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Dear NC BREATHE Participant,

Welcome to the fifth annual NC BREATHE Conference! Since 2015, Clean Air Carolina has organized this important conference to bring together health professionals, government officials, academics, students, clean air advocates, and policymakers to share the latest research on the health, environmental and economic impacts of air pollution and climate change. In the previous years, the conference has focused its theme and sessions with talks ranging from the health benefits of clean air policymaking in North Carolina to the connection between wildfires, climate change and health to engaging vulnerable communities in air quality research.

For our fifth conference, we decided to structure it a little differently and focus more broadly on environmental justice issues in North Carolina. The keynotes will take a deeper look at three key environmental justice issues North Carolina is facing: the health impacts of living near hog farms, the vulnerability of North Carolina to climate change and the implications of GenX as an emerging contaminant. The afternoon breakout sessions will then look at three ways North Carolinians are addressing environmental justice and what more can be done.

North Carolina is the birthplace of the environmental justice movement and we are excited to have such esteemed researchers, policymakers, community leaders and government officials join us to continue to prioritize the issues of environmental justice in our state. We thank you for coming and hope you go home with a renewed sense of purpose to join us in ensuring cleaner air quality for all North Carolinians through education and advocacy and by working with our partners to reduce sources of pollution.

Enjoy your day!

June Blotnick, M.Ed.
Executive Director
Clean Air Carolina
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AGENDA

8:00 AM  •  BREAKFAST & REGISTRATION

8:30 AM  •  WELCOME AND OPENING REMARKS
  • June Blotnick, M.Ed., Clean Air Carolina

8:45 AM  •  ENVIRONMENTAL JUSTICE IN NORTH CAROLINA
  • Naeema Muhammad, N.C. Environmental Justice Network

9:30 AM  •  HEALTH AND COST-OF-LIVING IMPACTS NEAR HOG FARMS
  • Chris Heaney, Ph.D., Johns Hopkins University

10:15 AM •  BREAK, VISIT POSTERS AND EXHIBITS

10:45 AM •  VULNERABILITY OF N.C. TO CLIMATE CHANGE
  • Chris Weaver, Ph.D., U.S. Environmental Protection Agency

11:30 AM •  HEALTH IMPACTS OF EMERGING CONTAMINANTS: A LOOK AT GENX
  • Jane Hoppin, Sc.D., N.C. State University

12:15 PM •  LUNCH, VISIT POSTERS AND EXHIBITS

1:15 PM  •  STUDENT LIGHTENING TALKS

1:45 PM  •  BREAK, VISIT POSTERS AND EXHIBITS

2:00 PM  •  BREAKOUT SESSIONS
  • Using Citizen Science to Address Environmental Justice (Room 512)
  • Using Science Communication to Address Environmental Justice (Room 527)
  • Using Data to Address Environmental Justice (Room 528)

3:00 PM  •  OUTCOMES OF BREAKOUT SESSIONS

3:50 PM  •  POSTER AWARDS

4:00 PM  •  CLOSING SESSION
  • Leoneda Inge, M.A., N.C. Public Radio, WUNC 91.5FM

4:30 PM  •  ADJOURN
ENVIRONMENTAL JUSTICE IN NORTH CAROLINA

DESCRIPTION

The environmental justice movement was started in North Carolina and Naeema Muhammad has spent a large part of her career working to address environmental justice. Muhammad was appointed to the N.C. Department of Environmental Quality’s Environmental Justice and Equity Advisory Board that was created last year. During her opening talk, Muhammad will discuss environmental justice in North Carolina, her experience and the new Environmental Justice and Equity Advisory Board.

Naeema Muhammad has been the director for the North Carolina Environmental Justice Network since 2013. Muhammad has worked on two NIEHS-funded grants. The first was the Community Health and Environmental Reawakening grant in which she served as a community organizer working with communities dealing with waste from industrial hog operations. In the position, she worked with Steve Wing, Ph.D., Associate Professor at UNC Chapel Hill School of Public Health, and was supervised by Gary R. Grant, executive director of the Concerned Citizens of Tillery.

Muhammad has co-authored publications with Wing regarding community-based participatory research (most recently in the New Solutions: A Journal of Environmental and Occupational Health Policy). She kindly serves on the N.C. Department of Environmental Quality’s Environmental Justice and Equity Advisory Board.

She is married to Saladin Muhammad and together they have three children, ten grandchildren and seven great-grandchildren. They have been married for fifty-two years and reside in Rocky Mount, N.C.
HEALTH AND COST-OF-LIVING IMPACTS OF LIVING NEAR HOG FARMS

DESCRIPTION

Air quality health and environmental justice impacts of hog farms on North Carolina communities are evident in Chris Heaney’s work. Heaney will discuss his longtime work in North Carolina hog farms and his recent research on antimicrobial resistance and its impacts on workers.

Chris Heaney, Ph.D.
Associate Professor
Johns Hopkins University

Chris Heaney earned his Master of Science degree in environmental health microbiology and virology and his Ph.D. in epidemiology at the University of North Carolina Gillings School of Global Public Health in 2008. His dissertation, Contact with Beach Sand and Risk of Illness, examined the relationship between beach sand contact, densities of fecal microbial pollution in sand, and the risk of enteric and non-enteric illnesses.

Heaney’s research focuses on environmentally-mediated impacts on health and well-being, specifically community land use, waste disposal, and food production practices, and integrates the academic disciplines of environmental microbiology, molecular biology, immunology, epidemiology, and community-based participatory research (CBPR).

Heaney is the director of the Johns Hopkins Environmental Health Microbiology and Immunology Laboratory (EHMIL).
VULNERABILITY OF NORTH CAROLINA TO CLIMATE CHANGE

DESCRIPTION

Climate change will continue to cause increasing temperatures, extremes of precipitation, flooding events, catastrophic wildfires, ocean acidification and warming, according to the Fourth National Climate Assessment released last November. Chris Weaver will discuss these changes and how they impact communities and their health in North Carolina.

Chris Weaver, Ph.D.
Climate Scientist
National Center for Environmental Assessment
U.S. Environmental Protection Agency

Chris Weaver is a senior scientist in the U.S. Environmental Protection Agency’s National Center for Environmental Assessment (NCEA), in the Office of Research and Development (ORD). His research has focused on the role of clouds in the climate system, land-atmosphere interactions, and the water cycle; the intersection of climate change with air quality, water quality, human health, ecosystems, and coastal risk management; planning and decision-making under uncertainty; and the key role of the social sciences in moving science into action.

From 2011-2015, Weaver served in a number of leadership roles within the U.S. Federal climate science and policy enterprise, including as Deputy Director and Acting Director of the U.S. Global Change Research Program (USGCRP) and as a Senior Advisor in the White House Office of Science and Technology Policy (OSTP).

Prior to joining the U.S. Environmental Protection Agency in 2005, Weaver was on the faculty of the Department of Environmental Sciences at Rutgers University, where he was also the Associate Director of the Center for Environmental Prediction. Weaver received his Ph.D. from the Scripps Institution of Oceanography and his undergraduate degree from Princeton University.
While GenX is typically considered a water quality issue, the air emissions are a concern because of the deposition near private drinking water wells. Jane Hoppin will speak about her research and work with GenX, communities members, environmental justice and how air quality is connected to GenX.

**Jane Hoppin, Sc.D.**  
*Deputy Director*  
*Center for Human Health and the Environment*  
*North Carolina State University*

**Jane Hoppin** is an environmental epidemiologist with interest in the health effects of pesticides and other agricultural exposures, phthalates, and, most recently, emerging water contaminants including per- and polyfluoroalkyl substances (PFAS).

Hoppin is principal investigator of the GenX Exposure study designed to characterize exposure to PFAS chemicals among people in Wilmington and Fayetteville, N.C. She has published extensively on the respiratory and allergic impacts of pesticides and phthalates in adults and is particularly interested in appropriate characterization of exposure of these compounds.

Currently an associate professor in the Department of Biological Sciences at North Carolina State University, Hoppin has authored over 215 peer-reviewed publications. She received her B.S. in Environmental Toxicology at the University of California, Davis and her S.M. (Environmental Health) and Sc.D. (Environmental Health and Epidemiology) from the Harvard School of Public Health.
BREAKOUT SESSIONS

Using Citizen Science to Address Environmental Justice

Using Science Communication to Address Environmental Justice

Using Data to Address Environmental Justice

KEY QUESTIONS

1. What is currently happening to address environmental justice through citizen science?
2. Where are the opportunities to do more?
3. What can and/or should communities, researchers, policymakers and other stakeholders do to address these opportunities and need?
4. What would a timeline to address these needs and opportunities look like?
This session will focus on how we can use citizen science as a tool to address environmental justice. Citizen science is the involvement of the public in scientific research – whether community-driven research or global investigations. Communities and researchers in North Carolina have been using sensors and tools to measure environmental health issues.

**OVERVIEW**

**PANELISTS**

**Devon Hall**  
Rural Empowerment Association for Community Help: Hall is a community leader in Duplin County who has used low-cost sensors and citizen science in Duplin County to look at environmental pollution related to concentrated animal feeding operations (CAFOs).

**Ron Ross**  
Northwood Estate Community Organization, Historic West End Neighborhood Association: Ross is a community leader that is working with Clean Air Carolina to place several particle pollution sensors in the Charlotte’s Historic West End to assess the area’s air quality.

**Omega Wilson**  
West End Revitalization Association: Wilson leads WERA and has used citizen science and community engagement to address water quality issues in Mebane, N.C. He has also worked with E.P.A. on environmental justice issues.

**Amanda Kaufman, M.S.P.H.**  
(Moderator) U.S. Environmental Protection Agency: Kaufman has been a leader in citizen science at the federal level and the use of air sensors.
This session will focus on how we can use science communication to address environmental justice. Science communication takes complex scientific information and disseminates it to the public in a knowledgeable and digestible manner. This tool is key to inform affected communities and stakeholders about the negative impacts of environmental justice.

**OVERVIEW**

**PANELISTS**

**Veronica Carter**  
Coastal Federation Board: Carter is a leader in environmental justice issues, digests scientific information and shares it with communities.

**Beth Hassett-Sipple, M.S.P.H.**  
U.S. Environmental Protection Agency: Hassett-Sipple is a science associate with the Air and Energy program who regularly communicates complex issues with a variety of audiences.

**Virginia Guidry, Ph.D.**  
N.C. Department of Public Health: Guidry is a science communicator and did her graduate work on CAFOs and working with communities.

**Neasha Graves, M.P.A.**  
(Moderator) UNC Chapel Hill: Graves coordinates environmental health outreach programming aimed at helping the public understand environmental health issues.
OVERVIEW
This session will focus on how we can use data to address environmental justice. Data is essential to clarify and support all issues. Data is key to inform affected communities, stakeholders and policymakers about the negative impacts of environmental justice.

PANELISTS

Will Hendrick, J.D.
Waterkeeper Alliance: Hendrick is an attorney that has used data to combat threats to environmental health.

Julia Kravchenko, M.D., Ph.D.
Duke University: Kravchenko recently published articles in the NC Medical Journal using large datasets to look at the disproportionate effects CAFOs and Coal Ash has on N.C. counties.

Chandra Taylor, J.D.
Southern Environmental Law Center: Taylor is a senior attorney specializing in transportation and land use issues. She is also president of the Julius S. Chambers Center for Civil Rights.

Gregory Kearney, Dr.P.H., M.P.H.
(Moderator) East Carolina University: Kearney worked for the CDC, National Environmental Public Health Tracking Program. Currently he is assisting with implementation of the N.C. Environmental Health Tracking Program, a large database of information that can be used to better understand environmental health related issues in North Carolina.
Leoneda Inge’s reporting on local community issues, environmental justice and equity gives her a unique perspective on how environmental justice issues have been addressed and are being addressed in North Carolina. As a WUNC reporter, she regularly and quickly summarizes information from many sources and reports back to the community. Inge will close the conference with her thoughts on the issues raised throughout the day and give her perspective and where she sees North Carolina going on environmental justice issues.

Leoneda Inge is the “Race and Southern Culture Reporter” at North Carolina Public Radio - WUNC. She is one of the first journalists in the South to hold such a position, exploring modern and historical constructs to tell stories of poverty and wealth, health and food culture, education and racial identity.

Inge’s most recent work of note includes the series When a Rural North Carolina Clinic Closes, produced in partnership with the USC Annenberg Center for Health Journalism. Other work includes the debate surrounding Race, Slavery & Monuments, Undocumented Immigrants Living in Sanctuary, and The Hanging of Lennon Lacy, in partnership with UNC-TV and Independent Lens.

Inge is the recipient of three Gracie Awards from The Alliance of Women in Media and several awards from the Associated Press and the Radio, Television, Digital News Association (RTDNA). In 2017, Leoneda was named “Journalist of Distinction” by the National Association of Black Journalists.

Inge is a graduate of Florida A&M University and Columbia University, where she earned her Master’s Degree in Journalism as a Knight-Bagehot Fellow in Business and Economics. She is also a former University of Michigan Knight-Wallace Fellow, where she studied Environmental Justice. In 2014, Leoneda traveled to Berlin, Brussels and Prague as a German/American Journalist Exchange Fellow.
PLANNING COMMITTEE

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N.C. State University

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Vidant Health

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N.C. Conservation Network

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Duke University
**POSTER ABSTRACTS**

**Maggie Abbott**, Jonathan Thornburg, Michelle McCombs, and Camille Raynes-Greenow  
Undergraduate, Environmental Engineer, NSCU  

**Pilot Study Assessing Household Air Pollution Reduction Using LPG Cook Stoves**  
The HAPPeN trial, Household Air Pollution and Perinatal & Neonatal mortality, was started to estimate the perinatal burden from household air pollution in Bangladesh. The study is going to use the findings and conclusions from our pilot research to improve upon the effectiveness of the trial that will investigate the impact of household air pollution on pregnancy. This pilot study assessed whether or not liquefied petroleum gas (LPG) cook stove intervention could be implemented in the Mymensingh District of Bangladesh to replace their traditional cooking stoves. Our primary objective was to measure if household PM2.5 exposure was reduced when cooking with a LPG cook-stove. Our secondary objectives were to determine if participants would wear MicroPEM to provide accurate measurements and to assess the quality of the exposure data. We found that PM2.5 exposure was reduced during the intervention phase after we corrected the PM2.5 concentrations for high ambient levels. The intervention phase coincided with the dry season in Bangladesh, a period when brick kilns operate continuously thereby raising the baseline ambient concentration. Study participants wore the MicroPEM according to instructions about 80% of the time. Data quality was high with 90% of samples during baseline and 92% of samples during the intervention being valid. In conclusion, all three of our objectives were achieved. We are confident we will obtain the PM2.5 exposure data to assess the effectiveness of the LPG intervention when the full study starts in April, 2019.

**Oluwaseun J. Adeyemi**, Ahmed A. Arif and Rajib Paul  
Graduate Student (PhD, Public Health Sciences, University of North Carolina at Charlotte)  

**The Relationship of Healthcare Disparity and Functional Impairment among Patients with Chronic Obstructive Pulmonary Disease**  
Functional impairment refers to the limitations of a patient’s social and occupational life due to the effect of a medical condition. In chronic obstructive pulmonary disease (COPD), functional impairment manifests more from physical limitations than respiratory impairment. Patients with COPD are not immune to healthcare disparity. On the contrary, their health outcomes are hinged on the effects of healthcare disparity across the socio-ecological strata. To what extent health disparity affects the functional limitation among patients with COPD is yet to be known. This study, therefore, sets out to assess the relationship between healthcare disparity and functional impairment among COPD patients as well as investigate the influence of selected sociodemographic data on the healthcare access and coverage, and functional impairment.

In this study, a ten-year data from the Integrated Public Use Microdata Series - National Health Interview Survey (IPUMS-NHIS) was culled and analyzed. The outcome variable of interest was functional limitation among patients with COPD. The exploratory variables were questions on healthcare accessibility, affordability, availability, and healthcare coverage. There was a total of 14,321 subjects with COPD. The age, race, educational attainment, marital status, smoking status, and poverty-income ratio had a significant association with functional limitation (p<0.001). We performed a univariate analysis and multivariate analysis after controlling for age, gender, race, educational attainment, marital status, smoking, and poverty-income ratio. We found a statistically significant association of health insurance coverage, an available place for care, affordable services and access to care with functional limitation among subjects with COPD. The association was modified by poverty status of the study participants. A strong relationship exists between the quartet of healthcare coverage, healthcare accessibility, affordability, and availability and self-reported functional impairment among patients with COPD.
Sadia Afrin and Fernando Garcia Menendez
Graduate, Dept. of CCEE, NC State University
Public Health Impacts of Intense Prescribed Burn Activity in Socially Vulnerable Communities of the Southeastern U.S.

Prescribed burning is an important land management strategy used to reduce wildfire risk. However, assessing the impacts of prescribed burning on public health has become important research need due to the practice’s potential for high particulate matter emissions and poor atmospheric dispersion. Here, we rely on permit-based prescribed burning data to quantify the impacts of burning activity across clusters of vulnerable population in the Southeastern US. We identify statistically significant geographic clustering based on the spatial association between prescribed burning and the Centers for Disease Control and Prevention’s census-tract-level social vulnerability index. We find several significant prescribed burning and vulnerability hotspots, including large spatial clusters in Southwest Georgia, Northwest Florida and the central region of Southern Florida. Additionally, we use base-rate health incident data from the Georgia Department of Public Health and a reduced form air quality model (COBRA) to estimate the impact of prescribed burning-specific PM2.5 pollution on an increased rate of different negative health endpoints within these clusters. Finally, we compare the role of prescribed burning relative to other major emissions sources, including industrial combustion, vehicles, and wildfires. We find that a significant amount of premature mortality and respiratory disease is attributable to prescribed burning and these impacts can be larger than those associated with other important emissions sources, particularly at the social vulnerability and prescribed fire hotspots.

Calvin Arter and Sarav Arunachalam
Graduate, Environmental Sciences and Engineering, UNC Chapel Hill
Estimating the Health Burden Associated with Aviation-attributable PM2.5 from Commercial Aircraft Operations at Atlanta, Charlotte, and Raleigh-Durham Airports

In this study, we utilize the Decoupled Direct Method in Three Dimensions (DDM-3D as implemented in CMAQ) to calculate the resulting PM2.5 concentrations from growth scenarios of aircraft operations during landing and takeoff (LTO) cycles at three select airports.

We calculate first order sensitivities of PM2.5 to 2005 and 2015 aircraft emissions. We then use these sensitivities to perform quantitative analyses that estimate PM2.5 concentrations due to 25%, 50%, and 75% emission increases at three airports in the southeast: Hartsfield-Jackson Atlanta (ATL), Charlotte-Douglas (CLT), and Raleigh Durham (RDU). We then combine the estimated increase in PM2.5 concentrations with PM2.5 mortality concentration response functions (CRFs) associated with PM2.5 mortality, population projections, and baseline mortality incidence data to estimate the expected national premature mortalities resulting from the increases in emissions at each of these airports.

We find national premature mortalities from emission increases at ATL to be 1.0 to 2.6, 2.0 to 5.2, and 3.0 to 7.8 using two CRFs of 1.06 and 1.16 risk estimates per 10 ug/m3 of PM2.5 for a 25%, 50%, and 75% increase in emissions, respectively for 2005 values. For CLT, we find 0.6 to 1.5, 1.2 to 3.0, and 1.8 to 4.5 premature mortalities associated with a 25%, 50%, and 75% increase in emissions. For RDU, we find 0.2 to 0.6, 0.4 to 1.1, and 0.6 to 1.7 premature mortalities associated with a 25%, 50%, and 75% increase in emissions.

We will present corresponding results focused on premature mortalities associated with increases from each of these airports with 2015 values. Our results will focus on the trajectory of health burdens associated with aviation-attributable PM2.5 over a recent decade as seen at two of the largest airports in North Carolina, compared to Atlanta - Hartsfield, the world’s busiest airport.
Gabriel Beattie-Sergio and Dr. Greg Kearney
Graduate, East Carolina University, Masters of Public Health

Helping to Improve the Health of Low-Income, Eastern North Carolina Families with Children with Asthma through Environmental Assessments

In the United States, asthma is the leading chronic disease among children under 18 years old. In North Carolina, the prevalence of children reporting having asthma is 2% higher than the national average. Geographically, asthma is disproportional in N.C., with eastern counties having the poorest and highest percent black, non-Hispanic population along with the highest prevalence of asthma and asthma-related ED visit rates in the state. Low-income and vulnerable communities have less access to basic needs and opportunities to thrive and reach their optimal health because of the ways in which deep-rooted, inequitable systems and practices shape their environments.

The objectives for this project are to: 1) identify several of the major social determinants of health (SDOH) among eastern North Carolina families that have children with asthma; and 2) evaluate the presence of environmental asthma triggers in homes of children asthma.

In our project, we use a home-based intervention that includes a combination of tools, an environmental visual assessment checklist to identify asthma triggers present in the indoor environment and, a SDOH screening tool. Environmental measurements in the home are collected using 1) an Amprobe THWD-3 temperature and relative humidity device; and 2) Extech meter to measure moisture in home building materials. A SDOH screening tool is used to evaluate the socio-economic and non-medical family needs.

Thus far, there have been 74 families screened using the SDOH tool. 30 families identified the need for an environmental home assessment. 18 homes have been evaluated for environmental asthma triggers, with 100% having at least one trigger present. Families most often reported, having worries of losing their homes, their safety in their community, and no reliable transportation.

Medical providers should consider a child’s environment and social determinants of health as considerable risk factors when evaluating children with asthma.

James East and Fernando Garcia Menendez
Graduate, NC State University, Environmental Engineering

Sensitivity of Particulate Matter Pollution to Emissions Sector Changes in a Latin American Megacity

Bogota, Colombia, a city of 8.5 million people, frequently exceeds coarse and fine particulate matter (PM10 and PM2.5) daily air quality standards, exposing residents to harmful air pollutants. There are multiple sources of PM10, but the contribution of each source to total PM10 is not well understood. Air quality modeling can be used to assess how pollutant emissions sources contribute to air pollutant concentrations. This work builds on previous air quality modeling studies of Bogota (Nedbor-Gross et al. 2017) by characterizing contributions of various sources to PM10 pollution using a locally developed emissions inventory (Pachon et al. 2018). The performance of air quality model simulations is compared to observed values, and the response of PM to changes in emissions of various sectors is examined. Two three-month simulations were performed: a dry season simulation (January, February, March), and a wet season simulation (October, November, December). Model inputs included meteorological simulation data using 2014 meteorology, chemical boundary and initial conditions, and a local emissions inventory. The Community Multiscale Air Quality Model (CMAQ v5.0.2) was used to perform the analysis. Model results were evaluated against daily air quality observations measured at 14 sites across the city. In the sensitivity analysis, emissions sectors were each varied by 20% and the differences in the modeled pollutant concentrations compared to determine the contribution of each sector to overall PM pollution. Results show that PM10 performs better in the wet season than the dry season, PM2.5 is overestimated at high concentrations in both seasons, and that resuspended road dust is the largest contributor to PM pollution in the city.
Sung Han Rhew, Julia Kravchenko, and H Kim Lyerly
Undergraduate, York College Environmental Health Science major

**Effect of Exposure to Low Level of Fine Particulate Matter Air Pollution on Neurodegenerative Diseases in North Carolina**

Recent studies suggest that exposure to even low level of air pollution is associated with a number of adverse health effects. The improvement in air quality, especially declines in PM2.5 levels in the air contributed to the improved respiratory health of the NC population. The association between neurodegeneration and long-term exposure to fine particulate matter has not been explored in NC. We investigated whether zip code level PM2.5 exposure was associated with neurodegenerative diseases.

Zip-code level hospital admissions and emergency department visits due to Parkinson’s disease (PD) (ICD: 332, G20), Alzheimer’s disease (AD) (ICD:331.0, G309), mild cognitive impairment (MCI) (ICD:331.83, G3184) and stroke (ICD:430-434), in NC have been obtained from Database of the Healthcare Cost and Utilization Project (H-CUP), 2007-2014. Zip code level concentrations of PM2.5 from 2007 to 2014 were derived using annual PM2.5 grids from Moderate Resolution Imaging Spectroradiometer (MODIS), Multi-angle Imaging Spectroradiometer (MISR) and Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Aerosol Optical Depth (AOD) with Geographically Weighted Regression (GWR). PM2.5 grid were matched to population centroid of zip code.

Multivariable logistic regression was used to evaluate whether associations exist between the odds of neurodegenerative diseases and the PM2.5 while accounting for potential cofactors (income, education, health insurance, smoking prevalence, number of primary care providers, and arsenic concentration on the 5cm top soils).

Residential population of zip codes with the upper quartile of PM2.5 (>=9.59 µg/m3) represented the Study group and compared to population with zip codes with the lower quartile of PM2.5 (<=8.31 µg/m3) as control group. We compared odd ratios between study group and control group with primary plus secondary diagnosis for mortality, hospital admission/ED visits. We also used the greedy matching algorithm (described in more details in recently published paper by Kravchenko with co-authors) to perform a propensity-score-based matching of zip codes from the Control group to zip codes in the Study group by demographic and socio-economic characteristics.

There were significant association between annual ground level PM2.5 exposure and neurodegenerative diseases even after controlling area cofactors. In multivariable analysis, Study group had OR of 1.17 (p<0.0001) for AD mortality in older age, 1.21 (p<0.0001) for hospital admission, and 1.40 (p<0.0001) for ED visits. Increased ORs for stroke was observed in the Study group at older age. In sensitivity analysis, matched group showed decreased ORs most of diseases.

Overall air quality of NC have been improved during last decade. Even upper quantile of average annual PM2.5 was marginal at WHO standard (9.6 µg/m3 compared to WHO standard of 10 µg/m3). However, we observed that low level of PM2.5 exposure were associated increased risk of mortality and hospital admission as well as ED visit in terms of neurodegenerative diseases.

Collins Gameli Hodoli, Coulon, Frédéric and Mead, Iq
Cranfield University, College Road, Wharley End, Cranfield, Central Bedfordshire, MK43 0AL, England, UK

**Low-cost, High-Resolution Sensor Networks for Air Quality Monitoring in Logistically Difficult Environments: Ghana Case Study**

Pollution is a major cause of death in both low and middle income countries. In 2012 alone, exposure to polluted soil, water and air contributed to an estimated 8.4 million deaths in these countries. Low-cost feasible new approaches is required for air quality monitoring in these regions. Ghana, among others, is an emerging economic powerhouse in Sub-Saharan African (SSA) region featuring rapid industrialization and urbanization associated with a high demand for energy, food and water that has repercussions on local air quality. Appropriate air quality management plan is required to inform
and guide environmental policy and pollution mitigations measures. This study seeks to demonstrate that low-cost miniaturized environmental sensing technologies can be used to develop cheaper and regionally specific methodologies for air quality monitoring in the SSA region by providing fast, detailed, accurate and near real-time data. In this work, a deployment in Ghana will be used as a regional case study.

Currently, the use of multiple low-cost sensors within a network is being validated for the routine analysis of selected key atmospheric species, including NO, NO2, CO, O3, and particulates matter (PM1, PM2.5 and PM10). Other key environmental parameters, such as relative humidity and temperature, are also measured by the sensor nodes and will be used, along with auxiliary data, to establish the influence of meteorology on the observed air quality. The analysis of results and validation of these deployments will allow the implementation of appropriate air quality networks initially in Ghana, and later across the wider SSA region.

Mohammad Maksim Islam and Andrew Grieshop
Graduate, Civil, Construction and Environmental Engineering, NC State University

Factors Contributing to Seasonality and Inter-location Variability in Emissions Measured in a Multi-year Cookstove Intervention Trial in Rural India

Globally over 3 billion people use solid fuel cookstoves to meet their household energy demand. Although there are studies showing alarming pollutant emissions associated with biomass stoves, little data is available on seasonality and inter-location variability in emissions. In this study, in-home emission factors of various gas- and particle phase pollutants were measured in two rural areas in India: Kullu in Himachal Pradesh State and Koppal in Karnataka State. The study had three measurement periods (baseline: BL, follow-up-1: F1, follow-up-2: F2) for each location and included a wide range of cookstove models. Here, I discuss measurements of traditional stove emission as these display substantial inter-site and inter-period variability in emissions. In Koppal, PM2.5 emission factors (EF) of traditional stove showed significant increase (p < 0.05) in the F2 compared to the BL (mean: 51%) and F1 (32%). In Kullu, PM2.5 EF in F1 was significantly lower relative to BL (40%) and F2 (32%). Emission optical properties (EC/TC and single scattering albedo, SSA) also showed inter-period variability. Multilinear regression models were used to evaluate how emissions varied by season, location, fuel properties (e.g. fuel moisture content: MC and fuel use), ambient condition (e.g. relative humidity: RH), modified combustion efficiency (MCE) and cooking duration. MC, RH, and MCE appeared to be significant predictors of PM2.5 and OC EF that can explain ~25% and ~21% variability respectively. Model predictability was highest for SSA where ~50% variability was explained by season (as well as location), fuel use and cooking duration. The result of this study would help understand the factors affecting emission and thus reduce the overall emission.

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Uncertainty in Estimated Health and Air Quality Impacts from the 2016 Southern Appalachian Wildfires

Wildfire events often lead to elevated concentrations of fine particulate matter (PM2.5) that can be harmful to human health. However, there is considerable uncertainty in estimating wildfire-attributable concentration fields and the associated health impacts. We use the 2016 Southern Appalachian wildfires as a case study to evaluate the uncertainties in estimating wildfire-attributable health outcomes for the population of North Carolina. Using multiple spatially- and temporally-resolved concentration fields, this work compares the uncertainty associated with fire-attributable PM2.5 estimation methods to the uncertainty related to the use of concentration-response functions and epidemiological studies in smoke impacts analyses.
Multiple fire-attributable PM2.5 concentration fields were created using monitor data, satellite aerosol optical depth retrievals, and a model-based smoke forecast product. Differences in these concentration fields and in health impacts estimated from them are evaluated and compared. Uncertainty in health outcomes due to increased PM2.5 is quantified using various concentration-response functions for multiple health endpoints including mortality, work loss days, respiratory-related hospital admissions, and non-fatal heart attacks. Estimated premature mortalities range from tens to hundreds. By contrasting major sources of uncertainty, this work helps identify the largest research needs to achieve improved estimates of wildfire-attributable impacts on public health.

Chelsea Khan
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The Influence of Environmental Factors on Particulate Matter Concentrations in Queens, NY

Fine particulate matter (PM2.5) is linked to public health issues, particularly in urban areas where mobile source emissions are prevalent. The Environmental Health Science (EHS) 140 class conducted air quality monitoring pilot project to determine whether there are higher concentrations of PM2.5 in locations closer to vehicular traffic and other emission sources were higher than levels found in locations farther away from emissions, to assess the risks posed by ambient PM2.5 concentrations.

The Air Beam 2, a portable low-cost sensor, was used to measure PM at a transportation hub in Jamaica Center in Queens, New York; viz, the Metropolitan Transportation Authority (MTA) subway and bus stations and in parks farther away from the influence of emissions from vehicular traffic. The Air Beam has made air sampling affordable and accessible by generating data for real-time visualization, comparable to those obtained from regulatory sensors. There was a strong correlation with PM2.5 and relative humidity, over the four-week period. An inverse relationship was observed between all size fractions of PM and temperature. These preliminary findings are consistent with previous studies that explain the influence of atmospheric effects on particle pollutants, and may have public health implications for commuters in areas with environmental conditions similar to Jamaica Center. Future research would investigate air monitoring throughout the year, to assess seasonal variations in PM concentrations in the study area.

Julia Kravchenko, Sung Han Rhew, and H. Kim Lyerly

Alzheimer’s Disease Morbidity and Mortality in North Carolina Areas with Higher Levels of PM2.5

Recent studies suggest that Alzheimer’s disease risk could be associated with higher levels of ambient air pollutants, especially particulate matters (PMs). In North Carolina (NC), air quality substantially improved over time; however, in certain areas (predominantly urban areas with intense traffic) PMs levels remains higher than in other NC regions. We analyzed age-adjusted rates of mortality, hospital admissions, and emergency department (ED) visits across the NC: health outcomes were compared in zip codes with PM2.5 levels above the World Health Organization (WHO) standard (≥10 μg/m3) and in NC areas with the lowest 10th (<7.61 μg/m3) and lowest 5th (<7.28 μg/m3) percentiles of PM2.5 level. Data on disease-specific mortality were obtained from the State Center for Health Statistics for 2007-2015. Data on ED visits and hospital admissions were obtained from the Healthcare Cost and Utilization Project’s (HCUP) State Emergency Department Database (SEDD) and State Inpatient Database (SID) for 2007-2015. Age adjusted rates of Alzheimer’s disease were calculated for the residents of zip codes using population centroids located along major road throughout NC and compared with NC areas without intense traffic. Age-adjusted mortality rates from Alzheimer’s disease among the residents aged 65+ who live near the roads with intense traffic (e.g., in Charlotte area) and with the levels of PM2.5 exceeding 10 μg/m3 were higher (322.8/100,000, 95%CI=314.2-331.4) than in NC areas with PM2.5 levels in low 10th (256.8/100,000, 95%CI=239.9-273.8) and in low 5th (235/100,000, 95%CI=214.2-257.5) percentile. Also, people aged 65+ in NC areas with PM2.5 levels over 10 μg/m3 had increased age-adjusted rates of hospital admissions and ED visits for
Alzheimer’s disease (1,180/100,000, 95% CI = 1,163-1,196, and 1,030/100,000, 95% CI = 1,015-1,046, respectively) compared to respective rates in the areas with low 10th (876.7/100,000, 95% CI = 845.3-908.2, and 675.5/100,000, 95% CI = 647.8-703.2) and low 5th (804.8/100,000, 95% CI = 764.4-845.2, and 682.9/100,000, 95% CI = 645.5-720.3) percentile of PM2.5 level. The study results show potential association between increased risk of Alzheimer’s disease morbidity and mortality and higher levels of PM2.5 in the air in North Carolina areas with intense traffic.

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Graduate, Environmental Engineering at NC State University

Optimal Use of Grid-Connected Energy Storage to Reduce Human Health Impacts

Grid-connected energy storage can perform a wide variety of applications, yielding potential benefits to power system operations and system-wide costs. Current applications for energy storage, however, do not explicitly consider the potential to reduce adverse human health impacts from power generation. In this study, by taking advantage of energy storage's ability to shift both the time and location of power sector emissions based on their charging and discharging strategies, we propose a method that enables energy storage to cost-effectively reduce human health impacts from power sector. To do this, we determine the hourly health damage cost for each electricity generating unit associated with the exposure to PM2.5. We then internalize these health damage costs in the power plant dispatch decisions, re-optimizing the unit commitment and economic dispatch model in light of these costs.

We introduce two factors, energy storage and health damage cost, to the traditional unit commitment and economic dispatch model, and our preliminary results show that both can contribute to a health impact reduction: a reduction in human exposure was achieved through changes in the commitment and dispatch of existing generators in the absence of energy storage; energy storage allowed further reducing health damages when costs were internalized by adding more flexibility to the system. It is worth noting that the current model is based on the relative risk (RR) value of SO2 and the result is very sensitive to RR value. This result provides the motivation to apply this method to reduce the health impacts of PM2.5 which has a much higher RR value than SO2 but more sophisticated air quality model to simulate the change of PM2.5 concentration will be needed.

Rachael Mott, Megumi Shimizu, Brooks Avery, Robert Kieber, Ralph Mead, and Stephen Skrabal
University of North Carolina Wilmington Graduate Student of Chemistry

Targeted and Non-Targeted Analysis of Per- and Polyfluoroalkyl substances in Rainwater

A series of wet and dry deposition samples are being analyzed for targeted and non-targeted per- and polyfluoroalkyl substances (PFAS) by LC-MS/MS. Precipitation samples are being collected on an event basis at the University of North Carolina Wilmington atmospheric collection station for a period of one year. Additional seasonal samples (3 winter and 3 summer) are being collected at various sites throughout the state of North Carolina including Bald head Island at the mouth of the Cape Fear River, University of North Carolina at Chapel Hill, University of North Carolina at Charlotte, East Carolina University, and Western Carolina University. PFAS are extracted via weak anion exchange cartridges with acceptable recoveries of surrogate standard MPFOA (n=11) of 70-120%. Travel blanks, field blanks, and procedural blanks show non-detects of PFMOPra, PFMOBA, PFPrOPPrA, PFOA, and PFOS with concentrations falling below the level of quantification. Preliminary results indicate that there is a significant influence of air mass back trajectory on PFAS abundance and distribution where events coming from coastal origins have very low to non-detectable concentrations of analytes whereas terrestrial dominated events result in higher presence of these compounds. Terrestrial rain events (n=2) indicated PFPOPra concentrations ranging from 24 ng/l to >500 ng/L. Marine and coastal rain events (n=3) showed non-detects for PFMONa, PFRPOPrA, PFOA, and PFOS. Results of this study are significant because they suggest that PFAS are precipitation in North Carolina. Data also indicate that these anthropogenic contaminants have the potential to travel significant distances from where they are emitted.
Factor Analysis of Laboratory Aging of Organic Aerosol Emissions from Biomass Cookstoves

Roughly 2.5 billion people burn biofuels in cookstoves to meet their daily needs which have implications on health and climate. Emissions include primary organic aerosol (POA) and gas-phase emissions which undergo conversion to form secondary organic aerosol (SOA) during atmospheric aging. Under ambient conditions, these two components (POA and SOA) are difficult to resolve. However, spectral fragment information from aerosol mass spectrometers used with a statistical approach, positive matrix factorization (PMF), can combine several individual fragments into mass spectral factors or ‘fingerprints’ for different sources/processes. Here, we adopt this approach in a controlled laboratory environment, where experiments were designed with known sources (three stoves of varying combustion efficiencies and two fuel types) and SOA was generated using an oxidation flow reactor (OFR). Preliminary results indicate a three factor solution – one POA and two SOA (intermediately and substantially aged) with reasonable consistency across repeat experiments/conditions. However, the strength of these factors vary with stove and fuel type along with differences in reactor dynamics of the OFR. For instance, the intermediately aged factor is less dominant in more efficient stoves while reactor dynamics affects both SOA factors. The factors extracted here will be compared to ambient studies under similar conditions from the literature.

Estimation of PM2.5 Exposures for an Environmental Justice Community in Denver, CO, Using Various Assessment Approaches

Various approaches have been used to assess air pollution exposure to understand its association with health effect outcomes. Emerging low-cost sensor technologies and sensor networks can be used to collect high resolution ambient and personal air monitoring data to provide exposure estimates for different populations. Additionally, there have been efforts to downscale advance air quality models to predict air quality in neighborhoods. In this study, we assessed the usefulness of MicroPEM sensor measurements and examined the feasibility of a downscaled WRF/Chem (v3.9) air quality model. Citizen scientists in Globeville, Elyria, and Swansea (GES), an environmental justice community north of Denver, conducted air quality measurements with support from researchers. RTI MicroPEM sensors collected real-time PM2.5 concentration and filter samples within a 16 km2 network consisting of 17 sites for 3 weeks in August 2017.

MicroPEM 1-hour averaged real-time measurements showed high accuracy for most units (>90%) after adjustment using filter-based gravimetric data and correcting temperature-associated bias. PM levels measured by both MicroPEM and Grimm at three reference sites showed relatively small spatial variabilities (2-16%) with high correlations (r = 0.85-0.90). Time-integrated ambient PM2.5 data showed significant spatial variabilities among the 17 sites with up to a 2.8 time difference in PM concentration. The preliminary WRF/Chem downscaled simulation captured a high concentration region near Denver at the 6-km resolution (normalized mean bias = -1.3%), though not as precise in the community scale at 1-km resolution (normalized mean bias = 41.2%).

The results provide insight on how sensor networks can support the existing monitoring networks to better assess the spatial and temporal variability of air pollution for a community with multiple sources. High resolution sensor network data can also be used to calibrate air quality models to reduce bias. This will help improve health effects estimates and exposure assessment methodology.
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Graduate, UNCW Masters in Chemistry

Local Contribution of Uncombusted Ethanol in Wet Deposition in Wilmington, NC

A headspace solid phase micro-extraction gas chromatograph-combustion-isotope ratio mass spectrometry method was developed for the determination of ethanol isotopes in rainwater. Wet deposition samples collected over a two-year period in Wilmington North Carolina had a range of δ13C values of ethanol between -30 to -12 ‰. Plant leaves were sampled to measure carbon isotope signatures of ethanol, including two C4 plants (corn and cordgrass) and six C3 plants (oak, white willow, American beech, crepe myrtle, pine, and cypress). Carbon isotope signatures of C4 plants like corn and sugarcane and biofuel ethanol emission sources (δ13C = -10 to -13 ‰) differ greatly from the isotope signature of ethanol emissions found in the more common C3 plants that are not used as biofuel (δ13C = -20 to -37 ‰). A two-end member isotope mixing model indicates that biofuels contribute 11% to 97% of ethanol in wet deposition (average 73 ± 16% (n=97)). This percentage is over five times higher than previously predicted for atmospheric ethanol. Significantly lower ethanol concentrations and higher δ13C ethanol in rainwater from marine air mass back trajectories originating from the east were significantly different relative to samples collected from storms influenced by predominately terrestrial air masses. No other significant difference was found between any other trajectory (terrestrial, mixed, and coastal) or among seasons. This lack of significant differences indicates that ethanol concentrations found in wet deposition is from primarily local sources rather than originating from other sites. Results of this study have important implications for air quality because ethanol in the atmosphere can lead to formation of acetaldehyde and peroxyacetyl nitrate (PAN) both of which are toxic and contribute to ozone pollution. Due to the increasing production and use of ethanol as a biofuel, understanding of the sources will help model future air quality impacts of biofuel.

Evan Watson
MS in Sustainability Studies at Lenoir-Rhyne University, Asheville

Health Impacts of Asheville's Transportation Design: A Collaborative Framework to Re-designing I-26 Connector with Everyone in Mind

Health is the backbone of a community – if the people are not well, they will not thrive. The North Carolina Department of Transportation (NCDOT) is about to begin a highway renovation project, known as I-26 Connector, which will run 7 miles through the heart of Asheville, NC. It will surely impact the communal health. The direction of that impact is dependent upon whether the governments and decision makers recognize the systemic nature of a project this size.

This research is a collaborative framework between Lenoir-Rhyne University MS in Sustainability Studies Program, Clean Air Carolina, Asheville Design Center and MountainTrue—all organizations that work towards improving the environmental and social systems that support human health. It explores how the City of Asheville transportation design can use a Health Impact Assessment (HIA) to follow along Section B, Alternative 4B of the NCDOT I-26 Connector Project. It explains the purpose of and application process for an HIA, delving into the health impacts of air quality, physical activity and traffic safety. Relatable community projects are suggested, determining how goals specific to these 3 baselines can be met even if an HIA is not conducted.

While protecting the health needs of the whole community is the priority of this project, it focuses specifically on vulnerable and susceptible populations—if the needs of these often-marginalized groups are met, then the needs of the whole will also be met. The hope is that these findings can encourage the state, county and city governments and decision makers to invest in a more sustainable, environmentally and socially conscious transportation system design. This is one crucial piece of the environmental-social system in Asheville which ensures that present and future Ashevillian generations are able to thrive in their physical health, and therefore, flourish as a whole community.
Xirui Xu, Cindy DeForest Hauser, and David Marin
Undergraduate, Davidson College, Environmental Studies Major

Correlating City Heat Maps and Local Air Quality Monitoring in the City of Charlotte

Urbanization not only stimulates economic and social development but also environmental degradation and pollution. With rapid population growth and industrial development, urbanization has enhanced global warming and air pollutant emissions. Many cities in the US suffer from high levels of summer time ozone produced from rapid photochemical oxidation of CO and hydrocarbons in the presence of NOx. However, with the lack of information on local level air quality, it is hard to evaluate the health impact and identify vulnerable population for air quality related health prevention. Information about local air quality is in great need for improving neighborhood health disparities. Therefore, the purpose of this research to evaluate the air quality characteristics in urbanized areas during summer time by conducting a case study in Charlotte. Our hypothesis is that locations in different temperature zones will have a different O3/NO2 patterns. In other words, we can potentially estimate local concentration of O3/NO2 based on the magnitude of temperature differences among sites. Local point-source air quality is monitored by OGAWA passive sampler pads and Aeroqual S500 sensors. A city heat map is generated by calculating the surface temperature from Landsat 8 thermal bands. If a reliable correlation between surface air pollutants and temperature is found, the heat map can be a useful proxy in estimating air quality changes at the local level and provide a more economically sustainable way to predict local variation in ambient air pollutants. Both OGAWA weekly average and Aeroqual 1h max average results showed that NO2 trend did not follow the temperature zone assignments. Weekly average and 8h max average O3 obeyed the temperature groupings. Statistical results show Aeroqual and OGAWA have significantly different measurements of O3/NO2 due to temperature, humidity and matrix effect of Aeroqual NO2 sensor.


Air Concentrations of Per- and Polyfluoroalkyl Substances (PFASs) in North Carolina

Per- and polyfluoroalkyl substances (PFASs) have been measured in atmospheric gas and particle samples collected from urban and rural areas in many parts of the world. However, there is a lack of knowledge regarding the atmospheric gas-to-particle partitioning, reactions, and transport for legacy and emerging PFASs. Air emissions of PFASs from the Chemours manufacturing plant in Fayetteville, NC, and the potential human exposure to these compounds across NC and beyond are critical to various stakeholders. To better understand the atmospheric aerosol compositions and concentrations of gas- and particle-phase PFASs in NC, we initiated an ongoing sampling campaign that involves a 6-day integrated sampling approach for particle- and gas-phase PFASs using quartz filters and polyurethane foam (PUF) plugs, respectively. These 6-day integrated samples will be collected for one year at 5 locations: Fayetteville (urban, near Chemours), UNC Wilmington (urban, occasionally downwind of Chemours), Research Triangle Park (urban, little Chemours influence), UNC Charlotte (urban, mostly upwind), and East Carolina University (sub-urban, typically downwind of Chemours). A targeted PFAS analytical method has been developed using AB SCIEX Triple Quad™ 6500 LC/MS/MS, with detection limits for selected PFASs in the range of 1-20 ppb. A non-targeted PFAS analytical method will be developed using a Hydrophilic Interaction Liquid Chromatography (HILIC) column coupled with Agilent 6520 Accurate Mass Q-TOF LC/MS. We anticipate that our results will clarify the gas-to-particle partitioning as well as the spatial and seasonal distributions of atmospheric PFASs across NC, contributing to the PFAS database for future studies.
EXHIBITORS

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