RESEARCH TRIANGLE ENVIRONMENTAL HEALTH COLLABORATIVE

2013 Environmental Health Summit

Public Health and Climate Change: Focusing North Carolina Forward

Representing Expert Discussions/Recommendations to Address Impacts on North Carolina

Abstract

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased. *- Allen, Simon K., G-K. Plantner, M. Tignor, J. Boschung, A. Nauels, Y. Xia, V. Bex, P. Midgle. 2013: Climate Change 2013: Impacts, Adaptation, and Vulnerability. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, T. Stocker, D. Qin, Eds., Online.*

This was the conclusion drawn by Working Group I of the Intergovernmental Panel on Climate Change (IPCC) after aggregating paleoclimate reconstructions, global-scale climatic observations from the mid-19th century, and extensive observations and modeling from the post-World War II era. The conclusion is stated in "The Physical Science Basis," the working group's contribution to the IPCC's Fifth Assessment Report, published September 2013.

This assertion is alarming for many reasons, but perhaps more so considering the report's assertion that climate change currently contributes to the global burden of disease and premature deaths and that projected trends in climate change related exposures will negatively impact public health around the globe.

In October 2013, the Research Triangle Environmental Health Collaborative (EHC) convened its sixth annual summit on environmental health issues. EHC invited stakeholders with wide-ranging expertise to consider the potential impacts of climate change on public health in North Carolina.* Participants represented varied perspectives within the climate change research and policy communities, including local-level government officials from throughout the state, nongovernmental health advocates, private sector public health consultants, and climate and public health researchers from government institutions and universities. As in the past, the EHC Climate Summit sought to provide an arena for experts to share research, discuss relevant developments, and identify gaps in the current knowledge of the potential impacts on public health statewide. Ultimately, the summit recommended a suite of both individual and coordinated policies,

[*]: Reports on previous Summits (shale gas extraction, 2012: incorporating public and environmental health into sustainable solutions, 2011: American healthcare policy, 2010: environmentally healthy development of nanotechnology, 2009: and pharmaceuticals in water, 2008) can be accessed from *http://environmentalhealthcollaborative.org/summit/overview/*

actions, and partnerships that could potentially help to better prepare North Carolinians for the types of climate change-related public health threats that are expected to be most pressing across the state. The recommendations presented here are directed toward state and local lawmakers, as well as related stakeholders in North Carolina.

The chief feature of the EHC Climate Summit was three Working Groups, convened to parse climate change's potential public health impacts into North Carolina's three demographic settings: the rural, urban, and coastal. Each group described the most pressing climate change-related public health impacts for each context, identified the most relevant gaps in knowledge and research for each impact, and recommended actions to address those impacts. Though in different ways, all three groups acknowledged the relationship between climate change and the frequency and severity of extreme weather events, such as coastal storms and increased riverine flooding. The Urban and Coastal working groups further acknowledged the critical role that land use planning and regulation could have in mitigating the public health impacts associated with such events.

An additional thread connecting the discussions of the three working groups was the variability in vulnerability to the effects of climate change among North Carolinians in each context. Climate change-related public health threats will not impact everyone in each context equally, and each working group identified environmental justice concerns as a significant gap in public health knowledge.

Plenaries

Prior to separating into context-specific working groups, participants convened for plenary presentations from noted experts in the fields of climate change adaptation and public health. The case studies and fact bases of these presentations provided the scientific foundation for the working group discussions.

- **John Balbus, M.D., M.P.H.**, Senior Advisor for Public Health at the National Institute of Environmental Health Sciences, outlined the key messages from the Human Health chapter of the draft National Climate Assessment, namely that: climate change threatens human health, and those impacts are already underway in the U.S.; climate change will amplify existing nationwide health threats, especially for vulnerable communities; preparedness and prevention can protect people from some of these threats, but given that national capacity to adapt to increasing threats may be limited in the future, early, preemptive action has the most impact potential; and responding to climate change provides opportunities to improve health and well-being in a variety of areas including energy, agriculture, and transportation.

  Using data culled from a variety of sources, Dr. Balbus interpreted each of these key messages, and articulated some of their applications in North Carolina. He specified, for example, that North Carolina's primary climate change health threats are extreme heat, flooding, sea level rise, and infectious disease. Dr. Balbus showed a map of the gradient in heat vulnerability by county, noting that reliable heat vulnerability index data is not available in most parts of the state (a point further discussed later in this report). Next, he described 11 transformative initiatives for health adaptation to climate change, many of which, such as working safely in a changing climate, would prove also to be key recommendations of the working groups. Finally, he detailed the co-benefits of active transportation on climate change mitigation and related public health impacts. His presentation can be viewed at: *http://environmentalhealthcollaborative.org/images/John_Balbus.pdf*.
- Duke University's **Kim Lyerly, M.D.,** expanded on the state-specific themes of Dr. Balbus' talk using his own research on the relationships between climate change induced heat waves and changes in air quality and respiratory disease, primarily to illustrate the need for improved harmonization of environmental and human health. This call echoes recommendations from a previous EHC summit held in 2010 in which an Environmental Data Sharing workgroup recommended making "better use of environmental health data by creating links among environmental and

health databases maintained by various agencies and organizations throughout North Carolina, as well as to establish programs to link data sets that would build new connections among disparate agencies in North Carolina with roles in environmental protection and public health." Dr. Lyerly's presentation can be viewed at *http://environmentalhealthcollaborative.org/images/Kim_Lyerly.pdf*.

- **Tim Watkins, M.S.**, Deputy National Program Director at the US EPA's Office of Research and Development, added to the Climate Summit's fact base by describing research from both the IPCC and the NCA reports to underscore how global climatic changes will impact national and regional temperatures, precipitation, sea level rise, and extreme weather events. Like Dr. Balbus, Mr. Watkins spotlighted the key issues for the Southeast and North Carolina, emphasizing the health impacts of sea level rise, extreme weather events such as hurricanes and storms, decreased water availability, and an increase in the frequency, intensity, and duration of extreme heat events.

  Watkins then describes ways in which the United States can, and in some cases is currently responding to health impacts and climate change overall through a variety of mitigation and adaptation approaches. In addition to pointing at federal actions including more robust EPA air quality regulations to reduce carbon pollution and the mix of mitigation and adaptation measures called for in the President's Climate Action Plan, Watkins described the role of sustainability and systems thinking in addressing climate change in the United States. For example, by improving understanding of the relationship between policies for managing both air pollution and climate change, these individual, but interconnected environmental health impacts can be better addressed. This approach is a significant influence in determining future EPA research. Mr. Watkins's presentation can be viewed at *http://environmentalhealthcollaborative.org/images/Tim_Watkins.pdf*.
- **Caroline Dilworth, Ph.D.**, a health scientist administrator at the National Institute of Environmental Health Sciences who leads the institute's Climate Change and Human Health funding program, provided an overview of National Institutes of Health-supported research on climate change and human health. Much of this research, she said, concentrates on increasing understanding of differentials in vulnerability. By identifying specific characteristics of populations associated with vulnerability, this research seeks to help communities more effectively target and implement health interventions related to climate change. Accordingly, the National Institute of Health prioritizes research that explores the impacts of heat and air pollution on older adults, pregnant women and children, and other vulnerable populations when allocating climate change-related grant funding. One research project supported by the National Institute of Environmental Health Sciences, which is focused on space-time modeling for linking climate change, pollutant exposure, and built environment, is being led by researchers from Triangle area universities. Dr. Dilworth's presentation can be viewed at *http://environmentalhealthcollaborative.org/images/Caroline_Dilworth.pdf*.
- In the final plenary presentation, **Eric Lindland, Ph.D.**, senior researcher at the FrameWorks Institute, provided a social science perspective to complement the natural science approach of the other plenaries. Lindland discussed climate change frames as "…sets of choices about how information is presented through the selective use of particular values, symbols, metaphors, tone, messengers, and other elements of a message." Such frames, he said, seek to explain the disconnect between the swiftly accumulating mass of data supporting anthropogenic climate change and dominant patterns in American public thinking. Dr. Lindland recommended methods of communication that can reframe climate change as a public health issue: organizing communications in narrative form, making effective use of values and analogies, and building causal chains to describe climate change and its human health impacts, he said, can make climate science "sticky" in people's thinking, potentially generating more public buy-in for climate-related public health interventions. Dr. Lindland's presentation can be viewed at *http://environmentalhealthcollaborative.org/images/ERIC_LINDLAND.pdf*.

Overview

Climate Change

Earth's climate, which is comprised of many different meteorological components, including temperature, humidity, atmospheric pressure, wind, and precipitation, fluctuates due to a variety of natural and anthropogenic forces. Major variation in global climate predates human life on Earth. However, prior to the Industrial Revolution, this variation occurred naturally over very large time horizons, and was exclusively attributable to natural events such as changes in the sun that altered the amount of solar energy reaching Earth, catastrophic events such as massive volcanic eruptions and asteroid strikes, or natural changes in the concentration of heat-trapping greenhouse gases (GHGs).*

Recently, however, human activity has superseded these natural processes, accelerating climate change and exacerbating many of the public health threats that accompany it. GHGs from human activity such as the burning of fossil fuels (carbon dioxide) and industrial agriculture (methane) allow solar energy to enter the Earth's atmosphere, and then prevent it from leaving, resulting in planetary warming known as "the greenhouse effect." Other human activities such as deforestation, which limits the capacity of carbon-breathing trees to absorb excess GHGs, both exacerbate the greenhouse effect and alter the ways in which Earth's surface can reflect solar energy.

By changing global temperatures, these activities and other factors affect the other meteorological components of climate. Though it is probably impossible to unravel the entire chain of climatic causality, it is likely that, due to changing temperatures, every ecological process on Earth will be different in some way in the future. And, due in part both to the relatively fixed locations of our infrastructure, which impedes our ability to flee from these potentially major variations, and the anthropogenic, rapid nature of climate change, which prevents our bodies and ecosystems from gradually adapting to a new climate, these changes can have dire implications for human health around the globe. Summit participants were encouraged to consider the public health impacts of four distinct climatic drivers: 1) changes in frequency, magnitude, and track of extreme events (e.g. hurricane and tropical storms), 2) changes in sea level, 3) changes in precipitation variability (e.g. flood or drought), and 4) changes in temperature variability (particularly elevated temperatures).

* US Environmental Protection Agency, December 2013. Causes of Climate Change. Online.

Impact on Human Health

The IPCC's *Fourth Assessment Report*, published in 2007, offers insight into the connections between climate change and human health worldwide. Based on the overall reliability of the data sets and methods used to support conclusions, IPCC authors assign qualitative levels of confidence (ranging from "very low" to "very high") to conclusions and key findings. The global climate change-related health risks identified in this report as receiving "high" or "very high" confidence designations include:

- *Increase [in] malnutrition and consequent disorders, including those relating to child growth and development*
- *Increase [in] the number of people suffering death, disease and injury from heat waves, floods, storms, fires, and droughts*
- *Continu[ous] change [in] the range of some infections disease vectors.*
- *[...] mixed effects on malaria; in some places the geographical range will contract, elsewhere the geographical range will expand and the transmission season may be changed*
- *Increase [in] cardio-respiratory morbidity and mortality associated with ground-level ozone*†

† Confalonieri, 2007.

While some of the global impacts chronicled in the IPCC report may not constitute likely threats in North Carolina, the state's geographic, climatic, and demographic contexts leave its residents vulnerable to a number of climate change-related impacts. For example, according to the National Resources Defense Council's public health mapping tool, climate change impacts that explicitly threaten public health in North Carolina include: increased air pollution including smog, smoke, and pollen; more intense hot days and heat waves; increased rates of infectious diseases such as Dengue Fever, West Nile Virus, and Lyme Disease; and more severe droughts, flooding, and other extreme weather events.‡ These predictions may be more dire when considered in light of the (controversial) predictions of the state's Coastal Resources Commission Science Panel on Coastal Hazards, which advised the state to plan for 1 m (39 inches) of sea level rise by the year 2100.§ After a contentious battle in the state legislature, those predictions were effectively deemed illegal (temporarily)¶, but nonetheless, the specter of rising sea level underscores the likelihood of public health impacts of climate change, especially impacts from flooding and coastal storms.

‡ National Resources Defense Council. Climate Change Health Threats in North Carolina. Online (December 2013)

§ Rogers, Spencer. "Putting N.C. Sea-Level Rise in Human Terms." North Carolina Sea Grant, Online. (June 2012)

¶ Frank, John. "New law bans policies on sea-level change for 4 years." Raleigh News and Observer, 3 July 2012.

Summit Findings and Recommendations

Crosscutting Issues

Though the Climate Summit's three working groups concentrated on the most pressing public health impacts in their distinct geographic and demographic context, the groups independently identified several health impacts, knowledge gaps, and corresponding recommendations that apply equally statewide. These issues were found to transcend the boundaries between rural, urban, and coastal North Carolina and are presented below.

Heat-related Illness

Each Working Group identified heat-related illness as a primary climate change-related public health threat, and each group acknowledged that vulnerability to heat stress is not evenly distributed within each context. Research to understand the different heat thresholds for vulnerable populations in different regions of North Carolina can cut across the state's geographic and demographic boundaries. Preliminary recommendations for data sets that might be integrated to assess heat vulnerability include weather data from the National Weather Service, employment data from the Bureau of Labor Statistics, and data from the Social Vulnerability Indices.

However, given the significant distinctions in exposure to heat throughout the state, it is critical to describe vulnerability using context-specific methodologies. For example, the rural working group recommended exploring the potential usefulness of a measure of heat vulnerability that aggregates data from unconventional sources such as agricultural weather data reported by the USDA.**

Mental Health Vulnerability

The working groups expect the various consequences of climate change to impact mental health in all types of communities throughout the state. In addition to the stress of new or exacerbated climate change-related public health threats, North Carolinians in rural, urban, and coastal contexts will likely have to contend with mental health threats arising from climate change impacts on society. Financial uncertainty, grief from the loss of familiar ways of life, and malaise over potentially irreversible anthropogenic environmental degradation can have significant and systemic impacts on mental health throughout the state. Anticipating, articulating,

** Other examples of potentially useful USDA datasets include the Heat Stress Forecasts (*http://www.ars.usda.gov/Main/docs.htm?docid=21306*) and Drought Monitor (*http://droughtmonitor.unl.edu/*).

and mapping the mental health vulnerability of North Carolinians in all three contexts may help to better mobilize mental health care providers to provide treatment to those most vulnerable to these stressors.

Water Quality and Availability

All of the working groups anticipate that reliable access to safe drinking water will be a critical concern amidst changing climates statewide. Not only does the expected increase in drought figure to seasonally reduce the amount of available water and increase competition for water with other users such as agriculture and industry, but drought followed by heavy rains can degrade water quality through the deposition of contaminants into surface waters. These impacts to water quality and availability in the state's watersheds transcend rural, urban, and coastal boundaries because runoff into waterways from rural, suburban, and urban landscapes ultimately drain to coastal areas.

Polluted waterways and contaminated drinking water expose North Carolinians to a host of health effects from gastrointestinal to reproductive problems. Therefore, the working groups recommended research and policies at the watershed level that focus on water quality and availability in all parts of the state. Watershed management that acknowledges the interconnected, regional nature of water issues, came up repeatedly in the working group discussions as a central topic regarding water security.

Training and Outreach

The working groups agreed that increased capacity among government officials, health care providers, and the general public to engage on all aspects of climate change will better enable North Carolina to respond to climate change-related public health impacts. Increasing such capacity will entail education campaigns to both the public and relevant state, county, and local governmental agencies on a range of North Carolina-specific climate change issues, including public health impacts.[††] Additionally, the working groups recommended enhanced technical training of health professionals throughout the state on health-related climate change impacts. Specifically, the establishment of university degree programs in coastal planning and public health, as well as interdisciplinary programs in climate and health issues, were considered measures that would help increase North Carolina's technical capacity to respond to climate change-related public health impacts.

Increased Vector Borne Diseases

In all contexts statewide, rising temperatures are expected to lead to an increase in many disease-bearing vectors, in particular arthropods like mosquitoes and ticks. Changes in temperature, rainfall, humidity, wind, and even duration of daylight are expected to increase the lifespan, breeding rates, and geographic ranges of many disease vectors and of the pathogens they carry[‡‡]. Disease of particular concern for North Carolina are Rocky Mountain Spotted Fever and La Crosse encephalitis, both of which could become more common under various projected climate scenarios. The working groups recommended reestablishing vector population monitoring programs for Rocky Mountain Spotted Fever and La Crosse encephalitis, and creating a workshop devoted to vectorborne diseases to address this public health impact.

Planning for Response to Extreme Weather Events

While Climate Summit participants acknowledged the immense value of pre-event land-use planning on mitigating the impacts of extreme weather events, the working groups particularly emphasized the role of pre-event planning to increase emergency response capacity. By coordinating response protocols, thoroughly training and equipping personnel, and working towards a more resilient built environment before potentially disastrous weather events such as hurricanes, floods, and extreme heat occur, communities throughout North Carolina can lessen the public health impacts of these events.

†† See Woodruff, S.C. et al. (2013). Adapting to Climate Change: A handbook for local governments in North Carolina. Chapel Hill, NC: Coastal Hazards Center at the University of North Carolina at Chapel Hill. Available online at: *http://coastalhazardscenter.org/adapt.*

‡‡ Gohlke, 2013.

Inequity in Vulnerability and Exposure to Climate-Related Public Health Impacts

All of the working groups anticipated that disparities in public health, particularly among low-income, aging, children, immigrant, and indigenous populations, will persist and likely be exacerbated by a changing climate. While specific climate change-related public health impacts may vary among North Carolina's coastal, rural, and urban contexts, participants determined that vulnerability and exposure to these impacts will be higher among the communities that are least able to prepare for and adapt to climate change due to relative lack of individual and community resources.

Rural Working Group

In many cases, the impacts of climate change on public health in urban communities are better understood than they are in rural communities nationwide. Despite North Carolina's large rural population and legacy of a strong social support network in rural areas, much of our understanding of climate change's impact on rural public health is extrapolated from larger datasets in urban communities.[§§] A more detailed understanding of the unique risks that rural communities face is critical to addressing the public health impacts in this demographic context. The master table of the Rural Working Group's recommendations can be seen in Appendix I.

Heat-related Illness

While heat-related illness as a result of climate change is by no means unique to rural communities, many features of rural life in North Carolina may place rural residents at high levels of risk from this health threat. For example, the predominantly agricultural nature of the rural economy, and the amount of labor it requires—much of it outdoors—means that the rural labor force may be particularly at risk from rising temperatures. Additionally, the large distances between rural communities and adaptation interventions such as cooling centers hinder rural communities from responding to extreme heat. Summit participants emphasized the environmental justice implications of this impact; in the rural context, many of those likely to be disproportionately exposed and vulnerable to heat-related illnesses will be already-disadvantaged groups like poorer farmers and seasonal immigrant workers. Understanding how these and other factors affect rural communities, and how those effects are borne in different rural communities throughout the state will provide a better sense of how to address rural heat-related illness.

Heat Thresholds

A major gap exists in understanding the differences in heat thresholds for different rural populations and regions, due largely to nuances of state rural geography. Because rural communities can be found in the mountains of the western part of the state, the broad coastal plain of the eastern part, and the foothills in between, these communities have different heat-stress thresholds, so generalizations about rural public health impacts are difficult.

Recommendation:

- Aggregating data from sources such as NCDETECT, the National Weather Service (NWS), census and Bureau of Labor Statistics (BLS), Social Vulnerability Indices (SoVI) with agricultural crop type data, can help health officials and communities more accurately map geographic areas and populations that are potentially vulnerable to heat-related illness and develop appropriate public health interventions and responses.

Distribution of Heat-related Chronic Diseases/Conditions

The unequal distribution of preexisting, underlying, and chronic health conditions in populations in rural areas that may increase susceptibility to heat-related illness is not yet well understood. Just as a more nuanced picture of specific areas and populations that are at the most risk of heat-related illness will

§§ (Julia Gohlke's presentation)

allow more specific and effective interventions, so too will a clearer understanding of the degree of susceptibility created by preexisting conditions such as diabetes, obesity, pregnancy complications, renal, cardiovascular, and pulmonary issues.

Recommendations:

- Improve disease surveillance data for rural areas, including for outdoor workers.
- Improve heat-related illness forecasting models that incorporate both disease and climate surveillance data.
- Partner with state Area Health Education Centers, the North Carolina Cooperative Extension, public health workers, faith-based groups, and environmental justice and farmworker non-governmental agencies such as the North Carolina Farmworker Advocacy Network to conduct community health surveys on heat-related illnesses.
- Improve the outreach and educational capacity of Area Health Education Centers, public health department, and other medical professionals in the rural context on the monitoring of heat-related illnesses.
- Analyze statewide Agricultural Health Study data in relation to questions about heat related illness, and then incorporate these research questions into the next round of data collection.

Gastrointestinal Illness

Increased gastrointestinal illness as a result of climate change impacts on water quality threatens communities in all parts of North Carolina. However, there are several factors that are specific to the rural context that may make these populations uniquely vulnerable to this public health threat, two of which were prioritized by the rural working group. First, according to the EPA, non-point source pollution from agriculture is a major contributor to reduced water quality in surface and groundwater.¶¶. Second, the reliance on privately owned wells for drinking water in rural areas results in less testing and maintenance of rural water quality than in more urban communities.

Another factor in the rural risk of gastrointestinal illness is "flushing events:" flooding from increased precipitation following substantial drought. As climate change alters temperature and weather patterns, major flushing events are expected to become increasingly common. For rural communities, in particular those located near or downstream from industrial livestock farms, flushing events could have dire implications for water quality and potentially gastrointestinal health.

Recommendations:

- Collect pharmacy data on over the counter anti-emetics and antidiarrheals, and on emergency department visits related to gastrointestinal illness to look for trends in connection with storm events.
- Improve water quality monitoring for bacteria after climate events
- Create a sanitary survey with a focus on gastrointestinal illness events to administer to people who have recently been in recreational water bodies

Watershed Management

Gastrointestinal pathogens within the rural context do not just potentially threaten the communities in which they are produced; rather, the impacts potentially can also be felt downstream, requiring a watershed management-based approach to minimize the spread of such illness.

Recommendations:

- Research how upstream watershed management impacts downstream rural communities from both water supply and water quality perspectives.
- Expand policies for riparian buffer zones in some areas.
- Adopt policies to restrict livestock access to streams, and encourage use of alternative water supplies.

¶¶ *www.epa.gov/owow/nps/Ag_Runoff_Fact_Sheet.pdf*

Clean Water Access and Security

Without access to urban water infrastructure, many rural communities rely on private wells for drinking water and agricultural use. In most cases, these water sources are not subject to federal or state health regulation or management, constituting a major gap in understanding of waterborne pathogens and a potential threat to rural public health in North Carolina.

Recommendations:

- Institute policies to improve access and funding for water testing in private wells. This initiative can piggyback on current programs that promote well testing related to hydrologic fracturing ("fracking").
- Assess the long-term capacity of aquifers under various water use and climate scenarios.
- Investigate the impacts of expanding water infrastructure in rural communities.
- Develop programs to improve water conservation and supply among rural residents and industries such as agriculture.

Mental Health Effects and Stress

Significant changes in climate and weather will likely be accompanied by significant changes in lifestyle, in particular among agriculture-dependent rural communities where generations-old ways of life are threatened by unpredictable climate conditions. Mental health stressors that may accompany climate change, including anxiety and grief over mounting disasters, financial uncertainty, and the psychological aspects of other health threats,*** were identified as being of particular importance for North Carolina's rural communities. The working group also identified the dynamic nature of mental health vulnerabilities over time as a critical gap in knowledge surrounding this issue.

Recommendations:

- Map mental health services and vulnerable populations in rural areas.
- Track the relationship of reported mental illness and stress with climate-mediated events such as loss of natural environment, drought, and extreme weather events.
- Educate mental health treatment providers on the known impacts of climate change.
- Train Area Health Education Center and Cooperative Extension agents to recognize signs of mental stress among farmers or rural residents and to provide referral information to mental health care providers.

*** Psychologists for Social Responsibility. "Climate Change and Mental Health." Online (November 2013).

Urban Working Group

Weather-related disaster events like Hurricane Katrina and Typhoon Haiyan serve as grim indicators of the public health impacts that climate change and extreme weather can have in the urban context. Not only are residents vulnerable to drowning and other trauma from the initial force of the storm on the built environment, but residual impact from ancillary effects like power or other infrastructural loss can linger for months and even years, placing urban communities at an even greater risk from disaster events.

In North Carolina, urban communities have been and are expected to continue growing at some of the fastest rates in the nation.††† As the exposure of people and infrastructure to the public health impacts of climate change in urban areas grows, so too does the importance of city and regional planning approaches to mitigating such impacts. As the urban working group's recommendations indicate, health interventions that emanate from disciplines such as land use and transportation planning can be instrumental in addressing the public health threats that climate change poses to urban communities. The master table of the Urban Working Group's recommendations can be seen in Appendix II.

††† Kotkin, Joel. "America's Fastest Growing Cities Since the Recession." Forbes Magazine (online version; June 2013).

Post-Disaster Recovery and Risk Reduction

The urban working group identified gaps in the post-disaster recovery process as major hurdles to making urban communities more resilient to climate change public health threats. Following disaster events from extreme weather, communities—both urban and more rural—often seek to salvage from the devastation the pre-disaster status quo to return their community to the built form with which people were familiar. Recognizing the difficult balancing act between speed and deliberation in reconstructing following a disaster event, the Urban Working Group recommends that communities focus on recovery efforts that reduce future risk from similar disaster events.

Recommendations:

- Pursue a risk-based disaster policy agenda that disincentivizes rebuilding the pre-disaster community in a manner that maintains vulnerability to major storm events.
- Link state and county post-disaster funding to demonstrable risk reduction activities.
- Incorporate the uncertain impacts of climate change and post-disaster risk reduction into hazard mitigation plans.
- Explore the role of public-private partnerships, such as between city governments and the insurance industry, on pre-disaster planning activities.
- Match emergency response resources to climate risk.

Asthma

In addition to the disproportionately urban impacts on air quality from sources like automobile use and industrial processing, climate change is expected to further negatively impact air quality. While the impact of changing weather conditions on particulate matter is not yet entirely clear, ozone levels are expected to increase throughout the United States, in particular in its urban areas.[‡‡‡] Furthermore, deteriorating air quality as a result of climate change is expected to have significant environmental justice impacts by disproportionately affecting the poor and children[§§§], two predominant groups in urban areas whose current vulnerability to air pollution and asthma has been well documented. While many present vulnerabilities to air pollution and asthma are understood, gaps still exist concerning the policy solutions to these public health issues. It is critical to craft policy at all levels of government that connect mitigation and adaptation to climate change with air pollution's effects on health.

Recommendations:

- Better articulate impacts of climate change and air quality on children's health.
- Work towards policies—at the state, national, and international levels—to reduce greenhouse gas emissions by seeking the co-benefits of simultaneously mitigating climate change and air pollution.
- Take proactive steps to reduce ozone precursors to safe levels.
- Explore construction methods that increase building energy efficiency without adversely impacting indoor air quality.
- Factor pollen production into urban forestry and other city planning-related programs, such as landscaping regulations and reforestation programs.

‡‡‡ West, Jason.

§§§ Blotnick, June.

Coastal North Carolina features both rural and urban geography, and the findings of the working groups dedicated to discussing those contexts apply to rural coastal communities like Hyde and Tyrrell Counties, as well as urban coastal cities like Wilmington and Jacksonville. Determining policy solutions that will enhance coordination between coastal planning and public health is a gap that spans disparate coastal communities The coastal working group recommends funding for expanded multidisciplinary coastal research, establishment of joint degree programs in coastal planning and public health, and creating a working group to foster policy dialogue across disciplines to help address climate change-related public health threats along the coast by uniting these disciplines.

Heat-related Illness

Those employed in labor-intensive, predominantly outdoor industries such as agriculture and construction are particularly vulnerable to heat stress from rising temperatures. This issue is equally concerning in the rural parts of Coastal North Carolina, but it is affected by several distinctive factors of the coastal context. First is a uniquely vulnerable labor sector—the fishing industry, which supports 8,850 jobs throughout the coast. Second, the combination of extreme weather events and sea level rise disproportionately threatens coastal medical infrastructure, potentially limiting the ability of coastal communities to respond to climate change impacts. Third, the Sandhills areas, which is part of the coastal plain, has higher rates of heat-related emergency department visits than other regions of the state, indicating that this area is particularly vulnerable to extreme heat.¶¶¶

¶¶¶ Lippmann 2013 Environmental Research, Ambient temperature and emergency department visits for heat-related illness in North Carolina, 2007-2008.

Vulnerable Populations and Facilities

Addressing heat vulnerability and the compounding effects of vulnerable coastal medical infrastructure requires a deeper understanding of who and where these populations are, and the extent to which the hospitals, clinics, and other health care facilities they use are vulnerable to sea level rise and increased extreme weather events. Participants viewed these questions as critical knowledge gaps.

Recommendations:

- Inventory available information on vulnerable coastal populations, and determine the needs of these individual groups.
- Create tools for identifying medical facilities and their locations that are vulnerable to sea level rise, flooding, and storms, and then deploy these tools to assess individual facilities throughout the coast.
- Incorporate coastal hazards preparedness into hospital preparedness programs.

Injuries and Illness from Coastal Extreme Weather Events

As was discussed in the Urban Working Group, the destructive impact of major storm events along the coast presents several types of severe public health threats. In addition to trauma from high winds, storm surge, and storm debris, potential health threats from such issues as food spoilage from power loss, increased vector borne illness from increases in mosquitoes due to standing water, and water contamination from industrial discharges and land runoff constitute perhaps the largest set of climate-related public health threats in the coastal context. While these concerns exist throughout North Carolina, the coast is particularly vulnerable, where lasting topographical and geographical alterations such as lost of coastal wetlands and barrier islands may strip communities of some of their natural defenses and limit the ability of coastal ecologic systems to mitigate the impact of future storms.

Hazard Preparedness, Mitigation, and Recovery Planning

Facilitating development planning that recognizes the potentially devastating nature of coastal storms, both before and after storms occur, can help offset the loss of natural mitigation features like coastal wetlands and barrier islands. More robust planning efforts that anticipate climate change's effect on sea level rise will be critical for addressing the climate-related public health concerns associated with storm events.

Recommendations:

- Require the incorporation of climate change into disaster mitigation plans.
- Facilitate planning to address climate change and sea level rise by providing technical guidance on the benefits of planning for these conditions.
- Create incentives that encourage local government Coastal Area Management Act (CAMA) plans to address climate change and sea level rise.

References

1. *Allen, Simon K., G-K. Planter, M. Tignor, J. Boschung, A. Nauels, Y. Xia, V. Bex, P. Midgle: Climate Change 2013: Impacts, Adaptation, and Vulnerability. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, T. Stocker, D. Qin, Eds.*
2. *Blotnick, June. "Public Health and Climate Change: Focusing North Carolina Forward." Presentation to the Research Triangle Environmental Health Collaborative Summit. 29 October, 2013.*
3. *Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich, and A. Woodward. "Climate Change 2007. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431. http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter8.pdf*
4. *Frank, John. "New law bans policies on sea-level change for 4 years." News and Observer, 3 July 2012. http://www.newsobserver.com/2012/07/03/2177975/new-law-bans-policies-on-sea-level.html*
5. *Gohlke, Julia. "Preterm birth and mortality during heat waves in urban and rural communities in Alabama." Presentation to the Research Triangle Environmental Health Collaborative Summit. 30 October, 2013.*
6. *Intergovernmental Panel on Climate Change. "Climate Change 2013: The Physical Science Basis." 27 September 2013. http://www.climatechange2013.org/images/uploads/WGI_AR5_SPM_brochure.pdf*
7. *Kotkin, Joel. "America's Fastest Growing Cities Since the Recession." Forbes Magazine. Online. June 2013. http://www.forbes.com/sites/joelkotkin/2013/06/18/americas-fastest-growing-cities-since-the-recession/*
8. *Lippmann, Steven. "Ambient temperature and emergency department visits for heat-related illness in North Carolina, 2007-2008" Environmental Research. 30 May, 2013.*
9. *National Oceanic and Atmospheric Administration. "Fisheries Economics of the United States: Economics and Sociocultural Status and Trends Series." Online. December 2012. http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2011/FEUS%202011-Revised.pdf*
10. *Natural Resources Defense Council. "Climate Change Threats in North Carolina." Online. http://www.nrdc.org/health/climate/nc.asp*
11. *Psychologists for Social Responsibility. "Climate Change and Mental Health." Online. November 2013. http://www.psysr.org/about/programs/climate/mentalhealth.php*
12. *Rogers, Spencer. "Putting N.C. Sea-Level Rise in Human Terms." Online. 1 June, 2012. http://www.ncseagrant.org/home/about-ncsg/news-events?id=1182&task=showarticle*
13. *United States Environmental Protection Agency. "Causes of Climate Change." Online. http://www.epa.gov/climatechange/science/causes.html. 2013.*
14. *US Environmental Protection Agency. "Protecting Water Quality from Agricultural Runoff" fact sheet. Revised March 2005. www.epa.gov/owow/nps/Ag_Runoff_Fact_Sheet.pdf*
15. *West, Jason. "Climate Change and Health in NC Urban Areas." Presentation to the Research Triangle Environmental Health Collaborative Summit. 29 October, 2013.*

Appendix I: Rural Working Group

Recommendations for Prioritized Gaps

Table 1-1

Health Impact: Heat-Related Illness	
Associated Climate Change Driver: ***Temperature Variability***	**GAP:** What are different heat-stress thresholds for different rural populations and regions? Understanding of heat vulnerability in 6 NWS areas.
	RECOMMENDATIONS: • Aggregate NCDETECT, National Weather Service, census/GIS, BLS, and SoVI, and Ag crop type data to map vulnerability areas and populations. These data capture age, sex, occupation, economic, race, ER records, geographic area, climate data (heat and humidity), crop type, etc. [1-3 years] • Develop, design, and provide affordable, lightweight protective clothing for outdoor workers in heat-stress vulnerable areas. [3-6 years]
	GAP: Understanding of distribution of chronic diseases/conditions in rural populations that may be affected by heat (diabetes, obesity, renal, cardiovascular, mental health, pregnancy).
	RECOMMENDATIONS: • Improve disease surveillance data for rural areas (incl. outdoor workers, real-time data). [>6 years] • Improve heat-related illness forecasting models that incorporate disease and climate surveillance data. [3-6 years] • Improve communications/education of AHEC, public health dept, and other medical professionals on monitoring of heat-related/affected illnesses. [1-3 years] • Partner AHEC, Extension, public health workers, and farmworker/EJ NGOs, faith-based groups to conduct community health surveys on heat-related illnesses. [1-3 years] • Analyze Agricultural Health Study data for NC in relation to questions about heat-related illness; incorporate these research questions in next round of data collection. [1->6 years]

Appendix I: Rural Working Group

Table 1-2

Health Impact: Gastro-intestinal illness	
Associated Climate Change Driver: ***Ag runoff due to precipitation***	**GAP:** What effects do "flushing events" (flooding post drought) have on rates/risk of increased illness (esp. near industrial livestock farms). Evidence of GI-related illness in rural areas due to climate driver events.
	RECOMMENDATIONS: • Collect pharmacy data on OTC anti-emetics and anti-diarrheals and antibiotics, and ER visits related to GI illness to look for trends in connection with storm events; overlay this data with land use mapping and specific climatic event data. [3-6 years] • Improved water quality monitoring for bacteria post-climate events. [3-6 years] • Sanitary survey tool of people post-recreational water body use for GI illness events. [1-3 years]
	GAP: Rural v. urban clean water security/access.
	RECOMMENDATIONS: • Policies to improve access/funding for water testing of private wells (piggyback on current program promoting testing re. fracking). [1-3 years] • Assessing long-term capacity of aquifers under climate scenarios. [>6 years] • Investigate impacts of expanding water infrastructure on rural communities. [1-3 years] • Program to improve water efficiency/supply among residents and industries. [1-3 years]
	GAP: Watershed management for nutrient and bacterial runoff; livestock access to streams.
	RECOMMENDATIONS: • Research on how upstream watershed mgmt impacts downstream rural communities (supply and quality). [1-3 years] • Expansion of policies for riparian buffer zones. [1-3 years] • Adopt policies to restrict livestock access to streams, encourage alternative water supplies (cost-share programs). [1-3 years]

Appendix I: Rural Working Group

Table 1-3

Health Impact: Mental Health / Stress	
Associated Climate Change Driver: ***All 4 Drivers***	**GAP:** Understanding mental health vulnerabilities of rural populations over time, related to climate change.
	RECOMMENDATIONS: • Mapping of mental health services and vulnerable populations in rural areas. [1-3 years] • Track relationship of reported mental illness and stress with climate events such as drought, extreme events, loss of natural environment. [3-6 years] • Educate mental health treatment providers on climate change impacts. [1-3 years] • Training Area Health Education Centers and Extension agents to recognize signs of mental stress among farmers or rural residents to provide referral information. [1-3 years]

Appendix II: Urban Working Group

Recommendations for Prioritized Gaps

Table 2-1

Associated Climate Change Driver:	
Extreme Weather Events	**Health Impact: Disasters**
	GAP: Post-disaster focus on reducing risk rather than return to status quo (policy gap); Specific urban features include rivers, storm surges, land slides.
	RECOMMENDATIONS: • **Pursue a risk-based post-disaster policy agenda (i.e., do not re-build in a flood plain). [Near-term]** • Tie post-disaster funding to demonstrable risk reduction. • Build climate change and post-disaster risk reduction into hazard mitigation plans. • Public-private partnerships on pre-disaster planning (e.g., engage insurance industry). • Match emergency response resources to climate risk (research to determine location-specific risk).
	GAP: Communicating the "new normal" to the public.
	RECOMMENDATIONS: • **Use established messaging techniques to frame new climate realities to the public and decision-makers. Emphasis empowering solutions, focus on co-benefits. [Near-term]**
	Health Impact: Asthma
	GAP: Policies for climate and air pollution mitigation (i.e., reduction of GHGs, black carbon), connecting climate change with health of children.
	RECOMMENDATIONS: • **Better articulate impacts of CC and AQ on children's health. Currently asthma is the leading cause of school absenteeism. This will go up. [Near-term]** • Need stronger policy at global, state and national level to reduce all GHG emissions. Policies should seek co-benefits of mitigating climate change and air pollution together. • Knowing that temp will continue to rise, need to take proactive steps to reduce ozone precursors at levels that will be safe. • How to increase energy efficiency of building without adversely impacting indoor air quality. • Take pollen production of plants/trees and climate resilience into consideration in city planning, urban forestry programs.

Appendix II: Urban Working Group

Table 2-2

Associated Climate Change Driver:	
Extreme Weather Events	**Health Impact: Water security (quality and quantity)**
	GAP: Linking development and climate change to water security in specific water sheds (policy).
	RECOMMENDATIONS: • **Develop methods/tools to take regional projections of precipitation and temperature to local watershed level (and potentially jurisdiction level). [Near-term]** • Local planning staff (local land use planners) participate in hazard mitigation plans. • Require growth managers to take water supply into account. • Require urban forestry and green infrastructure to increase climate resilience (e.g., storm water management, groundwater recharge). • Proactively revise water quality testing to reflect new climate characteristics and risk (e.g., biological testing for GI infection in hot season).
	Health Impact: Heat stress and chronic diseases exacerbated by heat
	GAP: Development of reporting/management system.
	RECOMMENDATIONS: • **Immediate reporting for heat-related cases (ICD9 coded heat-related cases on a daily basis). [Near-term]** • Identify a local list of chronic diseases. • Communicate list to local clinicians and patients. • Training of supervisors of organized outdoor activities to avoid risks. • Development of cooling centers (Churches, schools, libraries).

Appendix III: Coastal Working Group

Recommendations for Prioritized Gaps

Table 3-1

Health Impact: Multiple	
Associated Climate Change Driver: ***Hurricanes/ SLR/ppt***	**GAP:** Policy gap - Climate change considerations needed in hazard mitigation/ preparedness/recovery plans.
	RECOMMENDATIONS: • Require the incorporation of climate change into disaster mitigation plans. National Disaster Recovery Strategy. [short term] • Facilitate planning to address CC and SLR; provide technical guidance on CC and SLR planning benefits. [short term] • Create incentives to encourage local government CAMA plans to address CC and SLR. [short term]
	GAP: Policy gap – Closer linkage needed between coastal planning and public health community (research and practices)
	RECOMMENDATIONS: • Create a working group to foster policy dialogue across disciplines. [short term] • Support decision framework that links coastal planning and public health. VCAPs. [short term] • Expand multidisciplinary research funding in coastal planning and public health. [short to long term] • Establish university degree courses and encourage training programs in coastal planning, public health, and climate change. [short to long term] • Conduct pilot health impact assessments on land use decisions in coastal hazard areas. [short term]
Health Impact: Heat Stress/Multiple – Access and Delivery of Health Care	
Associated Climate Change Driver: ***Temp/ ppt/ SLR/ Hurricanes***	**GAP:** Research gap - Need to identify vulnerable populations (medically vulnerable) that need access to medical facilities and vulnerable facilities (resulting from SLR and coastal flooding) [1]
	RECOMMENDATIONS: • Inventory available information on vulnerable populations and determine their needs. [short term] • Create tools for identifying vulnerable populations/facilities. [mid term] • Conduct vulnerability assessment of and identify vulnerable facilities with respect to SLR, flooding, and storms. [short term] • Incorporate coastal hazards and preparedness into hospital preparedness program. [mid term]

Appendix III: Coastal Working Group

Table 3-2

Health Impact: Vector-Borne Diseases – Tick and Mosquito	
Associated Climate Change Driver: ***Temp/ppt***	**GAP:** Research gap – Need a better understanding of local drivers and variables to NC specific vector-borne illnesses – Rocky Mountain Spotted Fever and Lacrosse encephalitis.
	RECOMMENDATIONS: • Reestablish state vector population monitoring program. [short term] • Expand research funding for understanding drivers of Rocky mountain spotted fever and Lacrosse encephalitis. [short to long term] • Create a workshop to address vector-borne diseases in NC. [short term]
Health Impact: Mental Health	
Associated Climate Change Driver: ***ppt/ SLR/ Hurricanes***	**GAP:** Research gap - Implication of loss of wetlands / barrier islands and economic way of life.
	RECOMMENDATIONS: • Need to have access to existing data (NC Flood insurance rate maps) for coastal planning and policy making as well as SLR data. [short term] • Querying health data systems for NC mental health impacts of severe coastal hazards. [short term] • Exploring existing data (Katrina, Gulf, Sandy) on psychological impacts. [short term] • Incorporate lesson learned into training for mental health professional and emergency responders. [medium term]

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