Climate Change and Public Health Through the Lens of Eastern NC

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November 2, 2018
Fall Forum
Duke University
Climate change is the biggest global health threat of the 21st Century. Climate change will have its greatest impact on those who are already the poorest in the world: it will deepen inequities and the effects of global warming will shape the future of health among all peoples.
Everybody talks about the weather. But climate? Only in some places.

Counties where adults discuss global warming at least occasionally

Purpose:
Report the human health effects associated with climate change while providing an estimate of the percent of climate sensitive population groups in Eastern NC (ENC)

http://www.ncmedicaljournal.com/
Background

World Energy Consumption for Each Fuel

- Oil
- Coal
- Natural Gas
- Nuclear
- Hydro
- Other Renew
Atmospheric CO₂

Latest CO₂ reading
October 15, 2018

405.93 ppm

Carbon dioxide concentration at Mauna Loa Observatory

Full Record ending October 15, 2018

CO₂ Concentration (ppm)
How does GHGs Heat the Earth?

https://climate.nasa.gov/causes/
Global temperature trend (1900-2014)

Source: Meehl et al. 2009
One degree increase... so what?

Climatic shifts

https://climate.nasa.gov/effects/
Current Signs of Extreme Weather and Impacts

Flooding: Miami Beach

California wildfires

Chicago heatwave, 1995

Texas - Harvey
The Places in the U.S. Where Disaster Strikes Again and Again

Losses from natural disasters 2002-2017 (NY Times 5/18)

Billion-dollar weather and climate disasters frequency mapping: 1980-2017*

Droughts and Heat Waves
1980-2017* Billion-Dollar Drought Disasters By State (CPI-Adjusted)

Winter Storms
1980-2017* Billion-Dollar Winter Storm Disasters By State (CPI-Adjusted)

Tropical Cyclones
1980-2017* Billion-Dollar Tropical Cyclone Disasters By State (CPI-Adjusted)

Flooding
1980-2017* Billion-Dollar Flooding Disasters By State (CPI-Adjusted)

Wildfires
1980-2017* Billion-Dollar Wildfire Disasters By State (CPI-Adjusted)

Severe Local Storms
1980-2017* Billion-Dollar Severe Storm Disasters By State (CPI-Adjusted)

* 219 weather and climate disasters reached or exceeded $1 billion during this period (CPI-adjusted); cost > $1.5 trillion in damages

Please note that the map reflects a summation of billion-dollar events for each state affected (i.e., it does not mean that each state shown suffered at least $1 billion in losses for each event).
Examples of Impacts of Climate Change on Society

- Energy – increase demands
- Agriculture & Food Security – availability, crop failures, shifts in planting harvesting
- Water Resources – impact on quality
- Ecosystems – Wetland loss, shifting migration of fish, birds
- Flooding – infrastructure, property values
- Human Health

https://www.globalchange.gov/climate-change/impacts-society
Human Health Impacts of Climate Change

Climate change

Direct effects
- Storms
- Drought
- Flood
- Heatwave

Indirect effects
- Water quality
- Air pollution
- Land use change
- Ecological change

Social dynamics
- Age and gender
- Health status
- Socioeconomic status
- Social capital
- Public health infrastructure
- Mobility and conflict status

Health impact
- Mental illness
- Malnutrition
- Allergies
- Cardiovascular diseases
- Infectious diseases
- Injuries
- Respiratory diseases
- Poisoning
Direct health effects: Heat

Health Effects:
- Heat Rash
- Heat Cramps
- Heat Exhaustion
- Heat Stroke

European Heatwave 2003

Russian Heatwave 2010

Robine, Jean-Marie; Cheung, Siu Lan K.; Le Roy, Sophie; Van Oyen, Herman; Griffiths, Clare; Michel, Jean-Pierre; Herrmann, François Richard (2008). "Solongo". Comptes Rendus Biologies


Direct health effects: Extreme Weather Events

- Physical injuries (including drowning)
- Food security
- Displacement
- Mental health issues

Fits a pattern expected with a warming planet.

Extreme weather becoming more frequent, intense and severe
Indirect Health Effects: Air Quality

- Air Pollution = Increase ground level ozone, PM pollution
- Warmer weather + higher temperatures means longer summer days and more exposure
- Increased CO2 can elevate production of plant allergens such as pollen
- Pollen season starting earlier, lasting longer and more severe - Changes in Ragweed Pollen Season

Health Effects
- Respiratory health - asthma, COPD, allergies other respiratory concerns
- Chronic and acute cardiovascular problems (inflammatory effect on heart)
Indirect Health Effects: Changes in Vector Ecology

- Warmer temperatures, increased rainfall, longer warm season and less severe winters can impact the range and incidence of vector-borne disease.

Health Effects

- Tickborne diseases: Lyme Disease (fever, headache, fatigue, skin rash)
- Mosquito borne diseases: Chikungunya virus, West Nile virus, Malaria, Dengue

Maps show the reported cases of Lyme disease in 2001 and 2014 for the areas of the country where Lyme disease is most common (the Northeast and Upper Midwest). Both the distribution and the numbers of cases have increased. (Figure source: adapted from CDC 2015)

Data source: CDC, 2015
Indirect Health Effects: Water Quality

Heavy rains, runoff, downpours, flooding, warmer waters

Increases Water-borne contaminants - pathogens; wells, aquifers, recreational water, harmful algal blooms, shellfish harvesting areas, etc.,

Health Effects

GI Illness, Liver, Kidney Damage
CO2 emissions per capita

High emissions
Low emissions

Those who contribute the least greenhouse gases will be most impacted by climate change
US - Populations of Concern


- Poor
- Communities of color
- Children and Pregnant women
- Older adults
- Outdoor workers and military
- Disabled
- Persons with pre-existing medical conditions

What does this mean for the Southeastern U.S.?

- Difficult to predict and impacts will not be homogenous across regions, sectors, pop. groups or time
- SE climate influenced by latitude, topography, proximity to Atlantic and Gulf of Mexico.
- US National Climate Assessment Report regional variations and models for SE U.S. predict:
  - Increased Sea Level Rise, more frequent and intense storms leading to flooding = impacts to coastal wetlands, threats to fresh water aquifers, infrastructure (Fig. 1)
  - Hotter temperatures will lead to more HRI, Respiratory and other health concerns (Fig. 2)
  - Increased health burden to existing healthcare delivery system
  - Additional pressure on environment will create higher costs for food and energy
  - Vulnerable populations, those with the fewest resources are at high risk

Fig. 1

Direct hurricane hits (1851-2017)

http://apa-nc.org/climate-change-what-to-expect
What does this mean through the lens of Rural, Eastern N.C.?

**RURAL**: Region has low lying topography; vastly rural, limited healthcare providers.

**POVERTY**: Highly impoverished with considerable number of communities of color & outdoor workers.

**HEALTH**: Highest mortality and prevalence rates of disabilities and incidence of major chronic health conditions and diseases in NC.
ENC Topography & Ecology Factors

Figure 4. Wetlands

Wetlands
- Deepwater habitats
- Deepwater rivers
- Areas predominately wetland
- Rivers or streams predominately wetland

ENC Coastal Ghost Forests

Photo by Lindsey Smart

Source: Lindsey Smart.

https://ncseagrant.ncsu.edu/currents/2017/10/ghost-forests-more-than-halloween-scenes/
ENC “rural” socio-vulnerability factors

- Vast majority of ENC is largely rural, vastly isolated climate sensitive sub-populations
- Socioeconomically disadvantaged, lower earnings, lower literacy, higher poverty, dependency on government funds
- Living Rural means further distance to travel for food, medicine, school, and other essential services
- Lower education, make less money, higher unemployment, far more time to travel to work
- More dependent on local resources, jobs, food
- Less likely the have insurance, and see a doctor
ENC Health Outcomes

ENC Health Factors: Social & Economic

Darker areas rank worse than lighter areas

http://www.countyhealthrankings.org/
ENC: Extreme Heat Temperatures

Geography of Heat Related Illness in North Carolina

Credit: Maggie Sugg and Dr. Ashley Ward
ENC: SLR increases flooding

https://sealevelrise.org/north-carolina/
ENC: Extensive Flooding from Hurricanes Matthew & Florence

Hurricane Matthew: 2016
Individual Assistance Applications - Approved: 29,003
Total Individual & Households Program = Dollars Approved: $98,949,469.25

Hurricane Florence (2018)
NOAA Imagery

https://storms.ngs.noaa.gov/storms/florence/index.html#8/34.789/-77.588
ENC Homeowners concerns: Flooding

- **ISSUES:**
  - Overflowing septic tanks and drain fields
  - Contaminated private drinking water wells from leachate
  - Housing concerns; roofing, mold, crawlspace – heating/air conditioning ductwork
  - Transportation - Access to services
  - Restored power services – Internet, electricity, communication
ENC Agricultural Impacts

https://m.thewashingtondailynews.com/2016/10/05/farmers-hurry-to-harvest-before-storm/
Water Quality Impacts

Runoff: Agricultural – CAFOs, pesticides from crops, stormwater, industrial; fish kills

3.4 million poultry, 5,500 hogs drowned in Florence flooding
Respiratory and Cardiovascular Health Impacts

- Longer pollen season
- Increased pollution and wildfires
Health cost burden and access to care

https://www.nrdc.org/sites/default/files/accountingcosts.pdf
Methods

• **Purpose:** Report the human health effects associated with climate change while providing an estimate of the percent of climate sensitive population groups in Eastern NC (ENC)

• Comparison of Socio-Vulnerability Population Characteristics of ENC-41 counties to rest of NC and to Piedmont and Western Counties

• Data: US Census Bureau, American Census Survey (2009-2013), UNC Sheps Center socio-vulnerability indicators

• One-way ANOVA to compare differences and ArcGIS to display maps
Selected Socio-Vulnerability Variables (County-Level)

- % population of below poverty level
- % population with a disability
- % population under 18 years of age in poverty
- % population of elderly in poverty
- % population non-white
- % of primary care physicians (per 10,000 population)

Data: US Census Bureau, American Census Survey (2009-2013), UNC Sheps Center socio-vulnerability indicators
Non-White Category Includes: African-American, Asian, American Indian or Alaska Native

*US Census, 2010

North Carolina state
Percent Non-White 30.0%
North Carolina state poverty level 17.2%

Percent of Individuals Living Below Poverty Level
(based on data from US Census American Community Survey 2009-2014)

Poverty level based on US Census definition for 2014
Poverty threshold for one person = $12,071
Poverty threshold for four people = $24,230
For additional information see US Census poverty definitions: https://www.census.gov/hhes/poverty/methods/definitions.html
Results

- Percent of ENC-41 counties compared with State County Average (N=100)
  
  - ENC Poverty: 27 (66%) counties higher poverty than state avg. (17.2%)
  
  - ENC Elderly in Poverty: 28 (68%) counties higher than state avg. (10.0%)
  
  - ENC Children in Poverty: 31 (76%) counties higher than state avg. (24.9%)
  
  - ENC Disability: 37 (90%) counties higher than state avg. (13.3%)
  
  - ENC Non-white minority: 28 (68%) counties higher than state avg. (30%)
  
- NC primary care docs state avg: 8.5 (per 10,000); ENC counties 28 counties had fewer; 2 counties reported 0
Results

<table>
<thead>
<tr>
<th>Socio-vulnerability characteristic</th>
<th>ENC-41 counties (N = 41)</th>
<th>95% CI</th>
<th>Piedmont and Western counties (N = 59)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals with a disability</td>
<td>17.48</td>
<td>0.62</td>
<td>15.78</td>
<td>0.51</td>
</tr>
<tr>
<td>Individuals w/income below poverty</td>
<td>20.87</td>
<td>0.77</td>
<td>18.76</td>
<td>0.64</td>
</tr>
<tr>
<td>Under 18 and living in poverty</td>
<td>31.82</td>
<td>1.25</td>
<td>27.24</td>
<td>1.04</td>
</tr>
<tr>
<td>Elderly people (over 65) in poverty</td>
<td>13.11</td>
<td>0.54</td>
<td>10.80</td>
<td>0.51</td>
</tr>
<tr>
<td>Non-white</td>
<td>37.23</td>
<td>2.49</td>
<td>20.31</td>
<td>2.01</td>
</tr>
</tbody>
</table>

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 6.5, (per 10,000 population), SE, 0.57, 95% CI [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, Shaps Center, 2013)
Discussion

• The majority of counties in ENC are rural and have higher percent of climate sensitive, socio-vulnerability characteristics when compared to the rest of the NC

• As the planet continues to warm, climate related threats will continue to increase economic and health challenges for poor and undeserved populations in ENC

• Efforts to mitigate these foreseeable public health challenges need to be addressed
Future Challenges: IPCC Special Report
October 6, 2018

• Limiting global warming to 1.5ºC would require rapid, far reaching and unprecedented changes in all aspects of society.

• World needs to decrease emissions by 45% by 2030

Gov. Cooper targets climate issue, orders NC agencies to reduce carbon emissions

- Reduce GHG emissions 40% by 2025
- Increase in Zero Emission Vehicles
- 40% reduction in energy consumption in state-owned bldgs.

“Tackling climate change could be the greatest global health opportunity of the 21st century, and that the barriers to realizing this are primarily political rather than economic or technical.”

June, 2015

Policy and Personal Intervention Strategies
Health co-benefits of climate action

• Reduced carbon emissions and Air Pollution = Improved Air Quality & Respiratory and Heart Health
• Better designed communities that encourage populations to walk and exercise = improved fitness
• Eat foods grown locally and reduce livestock consumption = better heart health

https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(17)30003-7/fulltext?code=lancet-site
Conclusion

• Climate change is real and it’s happening now.

• Serious efforts are needed to engage rural communities and medical professionals to address and plan for the impacts of climate in eastern NC.

• Continue to increase climate literacy, communicate effectively with policy and decision makers to make this a public health priority particularly in rural areas.

• *Climate change is the single largest threat facing humanity, but it also provides an unprecedented opportunity for collaboration and innovation.*

• Stay positive, continue to do your part and, Vote

Additional References

- *Global Climate Change and Human Health: From Science to Practice.* Luber G & Lemery J, Eds.


- The Southeast Climate Center

- CDC Climate and Health
  [https://www.cdc.gov/climateandhealth/](https://www.cdc.gov/climateandhealth/)

- EPA
  [https://www.epa.gov/climatechange](https://www.epa.gov/climatechange)

- World Health Organization (WHO)
  [http://www.who.int/topics/climate/en/](http://www.who.int/topics/climate/en/)

- New York Times
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Thank you