to how NFIP may or may not appropriately respond to the intersection of climate justice and flood damage in the coming years (Wing et al., 2020).

Here we present a method to analyze and compare flood insurance and mitigation program outcomes at sub-state levels. We include a case study to assess NFIP claims at the census tract level in North and South Carolina (the Carolinas). In doing so, we seek to explore if and the extent to which there are differences in NFIP claims in various types of racially disproportionate tracts relative to their county's level of racial disproportionality.

DATA AND METHODS

The Carolinas are a geographically and socioeconomically diverse region in the southeast United States split into distinct regions: western mountains, central Piedmont, and coastal in the east (Rhee et al., 2008). The coastal region is a broad low-lying area with complex geographic features influencing flood dynamics. The population in this region is primarily low income with more non-White people compared to national, regional, and state averages. There are also pockets of wealth, including some of near-exclusively White wealth (Kahrl, 2016; Kearney et al., 2018), with many of those areas including second homes or nonprimary residences (Crawford et al., 2013). To assess relationships of racial inequality, we evaluate the distribution of federal funding for flood mitigation and insurance claims. Primary data accessed are NFIP claims and census variables used to indicate social vulnerability, similar to methods in Bathi and Das (2016). The central questions guiding this study are as follows:

—What are the rates of receiving benefits from government flood programs?

—What are the differences due to race?

—What are the differences due to population density?

NFIP Claims Data

NFIP provides free and open data on flood losses, date of loss, and amount paid out, among other variables. We use the census tract spatial unit allowing for analysis of loss data, damage magnitude and payout, and for attribution to a specific event (National Research Council, 2015). While data on participation status for specific communities exists, NFIP data does not include personal identifiers, therefore the people (and their demographic descriptors) who own and/or live at a specific claim location cannot be determined (Kousky & Michel-Kerjan, 2017). Communities participating in NFIP must maintain minimum flood plain standards, including adopting a flood map and implementing permitting protocols that ensure new development does not lead to additional flooding (FEMA, 2005). If communities fail to maintain standards, they can be placed on probation, influencing their ability to access federal disaster assistance and mortgages (Horn & Brown, 2017).

Sociodemographic Data

Census variables are available at the county and census tract level. We use variables from the Social Vulnerability Index hosted by the Centers for Disease Control and Prevention. 2010 Census tracts are used to aggregate demographic data. A primary advantage of using tracts instead of other standard spatial aggregation units is their co-termini with country boundaries, which is imperative for our study, and their relative uniformity in population represented (approximately 4,000 people per tract), compared to, for example, zip codes that can exceed 100,000 people and vary in population.

Population Data

Tract-level total population was also sourced from the American Community 5-Year Survey 2019 to normalize NFIP claims by total number of people within a tract and county. We ultimately chose to assess NFIP claims per person at the tract and county level, rather than total NFIP claims. In an approach similar to Helderop and Grubesic's (2022), we find that normalizing by total tract population permits for like-to-like comparison between tracts. This choice allowed us to explore differences in NFIP uptake between tracts and counties without having the total county population skew the results.

METHODS

We join the data by spatial units to create a merged format for analysis in R (R Development Core Team, 2009). We use census tract spatial units to match the highest resolution where both the NFIP data can be deemed representative of uptake and availability, and at which the geographic dynamics are sufficiently distinct (Ratnadiwakara & Venugopal, 2019). Demographic measures of race and population are appended using tract boundaries. As we are interested in exploring how racial privilege operates relative to NFIP across different types of census tracts (both in terms of relatively more or less White, or non-White, and over different types of geographic types of tracts), we compute a difference score, from −100 to 100, representing racial proportion. Similar to Elliott et al. (2020), scores that are near zero indicate a tract that is equally disproportionate (or proportionate) (for example, 40% minority tract in a 40% minority county) to the surrounding county, with higher positive (negative) values indicating tracts that are more highly White (non-White) concentrated in an otherwise non-White (White) country.

RESULTS

In calculating the count of NFIP claims at the tract level (Figure 1), a large proportion of claims are in the coastal region, with claims in the Piedmont predominantly in urban areas. The western mountain region has claims in both built-up and rural areas. While Figure 1 provides some insight regarding where NFIP claims have and have not occurred, it does not address if and to what extent NFIP claims are occurring disproportionately across a county. While there are standards for delineating census tracts, there is variance in population in each, with differences in the hundreds not uncommon. To understand these differences, we calculated the percentage of NFIP claims found in each tract relative to their county total. Figure 2 shows the distribution of tracts that represent a spectrum of proportions of claims relative to their county. The darkest red tracts indicate tracts that have at least 61.2% of their respective county's NFIP claims.

Figures 1 and 2 provide information on the geographic distribution of NFIP claim count and tract disproportionality across the Carolinas, but do not address more refined questions regarding where NFIP claims across racial demographics may have or have not occurred. Figure 3 shows each tract in the Carolinas by the difference in proportion of non-White population in the tract relative to county levels. Higher negative values indicate tracts that have a higher non-White proportion compared to the county they are in, such as found in western and northern areas of Mecklenburg County, North Carolina (where Charlotte, North Carolina, is located). Higher positive values indicate tracts that have a higher White proportion compared to the county they are in, such as in areas of Charleston County, South Carolina, that are just east and south of the city center of Charleston. Values of around zero indicate tracts with a similar proportion of non-White population compared to their counties, such as many tracts in

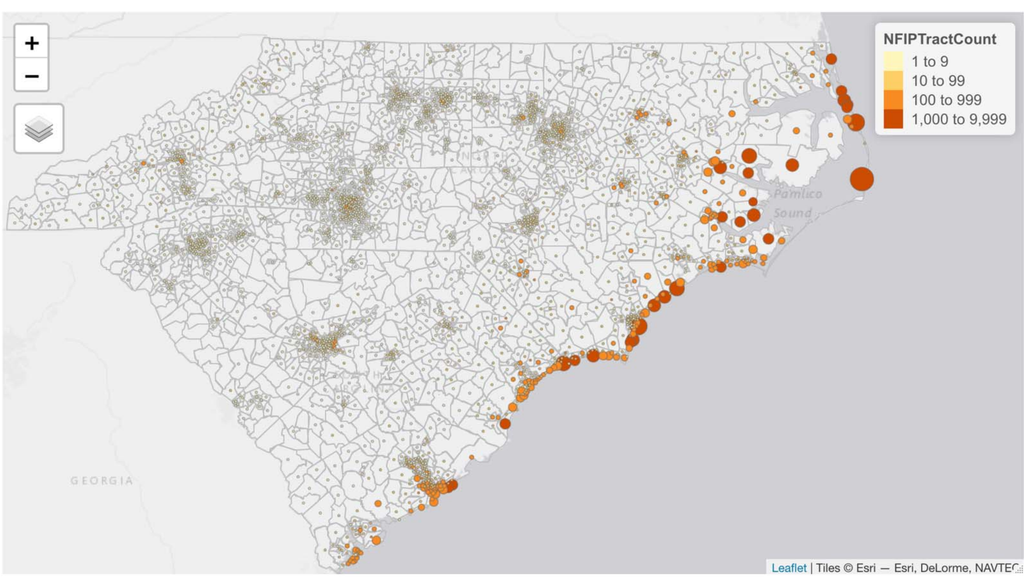

Figure 1. The count of National Flood Insurance Program (NFIP) claims per census tract.

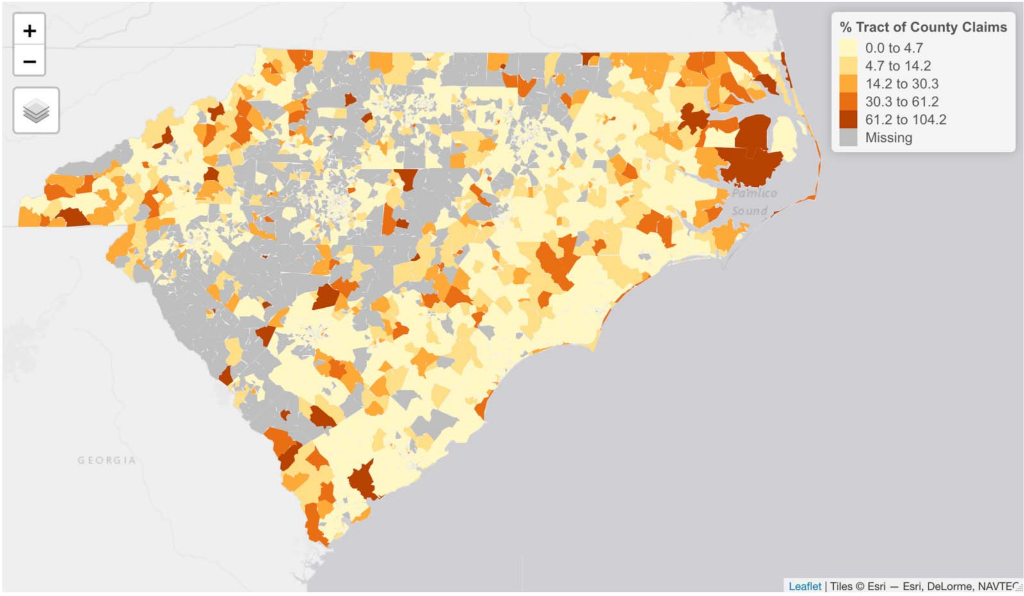

Figure 2. Percentage of National Flood Insurance Program (NFIP) claims in each census tract as a total within the county.

Currituck County, North Carolina, and Allendale County, South Carolina. However, a near-zero value does not necessarily represent similar tract demographic structures, as they can differ significantly—such as in the above example with Currituck County being 90% White and Allendale County being approximately 80% non-White. Tract racial disproportionality can be considered a metric for assessing the degree to which disparities exist in terms of differences in social dynamics in tracts compared to county level and as a way to understand potential political and social power structures that exist at the intersection between tracts and counties governance, collaboration, and influence (Elliott et al., 2020).

With the information on NFIP claim distribution and tract racial disproportionality, we assessed the relationship between the racial proportion of each tract compared to their county

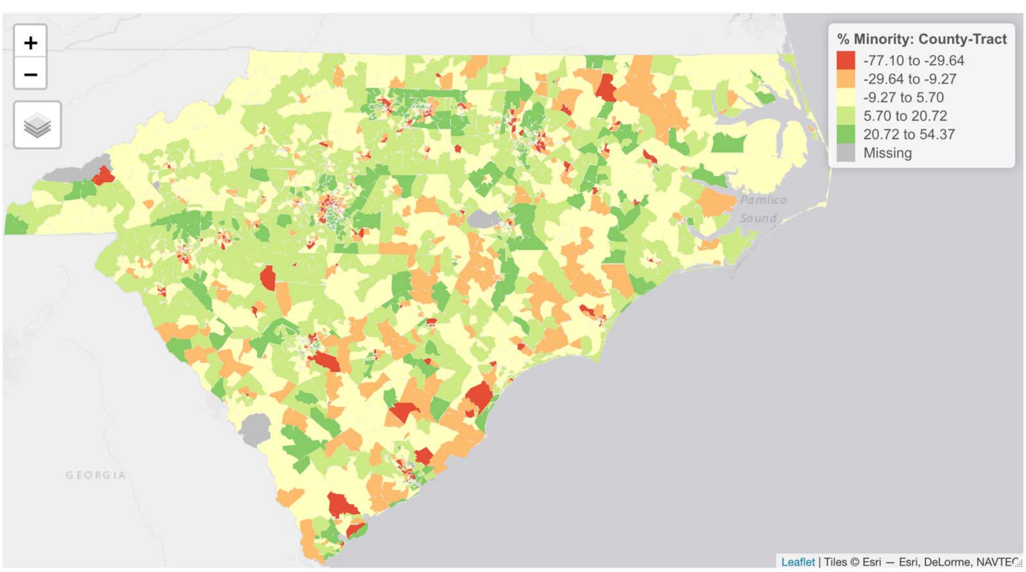

Figure 3. Percentage of minority in county minus the percentage of minority in tract.

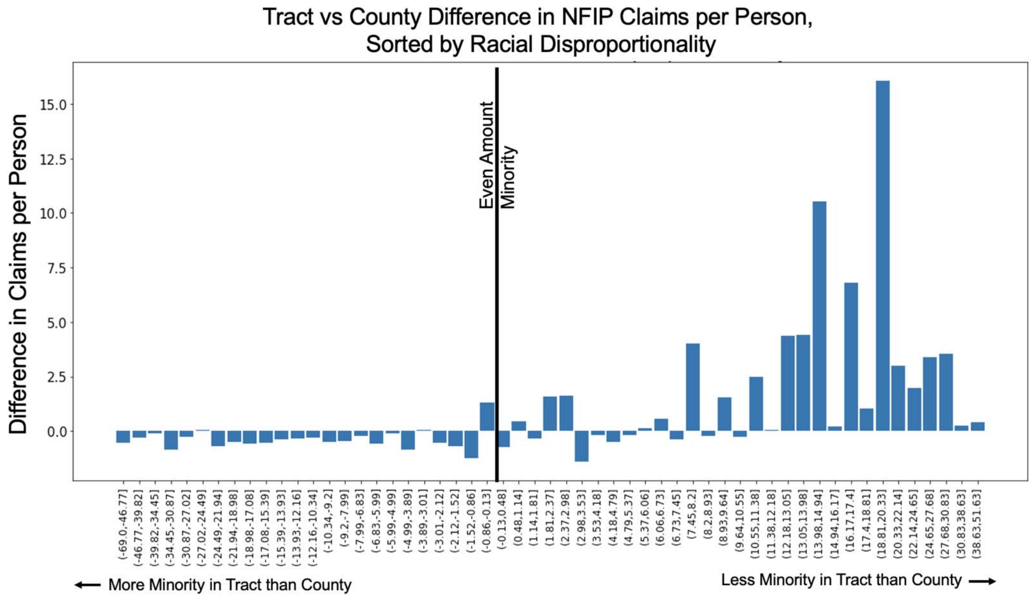

Figure 4. Percentage of National Flood Insurance Program (NFIP) claims in the census tract of the total within the county, normalized for population.

with the percentage of claims of each tract relative to the county total (Figure 4). This is one way to understand the relationship between Figures 2 and 3. Results show a skewness in the data, indicating that for tracts that are disproportionately White compared to the county, there is a greater likelihood for those tracts to have a higher percentage of NFIP claims.

On the *y*-axis, we plot the difference in NFIP claims per person between census tracts and their associated county. Tracts that received less NFIP benefits than their associated county, normalized by population, are shown to have negative values. We find that the majority of tracts that receive a greater rate of benefits have a higher percentage of White population compared to their associated county. This indicates that tracts with large White populations in relatively non-White counties receive a greater percent of the NFIP benefits in their area.

For example, for all tracts that are between 17.40% and 18.81% disproportionate White compared to their counties, 1.5% of claims were received when normalized for population. This value is similar to the inverse tract profile of roughly −.13% to −.86% disproportionate non-White. Overall, tracts with a high non-White population in relatively White counties are shown to be less likely to receive NFIP benefits compared to the remaining tracts within their county.

DISCUSSION

The analyses in this article highlight aspects of NFIP related to the geographic distribution of claims and for whom benefits have and have not been received. Given the future risks of flooding, including increased frequency and areas exposed, combined with vulnerable populations that already receive a lower proportion of societal benefits, it is critical to further examine the potential mechanisms for barriers to access and assistance, such that climate risks do not further burden vulnerable communities (Kruczkiewicz et al., 2021; Lufoff & Wilkinson, 1979; Thistlethwaite et al., 2020).

Spatial analyses examining FEMA programmatic outcomes can be informative for (1) preparing for current climate risks, (2) monitoring and evaluation of how effect of programs overlap with areas that are and will likely be at risk to floods, and (3) presenting a baseline for which future climate risks can be better anticipated—necessary for ensuring equitable housing policies and local disaster recovery assistance (Limaye et al., 2019; Stephens, 2020). Specifically, the analyses in this article expand upon the potential for local-level social and political dynamics at play as a critical factor in understanding racial and demographic drivers of flood insurance program availability, trust, and access (Wilson et al., 2021).

This analysis shows where NFIP claims have occurred, allowing for a visualization of the geographic spread of land-use types that may be more affected by flooding or maintain access in submitting NFIP claims (Figures 1 and 2). In North and South Carolina, the National Oceanic and Atmospheric Administration (NOAA) delineates floods into two main types, coastal and inland (NOAA Digital Coast, 2017). The majority of NFIP claims in this geographic analysis occurs in coastal counties, which while bearing the risk of coastal hazards, they also host the majority of economic production related to coastal and ocean resources (NOAA Digital Coast, 2017). Furthermore, many of the inland tracts with a higher proportion of NFIP claims are in urban areas, which face risks of exacerbated flooding due to the high percentage of impervious surface (Hardison et al., 2009; Zhou et al., 2017). An absence of NFIP claims does not deem an area safe from future floods, nor does it imply that floods have not occurred in the past. However, this absence may imply the existence of certain barriers to access in filing for or receiving recovery assistance measures, and further research should be conducted.

It is important to understand the geographic distribution of NFIP claims in a sociopolitical context to provide insight on potential injustices within flood recovery and mitigation assistance related to access, availability, and uptake. The results in Figure 4 show that for majority non-White census tracts in majority White counties, there are disproportionately fewer NFIP claims. This suggests tract racial disparity within a county can contribute to access barriers, which potentially can contribute to increased flood vulnerability for minority populations often already disproportionately burdened by climate injustices. Lower levels of assistance in flood recovery, resilience, and preparedness in non-White communities aligns with previous findings that indicate non-White populations were deprioritized during response and recovery efforts related to Hurricane Harvey and Hurricane Katrina (Houston et al., 2021; Reid, 2013; Zahran et al., 2008). Such analyses noting disproportionate assistance provisions, however, have typically identified these disparities at a broader scale—such as differences between states or counties—suggesting access barriers at various governmental scales, especially through differences in governmental capacity (Sloan & Fowler, 2015; Wilson et al., 2021). The limited administrative capacity of some county-level governments leads to challenges in ensuring adequate management of disaster-related recovery and resilience programs, including NFIP. This leads to inadequate preservation of institutional memory, less than ideal technical assistance, limited outreach services, and gaps in translating what the flood risk data can mean for specific at risk communities (Elliott et al., 2020; Mach et al., 2019; Sloan & Fowler, 2015; Wilson et al., 2021). Our analyses focus on county-level differences, therefore identifying a unique discrepancy where community members experiencing the same governmental structure still receive disparate benefits, with census tract difference in minority population as an indicator. This suggests local-level (within county) sociopolitical access barriers for non-White populations exist in various stages of flood management, including when receiving flood recovery benefits. However, disproportionality alone may be incomplete to determine causality, and additional steps could be necessary to assess the degree to which racial disproportionalities exist relative to exposure to various types of floods.

Mechanisms leading to access barriers for non-White individuals include bias in damage inspections, informal property titles leading to denied claims, and discriminatory historical policies leading to depreciated housing values and subsequently reduced assistance values (Grube et al., 2018; Wilson et al., 2021). In addition, non-White population demographics often overlap with other underlying sociodemographic characteristics such as lower incomes or higher probabilities of renting, all of which maintain other access barriers that may exacerbate the racial issues related to programmatic assistance uptake. For example, during FEMA inspections in Houston following Hurricane Dolly, over 100,000 cases of individuals seeking recovery assistance were denied based on "insufficient damage," as the homes prior to the event were in poor condition and damage could not be attributed to the hurricane. These denials occurred mostly in neighborhoods that were predominantly low income and non-White (Sloan & Fowler, 2015). A better understanding of access barriers, and the types of procedural justice that must be in place to address them, must inform capacity development and the design of disaster policies focused on delivering justice and sufficient assistance (Paavola & Adger, 2002).

The potential to model NFIP exists, and it must react to current levels and plan for future levels of natural hazard risk (Hino et al., 2017). This includes addressing risk of various individual flood types and the interaction between multiple flood types (Green et al., 2000). While managed retreat strategies promote relocation opportunities to populations with exposed property while intending to provide support to the most vulnerable populations, these groups face various types of implicit sociocultural stresses (Agyeman et al., 2009) and more explicit financial (Hanna et al., 2020) and political barriers related to the accessibility and cultural appropriateness of these policies (Maantay & Maroko, 2009; Paganini, 2019). Therefore, even if certain populations are determined to be the most socioeconomically vulnerable or the most exposed (Martinich et al., 2013), programs like NFIP should be designed to ensure access, justice, and equity (Siders, 2019b). Doing so is critical in order to accomplish goals associated with addressing the public health crisis around availability and access to healthy housing and resources (Limaye et al., 2019; Stephens, 2020), as well as supporting strategies to build resilient communities in both rural and urban areas (Mehryar & Surminski, 2021; Minano et al., 2021), especially those with racial and socioeconomic diversity such as the Carolinas (Thomson et al., 2021).

Given the history of discriminatory practices in urban development and housing policies, there are various questions that should be raised regarding what the "most just" or "most equitable" methods are to ensure that in their application certain subsets of the populations that are intended to be supported are not driven to increased levels of risk. In addition, those in positions of political power and in trusted roles in the community have a responsibility to communicate climate risks in a way that will significantly decrease prioritization of resources that does not ultimately yield to decreasing disproportionate impact from extreme events.

CONCLUSIONS AND NEXT STEPS

Given the accumulated distribution of NFIP claims presented across the Carolinas in the context of different flood types and a projected increased risk of flooding due to climate change, development, and aging infrastructure, this geographic analysis provides a tool to visualize current and potential future funding needs and a means to identify areas to prioritize for enhanced outreach and communication efforts. Our research outlines a process that can be iterated in other locations of interest, and potentially applied to other contexts outside of the tract-to-county spatial scale. As investment in climate change adaptation increases, and as attention grows in terms of understanding and taking steps to avoid burdens on historically underserved populations, our analyses contribute to the body of work centering justice while integrating climate science within policy development, community building, and communication. In this realm, we present four priorities.

First, for research, climate and environmental scientists must seek to further integrate a justice lens within all aspects of disaster risk. Doing so should incentivize attention on the implications of different forms of justice including but not limited to distributive, procedural, recognitional, and interactional justice. A strong propensity to pursue real or perceived "unfairness" in disasters can be made more tractable by examining the procedural justice issues, such as involvement in planning, that later influence distributive justice (i.e., who gets resources or who is impacted). Then, considerable experience and guidance from social and environmental justice and participatory governance could be brought to bear (Lukasiewicz & Baldwin, 2020). Progress toward flood risk policy centering justice would be incomplete without more specifically identifying factors related to gender, especially traditionally underserved and undocumentable community members, such as nonbinary and transgender populations, for which there is a noted and identified gap across research and policy contexts (van Daalen et al., 2020).

Second, for policy, we must continue to develop science- and justice-based standards for reviewing policy and programs addressing climate risk within and across communities. Such policies and processes are often only evaluated by focusing on questions related to "what was the positive impact?" and "did we accomplish what was intended?" This study, and others, shed light on the appropriate, more complex question of "what was the net benefit considering impacts and gains across the spectrum of demographic groups?" Investment in policy evaluation is critical, especially as willfully manipulated "success stories" influence the scaled, iterated decisions in the same and additional areas, threatening to exacerbate negative impacts without informed knowledge of doing so.

Third, for communication and dissemination, approaches must contribute to, and describe, accurate and risk-sensitive science information to all communities in a way that is appropriately salient, yet sufficiently detailed and nuanced for those affected in different ways. This is increasingly important as hazards continue to evolve and lead to non-stationary risk profiles that can vary significantly across state, county, and even tract.

Fourth, as barriers to access programs can be at least in part attributed to a lack of outreach or inadequate acknowledgement and appreciation of community diversity, it is particularly important to describe complex and nonprimary disaster types within impact-based definitions. Doing so must first acknowledge historical variation of resource availability and access, and then seek to include participation of those traditionally deprioritized and underserved. Further work must seek to explore these relationships in more depth, particularly those between race, risk perception, access to services and programs, and flood risk reduction and resilience actions before, after, and during disasters.

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