

Climate Change and Public Health through the Lens of Rural, Eastern North Carolina

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BACKGROUND Recognizing that health outcomes are associated with climate threats is important and requires increased attention by health care providers and policymakers. The primary goal of this report is to provide information related to the public health threats of climate change, while identifying climate-sensitive populations primarily in rural, Eastern North Carolina.

METHODS Publicly available data was used to evaluate regional (eg, Eastern, Piedmont, and Western) and county level socio-vulnerability characteristics of population groups in North Carolina, including: percent of persons living in poverty, percent of non-white persons, percent of persons under 18 years living in poverty, percent of elderly people living in poverty, percent of persons with a disability, and number of primary care physicians. One-way ANOVA was used to calculate and compare mean value estimates of population socio-vulnerability variables in Eastern North Carolina with Piedmont and Western regions.

RESULTS Across all regional categories, the eastern part of the state had considerably higher averages than the state for percent of persons living in poverty (17.2%), percent of non-white persons (13.3%), percent of persons under 18 years old living in poverty (24.9%), percent of elderly people living in poverty (10.0%), and percent of persons with a disability (13.3%). Overwhelmingly, more counties in Eastern North Carolina had fewer primary care physicians (per 10,000 persons) than the state average (8.6 per 10,000 persons).

CONCLUSION Eastern North Carolina has a disproportionately higher percent of population groups that are vulnerable to the threats of climate change. The need for health care providers to understand and communicate the challenges faced by rural, vulnerable population groups is of great public health importance. Communicating these health risks to policy makers is of equal importance.

The Intergovernmental Panel on Climate Change (IPCC) reports that the release of carbon dioxide and other greenhouse gases (GHGs) from human activity is at the highest level in history and these gases are contributing to widespread impacts on human health and natural systems [1, 2]. Just over the past century, the release of anthropogenic GHG emissions into the atmosphere, primarily from the burning of fossil fuels, has contributed to increased global land and ocean surface temperatures by an average of 1.5°F with average temperatures projected to increase from 0.5°F to upwards of 8.6°F by 2100 [2]. Rising temperatures of the Earth have led to significant changes in the natural environment, including acidity of oceans, diminished ice and snow, and rising sea levels [1, 2]. Such environmental changes are credited with influencing regional weather patterns, leading to temperature extremes, shifts of climatic zones, heavy precipitation, drought, wildfires, hurricanes, heat waves, and coastal flooding [2, 3]

Vulnerability and Population Groups of Concern

While the influences of weather and climate on human health are complex, the consensus among scientists is that both observed and predicted associations of current climate effects will continue to negatively affect human health and pose new health concerns [1, 2, 4-7]. However, the impacts of climate change across regions and population groups are not homogenous [8]. Some population groups are considered more vulnerable and face greater stressors to both climate-related (ie, direct effects) and non-climate factors

(ie, indirect effects). For example, young children, elderly people, people with disabilities, and the poor are more vulnerable to sustained heat events (a direct effect), and social and economic stressors from rising food prices, medicine costs, and higher utility bills for keeping cool in the summer and warm in the winter (indirect effects) [1, 9, 10].

While physical and social impacts of climate-change-induced hurricanes and other severe weather events on urban and wealthy coastal communities have captured a great amount of attention [11], disadvantaged and marginalized populations living in rural areas are also considerably vulnerable [8]. By comparison, people living in rural communities tend to be older, have significantly lower incomes, have less education, suffer more health problems, and are more socially isolated than their urban counterparts [8, 12]. In addition, rural populations are often under-insured, have reduced access to medical care, and lack transportation to essential services [12].

Eastern North Carolina (ENC-41)

The Eastern region of North Carolina (ENC-41, defined as the 41 counties that make up the coastal plain, located east of Interstate 95) is characteristically vulnerable to climate

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change threats. First, the area is largely rural, with vastly isolated, climate-sensitive sub-populations that have low access to health care. Second, many counties in the area are highly impoverished with a considerable percent of communities of color and outdoor immigrant workers who live in poor housing. Third, the region historically has had the highest mortality and prevalence rates of discernable health disabilities and highest incidence rates of several major chronic health conditions and diseases in North Carolina [13].

Recent reports of heat-related events among the young, elderly people, and the outdoor workforce are indicators of rising temperatures and vulnerability in North Carolina [14, 15]. For example, from 2008 to 2010, Rhea and colleagues identified a significant correlation between increased temperatures in North Carolina and heat-related illness (HRI) emergency department visits. The highest percentage of heat-related exposures were among people aged 15-18; work-related heat exposures were highest among persons aged 19-45. Older adults were reported more likely to be admitted to the hospital than younger persons [16], suggesting elderly residents are more sensitive and may be less likely to have capabilities to cope with the threat of extreme rising heat temperatures. According to a separate report, from 1992 to 2006, North Carolina had the highest annualized rate of heat-related deaths in the United States, the majority of which occurred within the ENC-41 region [17]. Montz and Allen noted patterns of extreme summer heat across Duplin, Sampson, and Wayne counties, and increased heat-related exposure threats to farmworkers and other marginalized outdoor workers. [18].

Socio-Vulnerability

Socio-vulnerability is a term used to describe “socioeconomic and demographic factors that affect a community’s resilience to external stressors from natural or human-caused disasters [19, 20].” Flanagan and colleagues recognized the domains that form the basis of socio-vulnerability as a population’s socioeconomic status (ie, economically disadvantaged); household composition/disability (ie, number of children and older adults); minority status/language (ie, comprising race, ethnicity, and English language proficiency); and housing/transportation (ie, comprising housing structures and vehicle access) [20]. These domains

help classify factors for identifying vulnerable population groups and associated climate-related health concerns (see Table 1). A component of the disaster management framework, socio-vulnerability recognizes that the most vulnerable people are those who are more likely to suffer from lack of basic needs, such as financial support, transportation, care, and assistance with daily activities during disasters [20]. Identifying geographical areas where climate-sensitive populations are located can assist in determining where to allocate health resources and targeted climate-adaptation messages and mitigation strategies.

Purpose

While a majority of climate change health research has focused on physical and health impacts of coastal and urban populations, little has been published on climate-sensitive population groups living in rural areas of the United States. To our knowledge, no peer-reviewed studies have been published examining population vulnerability to climate change in Eastern North Carolina. The purpose of this study is to report the human health effects associated with climate change while providing an estimate of the percent of socio-vulnerable, climate-sensitive population groups in Eastern North Carolina. We summarize our findings by discussing future challenges and the roles health care and public health professionals play in communicating climate change to their communities.

Methods

Following an extensive review of government reports and the published literature, we selected population socio-vulnerability characteristics related to climate change and data variables that were publicly available. Selected socio-vulnerability variables included: percent of individuals with incomes below the federal poverty level, percent of individuals with a disability, percent of individuals (under 18 years) in poverty, percent of elderly people (over 65 years) in poverty, percent of non-white individuals, and number of primary care physicians (per 10,000 population). Socio-vulnerability variables for each of North Carolina’s 100 counties were identified and downloaded from the US Census Bureau and The University of North Carolina at Chapel Hill Sheps Center for Health Services Research websites [21, 22].

TABLE 1.
Climate-Sensitive Health Outcomes by Population Groups

Socio-vulnerable population groups	Climate-related vulnerabilities
Elderly people and people with chronic medical conditions, pregnant women	Heat stress, air pollution, water- and food-borne illnesses, vector-borne diseases, mental stress
Impoverished and low socioeconomic status	Heat stress, extreme weather-related events, water- and food-borne illnesses, mental stress
Outdoor workers	Heat stress, air pollution, vector-borne infectious diseases, ultraviolet light exposure
Children and infants in poverty	Heat stress, air pollution, water- and food-borne illnesses, vector-borne diseases, malnutrition

Data Analysis

Data variables were formatted in Microsoft Excel (2007) and uploaded into ArcGIS (ESRI, v.10) to create choropleth maps. The univariate general linear model was used in SPSS (version 24, Chicago, Ill.) to calculate one-way ANOVA. Statistical differences were compared between mean percent of socio-vulnerability variables in ENC-41 counties with Piedmont and Western North Carolina counties. *P* values < 0.05 were considered statistically significant. Cohen's *d* was used to measure effect size.

Results

Vulnerable Population Groups in ENC-41. As shown in Table 2, numerous ENC-41 counties in the region had a considerably higher percent of socio-vulnerable populations compared to the Western and Piedmont regions of North Carolina. As described below, several counties in the east had the highest socio-vulnerable population characteristics in the state.

Percent in poverty. Overall, the average percent of individuals with incomes below poverty level in North Carolina was 17.2%. For the ENC-41 counties that make up the Eastern region, 27 counties were above the state average, 24 counties were above 20%, and 2 counties, Scotland and Robeson, had mean estimates above 30% (32.3% and 31.7%, respectively).

Percent of elderly people (over 65 years) living in poverty. Overall, a high percentage of counties within the ENC-41 region reported high rates of elderly people in poverty. Twenty-eight counties were above the state average of 10%, with Chowan County reporting 23.6% and Hyde County reporting 20.7%. Other counties in ENC-41 reporting higher averages included Halifax (19.7%), Duplin (19.5%), Robeson (19.1%), and Bertie (19.1%).

Percent of children (under 18 years) living in poverty. A large proportion of counties in the east reported a higher percent of children living in poverty compared to the state average (24.9%). In the ENC-41 region, 31 counties ranked above the state average and 24 counties in the east reported child poverty as above 30%. Six counties—Edgecombe (60.8%), Bertie (64.4%), Northampton (48.3%), Chowan (47.9%), Scotland (46.8%), and Robeson (46.7%)—reported rates above 45%.

Percent of individuals with a disability. On average, 13.3% of individuals in North Carolina reported having any of 6 disabilities (ie, hearing, vision, cognitive, ambulatory, self-care, or independent living). Among counties in the ENC-41 region, 37 counties had a higher percentage of individuals with a disability than the rest of North Carolina; Northampton (25.8%), Jones (24.6%), Halifax (23.6%), Hertford (22.4%), and Washington (21.9%) counties were among those with the highest percentage in the region.

Percent of non-white, minority population. The average percent of non-white population in North Carolina was 30% (see Figure 1); 68% of counties in the ENC-41 were above

the state average. Counties reporting non-white populations above 50.0% included: Robeson (70.2%), Bertie (64.4%), Hertford (63.9%), Edgecombe (60.8%), Northampton (60.3%), Halifax (59.4%), Washington (53.4%), Hoke (52.5%), and Scotland (52.4%).

Number of primary care physicians (per 10,000 persons). The ENC-41 region ranked below the rest of North Carolina in the number of primary care providers (per 10,000 population). On average, North Carolina has 8.6 primary care doctors (per 10,000 population), while 18 counties in the ENC-41 region reported fewer than 5 primary care doctors and 10 counties had fewer than 2.8. Two counties, Camden and Tyrell, had no (0) primary care physicians [22].

As calculated by one-way ANOVA, statistically significant differences were identified between ENC-41 counties (*N* = 41) and both Piedmont and Western counties (*N* = 59) for all socio-vulnerability characteristics (see Table 3). The largest mean difference was observed between the number of average primary care physicians in the ENC-41 region and Piedmont and Western counties (5.45 versus 7.39 per 10,000 population).

Discussion

The results of this study identified that the majority of counties in Eastern North Carolina are rural and have a high percentage of socio-vulnerability population characteristics, which make them highly susceptible to the health impacts of climate change. Rural and remote areas of Eastern North Carolina with the highest percent of impoverishment and socio-vulnerable population groups will continue to experience the greatest impacts. As the planet continues to warm, climate-related threats will increase economic and health challenges for the most vulnerable groups while contributing to existing high poverty and disease burdens in the region.

Rural populations face different challenges related to climate change than urban, more populous areas. This study helps fill a gap in the literature by examining rural populations and climate vulnerability at a regional level. In addition, we advocate for increased public health research at a finer scale that can examine the challenges and other hidden influences of climate-related health among sensitive groups in rural areas. Below we discuss future challenges, communication, and strategies for Eastern North Carolina that support moving this research and issues surrounding climate change in rural areas forward.

Future Challenges

Experts predict that even if effective mitigation strategies were implemented to combat rising temperatures, the current elevated levels of carbon dioxide and GHG emissions would continue to warm the planet several decades into the future [23]. Although future climate threats to parts of the southeastern United States, including rural Eastern North Carolina, are difficult to predict with accuracy, such events are likely to include heavy rains and flooding that will cause

TABLE 2.
Percent Average of Socio-Vulnerability Characteristics among Individual ENC-41 Counties
and all North Carolina Counties (N = 100)

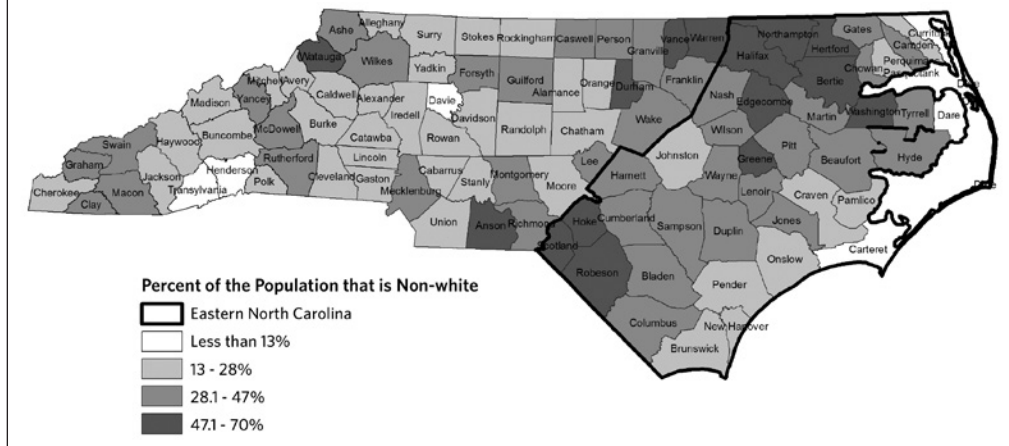
County	Poverty (%)	Elderly people in poverty (%)	Children under 18 in poverty (%)	Disability (%)	Non-white (%)	Primary care physicians (N)
North Carolina*	17.2	10.0	24.9	13.3	30.0	8.6
Beaufort	21	11.5	31.8	18.5	30.9	6.9
Bertie	23.4	19.1	40.4	20	64.4	2.4
Bladen	25.8	17.5	37.4	21.4	42.8	4.8
Brunswick	16.6	5.7	26.3	16.1	15.4	5.0
Camden	6.0	6.9	8.3	15.4	16.1	0.0
Carteret	14.4	7.2	23.3	18.1	8.9	6.1
Chowan	29.0	23.6	47.9	17.2	37.2	8.8
Columbus	25	13.4	36.1	20.3	37.5	5.9
Craven	16.6	8.7	26.6	17.7	28.0	8.3
Cumberland	17	9.9	24.1	13.9	46.1	7.4
Currituck	9.8	5.3	12.9	12.3	8.0	2.5
Dare	8.8	4	13.5	14.3	5.9	8.2
Duplin	26.3	19.5	39.4	16.2	41.8	2.7
Edgecombe	25.2	16.4	42.4	17.8	60.8	4.9
Gates	19.6	12.9	35	16.1	35.1	0.8
Greene	23.3	17.7	37.5	16.1	48.4	5.2
Halifax	27.4	19.7	39.4	23.6	59.4	6.5
Harnett	17.2	12.5	22.2	13.5	29.5	4.3
Hertford	26	18.3	39.1	22.4	63.9	7.3
Hoke	22.9	18.3	30.9	13.7	52.5	2.2
Hyde	25.6	20.7	36.5	18	35.2	1.7
Johnston	17.2	10.7	24.7	12.2	24.2	3.9
Jones	16.7	9.4	27.0	24.6	35.8	9.5
Lenoir	23.7	15.2	37.2	20.5	45.9	7.1
Martin	23.2	18.7	36.1	20.2	46.3	5.5
Nash	17	14.3	23.2	14.9	43.2	7.5
New Hanover	16.9	6.5	23	12.5	19.2	11.9
Northampton	26.3	14.3	48.3	25.8	60.3	2.4
Onslow	15.2	9.7	20.6	14.1	22.6	4.3
Pamlico	13.8	6.7	27.2	20	22.6	3.1
Pasquotank	18.4	8.8	26.9	15.1	42.0	9.4
Pender	19.3	13.4	27.9	16.8	22.4	2.9
Perquimans	20.2	9.8	31	19.6	27.0	1.5
Pitt	24.3	13	28.1	12	39.8	14.8
Robeson	31.7	19.1	46.7	17.4	70.2	6.1
Sampson	22.8	15.8	32.9	17.7	42.1	5.8
Scotland	32.3	13.2	46.8	21.8	52.4	9.7
Tyrrell	20.8	16.3	35.7	16.5	44.7	0.0
Washington	23.7	11.3	37.9	21.9	53.4	3.9
Wayne	22.1	11.2	34.4	15.2	39.7	6.2
Wilson	23.2	11.2	37.8	15.3	47.2	6.0

*Denotes percent average of all NC counties (N = 100)
 Source. Percent of individuals with a disability (ACS, 2009-2013)
 Percent of individuals with incomes below poverty (2009-2013, ACS)
 Percent living with a family whose income is below poverty (2009-2013, ACS)
 Includes black, Asian, American Indian, and other non-white races (US Census, 2010)
 Number of physicians per 10,000 persons (UNC, Sheps Center, 2013)

damage to infrastructure (eg, roadways, stormwater, drinking water, wastewater, and communication systems) [24], agricultural shifts in planting and harvesting times [25], drought, shifting migration patterns of fish, wetland loss, and river flooding [26]. Climate-sensitive groups, such as poor, elderly, young, health-compromised [1, 27], and under-

served populations in rural areas need special considerations to avoid being hard hit. For example, several rural “finger” counties in the northeast ENC-41 region currently experience extreme vulnerability including high poverty, with few or no primary care physicians. Based on the evidence from other scientific studies, the trauma associated with extreme

FIGURE 1.
Percent of Non-White Individuals: North Carolina Counties Including the ENC-41 Region (N = 100)



weather and increasingly warmer temperatures for Eastern North Carolina is likely to increase emergency department visits, including for HRI, respiratory problems (eg, asthma) from poor air quality and longer pollen seasons, injuries and mental health concerns from severe weather, and increased prevalence of vector- and water-borne diseases [2]. This poses serious challenges for rural populations in counties that have limited public health services such as mosquito control, environmental health, or a primary care clinic. Rural nursing homes that may not be able to provide water or electric services when power outages occur pose added concerns. Rural populations that are physically isolated and suffer home damage may have to wait long periods without basic repair services, or may face impassable roads from flooding, as with Hurricanes Floyd [28] and Matthew [29].

The physical geography of the coastal plain of North Carolina also poses evolving threats to human health beyond the direct effects of increased extreme heat and coastal storms. For instance, flooding will further stress fresh water supplies, exacerbate salinization of shallow coastal aquifers, and potentially degrade the effectiveness of on-site sewage (septic) disposal systems. Concomitantly, the increasing strength of tropical storms and heavy rainfall in a longer, hotter summer period could amplify stormwater runoff and nutrient export into many of the estuaries in the coastal plains. This loading, in turn, can contribute to heightened risks of water pollution, algal blooms, hypoxia, fish kills, contaminants, and pathogens (eg, *Escherichia coli*, *Vibrio vulnificus*). Under climate model projections, relative sea level rise in coastal North Carolina is also apt to accelerate, such that mosquito habitats expand with wetlands migrating landward and upward into the more isolated rural areas. Wetter summers may also see an increase in mosquito- and other vector-borne diseases (eg, West Nile Virus, Lyme disease, Zika, and Dengue). Storm surges, elevated by sea level rise, threaten water supplies and centralized wastewater infrastructure during storm disasters, disrupting potable water and spilling untreated wastewater.

Communicating Climate Change and Health

There is a paucity of studies examining rural populations and their attitudes toward climate change in the United States. Among the general population, it has been reported that the perception of disagreement among scientists is credited for creating continuous skepticism and doubt about climate change [30]. Nevertheless, recent polls indicate Americans may have turned the corner and are now more favorable toward accepting that climate change is actually occurring. A national Gallup poll conducted in March 2016 (N = 1,109) indicated that 64% of American adults worried a “great deal” or a “fair amount” about global warming, an increase from 55% in the previous year [31]. In another public opinion poll conducted by researchers at Yale (2014), an estimated 63% percent (about 6/10) of adults in the United States “think global warming is happening.” In the same opinion poll, North Carolina ranked similarly to the national average at 62% [32]; opinion estimates at the county level indicated slightly higher percentages (61-64%) among North Carolina coastal counties, but somewhat lower (56-62%) among many rural counties in the Eastern part of the state [32].

One source suggests that getting rural versus urban communities engaged in discussions on climate policy is challenging not only because of long-standing political obstacles, but also for geographic, cultural, and economic reasons [33]. To help influence decision-making in rural areas, local communication strategies could include increased social media campaigns on the economic benefits of switching to alternative energy sources, raising climate literacy education in school classrooms, and advocacy from health care providers to communities on the health benefits of climate-friendly activities (eg, reducing meat consumption, walking instead of driving).

Although acceptance of climate change appears to be increasing, the level of public engagement in the United States with climate change appears to be lacking [34]. Kaspersen and colleagues wrote that one of the difficulties

TABLE 3.
General Linear Model of Socio-Vulnerability Characteristics between ENC-41 Counties and Piedmont/Western North Carolina Counties (N=100)

Socio-vulnerability characteristic	ENC-41 counties (N = 41)				Piedmont and Western counties (N = 59)				F	P
	Mean (%)	SE	95% CI		Mean (%)	SE	95% CI			
			Lower	Upper			Lower	Upper		
Individuals with a disability	17.48	0.62	16.26	18.71	15.78	0.51	14.76	16.80	4.47	.037
Individuals w/income below poverty	20.87	0.77	19.35	22.39	18.76	0.64	17.49	20.02	4.49	.037
Under 18 and living in poverty	31.82	1.25	29.35	34.28	27.24	1.04	27.24	25.12	7.98	.010
Elderly people (over 65) in poverty	13.11	0.54	11.88	14.33	10.80	0.51	9.78	11.82	8.23	.010
Non-white	37.23	2.49	32.29	42.18	20.31	2.01	16.19	24.43	27.26	.001

Source. One-way ANOVA

Percent of individuals with a disability (ACS, 2009-2013)

Percent of individuals with incomes below poverty (2009-2013, ACS)

Percent living with a family whose income is below poverty (2009-2013, ACS)

Includes black, Asian, American Indian, and other non-white races (US Census, 2010)

Note. The mean number of primary care physicians in the ENC region was 5.5, (per 10,000 population), SE, 0.57, 95% [4.31-6.59]; and 7.4 (per 10,000 population) SE, 0.48, 95% CI [6.44-8.34], in the piedmont and western counties. Number of physicians per 10,000 population (UNC, Sheps Center, 2013)

with communicating climate change is that it is often viewed as a “hidden risk hazard,” and “despite serious consequences, may pass unnoticed until it reaches disastrous proportions [35].” Nevertheless, physicians and public health care providers in rural, Eastern North Carolina are in ideal positions to communicate, educate, inform, and empower community members and policymakers on climate change. Abelsohn and colleagues noted that family physicians have a responsibility to translate science and advocate health to the communities that they serve [36]. This could take place in the form of primary prevention strategies, such as increasing the dialogue about communities taking personal actions on this issue.

A Lancet report noted that restricting output of GHGs supports a cleaner environment and brings health co-benefits to populations [37]. For example, intervention strategies to reduce carbon emissions from coal-fired power plants can lead to improved respiratory health [38]. Other examples include less dependency on motor vehicles through better-designed communities that encourage populations to walk and exercise, leading to improved fitness [37].

Although more research is needed to strengthen the indirect effects of climate change on some health outcomes (eg, vector-borne disease and gastrointestinal illness), health care and public health professionals can raise awareness in communities in rural areas to influence their personal decision-making. Examples include increased effective messaging targeting the young, elderly people, and outdoor workforce on the risks of HRI and underscoring the importance of avoiding heat and accessing places that are cool on hot days. Other communication examples include strengthening community messaging by alerting those with asthma and respiratory diseases to take precautions on high-pollen days and during wildfire events.

Adaptation

Different regions face different climate change challenges. Crimmins and colleagues noted that effective adap-

tation measures are closely tied to local conditions and social networks [1]. Campbell-Lendrum and colleagues pointed out that the potential health impacts of climate change can be avoided through a combination of strengthening key health system functions and targeting improvements in the management of specific risks [39]. For example, health vulnerability and adaptation assessments, or resiliency plans, are valuable tools for considering which population groups are most vulnerable and specifying interventions [39]. Low-lying coastal communities including Miami Beach [40] and the City of Portsmouth, VA [41], have been leading efforts to adapt and implement strategies for resiliency planning, such as building resilient infrastructure. A website to help people find information and guidance to build climate resilience is available through the US Climate Resilience Toolkit (<https://toolkit.climate.gov/>).

Limitations

Although this work represents an ecological study design approach for identifying populations at risk, the results should be interpreted with caution. Climate change is dynamic across regions; adaptation and vulnerability of population groups vary considerably and may not be generalizable. Also, Lal and colleagues pointed out that 2 of the difficulties with analyzing the impacts of climate change on rural communities are the lack of separation between defining rural and urban areas and the variation among climate scenarios [8]. These types of considerations should be taken into account for future studies, particularly when examining a more granular level unit of analysis (eg, census tract level).

Conclusion

Serious efforts are needed to engage communities in environmentally sustainable practices that promote efforts to reduce the threats of carbon emissions and GHGs. Policy decisions made today at global and local levels influence the fate of our environment and health and shape how future generations will live their lives. Regardless of political lead-

ership, North Carolina should increase efforts to be a leader in environmental stewardship and clean energy. Movements toward alternative, renewable energy development; sustainable communities with less reliance on fossil fuels; and innovation and tax credits to preserve and protect our natural resources and human health are all achievable goals for our state. Concerned efforts by health care providers, public health professionals, and researchers to communicate the health impacts of climate change can ensure our policymakers and citizens in North Carolina are well-informed to achieve these goals [9]. Sophisticated predictive modeling can provide statistical estimates of climate-related health outcomes, but more hands-on research and monitoring of populations living in rural areas are needed to measure the physical and mental health impacts of climate change. An increased awareness of this important issue is needed to influence decision-making; to shape healthier, more climate-resilient communities; and to protect climate-sensitive populations in Eastern North Carolina. **NCMJ**

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