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Inequities in Climate Change Perceptions: The Rural Paradox

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Abstract

The southeastern United States faces escalating climate threats, including hurricanes, sea-level rise, flooding, and extreme heat, with socially and economically disadvantaged groups bearing disproportionate impacts. The low, near sea-level topography of Eastern North Carolina exemplifies these inequities. Spanning more than 15,000 square miles, the region's proximity to the Atlantic Ocean, extensive estuaries, and rural setting heighten vulnerability, while poverty, lower education, and limited access to health care, transportation, and digital infrastructure amplify risks. Despite these vulnerabilities, little research has examined how communities in the region perceive climate change. The primary objective was to assess local climate beliefs, risks, behaviors, and policy support across Eastern North Carolina, and to evaluate whether these diverged from modeled state and national estimates. A secondary objective was to examine variation in perceptions using county-level indicators of climate vulnerability: urbanicity, economic burden, and environmental sensitivity. Survey questions were embedded in a cross-sectional health assessment across 36 counties in Eastern North Carolina from April 1 to July 1, 2021. A total of 15,961 adults completed the survey in English or Spanish. Individual responses were weighted and compared with state and national modeled estimates. Climate-vulnerability classifications and participant responses were assessed at the county level. Multivariable logistic regression identified demographic, socioeconomic, and geographic predictors of perceptions.

Findings showed that participants in Eastern North Carolina were less likely to believe climate change is occurring (68.4% vs. 71–72%) or to worry about its effects (54.2% vs. 64–65%) compared with state and national modeled estimates. Perceptions varied significantly by socioeconomic status, race/ethnicity, age, and county-level classifications, with urban and more economically advantaged counties reporting higher perceived risks and stronger policy support than rural, disadvantaged areas. Promoting climate literacy, fostering community champions, and amplifying local voices are critical for addressing climate vulnerabilities and provide a scalable model for equity-focused, community-driven strategies to build resilience across diverse regions.

Keywords : community engagement, vulnerability, global warming, mitigation, adaptation, inequality, susceptibility.

INTRODUCTION

The southeastern United States (U.S.) stands on the frontlines of climate change, experiencing many of the nation's most adverse impacts, including intensifying heat waves, catastrophic hurricanes, sea-level rise and re-current flooding [1]. Although the threats of climate change apply to everyone, its impacts are not equally shared [1]. Low-income communities, people of color, Indigenous populations, immigrants, individuals with disabilities are often cited as bearing disproportionate burdens to climate-related hazards [1,2]. This inequitable distribution of exposure, coupled with limited capacity to mitigate and adapt, undermines health, housing, and livelihoods, is reflective of entrenched systems of structural racism and socioeconomic inequality [1,3-5]. This pattern is evident in the southeastern United States, where generational poverty, discriminatory policies, such as redlining, chronic disinvestment in infrastructure and services and systemic forces further exacerbates the challenges faced by communities that are ill-prepared to cope with the accelerating dangers of a warming planet [2,4,5].

A striking example of climate inequities in the southeastern U.S is the eastern coastal plain region of North Carolina. Bordered by the Atlantic Ocean to the east and Appalachian Mountains to the west, Eastern North Carolina encompasses more than 15,000 square miles, or nearly half of the state's total land area [6]. The east region's low-lying topography, extensive estuarine systems, and proximity to the Atlantic make the area one of the most biodiverse in the nation, yet same features heighten its vulnerability to flooding, hurricanes,

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and sea-level rise [7]. With a population density less than half the state average, the region is distinctly rural, shaped largely by intensive agriculture and economically collapsed, small towns [7]. The demographic and socioeconomic profile of the region further amplifies its social vulnerability. Minority groups, primarily African Americans, represent nearly one-third of region's residents, considerably a higher percent than the state average, while 9% identify as Hispanic or Latino. The percentage of older adults and those individuals with disabilities is also higher compared to the state average. Other characteristics include persistently high poverty rates, low educational attainment, and limited access to broadband, transportation, healthy food choices and healthcare services. Contrary to the region's rural characteristics, more urbanized centers and coastal retirement style communities' benefit from having overall higher quality infrastructure systems, high quality education, medical facilities, shopping, transportation options and military bases. These stark differences reflect structural inequities and place-based vulnerabilities, as well as social factors that can shape and influence community perceptions and communication of climate threats [8,9].

Climate skepticism in the U.S. is considerably more prevalent in rural than urban areas. This pattern reflects broader polarization in political attitudes, and has been attributed to factors such as, limited access to climate information, views on environmental regulation, cultural values, local autonomy and economic stability [10-13]. In general, research on climate perspectives among rural and disadvantaged communities is limited at the regional level and especially sparse in the southeastern United States, with most studies focusing instead on broader national and global scales [3]. The disconnect between those most vulnerable to climate threats and those most frequently studied underscores a critical knowledge gap. Addressing this gap requires reliable measures of climate attitudes; however, much of what is currently known comes from national public opinion polls. These polls remain the primary tool for gauging climate perceptions, yet their reliance on modeled data constrains their ability to capture the nuanced views of vulnerable subpopulations. In addition, sampling biases, low response rates, and social desirability effects further obscure variation within rural and underserved communities [14]. Consequently, there is a pressing need for community-based assessments that move beyond broad national averages to provide accurate, locally grounded insights. Such approaches can better inform tailored public health and policy responses [15].

In this context, the present study was conducted as part of a broad, regional community health assessment. For our purposes, the study had multiple aims. First, we sought to generate baseline data on beliefs, perceived risks, policy support, and behavioral responses related to climate change at the regional level. Second, we examined whether regional population perceptions at the regional level diverged from modeled data estimates at the state and national levels. Finally, we assessed variation in climate-related attitudes across levels of social vulnerability, applying a social determinants lens to understand how structural conditions shape climate beliefs and responses. By embedding climate measures into a regional assessment, this research leverages non-modeled data at a more granular level to capture the perspectives of often-overlooked communities. Collectively, these findings illuminate disparities in climate awareness and policy support and underscore the importance of equity-focused, community-engaged research for actionable strategies.

METHODS

This was a cross-sectional study analysis, embedded within a regional community health assessment (CHA) conducted across 36 counties in eastern North Carolina. Counties between April 1, 2021, and July 1, 2021. CHAs are mandated by the Internal Revenue Service, under the Affordable Care Act (Section 501(r) (3)), requiring nonprofit hospitals to conduct a CHA at least once every three years [16].

Participants were recruited through county health departments and not-for-profit health care partners using broad, community-based outreach strategies, such as television, social media, health fairs etc.., Recruiting efforts were conducted in efforts to gather a wide spectrum of regional community residents, ranging from small, rural towns with limited infrastructure to larger metropolitan areas that serve as regional hubs for healthcare, education, and commerce. Eligibility to participate in the CHA, were being an adult resident (≥18 years), and ability to read English or Spanish and resident of one of the 36 participating counties. There were no additional exclusion criteria. Participation was voluntary and anonymous.

The primary unit of analysis was the individual survey respondent. In addition, selected analyses aggregated responses to the county level (n=36) to examine geographic variation and to link survey results with county-level, sociodemographic and climate vulnerability indicators. The study was approved by the East Carolina University, Institutional Review Board (UMCIRB #21-000515), prior to data collection.

Survey Development

The CHA was developed collaboratively among representatives from county health departments, nonprofit organizations, and community coalitions The CHA survey instrument was co-developed with input from health departments, rural health coalitions, and community stakeholders. The goal of the CHA survey was to design questions that were centered on identifying and prioritizing community health

needs and evaluating community assets. The final survey instrument contained 23 questions in both English and Spanish and consisted of five domains: (1) sociodemographic characteristics, (2) health priorities, (3) access to care and services, (4) occupational characteristics and digital access, and (5) climate change (optional). The climate-related questions were adapted from the *Climate Change in the American Mind* survey (Yale Program on Climate Change Communication, 2020) [17]. Climate questions were categorized by belief in global warming, perceived personal harm, support for local climate policy, and climate-related behaviors (e.g., media exposure, interpersonal conversations). Response choices were in Likert-type scales and dichotomous categories. The final survey was distributed in paper and made accessible in an online format. Surveys were electronically accessible from county health department, social media and other government websites. Paper-based surveys were distributed and collected primarily by county health department representatives at events such as health fairs and public venues. Data was manually entered in REDCap, a secure, HIPAA-compliant data management platform.

Climate Vulnerability Classifications

To assess climate vulnerability, we applied proxy measures, or indicators at the county-level representing three primary domains that included, urbanicity, economic burden and environmental sensitivity. Urbanicity for each county was classified according to the U.S. Office of Management and Budget's Core-Based Statistical Areas (CBSA) system [18] US BA. CBSA defines urbanicity based on population size and commuting patterns. Metropolitan counties included those anchored by a core urban area of ≥50,000 residents. Micropolitan counties were defined as having an urban cluster of 10,000–49,999 residents plus adjacent areas with strong economic or commuting ties. Non-core counties, considered truly rural, lacked a significant urban center and were generally characterized by sparse populations and limited infrastructure.

County-level economic vulnerability indicators were classified for each county using the N.C. Department of Commerce Tier Classification System (2021) [19]. This system classifies each of the 100 N.C. Counties as either a Tier 1 (most distressed), Tier 2 (moderately distressed), or a Tier 3 (least distressed) category. The metric used for designating counties into one of the three Tiers are based on a composite of four measures: average unemployment rate, median household income, population growth, and adjusted property tax base per capita. Tier 1 counties typically exhibit high poverty, slow or negative growth, and limited fiscal resources, while Tier 3 counties are more economically stable.

Environmental vulnerability indicators were assessed using North Carolina's Coastal Area Management Act (CAMA) designations [20]. Under N.C. law, CAMA are coastal counties (n=20) with unique environmental features that are both aesthetically valuable and of exceptional concern due to their heightened susceptibility to flooding, storm surge, and shoreline erosion. Within the ENC region, counties with overlapping classifications, such as high economic distress combined with high coastal vulnerability, illustrate the compounded risks faced by these communities.

Data Analysis

Univariate analysis was used to summarize participant demographics and survey responses. Unweighted participation rates were calculated by dividing completed surveys by attempted surveys at the county level. County-level population weights were applied to generate mean values for comparison between state and national modeled estimates from the Yale Climate Opinion Survey. Survey responses were recoded into binary outcomes for analysis, and one sample t-tests were used to evaluate differences between regional survey responses and state and national modeled estimates. Chi-square and logistic regression were used to assess associations between demographic variables and climate perceptions. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to control for age, sex, race/ethnicity, education, and income. Missing demographic data were handled using listwise deletion for regression models, excluding respondents who did not report sex (4.6%) or race/ethnicity (7.0%). All analyses were conducted in SAS version 9.4 (SAS Institute Inc., Cary, NC), with statistical significance set at $p < .05$.

RESULTS

A total of 16,661 people initiated the survey. However, after removing incomplete surveys and data cleaning, a final sample size of 15,961 completed surveys from 36 counties, yielding an unweighted completion rate of 96.8%. As shown in **Table 1**, the largest percent of groups reporting were females (72.5%), age groups between 45 to 64 years old (45.9%), and those reporting White race (61.3%). Approximately 80% of all participants reported having an educational level that included having some college or a college degree, while nearly 20.0% had a high school diploma (HSD), equivalent or less. Most participants reported having an annual income above $50,000 (57.5%) and nearly 28.0% reported working in healthcare, followed by 15.0% in government and 15.4% in education. Nearly all respondents (96.0%) reported having access to Wi-Fi or the internet.

Table 1. Sociodemographic Characteristics Among Participants Responding to Regional Community Health Assessment Survey, Eastern North Carolina (n=15,961).

Characteristics	n	(%)
Total	15961	100
Sex		
Male	3937	25,3
Female	11297	72.5
Other	352	2.3
Age Group*		
<=24 years	803	5.2
25-34	1891	12.1
35-44	2946	18.9
45-54	3312	21.3
55-64	3838	24.6
Over 65	2791	17.9
Race/Ethnicity		
White	9557	61.3
Black	4096	26.3
Other	1183	7.5
Prefer not to answer	750	4.8
Ethnicity		
Hispanic	512	3.3
Education Attainment		
College degree or some college	12390	80.3
HSD, equivalent or less	3046	19.7
Income (annual)		
>=$50,000	8352	57.5
<$50,000	6178	42.5
Occupation (Top 3)		
Healthcare	4069	27.9
Government	2257	15.5
Education	2248	15.4
Wi-fi (% Yes)	14808	96.0

Notes: Percentages may not total 100% either due to rounding or missing data (e.g., a participant not responding to a question. Wi-fi includes dial up, broadband, cellular; excludes prefer not to answer, unreliable, poor internet connections.

Figure 1. Southeastern United States, North Carolina



Among participants and county-level climate vulnerability classifications (**Table 2**), over one-half (53.4%) reported living in Tier 1, or the most economically distressed counties, followed by 34.9% in moderately distressed Tier 2 counties, and 11.6% in Tier 3, or the least economically distressed counties. The percentage of counties urbanicity, the distribution across the region indicated higher urban predominance, with 51.0% of respondents residing in large urban areas, 27.0%, in small urban counties, and the fewest, 22.0% in rural areas. Most lived in CAMA) counties (54.0%).

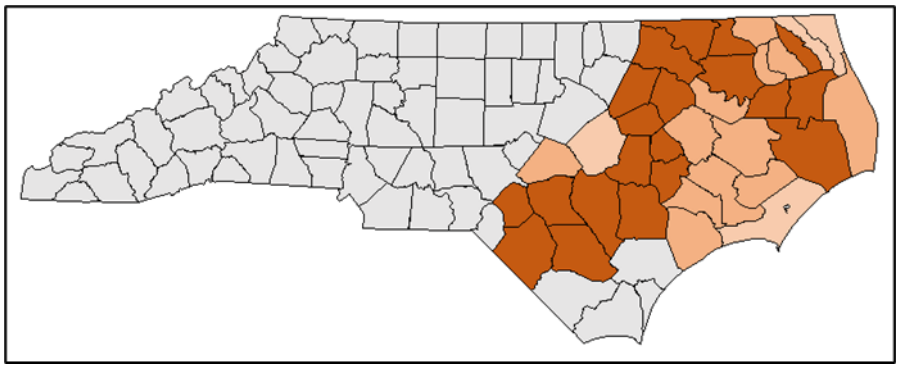
Table 2. Number of Participants and County-level, Climate Vulnerability Classifications, Eastern North Carolina (n=15,961)

County-level, Climate Vulnerability Classification	**n**	**(%)**
Economic Distress		
Tier 1 (most)	8528	53.4
Tier 2 (moderate)	5575	34.9
Tier 3 (least)	1858	11.6
Urbanicity		
Metro (large urban)	8142	51.0
Micro (small suburban)	4311	27.0
Non-core (rural)	3508	22.0
Environmentally Sensitive		
Non-CAMA	8762	54.9
CAMA	7199	45.1

Notes: Economic distress classifications are established by NC DOC for all N.C. counties (N=100). Percentages may not total 100% either due to rounding or missing data.

Source: N.C. Department of Commerce (2021); N.C. Department of Environmental Quality; U.S. Office of Management and Budget (2020)

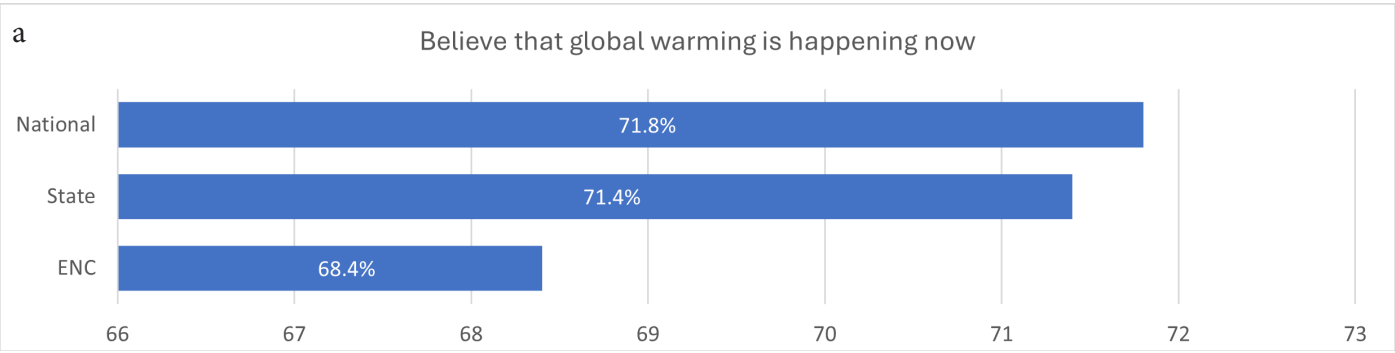
Figure 2. Eastern North Carolina Study Region (n=36 Counties)

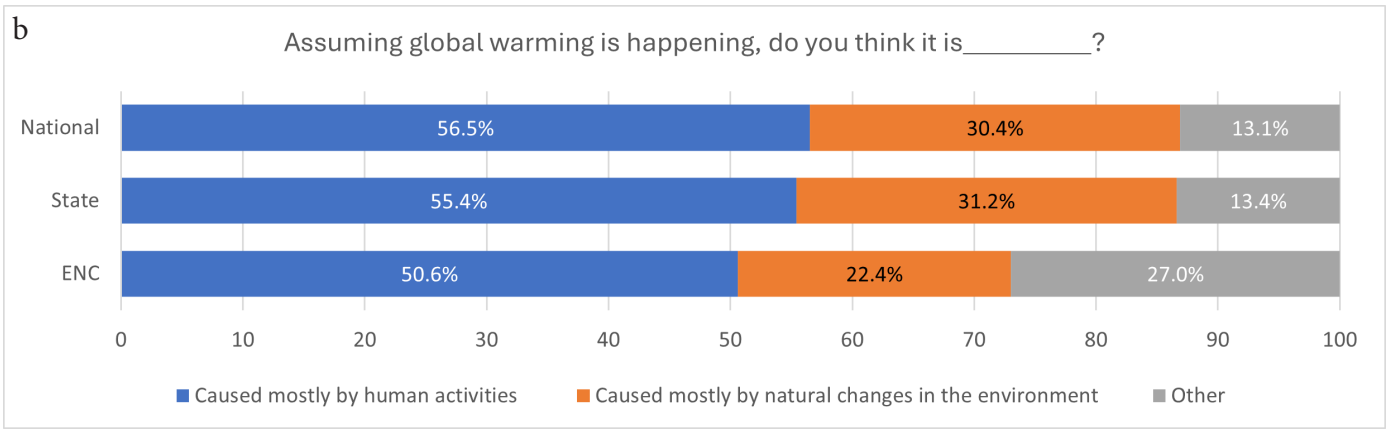


Beliefs, Risks, Policy Support and Behavior

Among participants that completed the climate module questions, **Fig. 3 (a),(b)** the ENC region reported comparatively lower certainty or acceptance (68.4%) when asked if they believed that global warming is happening now, compared to modeled estimates for the state (71.0%) and United States (72.0%). Similarly, ENC region participants were less likely to think that global warming is caused by human activity (50.6%), and more likely to think it was due to other causes (27/0%), compared to state and national level responses (55.4%, 56.5% and 13.4%, 13.1%, respectively).

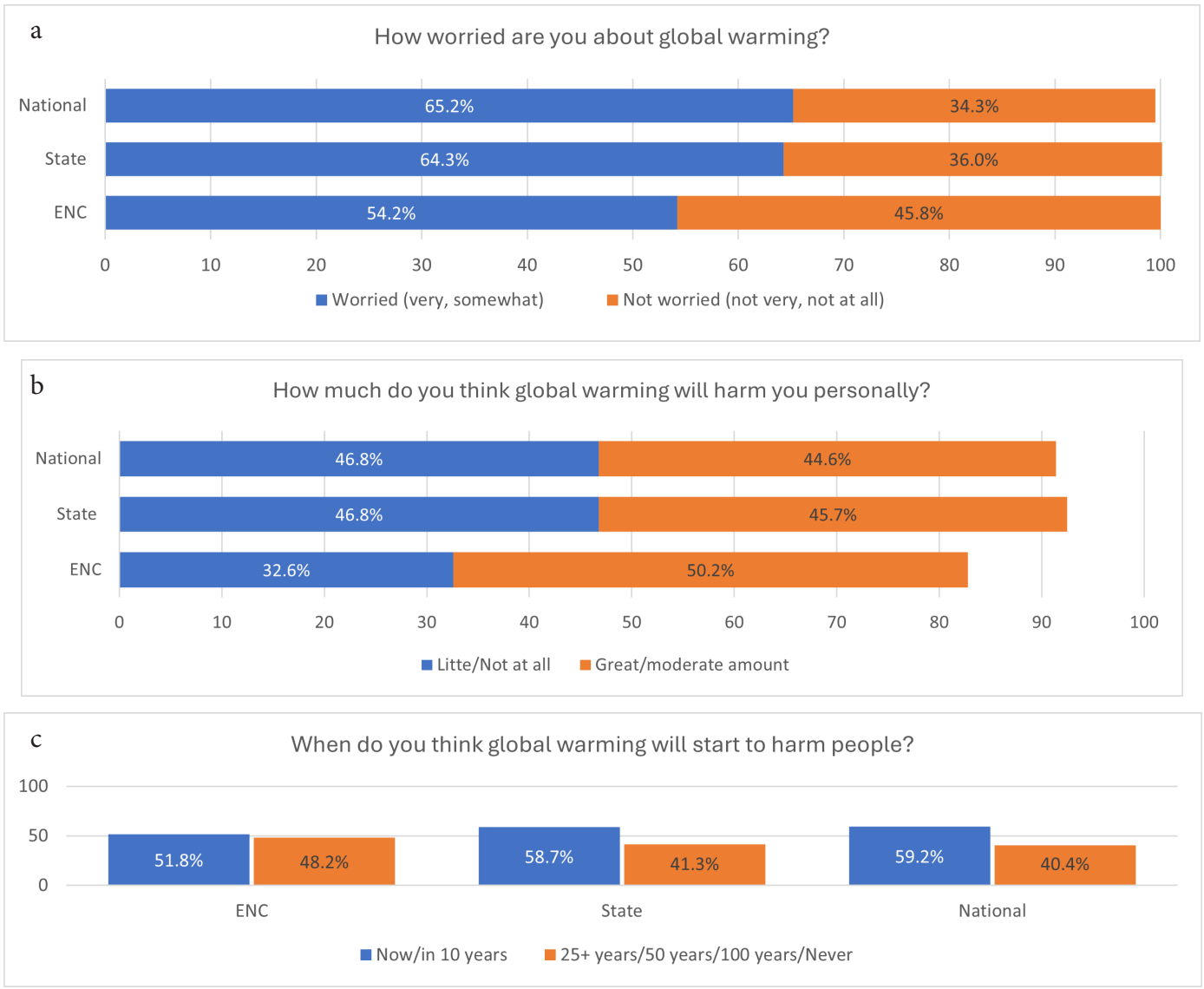
Figure 3. Beliefs

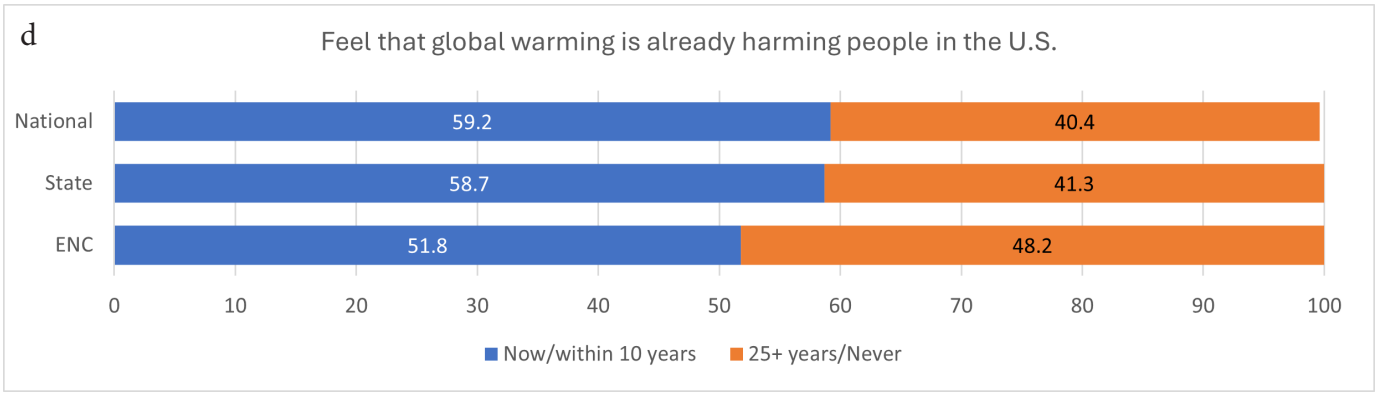




Regarding perceived risks, (**Fig. 4 (a)**), ENC participants expressed significantly less worry about global warming with 54.2% reporting feeling "very" or "somewhat" worried, notably lower than the modeled levels at state (64.0%) and national levels (65.2%). A higher percent of respondents (50.2%) perceived personal harm of global warming would harm them personally "a great deal" or "a moderate amount," (**Fig. 4 (b)**) significantly higher than the proportions observed in the modeled results for North Carolina (45.7%), and national modeled estimates (44.6%). As shown in Fig. 4 (c), ENC respondents felt far less likely (51.8%) that global warming was harming people "now" or within the next 10 years (48.2%), compared to state and national modeled estimates (58.7%, 41.3% and 59.2%, 40.2%, respectively).

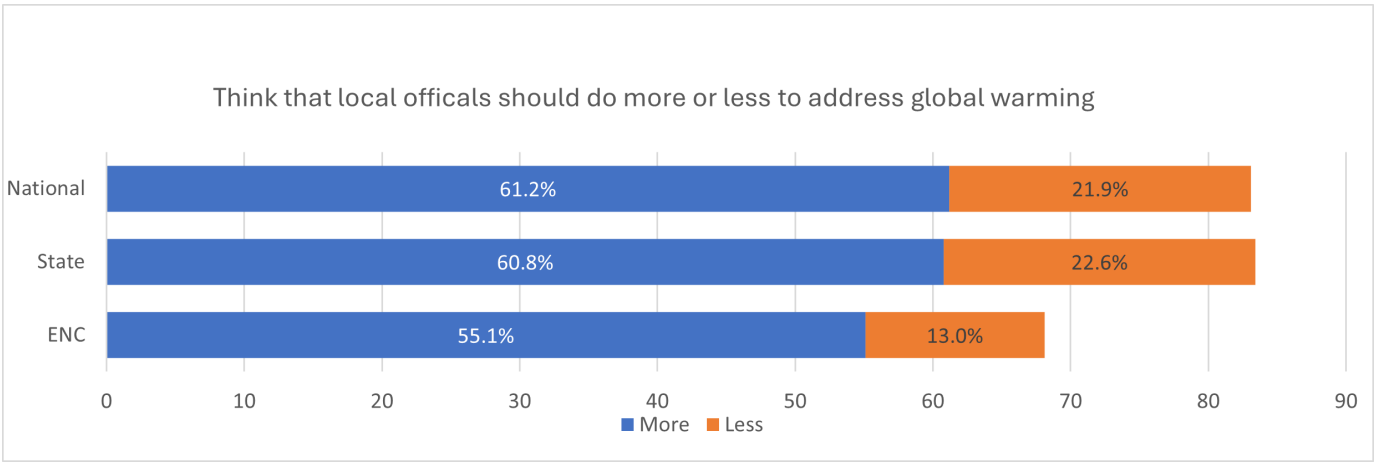
Figure 4. Perceived Risks





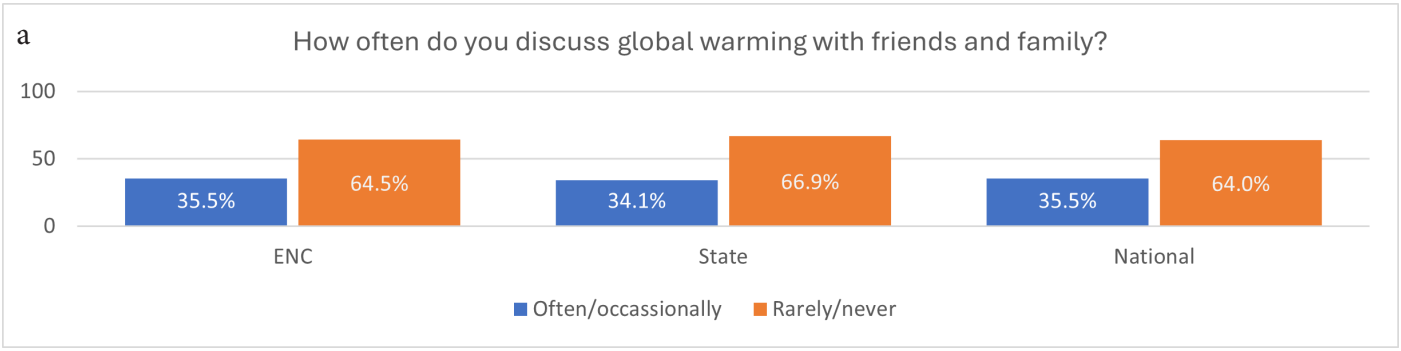
Approximately 55.0% of ENC thought that local government officials and politicians should be doing "more" to address global warming (**Fig. 5**). While this represents a majority, it still was significantly lower than the modeled estimates for North Carolina (60.8%), and the national average (61.2%). Interestingly, only 13.0% of ENC respondents reported that less should be done, which was markedly lower than in modeled estimates for the other geographic levels.

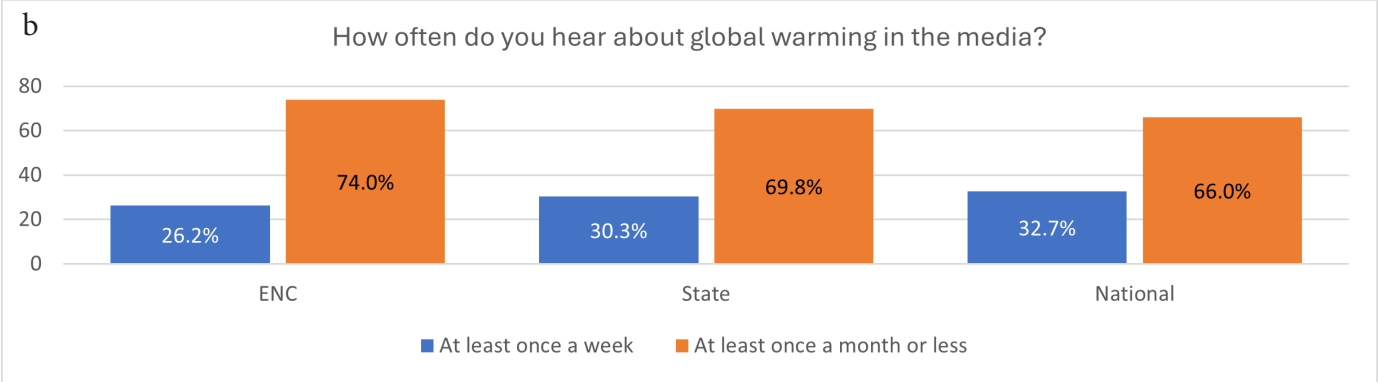
Figure 5. Policy Support



When asked about behavior and discussing "global warming with friends and family," (**Fig. 6**) ENC responses reflected similar compared to state and national levels (35.5%, 34.1%, 35.5%, respectively), but less likely to hear about it on a weekly basis when compared to state and national responses (26.2%, 30.3%, 32.7%, respectively).

Figure 6. Behavior





Modeled Estimates

In logistic models (**Table 3**), perceived harm was significantly higher among female respondents (OR = 1.41, 95% CI [1.30, 1.54], p < .001) among those under 24 years of age (OR = 1.63, 95% CI [1.33, 2.01], p < .001), those with more than a high school education (OR = 1.61, 95% CI [1.44, 1.79], p < .001).

Table 3. Participants Reporting "greatly" or "moderate amount" to "How much do you think global warming will harm you personally," Eastern North Carolina (n = 15,961)

Characteristic	n (%)	Adjusted OR (95% CI)	p-value
Gender			
Male	1321 (43.5)	1.00	
Female	5388 (53.4)	1.41 (1.30-1.54)	<0.001
Age Group			
<24 years	404 (62.4)	1.63 (1.33-2.01)	
25-34	894 (56.4))	1.08 (0.94-1.24)	<0.001
35-44	1338 (52.6)	0.94 (0.83-1.06)	0.272
45-54	1327 (46.1)	0.76 (0.67-0.85)	0.309
55-64	1656 (49.2)	0.89 (0.79-1.00)	<0.001
Over 65	1213 (50.4)	1.00	<0.049
Race/Ethnicity			
White	4060 (47.2)	1.00	
Black	1878 (57.7)	1.61 (1.47-1.76)	<0.001
Other	596 (64.1)	1.96 (1.68-2.28)	<0.001
Education			
HSD, equivalent or less	1035 (44.8)	1.00	
College degree or some college	5753 (52.2)	1.61 (1.44-1.79)	<0.001
Income (Avg Median NC)			
< $50,000	2730 (53.5)	1.00	
>=$50,000	3770 (49.9)	0.94 (0.88-1.04)	0.261
Occupation (Top 3)			
Healthcare	1793 (48.2)	1.00	
Government	983 (49.2)	1.11 (0.99-1.25)	0.075
Education	1105 (55.3)	1.38 (1.23-1.55)	<0.001
Wi-fi/internet			
Yes	6592 (51.0)	1.06 (0.85-1.31)	
No	218 (47.1)	1.00	0.628
Economic Indicator (2022)			
Tier 1	3500 (50.0)	1.00	
Tier 2	2573 (52.4)	1.18 (1.09-1.28)	<0.001
Tier 3	822 (50.4)	1.18 (1.04-1.33)	0.008

Urbanicity Indicator			
Non-core area	1211 (46.1)	1.00	
Micro area	1943 (51.2)	1.30 (1.17-1.45)	<0.0001
Metro area	3741 (52.6)	1.32 (1.19-1.45)	<0.0001
Environmentally Sensitive			
Non-CAMA	3834 (51.5)	1.00	
CAMA	3061 (50.2)	1.02 (0.95-1.10)	0.6025

Notes: Percentages may not sum to 100% due to rounding and participants choosing not to respond to certain questions. N.C. Counties designated as Coastal Area Management Area (CAMA

Source: N.C. Department of Commerce (2021); N.C. Department of Environmental Quality; U.S. Office of Management and Budget (2020)

Compared to White respondents, Blacks (OR = 1.61, 95% CI [1.47, 1.76], p < .001) and Other races had significantly greater odds of reporting perceived personal harm(OR = 1.96, 95% CI [1.68, 2.28], p < .001). Participants working in education were also more likely than those in healthcare to report harm (OR = 1.38, 95% CI [1.23, 1.55], p < .001). Among climate-vulnerability at the county-level, economic distress was significantly associated with risk perception. More specifically, participants in moderate, Tier 2 (OR = 1.18, 95% CI [1.09, 1.28], p < .001) and least economically distressed (Tier 3) counties (OR = 1.18, 95% CI [1.04, 1.33], p = .008) were more likely to report personal harm than those from Tier 1 counties. Similarly, residents of micropolitan (OR = 1.30, 95% CI [1.17, 1.45], p < .001) and metropolitan counties (OR = 1.32, 95% CI [1.19, 1.45], p < .001) had significantly higher odds of perceived personal climate risk than those in non-core, rural areas.

In models focused on perceptions about the timing of climate change harm to people "now or "in 10 years (**Table 4**), respondents in Tier 2 (OR = 1.22, 95% CI [1.12, 1.32], p < .001) and Tier 3 counties (OR = 1.14, 95% CI [1.01, 1.29], p = .035) were more likely to believe that people are already being harmed or will be within 10 years, compared to Tier 1 county residents. A similar pattern was observed with urbanicity. Participants in micropolitan areas (OR = 1.30, 95% CI [1.16, 1.45], p < .001) and metropolitan areas (OR = 1.25, 95% CI [1.13, 1.39], p < .001) were more likely to report near-term harm perceptions than those in rural, non-core counties. Additionally, respondents residing in environmentally sensitive CAMA counties were marginally more likely to perceive near-term harm (OR = 1.10, 95% CI [1.02, 1.19], p = .019).

Table 4. County-Level Vulnerability Indicators Among Participants Reporting, "Global warming and harm happening to people "now" or "in 10 years," Eastern North Carolina (n=15,961)

County Vulnerability Indicator	n (%)	Adjusted OR (95% CIs)	p-value
Economic Distress			
Tier 1 (high)	3471 (51.5)	1.00	
Tier 2 (moderate)	2527 (53.1)	1.22 (1.12-1.320	<0.001
Tier 3 (least)	770 (49.2)	1.14 (1.01-1.29)	0.0348
Urbanicity			
Non-core	1217 (48.0)	1.00	
Micro	1925 (52.6)	1.30 (1.16-1.45)	<0.001
Metro	3626 (52.7)	1.25 (1.13-1.39)	<0.001
Environmentally Sensitive			
Non-CAMA	3741 (52.1)	1.00	
CAMA	3027 (51.3)	1.10 (1.02-1.19)	0.0194

Notes: Percentages may not sum to 100% due to rounding and participants choosing not to respond to certain questions. N.C. Counties designated as Coastal Area Management Area (CAMA)

Source: N.C. Department of Commerce (2021); N.C. Department of Environmental Quality; U.S. Office of Management and Budget (2020)

When evaluating opinions on whether local government and politicians should have "more" support for local climate policy action (**Table 5**), predictors of support for increased local climate action, residents of Tier 2 (OR = 1.29, 95% CI [1.19, 1.40], p < .001) and Tier 3 (OR = 1.19, 95% CI [1.06, 1.34], p = .005) counties had greater support for increased climate action by local officials compared to those in Tier 1. Urbanicity was also a significant predictor, with micropolitan (OR = 1.40, 95% CI [1.25, 1.56], p < .001) and metropolitan (OR = 1.38, 95% CI [1.25, 1.52], p < .001) residents more likely to support stronger local government involvement than those in non-core rural counties. No statistically significant differences were observed by environmental designation (CAMA vs. non-CAMA, p = .169).

Table 5. County-Level Vulnerability Indicators and Climate Change Concern Among Participants Reporting, "More Should be Done by Local Government and Politicians to Address Global Warming" (n=15,961)

County Vulnerability Indicator	n (%)	Adjusted OR (95% CIs)	p-value
Economically Distressed			
Tier 1 (high)	3642 (52.4)	1.00	
Tier 2 (moderate)	2691 (55.2)	1.29 (1.19-1.40)	<0.001
Tier 3 (least	836 (51.4)	1.19 (1.06-1.34)	0.0047
Urbanicity Indicator			
Rural (non-core)	1235 (47.4)	1.00	
Suburban (micro)	2035 (53.8)	1.40 (1.25-1.56)	<0.001
Urban (metro)	3899 (55.1)	1.38 (1.25-1.52)	<0.001
Environmentally Sensitive*			
Non-CAMA	3995 (54.1)	1.00	
CAMA designated	3174 (52.3)	1.06 (0.98-1.14)	0.169

Notes: Percentages may not sum to 100% due to rounding and participants choosing not to respond to certain questions. N.C. Counties designated as Coastal Area Management Area (CAMA)
Source: N.C. Department of Commerce (2021); N.C. Department of Environmental Quality; U.S. Office of Management and Budget (2020)

DISCUSSION

This study provides a cross-sectional view of climate perceptions among vulnerable communities in Eastern North Carolina. To our knowledge, it represents the largest single-wave, population-based survey on climate change opinions conducted in the United States and the first of its kind in North Carolina. Embedding climate-related questions into a community health survey proved to be a straightforward yet innovative strategy for addressing a critical research gap. This design allowed us to capture local perspectives using a trusted tool administered by familiar health partners, thereby enhancing both participation and credibility. This "piggy-back" approach of integrating climate questions into an existing CHA also enlightened by presuming regional participants considered climate issues within the broader context of health and community concerns. More specifically, offering the climate module as an "optional" component was particularly effective, as completion itself signaled a degree of awareness and concern, regardless of individual attitudes. Overall, these findings provide actionable insights for both practice and policy. Community health organizations can leverage this evidence to design targeted outreach and education efforts aimed at closing climate literacy gaps, particularly in rural areas where awareness remains low despite high exposure and risk. Similarly, public health preparedness officials in vulnerable regions can use these results to strengthen grant applications and secure resources to bolster emergency response and resilience planning.

Polarization

The eastern region's lower perception of risk and limited political support were not unexpected. Rural agricultural communities, such as those across much of America, are often characterized by values of independence, self-reliance, adaptability, and resilience, traits shaped by close ties to the environment and long-standing experience managing variable weather conditions [2,22,23]. However, climate change remains a highly polarized issue, particularly in rural areas, where diminished perceptions of risk frequently correspond with weaker support for policy measures [13,24]. This polarization is closely linked to conservative political orientations and a broader distrust of government action [25,26]. For example, Pechar and colleagues (2020) found that rural Midwestern voters were more likely to support environmental policies when survey items avoided the phrase "climate change" and instead emphasized concrete environmental issues [12]. Taken together, these findings underscore how language and framing can strongly influence public opinion and point to the need for communication strategies that align with local experiences and values.

Sociodemographic Disparities

We found wealthier counties were more likely to perceive climate risks as being imminent and had higher support for local government action. This is consistent with other research findings that higher socioeconomic status often supports increased access to resources, information, and influence [8,14,15,26]. In contrast, economically distressed counties expressed lower concern and weaker support for climate policies, reflecting the "rural paradox," where communities most in need of infrastructure support are often least engaged [11]. Barriers such as lower educational attainment, lower SES, and limited access to information are considerable factors that contribute to this gap [4,5,8]. These findings underscore the need to incorporate climate equity into policy to ensure vulnerable communities receive adequate resources and support. Sociodemographic groups expressing greater concern about climate risks included, women, racial and ethnic minorities, as well as both younger and older

groups. These patterns mirror other studies conducted in the U.S. showing that younger groups are more emotionally engaged with climate change issues, while older adults often express concern for future generations [8–10]. Greater exposure to climate education and environmentally active social roles have been described to further explain these differences [9]. Racial and ethnic disparities were especially notable, with Blacks and other non-Whites perceiving higher personal harm than Whites, likely reflecting broader socio-economic vulnerabilities and legacy marginalization [1,11]. These findings underscore the importance of framing climate policies through an equity lens so that people of color and underserved areas are included in policy decision-making[12].

Urban-Rural Dilemma

Urban (metropolitan and micropolitan) counties expressed higher levels of concern about climate change and stronger support for government action compared to rural, non-core counties. This pattern is consistent with prior research showing that urban residents not only face heightened exposures, such as extreme heat, flooding, and air pollution—but also benefit from higher educational attainment and greater engagement in environmental movements, both of which can heighten awareness and policy support [13–15]. Although not the primary focus of this study, political affiliation and the broader rural–urban divide further amplify these differences, as conservative political orientations and skepticism of government intervention remain more prevalent in rural areas [16,17]. Interestingly, proximity to coastal areas (i.e., CAMA counties) exerted only modest influence on perceptions, suggesting that direct exposure to physical hazards alone does not drive climate concern. Instead, the findings point to the importance of structural and social factors, particularly education, economic resources, and civic engagement, that shape how communities interpret and respond to environmental risks [27]. Taken together, these results highlight that disparities in climate change perception are less about geography in isolation and more about the intersection of place-based vulnerabilities with socioeconomic and political contexts.

LIMITATIONS

While this study provides valuable insights, several limitations should be considered when interpreting the findings. Firstly, the study primarily focused on assessing the relationships between survey responses and commonly defined socio-vulnerability population characteristics. However, many other factors, such as personal experiences with climate-related events, can influence an individual's views, beliefs, and perceptions of climate change. These factors were not included in this analysis. Additionally, the timing of the survey during the pandemic may have impacted various components of the survey, such as access, participation rate and responses. The use of convenience sampling and self-reported data with fixed response options introduces potential biases and limitations in depth, which may not fully capture respondents' perspectives. These challenges highlight the need for mixed method approaches to validate and deepen these findings. Future research could benefit from longitudinal designs to track shifts in perceptions over time, potentially in response to policy changes or significant climate events. Nevertheless, by incorporating climate change questions into community health needs assessment surveys, these results provide valuable insights into how socio-economic, demographic, and geographic settings impact public perceptions and policy support for climate action.

CONCLUSION

Despite growing public concern, climate change remains highly polarized, frequently overshadowed by political agendas and a diminished focus on scientific evidence. Rural voices are often missing from this dialogue. Community health surveys offer a practical way to capture these perspectives and engage vulnerable communities, who often may prioritize more immediate daily needs over distant, far future threats. Raising awareness of climate change using personal stories can help bridge this gap, making it real and relatable, rather than abstract.

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Authors contributions

G.K. designed and supervised the study. SI, X.F. and K.J. analyzed the data. G.K., S.I. and K.J. designed the figures, tables and graphs. G.K., S.I., K.J.,X.F., and L.P., review and editing.

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Data availability

The data used for this project was generated as part of the community health assessment process and has not been made publicly available.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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