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Editors-in-Chief: Jesse M. Lane & Joyce Clapp

The North Carolina Geographer

Picture overlooking the Lucky Strike Tower located near the Bull's Baseball Stadium in Durham, North Carolina. NCGS/Jesse Lane

The *North Carolina Geographer* is published annually by the North Carolina Geographical Society and serves as an outlet for articles and reviews relevant to the geography of the state. Submissions from geography faculty, students, and professionals in all geographic fields are welcome. The journal publishes research articles, a Carolina Landscapes section, conference reports & book reviews, and articles related to pedagogy.

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VOLUME 20, 2021

The North Carolina Geographer

Introduction to *The North Carolina Geographer*, Volume 20

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Over the past two years, the North Carolina Geographical Society (NCGS) has undergone a transformation. The 2019 Annual Meeting was held at the University of North Carolina at Greensboro and was an astounding success. At that time, new officers were elected and an ambitious agenda was announced. One of the most important agenda items was the renewal of *The North Carolina Geographer*, a peer-reviewed journal that had faded with time. Work quickly began on publishing a new issue of the journal. Unfortunately, progress was stalled by the SARS-CoV-2 pandemic and subsequent measures issued by the Governor of North Carolina and the UNC System. In March of 2020, the UNC System ordered all associated schools to end in-person classes and transition to an alternative form of teaching by March 20 of that year. This decision directly affected the type of work undertaken by both students and academics alike. Research became one of the many casualties. As things normalized in the early fall semester of 2020, the NCGS was able to refocus efforts to reestablish *The North Carolina Geographer*.

Geography departments throughout North Carolina worked with the NCGS to promote the revamped peer-reviewed journal and several new manuscripts were submitted. Several early scholars responded positively to our promotion efforts on various social media platforms, but the NCGS Annual Meeting, held virtually on March 12, 2021, became the catalyst for manuscript submissions. The Annual Meeting was a success, with several paper and poster presentations. The key note speaker, The Nature Conservancy's Director of Restoration, Jeff Dequattro, delivered a presentation titled *Non-Traditional Career Pathways*, discussing his work to improve environmental justice in the Mobile Bay Area. Shortly after the Annual Meeting, several manuscripts were submitted to the journal website. We quickly began the review process. Each of the papers presented in this volume have been through a double-blind peer reviewed process and meet the standards set by the NCGS Executive Board. We would like to extend a thank you to all authors who submitted manuscripts to this volume of *The North Carolina Geographer* and all those who volunteered to review each submission.

In this volume, you will find much exciting research about geography and life in North Carolina. In "Trends in Flood Insurance Behavior Following Hurricanes in North Carolina," Julia Cardwell discusses uptake behavior in National Flood Insurance Program (NFIP) claims in North Carolina throughout the past 25 years. In "A Comprehensive Assessment and Evaluation of the Digital Geospatial Data Sources Used in the Study of Food Deserts and Food Swamps," Timothy Mulrooney et al., discuss the accuracy of spatial data in determining food deserts. In "Proliferating Transportation-Related Careers Through the NSTI," Chris McGinn et al., discuss the role of the National Summer Transportation Institute in providing educational and training opportunities to middle and high school students. In "Environmental Outcomes of Municipal Incorporation," Russell M. Smith and Richard G. Moye, Jr. investigate the disproportionate impact of environmental disasters on communities of color throughout the United States. We are so pleased that these authors shared their research with us during this critical, liminal point in history. We are excited about the future of this journal and look forward to future manuscript submissions.

The North Carolina Geographer, Volume 20, pp. 2-12

Trends in Flood Insurance Behavior Following Hurricanes in North Carolina

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In the past fifty years, North Carolina has experienced damage from a number of large hurricanes. The National Flood Insurance Program (NFIP) exists to offer federally backed flood insurance for at risk home owners. This study examines county level NFIP insurance uptake behavior after six major hurricanes in North Carolina to understand the relationship between experiencing a hurricane and novel insurance uptake in the following year, and finds conflicting results as to whether experiencing a hurricane is associated with a comparative increase in novel insurance uptake as compared to counties that did not experience hurricane damage. In addition, this study analyzes zip code level participation in recovery programs following Hurricane Florence as it relates to novel insurance uptake and finds that participation in disaster assistance is positively associated with insurance uptake.

Introduction

The National Flood Insurance Program (NFIP) was established in 1968 to address growing issues with flooding in the United States. The NFIP was developed after an onslaught of expensive disasters in the mid-60's (Strother 2016). These disasters were significantly damaging to communities in part due to the fact that most homeowners were not insured and that private insurance companies generally saw catastrophe insurance, like flood insurance, as bad business and refused coverage, which lead to a growing consensus that the federal government should play a role in protecting communities and individuals from flood risk (Strother 2016). The basis of the NFIP program is that risk and damage will be reduced in a number of ways. To begin, insurance coverage will reduce strain on individual households by providing support after a damaging event (Thomas and Leichenko 2011). Additionally, collective risk will be reduced because for a community to participate in the NFIP they must commit to efforts to limit new development and reduce existing development in flood-prone areas by adopting floodplain management strategies (Thomas and Leichenko 2011).

However, NFIP uptake and market infiltration has been, and remains low (Petrolia, Landry, and Coble 2013). This low uptake rate exists despite the fact that NFIP coverage is required in existing Special Flood Hazard Areas (100-yr floodplain). Many households that technically require coverage because of their location in the special flood hazard area remain without coverage due, in large part, to the fact that enforcement of this insurance purchase requirement falls to mortgage holders, which often fail to fully carry out this requirement (Huber 2012). It is also the case that low-income and minority populations uptake insurance at a lower rate than higher-income, whiter communities (Brody et al. 2017; Holladay and Schwartz 2010; Stewart and Duke 2017; Thomas and Leichenko 2011). In order to encourage participation in the NFIP, coverage has often been offered at subsidized or grandfathered rates, which combined with the increasing costs of flood damage, has resulted in the program now operating at an extreme deficit of billions of dollars to the United States Treasury Department (Wriggins 2014).

The Biggert-Waters Flood Insurance Reform Act of 2012 required significant changes to the functioning of the NFIP, focused largely on the actuarial soundness of the program (Vazquez 2015). The

Biggert-Waters Act largely focused on removing subsidies and grandfathered rates, which were originally implemented to improve the affordability of insurance in high flood-risk areas. However, the Biggert-Waters Act faced immediate backlash as communities and individuals reeled from the increase in insurance rates (Vazquez 2015). The rate increases for many communities would be devastating to individual and community financial sustainability, and low-income areas were more dramatically affected by Biggert-Waters Act than high-income areas (Frazier, Boyden, and Wood 2020). In response to the disarray caused by the Biggert-Waters Act, steps were taken towards delaying the insurance premium increases implicated in Biggert-Waters (Vazquez 2015). The Homeowner Flood Insurance Affordability Act of 2014 delayed rate increases and other parts of the Biggert-Waters Act to give the Federal Emergency Management Agency (FEMA) time to conduct an affordability study and check the accuracy of the flood maps (Vazquez 2015).

Besides uptake issues, the NFIP has suffered from inappropriate risk assessment. Analysis by both FEMA and external sources has indicated that the NFIP floodplain mapping efforts can, at times, be inaccurate in predicting flood risk (FEMA 2006; Xian, Lin, and Hatzikyriakou 2015). This, in combination with low uptake rates, results in situations where the majority of damage after extreme events exists in uncovered areas (First Street Foundation 2019; Kousky and Michel-Kerjan 2017).

The highest penetration rate of the NFIP has been, and remains, in coastal areas that have experienced frequent damaging flood events (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2011). Major events, including hurricanes, are typically associated with at least a temporary increase in policy uptake. For example, following Hurricane Katrina, Rita, and Wilma, the number of policies increased by three to four times the growth rates from years before (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2011). This has been referred to as the "Katrina Effect" (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2011). Other studies have found insurance uptake spikes in the year after a flood event with steady declines after that year (Atreya and Ferreira 2013; Gallagher 2014).

Complicating the trajectory of the "Katrina Effect" is the operation of other flood recovery programs available to uninsured individuals, including FEMA grant programs that do not require repayment. "Charity hazard" refers to the potential pattern in which expectations for disaster assistance after hazards results in individuals choosing to forgo insurance (Browne and Hoyt 2000). In this scenario, people may rely on federal recovery programs, like FEMA grants that do not require repayment and also do not require homeowners to pay insurance premiums, to assist if their home is damaged in a hurricane or other extreme event. In the event of "charity hazard" individuals and homeowners avoid personal responsibility for protective actions like insurance by focusing on the potential for recovery aid from other sources. However, examinations of the existence of charity hazards have had conflicting results in terms of the role of the expectation of disaster assistance and insurance decisions (Atreya and Ferreira 2013; Landry, Turner, and Petrolia 2021; Petrolia, Landry, and Coble 2013).

This study examines absolute and comparative novel insurance policy purchases, referred to as uptake, in counties with and without FEMA disaster declarations after six major hurricane years in North Carolina. This study finds conflicting patterns depending on the year and the storm. In addition, it explores the impact of the "charity hazard" phenomenon after Hurricane Florence in North Carolina by modeling participation in disaster assistance as it compares to insurance uptake after Florence and finds that participation in disaster assistance is positively associated with insurance uptake after Hurricane Florence.

Methodology

All NFIP policies were downloaded from FEMA's open-source data platform (downloaded 10-22-2020). Of these policies, all policies that were purchased to cover property within North Carolina were selected from the entire policy sample. Six major storm years were selected to represent the diversity of storms experienced by North Carolina in recent history. After examining insurance uptake trends in North Carolina (see Figure 2), Hurricane Fran and Bertha were selected to be the first hurricanes examined in the

study because of the extremely limited insurance uptake in the state before the 1990's. Following Bertha and Fran, flood loss by storm was examined to select a sample of hurricanes that experienced a range of losses and a temporal diversity between 1996 and present, which also represents a diversity in insurance coverage. The storm years selected were:

- 1996 – Hurricane Fran and Hurricane Bertha (4 July 1996 –10 September 1996)
- 1999 – Hurricane Dennis and Hurricane Floyd (23 August 1999 – 20 September 1999)
- 2003—Hurricane Isabel (18 September 2003 – 26 September 2003)
- 2011—Hurricane Irene (25 August 2011 – 1 September 2011)
- 2016—Hurricane Matthew (4 October 2016 – 26 October 2016)
- 2018—Hurricane Florence (7 September 2018– 29 September 2018)

Figure 1 shows the tracks of each hurricane through North Carolina. The tracks mainly involve the eastern part of the state with the exception of Hurricane Florence, which was significantly weakened when it traveled through the western part of the state.

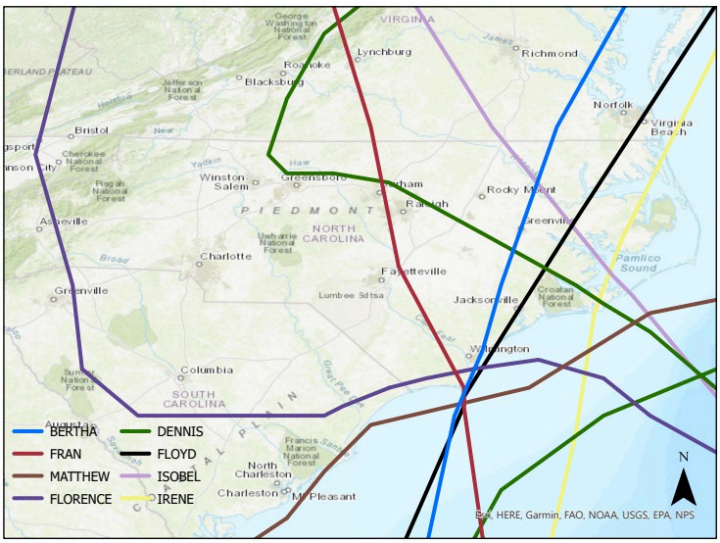

Figure 1. Tracks of all hurricanes in study (National Hurricane Center and NOAA 2020)

The dates of each storm were determined by FEMA designation for major disasters. The study focused on novel insurance uptake before and after each of these major storm event years. As such, for each storm the novel policies were isolated for a full year immediately preceding the storm, and a full year immediately following the storm.

Independent samples t-testing were run on two variables, each separated into two groups by counties with and without a FEMA disaster declaration that made a county eligible for Individual Assistance following the storm. The two variables were absolute increase by number of policies in the year following the hurricane, and percent increase from the year immediately preceding the storms. In several of the storm years, some counties were excluded from the percent increase t-testing due to having 0 policies purchased in the year before or after the storm, which precludes calculation of percent change.

To examine the effect of charity hazard on insurance uptake following Hurricane Florence, the FEMA Individual Assistance Program data (downloaded 9/2/2020) and NFIP Redacted Claims (downloaded 10/22/2020) were downloaded from FEMA's open-source data platform. FEMA and the Federal Government cannot vouch for the data or analyses derived from these data after the data have been retrieved from the Agency's website(s) and/or Data.gov.

For the Individual Assistance (IA) Applications, only those with a payout for rental assistance, repair assistance, or replacement assistance with a Florence disaster code (NC-4393) were isolated. Those qualifying only for Other Needs Assistance (ONA; including Personal Property Assistance) were excluded because some types of this assistance (including Personal Property Assistance) are only available for those who also qualified for Small Business Association loans, and these loans were not included in this analysis. After the payouts were isolated from all the claims, only those payouts that were not made in combination with an insurance claim were further isolated so comparisons could be made between applicants who used these two programs separately. For FEMA NFIP Redacted Claims, only those in North Carolina with a date of loss during FEMA's recognized incident period (Sept 7 – Sept 29, 2018) were isolated. The claims were further isolated to identify only those claims which had a payout.

In addition, demographic data were downloaded from the American Community Survey data for 2018 by zip code to test the influence of demographic variables on insurance uptake in the model. These demographic data included two variables—per capita income and percent non-Hispanic white. The per capita income data comes from ACS Variable B19301 (2018 5-year estimates), and the percent non-Hispanic white comes from ACS Variable B03002 (2018 5-year-estimates).

A negative binomial regression was run with novel insurance uptake after Hurricane Florence as the dependent variable, and NFIP and IA participation, along with the demographic variables, as the independent variables. Three variables were recoded to increase comprehension of the standardized beta coefficient. Per capita income was recoded as per capita/10,000, and NFIP and IA participation were recoded as NFIP/100 and IA/100.

Results

Figure 2 explores the general trends in novel insurance uptake in North Carolina. The data indicate that there were general increases in novel insurance uptake until 2010, with steady decline in uptake after these years.

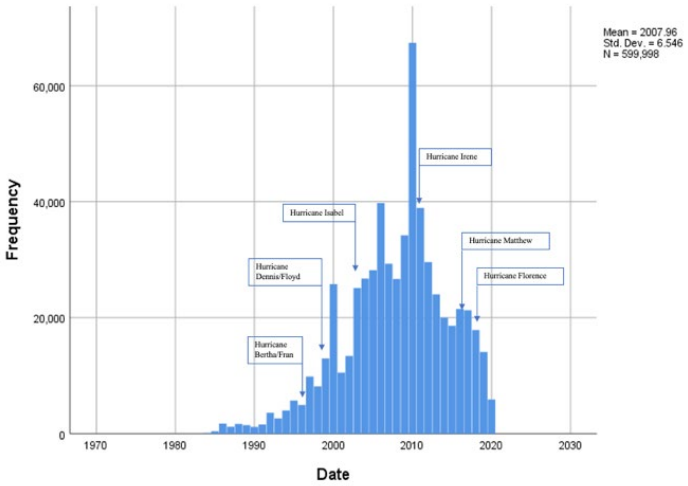

Figure 2. Frequency table of novel NFIP insurance policies

Hurricane Bertha and Hurricane Fran

Both disaster-designated counties and non-disaster counties had an average percent increase in novel insurance uptake after Hurricane Bertha and Hurricane Fran (1996). Disaster-designated counties had an average increase of approximately 144 percent, while non-disaster counties had an average increase of approximately 38 percent. However, this percent change difference is not significantly different between disaster and non-disaster counties at the $p < .05$ level ($p = .219$).

Disaster-designated counties added around 87 policies in the year following Hurricane Bertha and Hurricane Fran, while non-disaster counties added around 49. The policy uptake difference between the two designations was not significant at the $p < .05$ level ($p = .395$).

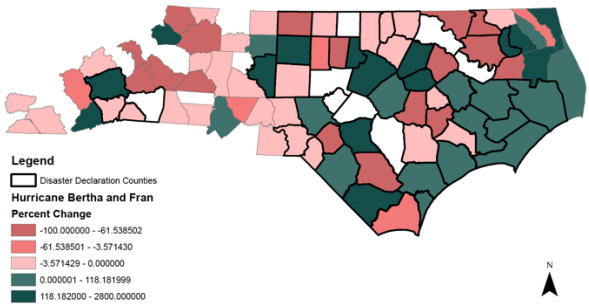

Figure 3. Percent change of novel insurance uptake one year following Hurricane Bertha and Hurricane Fran

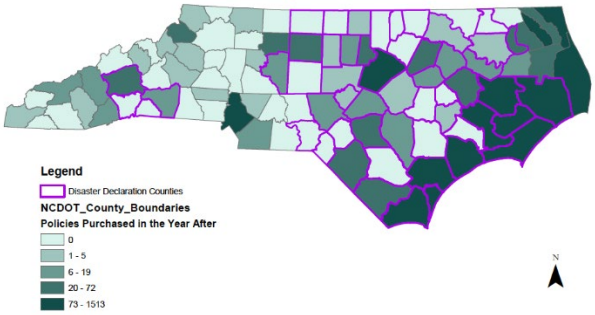

Figure 4. Number of policies purchased within a year following Hurricane Bertha and Hurricane Fran

Table 1. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Bertha and Hurricane Fran

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	46	144.631	493.53	106.08	.219
No	37	38.5502	185.4452	106.08	

Table 2. Independent samples t-test for mean difference in novel policy uptake between disaster- and non-disaster-designated counties following Hurricane Bertha and Hurricane Fran

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	54	86.70	218.533	38.117	.395
No	46	48.59	226.731	38.117	

Hurricane Dennis and Hurricane Floyd

Both disaster-designated counties and non-disaster counties had an average percent increase in novel insurance uptake after Hurricane Dennis and Hurricane Floyd (1999). Disaster-designated counties had an average increase of approximately 354 percent, while non-disaster counties had an average increase of approximately 139 percent. This percent change difference is statistically significant between disaster and non-disaster counties at the $p < .05$ level ($p = .015$).

Disaster-designated counties added about 434 policies in the year following Hurricane Dennis and Hurricane Floyd, while non-disaster counties added around 36. The policy difference between the two designations was significant at the $P < .05$ level ($p = .002$).

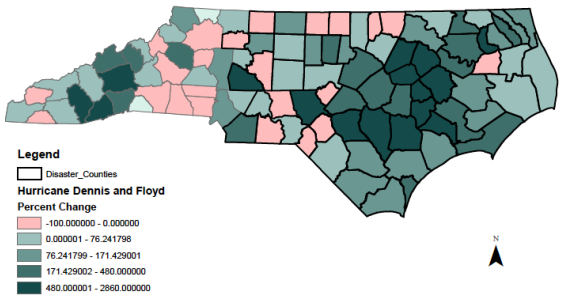

Figure 5. Percent change of novel insurance uptake one year following Hurricane Dennis and Hurricane Floyd

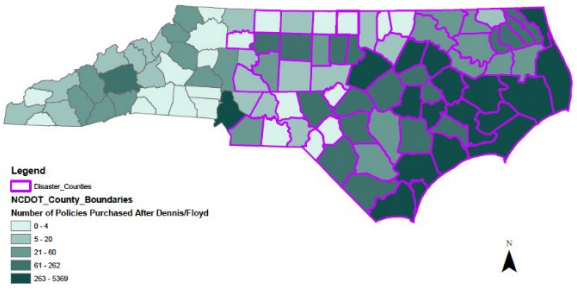

Figure 6. Number of policies purchased within a year following Hurricane Dennis and Hurricane Floyd

Table 3. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Dennis and Hurricane Floyd

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	60	354.01	543.273	214.994	**.015*** **
No	30	139.0157	276.591	214.994	

Table 4. Independent samples t-test for mean difference in novel policy uptake between disaster and non-disaster-designated counties following Hurricane Dennis and Hurricane Floyd

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	65	434.11	984.233	397.765	**.002*** **
No	35	36.24	81.693	397.765	

Hurricane Isabel

Both disaster-designated counties and non-disaster counties had an average percent increase in novel insurance uptake after Hurricane Isabel (2003). Disaster-designated counties had an average increase of approximately 26 percent, while non-disaster counties had an average increase of approximately 92 percent. In this case, non-disaster counties had a higher percent increase, however this percent increase difference is not statistically significant between disaster and non-disaster counties at the $p < .05$ level ($p = .226$).

Disaster-designated counties added around 536 policies in the year following Isabel, while non-disaster counties added around 30. The policy difference between the two designations was significant at the $p < .05$ level ($p = .007$).

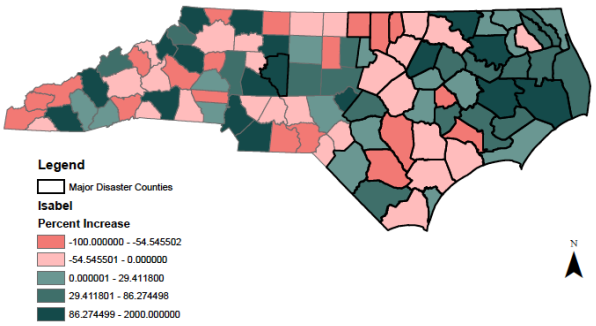

Figure 7. Percent change of novel insurance uptake one year following Hurricane Isabel

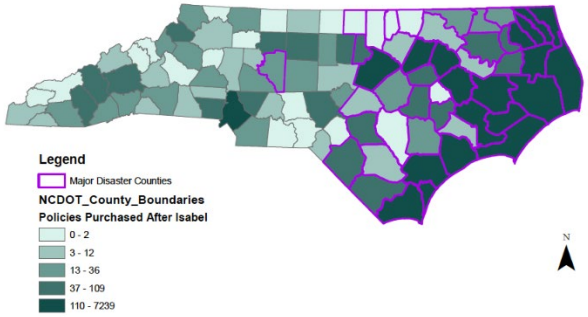

Figure 8. Number of policies purchased within a year following Hurricane Isabel

Table 5. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Isabel

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	45	26.239	84.525	-66.111	.226
No	35	92.35	275.19	-66.111	

Table 6. Independent samples t-test for mean difference in novel policy uptake between disaster- and non-disaster-designated counties following Hurricane Isabel

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	47	536.09	1228.19	506.047	**.007*** **
No	53	30.04	74.347	506.047	

Hurricane Irene

Following Hurricane Irene (2011), disaster-designated counties had an average decrease in policy uptake, whereas non-disaster-designated counties had an average increase. Disaster-designated counties had an average decrease of approximately 31 percent, while non-disaster counties had an average increase of approximately 2 percent. This percent change difference is significantly different between disaster and non-disaster counties at the $p < .05$ level ($p = .016$).

Disaster-designated counties added around 642 policies in the year following Irene, while non-disaster counties added around 106. The policy difference between the two designations was significant at the $p < .05$ level ($p = .003$).

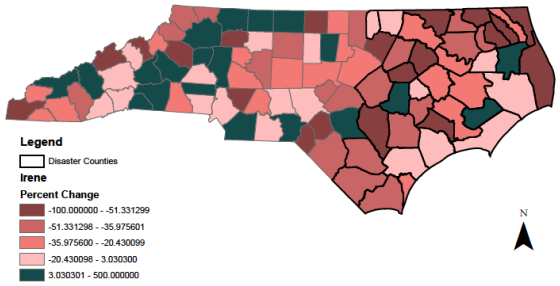

Figure 9. Percent change of novel insurance uptake one year following Hurricane Irene

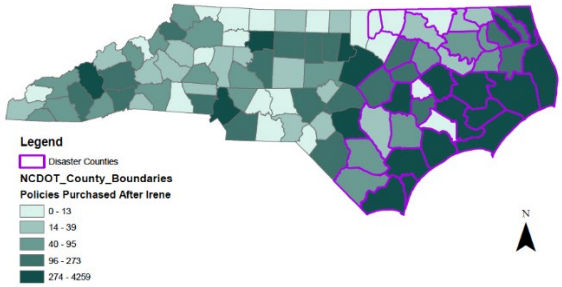

Figure 10. Number of policies purchased within a year following Hurricane Irene

Table 7. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Irene

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	38	-31.01	28.543	-32.699	**.016*** **
No	60	1.69	96.051	-32.699	

Table 8. Independent samples t-test for mean difference in novel policy uptake between disaster- and non-disaster-designated counties following Hurricane Irene

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	38	642.84	1045.23	536.16	**.003*** **
No	62	106.68	186.764	536.16	

Table 9. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Matthew

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	45	104.74	150.317	102.43	**.001*** **
No	54	2.302	133.56	102.43	

Hurricane Matthew

Following Hurricane Matthew (2016), both disaster and non-disaster counties had an increase in novel insurance policy uptake. Disaster-designated counties had an average increase of approximately 105 percent, while non-disaster counties had an average increase of approximately 2 percent. This percent change difference is significantly different between disaster and non-disaster counties at the $p < .05$ level ($p = .001$).

Disaster-designated counties added around 391 policies in the year following Irene, while non-disaster counties added of around 102. The policy difference between the two designations was significant at the $p < .05$ level ($p = .003$).

Table 10. Independent samples t-test for mean difference in novel policy uptake between disaster- and non-disaster-designated counties following Hurricane Matthew

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	45	391.07	572.281	288.685	**.003*** **
No	55	102.38	310.089	288.685	

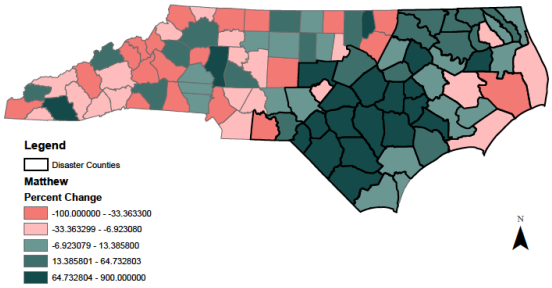

Figure 11. Percent change of novel insurance uptake one year following Hurricane Matthew

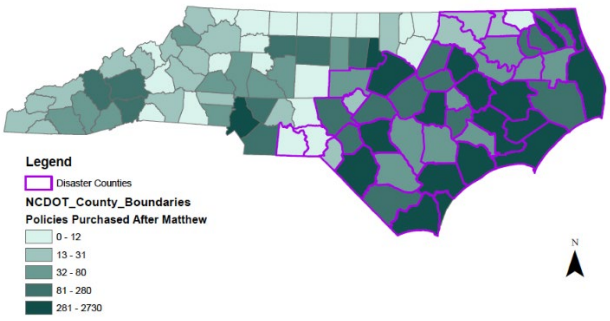

Figure 12. Number of policies purchased within a year following Hurricane Matthew

Hurricane Florence

Following Hurricane Florence (2018), both disaster and non-disaster counties had an increase in novel insurance uptake. Disaster-designated counties had an average increase of approximately 103 percent, while non-disaster counties had an average increase of approximately 13 percent. This percent change difference is not significantly different between disaster and non-disaster counties at the $p < .05$ level, but is significant at the $p < .10$ level ($p = .066$).

Disaster-designated counties added around 469 policies in the year following Irene, while non-disaster counties added around 66. The policy difference between the two designations was significant at the $p < .05$ level ($p = .007$).

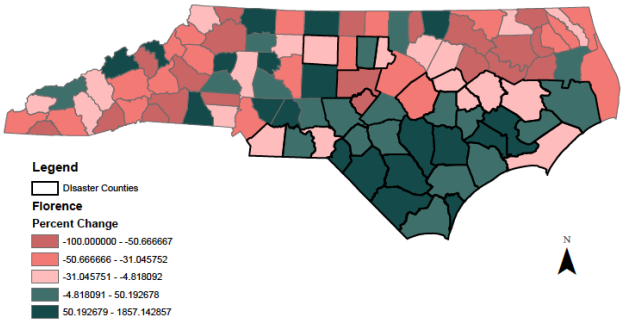

Figure 13. Percent change of novel insurance uptake one year following Hurricane Florence

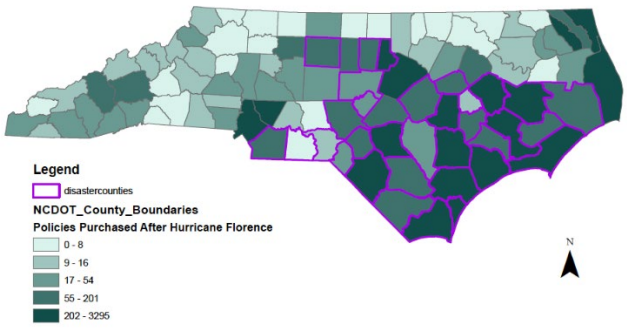

Figure 14. Number of policies purchased within a year following Hurricane Florence

Table 11. Independent samples t-test for mean difference in percent change between disaster- and non-disaster-designated counties following Hurricane Florence

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	33	102.57	346.824	89.53	**.066****
No	67	13.038	133.55	89.53	

Table 12. Independent samples t-test for mean difference in novel policy uptake between disaster- and non-disaster-designated counties following Hurricane Florence

Disaster County	N	Mean	St. Dev	Mean Diff	Sig
Yes	33	468.97	803.891	403.089	**.007*****
No	67	65.88	151.652	403.089	

Modeling Influence of Participation in Recovery Programs on Insurance Uptake

A statistically significant negative binomial distribution model indicates that three of the independent variables were significant—per capita income, IA participation, and NFIP participation, with per capita income being the biggest contributor to the model, followed by IA participation, and NFIP participation. For per capita income, a $10,000 increase in per capita income was associated with a 90 percent increase in NFIP uptake after Florence. For IA participation, an increase of 100 participants per zip code was associated with a 64 percent increase in NFIP uptake after Florence. For NFIP participation, an increase of 100 participants per zip code was associated with a 55 percent increase in NFIP uptake. Percent white was not a significant variable in the model.

Table 13. Negative Binomial Distribution Model Omnibus Test

Likelihood Ratio Chi-Square	Df	Sig.
431.822	4	**.000*****

Table 14. Negative Binomial Distribution Model Parameter Estimates

Parameter	B	Std. Error	Wald Chi Square	Sig	Exp(B)
Intercept	1.219	.2375	26.354	**.000*****	3.385
Per Capita	.644	.0957	45.284	**.000*****	1.903
Individual Assistance Participation	.485	.0588	71.060	**.000*****	1.641
NFIP Participation	.436	.1046	17.372	**.000*****	1.547
White Percent	.003	.0034	.802	.371	1.003

Discussion

Looking at overall trends in insurance policy purchasing behavior in North Carolina, there was a general increase in novel policies until 2010, followed by an average decrease in policies year after year. This is likely not due to market saturation because of continued low uptake of NFIP policies (Petrolia, Landry, and Coble 2013), and because each policy purchased is maintained for only two to four years on average (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2011). While in the history of NFIP participation in North Carolina there have been over 600,000 unique policies, the amount of people covered by a policy at any given time is much lower considering the low overall tenure of policies.

This study specifically examines the influence of hurricanes in NFIP uptake in the context of these general trends by examining novel purchasing behavior in the year immediately preceding and the year following major hurricane events in affected and non-affected counties following these events. Affected counties were represented by counties that obtained a FEMA disaster declaration that qualified the county for IA from FEMA, whereas non-affected counties did not obtain a declaration. The results indicate that there is not an overarching pattern in

purchasing behavior following storms. Three of the six storm events resulted in a statistically significant difference in percent change in the year after the storm (Hurricane Dennis and Hurricane Floyd, Hurricane Matthew, and Hurricane Florence). Hurricane Bertha and Hurricane Fran, and Hurricane Isabel were both associated with higher percent change in affected counties, but not at the statistically significant level. Hurricane Irene was associated with a statistically significant negative increase in affected counties as compared with non-affected counties.

The absence of an overarching pattern works contrary to studies indicating a more universal "Katrina Effect" following any storm. However, of particular note in this study are the three storms events that were associated with significant differences. These three storm events were some of the costliest storms, which indicates that hurricanes with more associated costs may conform more to this "Katrina Effect".

Table 15. Costs of Hurricanes

Hurricane Name	Associated Costs in North Carolina
Hurricane Fran and Hurricane Bertha (1996)	7.2 billion (in 2009 inflation-adjusted dollars) (RENCI at East Carolina University 2009b)
Hurricane Dennis and Hurricane Floyd (1999)	7.8 billion (in 2009 inflation-adjusted dollars) (RENCI at East Carolina University 2009a)
Hurricane Isabel (2003)	562 million (in 2013 inflation-adjusted dollars)(NOAA n.d.)
Hurricane Irene (2011)	686 million (in 2012 inflation-adjusted dollars) (NCDPS 2012)
Hurricane Matthew (2016)	1.5 billion (Associated Press 2016)
Hurricane Florence (2018)	17 billion (Porter 2018)

A notable exception to this is Hurricane Fran and Hurricane Bertha, which caused an estimated 7.2 billion dollars in damage, close to the damage caused by Hurricane Dennis and Hurricane Floyd, and more than the damage caused by Hurricane Matthew. However, as noted in Figure 2 insurance uptake in 1996 and 1997 was very low generally as compared to following years, which could explain a non-significant uptake after the event. Overall, this data adds to literature examining the potential effects of hurricanes on insurance uptake and finds that there is not an overarching pattern indicating a percent increase in novel insurance uptakes, but that more major storms (that cause more damage) are more associated with a positive pattern of novel insurance uptake.

All but one of the storm events were significant (besides Hurricane Bertha and Hurricane Fran) in the associated raw number of policies purchased in the year after the storm in disaster-designated counties as opposed to non-disaster-designated counties. However, this difference can also be explained by the fact that coastal counties, in general, have higher uptake due to increased risk (Michel-Kerjan, Lemoyne de Forges, and Kunreuther 2011). Thus, the percent difference might have more comparative predictive power.

An analysis of the impact of participation in recovery programs and NFIP uptake after Hurricane Florence indicated that participation in both programs (FEMA Individual Assistance, and NFIP participation) were both significant on the zip code, with the IA program contributing more to the model. In other words, after Hurricane Florence, both zip code participation in the IA program (uninsured individuals obtaining federal aid) and the NFIP program were associated with increased novel policy uptake. In this instance, the "charity hazard" actually had the opposite effect on the zip code level, in that participating in non-insurance programs (FEMA's Individual Assistance Program) was associated positively with insurance uptake. Because FEMA removes personal identification information, this pattern cannot be tested at the household level, which may provide more insight on the impact of disaster aid on the individual level. Of particular note in regards to the IA program is the stipulation that approved applicants living in a Special Flood Hazard Area are required to obtain and maintain flood insurance as a condition of receiving future assistance through the IA program (FEMA 2019). This may be a contributor to limiting the impact of "charity hazard"

by creating circumstances in which participation in federal programs may be disallowed if insurance is not purchased.

In this model, per capita income also had significant power when examining insurance uptake after Hurricane Florence specifically. This shows agreement with other studies that indicate that lower-income areas, in general, have lower insurance uptake, which puts low-income communities at greater risk (Brody et al. 2017). The social justice ramifications of this are significant, especially considering that currently most rates are subsidized, but are still not affordable for low-income individuals. There are limited studies that examine the role of social variables in understanding the existence, or absence of, a "Katrina Effect" after hurricanes or other extreme events. This study shows that social variables may be significant, at least relating to one storm (Hurricane Florence). Because of this, more work should be done to understand trends in insurance uptake while considering social variables, especially as it relates specifically to uptake after hurricanes and other extreme events.

Conclusion

This study analyzes insurance behavior after six hurricane years in North Carolina, spanning from 1996 to 2018. The results indicate that there is not a widespread existence of a "Katrina Effect", in which insurance uptake spikes after hurricanes, for all hurricanes with damage in North Carolina. However, there were several storms that were associated with significant differences in percent uptake in non-affected versus affected counties. These results indicate that there may be features of particular storms, for example financial damage, that result in increased uptake in damaged counties.

This study also analyzes the existence of a "charity hazard" for Hurricane Florence. This model indicates that participation in federal grants (in this case the FEMA IA program) is actually associated with an increase in insurance uptake in the following year after a storm. This works contrary to a "charity hazard" scenario. This model also found that per capita income was a significant predictor in uptake, meaning that higher income individuals were more likely to uptake insurance in the year after a storm. The results of this model indicate that social variables should be considered more regularly when analyzing questions of insurance uptake, especially in relationship to harmful events.

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A Comprehensive Assessment and Evaluation of the Digital Geospatial Data Sources Used in the Study of Food Deserts and Food Swamps: A Case Study in North Carolina

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Health outcomes due to poor diet are the result of many interrelated tangible and intangible factors. Differential access to food sources, both healthy and unhealthy, is one of these quantifiable factors that can be measured across space and place. Geospatial tools such as GIS (Geographic Information Systems) serve as a popular technology to assess and evaluate spatial dimensions of the food environment. For an eleven-county study area in Southeastern North Carolina, more than 2,400 points serve as potential food sources used in GIS analysis. However, little work has been done to test the accuracy and reliability of these data which serve as food sources. In this study, we developed a framework to assess and evaluate various forms of data accuracy (horizontal, attribute and temporal) and completeness of these data using comprehensive Quality Assurance/Quality Control (QA/QC) techniques. We found 77.5% of points were correct at the time of field testing. However, in exploring differences using between accuracies of various cohorts of these data sources, we found the accuracy for rural food sources to be less than urban counterparts at a 95% confidence. This can have a profound impact on the digital representation of food-needy regions calculated using GIS techniques and those regions that are truly food-needy.

Introduction

Negative diet-related health outcomes, which have been increasing in recent years, are a result of many interrelated tangible and intangible factors. Differential access to food sources, both healthy and unhealthy, is one of these quantifiable factors that can be measured across space. While "All Americans, rich and poor, have more access to healthy—and unhealthy—food choices than ever" (Brat 2015), individual-level choice to purchase a particular item is dependent upon many factors Contemporary research has popularized the term 'food desert' to express regions which have limited spatial access, combined with a poverty component, to healthy food

sources while even more recent research has coined the term 'food swamp' (Rose et al. 2009) to define regions with inordinately high access to unhealthy access compared to healthy counterparts.

While some research has linked socio-economics with this access (Block et al. 2008; Burns and Ingils 2007; Larson et al. 2009), other research (Cummins et al. 2005; Cummins and Macintyre 1999; Opfer 2010) has not seen such associations. However, many agree that underrepresented populations are not as resilient to the effects of poor access as others who may also live far from healthy food sources. This lack of resilience comes in the form of lack of individualized transportation, education, time, exercise and opportunity (Mari Gallagher 2006). Merely placing a market in the middle of a food desert or low-income region may not necessarily be a remedy to this problem.

Geospatial tools such as GIS (Geographic Information Systems) serve as a popular technology to measure and visualize spatial dimensions of the food environment. Proximity to healthy food sources (large supermarkets or supercenters) or the density of food outlets within an enumeration unit (census tract or zip code) is a commonly used proxy for access (Morton and Blanchard 2007; Sharkey and Horel 2008). Areas of high access and low access can be analyzed across place and time (Chen and Clark 2013), as well as the factors that try to quantitatively explain this access using existing data sources. These make powerful visual products both easy to understand and disseminatable to the entire community that can have long-term decision-making implications.

The number of points used in the spatial analysis of the food environment can range from the dozens (Love et al. 2012; Opher 2010) to hundreds (McEntee and Agyeman 2010; Mulrooney et al. 2017; Sharkey et al. 2009) and even thousands (Mulangu and Clark 2012; van Hoesen et al. 2013). For an eleven-county study-area in Southeastern North Carolina, more than 2,400 points serve as potential food sources in GIS analysis. However, little work has been done to test the veracity of these data using any type of formal framework or methodology. Externally, little insight is provided into what quality assessment was on these data. If a supermarket is not provided in GIS data when one in reality exists (error of omission), one may be mapping food deserts and providing remediations where it is not needed. On the other hand, if a food source is attributed as a supermarket when it only serves a minimal sampling of fresh food or is not a food source altogether (error of commission), researchers may not be properly identifying food deserts that exists in this area. The significance of data-driven decision making has necessitated the GIS community to think critically about the objective assessment, evaluation and reporting of data quality.

In this paper, we present a framework to quantitatively assess and evaluate GIS data sources for an eleven-county study region in Southeastern North Carolina. While verifying each individual store and accompanying attributes was an impossibility within the scope of this research, this research explored various QA/QC (Quality Assurance/Quality Control) assessment techniques and integrated procedures within the framework of accepted QA/QC standards for a variety of cohorts that compose the food environment. This can help determine if accuracy varies amongst different cohorts (urban vs. rural, healthy vs. unhealthy, urban groceries vs. rural groceries, etc.) and how this can be addressed in the large-scale analysis of the food environment.

Literature Review

GIS data, subsequent analysis and products of this analysis such as decisions and maps are only as good as the data on which it is based. Newcomer and Szajgin (1984) and later Heuvelink (1998) showed inaccuracies in original GIS data were propagated through the life of a GIS project, culminating in unreliable maps. For a particular food source, it is necessary to ensure that it is actually represented in a GIS, and its GIS representation is actually located where it is supposed to be. It is also crucial to guarantee attributes used to describe the source are correct. If a food source is attributed as fast food, it needs to be confirmed. The extent to which the real world and GIS data agree is referred to as *data quality* (Korte 1997). Various components contribute to spatial data quality to include: horizontal accuracy, attribute accuracy, temporal accuracy and attribute completeness.

Horizontal accuracy represents the error between the location in the GIS and from where it is located. It

is difficult to tell the exact location of where a feature should be placed since geo-rectified imagery and high precision Global Position Systems (GPS) location have some, albeit minimal error attached to them. Researchers found the positional accuracy (the actual location versus what the geocoding algorithm represents as the address) of geocoded rural addresses to be poorer than urban counterparts (Bonner et al. 2003; Cayo and Talbot 2003; Ward et al. 2005). This can be problematic in this large study area.

Attribute accuracy describes how well the assigned attribute values match the actual characteristics used to describe a feature in a GIS database. Attributes are the non-spatial characteristics used to describe GIS features. Food source attributes, typically represented as point features, are uniform across an attribute table, and distinguish one feature from another. Attribute values can be free text entries (e.g., CONAME = 'Piggly Wiggly' or NAICS = '44511003') or numerical integer values (SALESVOL = 2105). In other cases, InfoUSA, a supplier of geospatial business data, uses domain fields to describe particular attributes. For example, the square footage of the store, represented by the field name SQFTCODE, can only have one of four values: A: 1 – 2,499 Square Feet, B: 2,500 – 9,999 Square Feet, C: 10,000 – 39,999 Square Feet, D: 40,000+ Square Feet. If there are 100 features in a GIS database, there will be 100 accompanying records in the attribute table all described using the same attributes.

Attribute completeness measures the degree to which required attributes have actually been populated. This does not necessarily mean that they are correct. For example, the SQFTCODE must be populated and can be one of only the four possible aforementioned values matched through the appropriate domain table. For the SALESVOL attribute, which represents sales volume in thousands of dollars, it must be an integer. In some cases where it is not provided or unknown, a value of '0' is provided. These missing or unknown values may skew analysis when agglomerated with known values. In other cases, non-numerical data can also be incomplete. The CONAME attribute must be populated; incomplete attributes compromise summaries of these nominal data.

Temporal accuracy refers to the age of the data compared to the usage or publication date. Temporal accuracy errors are highlighted when a feature is indicated as open in the GIS database, but has since closed. The assessment of temporal accuracy is difficult because time is rarely treated as a separate entity within spatial databases except in historically-explicit databases such as the decennial census or time-series data (Longley et al. 2005). While feature-level metadata is able to collect information about individual features such as modification date(s), source material and accuracies, doing so within the confines of a 2,400 point feature class is problematic and time consuming.

Other forms of GIS data accuracy do in fact exist. The Federal Geographic Data Committee (FGDC) and spatial data transfer standards (SDTS) also consider vertical accuracy (difference in measured vs. digital elevation), data lineage (changes/updates in data and dates of these changes), data usability (adherence to requirements for a use-case scenario) and logical consistency (compliance of qualitative relationships inherent in the data structure) as part of data quality (FGDC 2000; USGS 1997). ISO (International Standards Organization) Standard 19571 further delineates logical consistency into quantifiable elements of conceptual, domain, format and topological consistency. In some GIS circles, semantic accuracy or "the quality with which geographical objects are described in accordance with the selected model" (Salgé 1995, 139) is also considered a facet of data quality. However, assessing these facets of data quality falls outside of the scope of this project.

Early pioneers of GIS recognized the importance of data quality, not only from a cost efficiency standpoint, but because of the legal ramifications in publishing incorrect spatial information which may lead to accidents or the misuse of data (Epstein 1987). Even then, they understood the compromise between accuracy, the cost of creating accurate data and the inevitability that some error will still exist. This compromise is what Bédard (1987) called *uncertainty absorption*. Regardless of resource allocation, verification of data quality should be done by discipline experts with a long-term goal of developing

data quality standards. This helps to protect the GIS data producer from the potential misuse of GIS data (Aronoff 1989).

Metadata has been used to describe data quality measures taken during the data development process and subsequent updates. Most generally thought of as "data about data", metadata serves as a formal framework to catalog the lifeline of a particular GIS data set. Although the aforementioned feature level metadata (Qiu et al. 2004; Devillers et al. 2005) has been able to capture data quality information, it is typically limited to quantitative measures of positional accuracy and qualitative information related to data lineage within eight of the more than 400 entries that comprise a complete FGDC-compliant metadata file. Even now, the population of these metadata elements is not fully automated, and some entries must be done by the GIS data steward. Given the efficiency at which this metadata population is done by each steward, data quality assessment done solely via the extraction of metadata entries is not advised.

As it pertains to GIS applications related to the food environment, empirical research on data quality is evolving. Liese et al. (2010) and Auchincloss et al. (2012) explored the quality of retail location data purchased from independent sources, referred to as Commercially Available Business (CAB) data. Examples of these CAB databases include InfoUSA, TDLinx and Dunn and Bradstreet. Larger-scale studies (Han et al. 2012; Hosler and Dharssi 2010; Mendez et al. 2016; Rummo et al. 2015) were performed for Durham, Chicago, Albany and Pittsburgh respectively. All cited some degree of difference among these CAB databases as well as field-based and automated methods, citing that caution must be taken when using CAB databases. Sharkey and Horel (2008) ground-truthed the addresses of food sources provided from various sources such as Internet telephone directories, telephone directories and the Texas Department of Agriculture. They found 18.9% of food sources provided via this public data could not be verified for a variety of reasons such as 1) businesses were no longer open 2) business where food source was formerly located was now occupied by non-food source 3) address did not exist or able to geocode and 4) located denoted as a food source was a residence with no apparent food business. In addition, they found 35.7% of food sources within their study area were only identified through ground-truthing (i.e., error of omission). In another study by Lake et al. (2012), field verification was performed on twenty-one different food source categories (Restaurant, Pub/Bar, etc.) across different permutations of socio-economic status (SES) and population density (urban, rural, mixed) across England. For the rural low SES, more than one third (36%) of food sources provided source could not be found in the field (i.e., error of commission).

Study Area

We conducted analysis in an eleven-county region in southeastern North Carolina (Figure 1). This mainly agricultural region, centered about Fort Bragg, serves as the economic and cultural center of this region, which has an area of about 17,380 km^2 (6,705 mi2) and a population of approximately 1 million people. The largest city in the region is Fayetteville, the sixth largest city in North Carolina with a population of nearly 208,878; other urban areas within the region include Sanford (est. 2019 population 30,037,267), Lumberton (20,875), Laurinburg (15,527), Pinehurst (17,484), Dunn (9,560), Rockingham (9,048) and Clinton (8,292). Outside of military and service industries, agriculture continues to serve as a vital part of region's and state's economy. Rural regions represent 53.2% of the population and 95.4% of the land area within the study area.

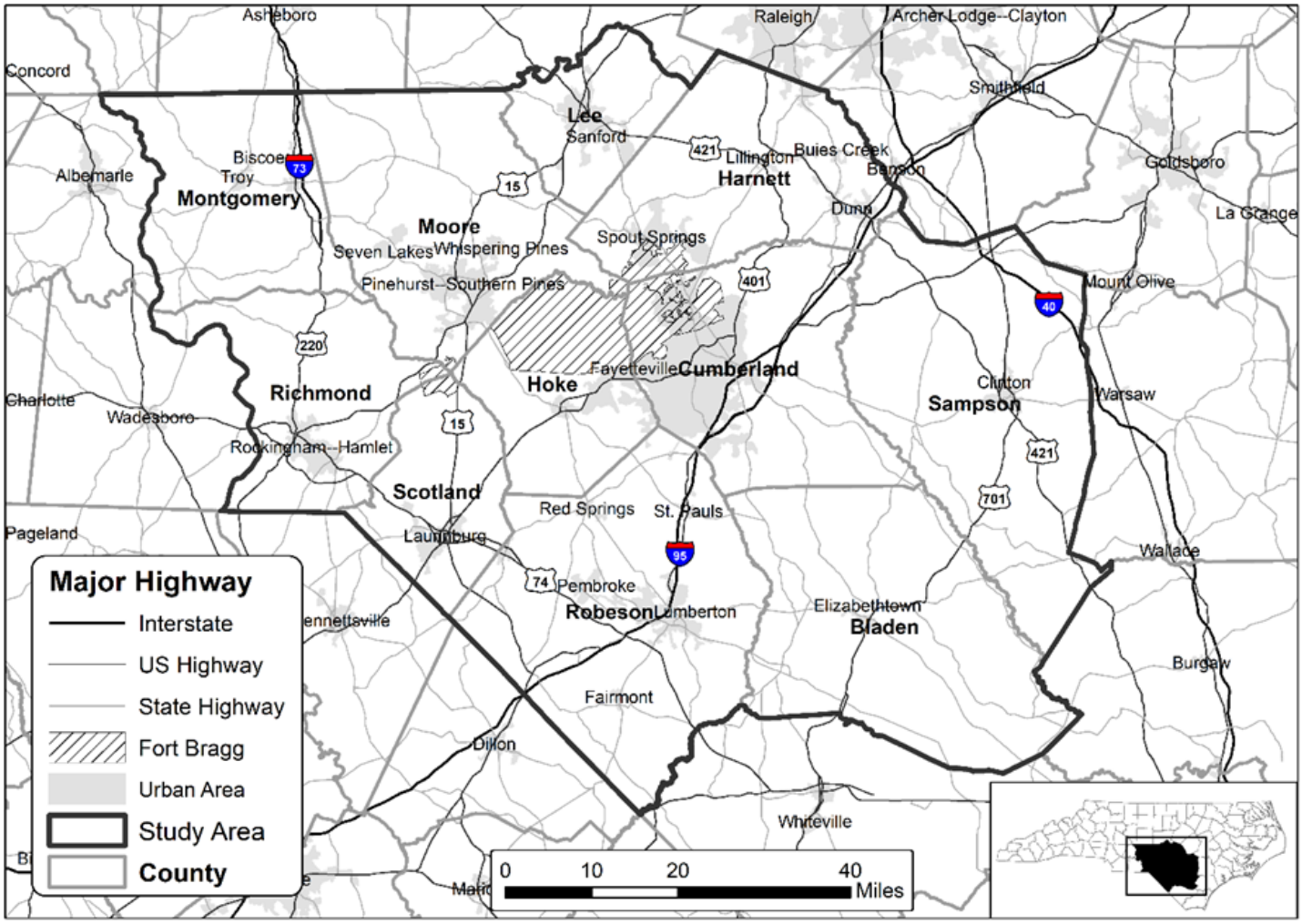

Figure 1. Location map showing the eleven-county study area.

Data

As with this and other GIS-based studies on the food environment, analysis must be based on data developed from scratch or provided as commercially available business (CAB) data. The creation of both, regardless of data developer, can be expensive and/or prone to all types of error. These data were provided as point locations by InfoUSA for the year 2017. According to the metadata, the dataset "contains locations of over 13 million private and public companies in the United States" (Esri 2017).

According to the metadata, these data are current as of 4/6/2017 and are updated annually. Data are agglomerated through third party vendors for use with Esri (Environmental Systems Research Institute). Tabular data was created via the aforementioned process of geocoding. One attribute represents how well the geocoding process matched with reality, whereby mismatches referred back to original coordinates provided in tabular format. More than 21 attributes are used to represent each point, ranging from the company name and location identifiers such as street, city, state and zip code to information specific to each company such as the NAICS code, SIC code, sales volume, company size and number of employees (Esri 2017).

Methods

Regardless of the organization, data quality is the end-product of a reconciliation that must be made between personnel, time and available resources so that GIS data can be created as quickly, accurately, completely and cost-effectively as possible. New data can be created from scratch based on known parameters to replace legacy data, but time, personnel and money may not allow for that. Spatial data quality assessment is the same way.

Using GIS functionality, a *Select by Location* technique was run to find all businesses within the 11-county study area. In this region, there are more than 34,500 businesses. Using the *Select by Attributes* functionality, food sources were selected according to their NAICS (North American Industry Classification Standard) code, a multinational (United States, Canada and Mexico) standard which classifies business establishments by their primary economic activity. Six different cohorts include: 1) Superstores that provide food 2) Fruit and Vegetable Markets 3) Supermarkets and Other Groceries 4) Convenience Stores 5) Fast-Food Restaurants and 6) Limited-Service Restaurants. These cohorts were further classified as 'healthy' and 'unhealthy' food sources, where that supermarkets and other groceries, fruit and vegetable markets and superstores that provide food are defined as 'healthy' food while 'unhealthy' food was represented by convenience stores, limited-service restaurants and fast-food restaurants.

The 2,493 resulting food sources amongst six cohorts were further classified as urban or rural. In most contemporary literature, 'rural' is simply defined as areas not classified as 'urban'. Urban can be conceptualized at various scales, including the more popular county-level Metropolitan and Micropolitan Statistical Areas (MSAs), which are based on population. Since aggregation at the county level is too coarse for many purposes, including this one, this research adhered to the Census Bureau (2010) definition of rural, which states that rural regions are any region that are not classified as urban. Urban areas are defined as 1) Urbanized areas (UA) of 50,000 people or more OR 2) Urban clusters (UC) of population between 2,500 and 50,000. Census divisions that meet a minimum population density requirement and are adjacent to UAs or UCs are also considered urban. Using GIS data demarcating urban areas provided via the United States Census through TIGER/Line Shapefiles, the *Select by Location* routine was run to find all businesses located within urban areas. The *Switch Selection* command was run to find all non-urban, or rural business. All business and cohorts are summarized in Table 1 below.

Table 1. Summary of NAICS codes used to define 'healthy' and 'unhealthy' food around and within study area

NAICS Code	Description	Healthy / Unhealthy	Entire Study Area	Most Frequent (#)	Urban Regions within SA	Most Frequent (#)	Rural Regions within SA	Most Frequent (#)
44511*	Supermarkets and Other Grocery	Healthy	324	Food Lion (65)	207	Food Lion (53)	117	Food Lion (12)
44523*	Fruit and Vegetable Market	Healthy	39	-	16	-	23	-
45211101	Superstore	Healthy	16	Walmart Supercenter (15)	13	Walmart Supercenter (12)	3	Walmart Supercenter (3)
		Total	379		236		143	
44512*	Convenience Store	Unhealthy	428	Kangaroo Express (87)	289	Kangaroo Express (73)	139	Kangaroo Express (14)
722511*	Fast-Food Restaurant	Unhealthy	1666	Subway (90)	1392	Subway (65)	274	Subway (25)
722211*	Limited-Service Restaurant	Unhealthy	20	Jersey Mike's Subs (8)	19	Jersey Mike's Subs (8)	1	New York Deli II (1)
		Total	2114		1700		414	

*Represents wildcard character where store class begins with the code

This project looked to inspect an adequate number of features so that database fidelity can be discerned within an acceptable confidence or threshold. The ANSI (American National Standards Institute) / ASQ (American Society of Quality Control) Z1.4-1993 Standard has been used for larger databases, but little guidance is provided to dictate an adequate sample size amongst these 12 different cohorts or varying sizes. Still other QA/QC protocols require that a certain percent of features (10% for example) be verified. However, while inspecting 294 (10% of all features) would serve as an adequate sample for the entire dataset, taking 10% of small cohorts of rural supermarkets, superstores and limited-service restaurants would result in small samples sizes and large margins of error in hypothesis testing, thus making comparisons between counterparts impractical. This data quality assessment was as comprehensive and seamless as possible given personnel and time constraints.

400 randomly selected food sources were divided between each of the two major divisions of food ('healthy' vs. 'unhealthy') within urban and rural food sources. In order to maintain consistency in field verification for hypothesis testing, 100 urban healthy (UH) sources were randomly selected, as well as 100 rural healthy (RH), 100 urban unhealthy (UU) and then 100 rural unhealthy (RU). As a result, 200 urban features within the GIS database were field checked against 200 rural food sources in the same database. 200 healthy sources were to be checked against 200 unhealthy counterparts.

Within each group of 100 candidates, candidates to be field checked were proportionally divided between each sub-cohort of healthy features' sales volume that contained the most features while ensuring that acceptable samples were taken where possible. This was done to ensure data where a people were shopping was being checked as correct. Supermarkets and other groceries made up 88% of healthy food sources in urban areas and 82% in rural areas, but less of the sales volume (65% and 69% respectively). Of the 200 healthy food sources to be field checked, 154 were evenly split between urban and rural. This equates to 77% of the healthy features to be checked, with the remainder split between fruit and vegetable markets and superstores given the already small number of them within the study area. The intent was to have higher sample sizes for the smaller cohorts (fruit and vegetable markets in particular) in proportion to the total number of each for hypothesis testing. As a result, 37% of urban supermarkets were field checked compared to 66% in rural regions. Even higher percentages of other healthy food sources were checked with all but 3 superstores being field verified. The same was done with unhealthy food, where the ratio of fast food to convenience stores was much higher in urban areas than in rural areas, but tried to maintain consistency between the two while ensuring that an adequate number of limited-service restaurants were selected.

Table 2. Summary of features that were field-checked in QA/QC process

NAICS Code	Description	Healthy / Unhealthy	Urban Regions within SA	Rural Regions within SA	Total Within Study Area
44511*	Supermarkets and Other Grocery	Healthy	77	77	154
44523*	Fruit and Vegetable Market	Healthy	10	20	30
45211101	Superstore	Healthy	13	3	16
		Total	100	100	200
44512*	Convenience Store	Unhealthy	40	50	90
722511*	Fast-Food Restaurant	Unhealthy	51	49	100
722211*	Limited-Service Restaurant	Unhealthy	9	1	10
		Total	100	100	200

All 400 points were randomly selected and placed into a database for on-site field verification. The goal of field verification was to determine 1) if the business was actually located where the GIS database dictated 2) if the business was still in operation 3) if the business activity (fast food, for example) is attributed correctly. Also noted in the database were other issues that may contribute to questions of data integrity and subsequent food desert analysis, such as 1) geocoding errors where that point is located nearby, but not exactly where it should be and 2) points that could be attributed differently. This may occur where a small grocery store could have been attributed as a convenience store. These errors are more qualitative in nature and were merely noted. Attributes were created specifically for field verification that contained placeholders for these notations that could be done in the field.

Using the ArcGIS *Network Analyst* tools, the *New Route* command determines the fastest route between a set of locations. The 400 points were placed into manageable subsets (counties) for each of the field verification teams. Using GIS data provided through the North Carolina Department of Transportation (NCDOT), each team was assigned a subset, calculated the quickest route for their particular subset and headed into the field.

Results

Summary of Errors

Business data were received in November, 2017, and field verification of the 2017 food source GIS data took place between December 2017 and early March 2018. 400 points were inspected to determine how well these GIS data and various permutations of these data aligned with geographic reality as well as cohorts against each other. Of the 400 total points inspected, 310 (77.5%) of them were accurate. Of the 90 that were deemed as incorrect, the following is a summary of the errors:

Table 3. Summary of errors in QA/QC process

Description of Error	Number of Occurrences	Type of Error
Food Source Permanently Closed	32	Temporal Accuracy
Point is Actually a Residential Location	24	Attribute Accuracy
Nothing Exists at the Point	18	Horizontal Accuracy
New Business Occupying Location	9	Temporal Accuracy
Does Not Sell Food Directly to Public (Distributor)	3	Attribute Accuracy
Business Name is the Same, but is not a food Source	2	Attribute Accuracy
Located Far Distance from Actual Feature	2	Horizontal Accuracy

All 90 errors were generalized into one of seven general descriptions as shown in Table 3. The most popular error, representing 35.6% of all errors, was that the food source represented in the GIS databases, was permanently closed. Two examples of these temporal inaccuracies are shown in Figures 2 and 3.

Figure 2. Urban Fast-Food Now Permanently Closed. This Location Was Represented in the GIS Database as Being Open.

Figure 3. Rural Supermarket Now Permanently Closed. This Location Was Represented in the GIS Database as Being Open.

Another type of error was that the GIS data actually represented a residential location, as opposed to a business, as shown in Figure 4. This can be more ascribed to an attribute error, where the address noted as the business location was incorrect, attributed as the owner's home address or the incorrect NAICS code. In this case, food-accessible regions may be identified when in reality they do not exist. 26.7% of all errors were of this type. Another type of error can be attributed to issues of horizontal accuracy where nothing, not a residence or another business, exists at the point. This is probably due to a geocoding error where the address provided could not be converted to an accurate X/Y location. Once again, food inaccessible regions may be denoted as having access to food. In addition, if the food source has not since been closed, analysis may be missing food accessible regions where the food source is really located.

Using the types of errors discussed in the literature reviews, Temporal Accuracy issues represented 45.6% of all errors, followed by Attribute Accuracy (32.2%) and Horizontal Accuracy (22.2%). Attribute Completeness was not an issue for overall error within the database, but 1 record did not contain sales volume and the number of employees, thus compromising analysis requiring these attributes.

Figure 4. Point Attributed as Urban Grocery Store that Clearly is Not a Grocery Store

Summary of Cohort Errors

These 90 errors were broken down between various cohorts of the food environment as shown in Table 4 in the Appendix. Most notable is the difference between urban and rural accuracy. 82.5% of all 200 urban features checked were correct compared to 72.5% of rural counterparts using the same sample size. These differences were also expressed between healthy food (82% urban vs. 70% rural) and unhealthy food (83% healthy vs. 75% unhealthy). Of the six different cohorts of food sources field verified, all four of them (grocery and other supermarket, fruit and vegetable market, convenience store and fast food) had urban accuracy to be greater than rural accuracy.

An independent t-test of two proportions was run between the two sets of results to determine if there was a difference between the percentages computed. Using the derived accuracy percentages for each cohort ($\hat{p}_1$ and $\hat{p}_2$), the combined accuracy ($\hat{p}_0$) and the sample sizes for each cohort (n_1 and n_2), this test helps determine the criteria in order to reject the Null hypothesis (percentage from each cohort is equal to each other) and accept the alternate hypothesis (percent from each cohort are not equal to each other).

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_0(1-\hat{p}_0)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

For example, when comparing healthy urban accuracy (n_1 =100, $\hat{p}_1 = .82$) versus healthy rural accuracy (n_1 =100, $\hat{p}_1 = .70$), with a pooled sample proportion ($\hat{p}_0$) of .76 ($\frac{82}{100} + \frac{70}{100} = \frac{152}{200} = .76$), the resulting z-score of 1.99 and p-value of .0483 show that these differences are at allowable limits for accepting the alternative hypothesis with 95% confidence (significance level α = .05). As a result, given this sample size, we can confidently state that urban healthy cohorts are statistically different, or more accurate in this case, than the rural healthy cohort for our parameters.

Permutations of the results from Table 4 were run against each other using the test of two proportions as shown in Table 5. There are differences between urban and rural accuracy for the some of the six different cohorts of food stores inspected. Most significant was the distinct differences between the accuracy for all urban food sources and less accurate rural food sources at the α = .05 level. Another result showed the aforementioned urban healthy food was more accurate than rural healthy food at the α = .05 level. Although not significant at an acceptable level (α = .1), the GIS data representing urban unhealthy food was more accurate than its rural unhealthy counterpart. However, if the sample size were slightly higher (n = 89 instead of n = 77), these differences would be significant at the α = .1 level if these accuracies (79.22% and 68.83%) for each cohort were to remain the same. The same can be said for the urban fast food (accuracy =84.31%, n = 51) and rural fast-food (accuracy = 73.47%, n = 49) where that a sample size of 76 would be required to achieve the α = .1 level if accuracies were to remain consistent. Also less accurate, but not significantly so, was the rural unhealthy GIS data versus the urban unhealthy data and the rural convenience stores. For other tests involving superstores, fruit and vegetable markets and limited-service restaurants, the limited number of stores in the areas and resulting samples resulted in unreliable results. Lastly, there was no statistical difference between the accuracy of healthy food (76%) versus unhealthy food (79%).

Table 5. Result for test of two proportions

Null Hypothesis	p-value
Urban Healthy (n =100) = Rural Healthy (n = 100)	.0483**
Urban Unhealthy (n =100) = Rural Unhealthy (n =100)	.1664
All Urban (n =200) = All Rural (n =200)	.0170**
Urban Supermarket (n =77) = Rural Supermarket (n =77)	.1266
Urban Fruit and Vegetable Market (n =10) = Rural Fruit and Vegetable Market (n =20)	.5638
Urban Superstore (n =13) = Rural Superstore (n =3)	NA
Urban Convenience Store (n =40) = Rural Convenience Store (n =50)	.3931
Urban Fast-Food (n = 51) = Rural Fast-Food (n = 49)	.1860
Urban Limited Service (n = 9) = Rural Limited Service (n = 1)	.6109
Healthy (n =200) = Unhealthy (n =200)	.4729

*ρ < .1 **ρ < .05 ***ρ <.01

Discussion

It is difficult if not impossible to develop and maintain a geospatial database for the purposes of food security in such a large area that can be kept accurately in real-time. The data collection process is inexact, with addresses collected from a variety of sources at various frequencies. In addition to errors addressed in this paper, stores close, new ones open and other are repurposed throughout the year. These changes are not reflected in the database until data are updated and even further delay may occur before it is distributed to the public. The creators of these data fully recognize these issues and typically issue liability and logical consistency statements through metadata to ensure data users are aware of any gaps or inconsistencies in the data. That has been the case with these data. Feature level metadata tools can be configured to collect information about individual features within a data layer to address entries such as source material, date of last modification, horizontal/vertical accuracy and security clearance. However, maintaining metadata with this granularity from an original database of more than 13 million points may require more resources (personnel, time and storage space) that are available.

Ways to evaluate data accuracy results vary depending upon the nature of the data. Cohen's Kappa is a popular metric that measures conformity

within categorical items. It is thought to be a more robust measure than simple percent agreement calculation, which this study uses, since it takes into account the possibility of this agreement occurring by chance. However, while this study does contain mutually exclusive categories with the entire population of food sources (e.g., Urban vs. Rural; Supermarkets and Other Groceries vs. Fruit and Vegetable Market vs. Superstore vs. Convenience vs. Fast-Food Restaurant vs. Limited-Service Restaurant; Urban Healthy vs. Rural Healthy) theses sources are not limited to those categories on the ground. In addition to misclassified data (grocery store in database is really a farmers' market on the ground) that Cohen's Kappa does address, it does not address issues where ground-truthed data do not fall within these defined categories (grocery store in database does not exist on the ground). Since source data do not necessarily have complementary fields in the correlation matrix, results from Cohen's Kappa analysis may be misinterpreted.

Lastly, this project just explored one popular source of geospatial data used in the study of food security. There are many others. In North Carolina, information on farmers' markets is provided by NC Farm Fresh (http://www.ncfarmfresh.com/index.asp), a reliable body that compiles the data for all the farms and farmers' markets within North Carolina. While not provided in spatial format, addresses can be placed into a text file, geocoded to ascertain and display the actual point location/geographical coordinates as geospatial data. For this particular study area, there are 191 farmers' markets provided via NC Farm Fresh compared to 83 provided in the InfoUSA database. Since metadata is not provided for NC Farm Fresh data, InfoUSA was used in this project. Further research could distinguish the differences between the data sets and determine the veracity of NC Farm Fresh data in future food desert studies.

Conclusion

Disparate health outcomes are a result of a wide spectrum of issues, ranging from household level motivation to eat healthy, access to health care, education about the long-term effects of healthy eating/living and policy designed to address broken links in food systems that is teeming with healthy food. While President Obama's Healthy, Hunger-Free Kids Act and New York's Healthy Bodega initiative are noble efforts to facilitate healthier eating habits, it only solves part of the problem because many of us, for better or worse, have acquired a palate. However, spatial access to healthy options is foundational to this change.

Operational definitions of food deserts and food insecurity differ from study to study. Among the reasons for these differences are variations in topical focus (e.g., obesity vs. rural development), spatial extent of geographic area of interest (e.g., national vs. sub-state region), and characteristics of available data (most notably, demographic and socio-economic data from the U.S. Census). No single classification scheme or boundary definitions are appropriate for all localities or study objectives. Category definitions can be thought of as a model of a complex food system in that they simplify and summarize, highlighting certain characteristics and leaving out others to show particular relationships. As with any model, the number and definitions of classification categories reflects a set of assumptions, a narrow focus, and a particular context.

GIS-based exploratory data analysis is a useful tool for this type of model development as it allows analysts to interrogate diverse geographically linked datasets to identify inherent patterns and develop testable hypotheses regarding factors contributing to those observed patterns. This data-driven approach minimizes bias from imposition of untested assumptions derived from studies for other purposes at other scales in other settings.

High-quality data serves as the fundamental basis for these decisions. These GIS data, whether provided through the United States Census or through other vendors can be easily converted to geospatial format if they are not already provided in that format. One of the challenges in working with these data at various scales is its reliability, or lack thereof. Explanatory demographic data are typically collected within enumeration units such as the census block group, tract, county and state level through the American Community Survey (ACS), a program through the United States Census that samples data in non-decennial census years. Inherent in all ACS data is a sampling error, which represents "errors that occur

from making inferences about the whole population from only a sample of the population" (ESRI 2014). Within quantitative calculations of error is an enumeration unit's determination of reliability. Three classes of reliability exist for ACS data: High, Medium and Low. These classes can give users and decision makers insight into the data used for analysis at a particular scale.

However, little work has been performed on the accuracy of geospatial data which represent store locations. This project presents a basic framework and methodology by which food sources represented as points can be assessed for horizontal accuracy, temporal accuracy, attribute accuracy and attribute completeness. Seven different types of error were found; the reasons for these errors varied from poor record keeping and misattribution to time lags between when data are collected and published. In all, the latter of these errors, temporal accuracy, represented 45.6% of all errors in the database. In these cases, the food environment at the time of QA/QC was different than when the data were collected. The use of old and outdated data can have a profound impact on the representation of food-needy areas and how we respond to them.

In exploring differences between various preselected cohorts of these data sources, distinct differences were found between accuracies for rural and urban cohorts. For n=200, the geospatial data representing rural food sources (72.5%) was less accurate than urban cohorts (82.5%) at $\alpha = .05$. In addition, rural healthy food sources were statistically less accurate than urban healthy cohorts at that same significance level. While rural communities are disproportionately affected by unhealthy food environments (Morton and Blanchard 2007) and some research has shown that disparities in food access are also greatest in rural communities (Morland et al. 2002; Smith and Morton 2009), this disproportionality also extends to the accuracy data sources within these regions. Further research into issues of data collections methods, data collection frequency and logical consistency can perhaps address the reasons for these distinct differences.

The framework approach described in this paper is flexible and broadly applicable, and can be useful for comparing and exploring spatial relationships among accuracies between different study areas if resources exist. We suggest that the approach, methods and results described in this paper be used to inform analysts and end-users of geospatial data research of any implicit or explicit error that may explain, elucidate, undermine and reinforce results using these data.

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Appendix

Table 4. Summary of features checked in QA/QC process

NAICS Code	Description	Healthy / Unhealthy	Total Correct	Total Incorrect	Percent Correct for Urban Cohort	Total Correct	Total Incorrect	Percent Correct for Rural Cohort	Total Correct	Total Incorrect	Percent Correct for All
44511*	Supermarkets and Other Grocery	Healthy	61	16	79.22%	53	24	68.83%	114	40	74.03%
44523*	Fruit and Vegetable Market	Healthy	8	2	80.00%	14	6	70.00%	22	8	73.33%
45211101	Superstore	Healthy	13	0	100.00%	3	0	100.00%	16	0	100.00%
		Total	82	18	82.00%	70	30	70.00%	152	48	76.00%
44512*	Convenience Store	Unhealthy	33	7	82.50%	38	12	76.00%	71	19	78.89%
722511*	Fast-Food Restaurant	Unhealthy	43	8	84.31%	36	13	73.47%	79	21	79.00%
722211*	Limited-Service Restaurant	Unhealthy	7	2	77.78%	1	0	100.00%	8	2	80.00%
		Total	83	17	83.00%	75	25	75.00%	158	42	79.00%
			165	35	82.50%	145	55	72.50%	310	90	77.50%
			Total for all urban			**Total for all rural**			**Total for all features**		

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Proliferating Transportation-Related Careers Through the National Summer Transportation Institute (NSTI)

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Timothy Mulrooney
North Carolina Central University

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It is difficult to find a more diversified field than the transportation sector. Having a successful and viable transportation network requires upkeep of the physical infrastructure, grounds and machinery to enable travel over land, rail, air and water, the development of technologies in support of more efficient and safe travel as well as the digital foundation and skills to facilitate decision-making. In addition to the wide range of skills required within this field, long-range transportation planners must account for skills and technologies that are required at the current time, as well as those that do not even exist yet. With relatively newer technologies such as autonomous vehicles, smart cars, global positioning systems, high-speed rail networks, gyroscopic vehicles and high-precision logistics, transportation planners must be forward-thinking to ensure these technologies seamlessly integrate with current skillsets while replacing existing transportation positions that are being vacated by an increasingly higher number of workers as the baby-boomer generation reaches retirement age.

In response to these current and future needs, the Federal Highway Administration (FHWA), with support from the North Carolina Department of Transportation (NCDOT), developed the National Summer Transportation Institute (NSTI) as a means to expose middle and high school students to transportation-related careers through classroom instruction, field experience and enhancement activities designed to foster soft-skill development. During the Summer of 2018, North Carolina Central University (NCCU) was provided funding by the FHWA and NCDOT to offer a 2-week commuter NSTI camp in July of 2018. Eighteen students, among them seventeen minority students and seven women, applied for and were accepted for this summer's camp. In addition to classroom instruction and enhancement skills, students took a trip of the new light rail network route planned for the Chapel Hill-Durham region, visited the North Carolina Transportation Museum via an Amtrak train, rode bicycles on the American Tobacco Trail and visited the Division of Aviation at the NCDOT as a sample of the various modes of transportation. The camp culminated in group presentations by the students that addressed a transportation-related problem in the state. For example, one group used an Unmanned

Aircraft Vehicle (UAV), or drone, to monitor traffic around the NCCU campus while another group used Geographic Information Systems (GIS) to find solutions to the parking issues on the NCCU campus. Pre-camp and post-camp surveys highlighted students learned and retained the concepts, terms and places covered during the camp while opened ended questions accentuated their preparation for the upcoming academic year. It is hoped that this camp can encourage high-school aged students, especially those from underrepresented groups, towards transportation-related careers and provide them with the technical acumen and soft-skills to be successful transportation professionals.

Introduction

Careers in transportation rely on the understanding of the technical and soft skills necessary to be successful transportation professionals. Part and parcel to understanding these skills is an exposure to all different modes of transportation available to residents of the state of North Carolina. North Carolina has more than 2,000 miles of limited-access highways among its more than 90,000 miles of paved roads which traverse almost 22,000 vehicular bridges. North Carolina also maintains more than 139 rail facilities and 4,800 rail crossings along 5,186 miles of railroads. More than 50 airports, including four international airports, support private aircraft and more than 27 million passenger boarding's every year. Eight ferry terminals provide ferry service up and down the coast of North Carolina and almost 7,000 miles of bicycle routes and numerous greenways fall under the full or partial responsibility of the North Carolina Department of Transportation (NCDOT).

In addition, the NCDOT engages in initiatives related to safe, efficient and environmentally-friendly transportation. These initiatives and programs that fall under the auspices of the NCDOT include rest areas, green energy, litter management, environmental monitoring, the regulation of Unmanned Aircraft Systems (UAS), state maintenance operations, work zone and safety, rail and highway safety, education initiatives, information technology, construction, construction planning and even drawbridges. Some careers related to the transportation industry have or will have pressing needs in the near future. According to the Bureau of Labor Statistics, careers directly related to the transportation industry as well as ancillary fields listed above such as environmental scientists, environmental engineers, civil engineers, urban planners, mapping technicians, geoscientists and water transportation workers have excellent outlooks and are experiencing "as fast as average" or "faster than average" growth. (Bureau of Labor Statistics 2018). Other related fields such as green energy workers, operations research analysts and information research scientists have a "much faster than average" job outlook (Bureau of Labor Statistics 2018).

In response to this demand, the Headquarters for Civil Rights (HCR) of the Federal Highway Administration developed the NSTI as a means to "address future transportation workforce needs by ensuring that the transportation industry has a well-trained qualified and diversified workforce" (Federal Highway Administration 2018). Working with the state-level organizations, the team request proposals from universities throughout the state to host an NSTI site. Objectives of the program include 1) Improve STEM (Science, Technology, Engineering and Mathematics) skills 2) Provide awareness about transportation-related careers 3) Encourage students to consider transportation-related fields of study in higher education and 4) Commit significant program time to classroom instruction. While no specific guidelines are in place, HCR encourages "encourages outreach to the target groups who are under-represented in the transportation workforce (i.e., minorities, females, socially economically disadvantaged individuals, students with disabilities)." In addition to exploring the careers and related technical skills in the transportation fields, another goal of the NSTI is the enhancement program that introduces students to methods to activities to improve study habits, promote academic achievement and foster self-awareness (Federal Highway Administration 2018).

As a result, the Department of Environmental, Earth and Geospatial Sciences (DEEGS) at North Carolina Central University (NCCU), a Historically Black

College and University (HBCU) located in Durham, North Carolina, applied for and was approved to host an NSTI site for the summer of 2018. NCCU is composed of 6,339 undergraduate students, 82% (5,198) of whom are minorities including 78% African-American, 2% Hispanic and 1.5% Asian. Furthermore, over 60% of the total undergraduates enrolled at NCCU are female, highlighting the diversity-rich community on campus. NCCU is a leading minority-serving institution in regard to retention and graduation rates, peer assessment, faculty resources, student selectivity, financial resources and alumni giving. NCCU is recognized in the North Carolina community for its competitive research and educational programs, ranks in the top ten among HBCUs by College Choice, and ranks in the top twenty in Washington Monthly magazine's annual College Guide and Rankings list of the Best Bang for the Buck Colleges in the Southeast. NCCU was named the third-highest rated public HBCU in the country for 2018 by the annual U.S. News & World Report (2018).

The aim of the Department of Environmental, Earth and Geospatial Sciences is to develop in students the analytical and methodological skills necessary to understand the earth's environment and society's impact on the environment. The DEEGS offers coursework in the earth sciences, sustainability, geography, geospatial techniques, natural resources and environmental science. Despite a relatively tight job market, a degree in the DEEGS at North Carolina Central University has a diversified set of job prospects, ranging from urban planners and environmental scientists to geophysicists, many of which can be related to the transportation industry.

Underrepresented minority students face numerous socio-economic challenges in addition to many times having academic struggles in public schools and colleges. Across the United States., large numbers of disadvantaged students are affected by one or more risk factors (e.g. single parent, low parental education, underemployed/unemployed parent(s), residential frequent changes, etc.) that have been linked to academic failure and poor health (Robbins, Stagman, and Smith 2012). Chief among these factors is family economic hardship, which is consistently associated with negative outcomes in these two factors (Schlee, Mullis, and Shriner 2009).

North Carolina is in among the top 12 states having the highest percentage of young children living in extreme poverty with single-parent households (Robbins, Stagman, and Smith 2012). Poverty does not affect all demographic groups equally but for all individuals, families, and communities impacted by poverty, the problems often result in similar educational, career, and health outcomes. Impoverished populations are limited by their lack of access to economic and social resources that routinely manifest in underfunded education and limited food access.

Durham, and surrounding regions, have seen significant increases in the percentage of people living in poverty since 2000. Large HBCUs such as NCCU can leverage existing successful STEM recruitment programs to expand capacity for those who are marginalized in local HBCU underserved communities and build networks to integrate compatible Geospatial technologies such as GIS (Geographic Information Systems) and RS (Remote Sensing) into transportation-related fields.

Disadvantaged youth may have no or fewer positive adult role models in their lives. The high school years are a pivotal time in the development of student behaviors, attitudes, and work habits. The influence of family status variables (family income, parental education, and family structure), peer support, and neighborhood risk is a strong factor in predicting African-American performance in high school students. Furthermore, 2016 Census Bureau data tell us that minorities are graduating from high school at a lesser rate, and those who do complete high school are less likely to immediately enroll in a two-year or four-year institution (Tinto 1993). The data also tell us that they are even less `likely to become STEM majors, and these effects are multiplied for women. These trends are made even more troubling in light of projected race/ethnic shifts in the US population (Gonzales et al. 1996; Harper and Griffin 2011). Therefore, an ecological approach is very important when addressing the problem of academic underachievement within the African-American community (Gonzales et al. 1996; Gorham-Smith, Tolan, and Henry 2000).

The Camp

Through the NCDOT and FHWA, NCCU applied for and was accepted to host an NSTI site for the Summer of 2018. This camp was intended for rising high school students (as of Fall 2018). Eighteen students were accepted for the camp, which ran from 8:30 AM through 4:30 PM on weekdays from Monday, July 9th through Friday, July 20th. Seventeen of the eighteen campers were minority students whose ages ranged from 13 to 17. Of the eighteen students, seven were female and eleven were male. Fifteen of the eighteen students were residents of Durham County and four of the students attended Josephine Dobbs Clement Early College High School, a high school located in the NCCU campus. Students in the early college attend grades 9 and 10 at a building on campus. For grades 11 and 12, students attend NCCU undergraduate classes and when these students graduate from the early college, they will already have transferable college credits.

Activities

NCCU worked hard to develop curriculum that covered the various modes of transportation, such as train, light rail, biking, driving, planes and ferries during the course of the camp.

Figure 1. Campers ride the Amtrak train from Durham to the North Carolina Transportation Museum near Salisbury.

Figure 2. Campers bike the American Tobacco Trail from the NCCU campus to downtown Durham.

During the first week of camp, campers took three transportation-related field trips. On Wednesday, July 11th, employees from GoTriangle, a local transportation planning organization, spoke to students about the proposed light rail project connecting Chapel Hill and Durham, with the one of the originating points being the NCCU campus. Students and staff took a driving tour of the proposed route, slated to begin construction in 2020, as well as a few of the proposed 18 stops along the route. On Thursday, July 12th, students took an Amtrak train from Durham to Salisbury to visit the North Carolina Transportation Museum located in Spencer, just north of the Salisbury (Image 1). On Friday, Dale McKeel, Bicycle and Pedestrian Coordinator for the City of Durham, spoke to campers about the many greenways that provide bicycle and pedestrian to the neighborhoods of Durham. After that, students rode bicycles from the NCCU and campus to downtown Durham on the American Tobacco Trail, a 22-mile pedestrian and bicycle trail that connects downtown Durham with Chatham County to the south (Image 2).

During the second week of camp, students took another two field trips. On Monday July 16th, campers visited Raleigh Durham International Airport's (RDU) observation deck and then visited the NCDOT Division of Aviation Headquarters. At the Division of Aviation, campers saw and toured one of the two planes that the NCDOT Division of Aviation owns and operates. One of the planes was used to

transport NCDOT personnel while students toured the NCDOT-owned plane that the NCDOT uses to collect imagery (Image 3). On Wednesday and Thursday (July 18th – 19th), campers took an overnight trip to the Outer Banks to visit the Wright Brothers Monument at Kitty Hawk, the site of the first successful and sustained flight by a heavier-than-air machine. After staying overnight in the Outer Banks, students took a ferry that crosses the Pamlico River on their way back to Durham.

In support of the commitment to provide quality classroom instruction to campers, classroom lessons focused on NCCU and DEEGS specialties to include Geographic Information System (GIS), Environmental Stewardship, Mapping, Cultural Geography, Transportation Geography and the Use and Application of an Unmanned Aircraft System (UAS), or drone. Students collected imagery using a UAS and some students used a UAS to address a transportation-related problem.

As previously mentioned, and as part of the enhancement program, students were broken into groups and presented with a transportation related-problem. Students used or created their own data to develop a hypothesis, analyze the data and present results to the entire camp related to this problem. These presentations culminated the camp during the last session on camp on July 20th.

Figure 3. Campers visit the NCDOT Division of Aviation headquarters and toured the plane used to collect imagery throughout the state.

Figure 4. Campers work on their final presentation with NCCU undergraduate student Rick Kia Howard.

Figure 5. An image of the NCCU NSTI campers as captured from a UAS.

Figure 6. UAS imagery collected of the NCCU campus by NSTI campers.

Assessment and Evaluation

As part of the assessment and evaluation portion of the camp, students were given a pre and post camp survey that covered various facets of transportation, geography, people, places, activities and technologies covered throughout the course of the workshop. This helped to reinforce the concepts learned in classroom instruction, the enhancement activities as well as the field trips. Soon after camp commenced on Monday, July 9th, 18 campers took the pre-camp survey. When the camp concluded on Friday, July 20th, 16 campers retook the survey using these same questions. Two students were not present to take the post-survey. Questions and assessment of the them are included below.

Table 1. Results of pre-camp and post-camp survey taken by campers covering the terms, concepts and places addressed during the NSTI camp.

Question	Correct Answer	Pre-Test %	Post-Test %
Another more formal name for a drone is a(n) _____.	Unmanned Aircraft System	22.2%	68.75%
What NCDOT division is responsible for dictating the laws on the prudent use of drones in the state of North Carolina?	Division of Aviation	55.6%	87.5%
The maximum elevation (above ground level) that you can fly a drone without a waiver is _____ feet.	400	61.1%	81.25%
In Geographic Information System (GIS) technologies, a(n) _____ is a type of question that we can ask the database.	Query	44.4%	62.5%
In our phones or web maps, the process of typing in an address and a physical location being displayed on the map is called _____.	Geocoding	44.4%	50%
In our phones or web maps, the process of connecting 2 locations using an algorithm such as the shortest travel time is called _____.	Networking	27.8%	56.25%
In an airport, the physical building from where people embark and disembark from airplanes is called a(n) _____.	Terminal	94.4%	93.75%
A boat used to carry passengers, cargo and even vehicles is called a _____.	Ferry	88.9%	93.75%
The_____ Brothers are credited with the first successful, sustained power flights in heavier-than-air machines in 1903.	Wright	88.9%	100%
The North Carolina Transportation Museum is located just north of the railroad terminal near the city of _____.	Salisbury	66.67%	100%
As of now, the Triangle Light Rail project will connect the cities of _____ and _____.	Chapel Hill and Durham	38.89%	62.5%
The _____ serves as a bike conduit between downtown Durham and the North Carolina Central University campus as well as points south to Chatham County.	American Tobacco Trail	55.56%	100%

From the results, response rates for all but one of these questions improved between the beginning and end of camp. These results are promising, as they helped reinforce the three-pronged curriculum focused on classroom instruction, field experiences and enhancement activities as intended by the NSTI.

Other Survey Results

During the post-camp survey, students were also asked questions about their response to their experiences and preparation for the upcoming school year as well as their desire to pursue transportation-related careers.

Table 2. Responses to field experiences and interest in transportation-related careers addressed in NSTI camp.

	Yes	No	Not Sure
Before this workshop, have you ever ridden on a train before?	8	8	0
Before this workshop, have you ever taken a ferry before?	5	11	0
Before this workshop, have you ever visited an airport before?	14	2	0
Before this workshop, have you ever walked or ridden on the American Tobacco Trail before?	5	9	1
Before this workshop, have you ever flown a drone before?	7	9	0
Are you interested in a career in transportation?	5	3	8

Lastly, students were asked open-ended questions about the academic and enhancement activities as they related to transportation careers. A sample of their answers are as follows (Tables 3, 4 and 5).

Table 3. Feedback regarding academic preparation for the next year.

In what area do you feel this camp has prepared you for the upcoming school year?
"This camp has helped me for the upcoming school year by enhancing my presentation skills."
"Technology and my project skills and managing my time."
"Get back in the feel of engaging and asking questions."
"How to project my voice when I'm talking and presenting."
"My PowerPoint skills are better and I am better with public speaking."

Table 4. Feedback regarding the understanding of transportation industry technical skill needs.

Briefly describe some of the technical skills that you would need to be successful in the transportation industry.
"Learning different things about maps and the data that we can put on them. We also learned about different types of transportation and different jobs within them."
"Skills such as knowing about GIS and engineering."
"Knowing how to read and understand a map."
"Depending on what job you are working at, computer skills are essential to a career in transportation."
"In the transportation industry you should know how to decode maps and pinpoint different locations."

Table 5. Feedback regarding other needs.

Briefly describe some of the soft (non-technical) skills that you would need to be successful in the transportation industry.
"Communication and Leadership Skills"
"In the transportation industry you should know how to communicate with your co-workers and be able to understand them."
"Adaptation because many of the speaker's said that most days you don't do the same thing they did."
"Creative thinking, ability to work with others, analytical thinking and speaking in front of others."
"Good public speaking skills and the ability to talk confidently in front of crowds."

Conclusions

The National Summer Transportation Institute is an initiative by the Federal Highway Administration to expose middle and high school aged students to transportation-related careers using a combination of field experiences, classroom instruction and enhancement activities and perpetuate STEM principles and how they can be applied in transportation-related fields. With support from the NCDOT, North Carolina Central University was provided with funding to host an NSTI site during the summer of 2018 on the campus of NCCU in Durham, North Carolina. Eighteen high school-aged students were accepted for the day program, which ran daily from July 9th through July 20th.

The camp consisted of a combination of day trips, overnight field trips, classroom instruction by university professors, problem-solving activities using

STEM principles, talks by members of the transportation workforce and eventually culminating in group presentations in front of the camp where students solved a transportation-related problem related to Durham and the state of North Carolina.

Using basic assessment techniques such as evaluating pre and post-test results of the terms, places and concepts covered during camp, it was found that students learned and retained the information covered across the field experiences, enhancement activities and classroom learning. Open-ended questions answered by the students highlighted preparation for the upcoming school year via enhancement activities as well an understanding of the technical skills and STEM principles necessary to be successful in today's ever-evolving transportation industry.

Discussion and Moving Forward

Reception from both campers and parents highlighted satisfaction in the premier year of NCCU's version of the NSTI. The NSTI given by the Department of Environmental, Earth and Geospatial Sciences at NCCU focused classroom instruction around departmental strengths such as Geography, Geographic Information Systems, Environmental Science and the Earth Sciences. This differs from other NSTI programs hosted by varying departments such Civil Engineering Departments (California State University – Los Angeles), Transportation (Cal Poly Pomona) and Technology (Elizabeth City State University), as well are larger entities such as colleges and centers like the College of Business and Economics (North Carolina A&T State University), Diverse Business Supportive Services Center (Cheyney University), Institute for Human Development (University of Missouri – Kansas City) and the Center for Transportation Studies (University of Minnesota).

Future iterations of this camp will look to expand on field experiences, enhancement activities and classroom learning to engage more of NCCU community and play upon on a much wider variety of skillsets. Other non-DEEGS NCCU majors such as law, criminal justice, public administration, computer science, mathematics, business, physics and chemistry can have an impact on the transportation industry, whether it be the testing of new and more durable highway materials, programming algorithms for autonomous vehicles, environmental testing of construction sites to ensure they meet mandated standards and the interpretation of UAV legislation for the lawful and prudent use them. Through these results and feedback, it is anticipated and expected that future NSTIs given by NCCU can provide underrepresented high-school students with the understanding, confidence and acumen to pursue careers in this ever-changing field.

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Environmental Outcomes of Municipal Incorporation: A Quantitative Analysis of Environmental Conditions in Incorporating Cities of Color and Majority White Municipalities

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Communities of color are disproportionately impacted by environmental justice issues and numerous scholars have highlighted the relationship between environmental racism and minority communities. However, little research has explored the relationship between the establishment of new majority-minority municipalities and issues of environmental inequality. Does a community of color's decision to incorporate lead to improved environmental conditions compared to recently incorporated majority white municipalities? This study explores the relationship between the incorporation of majority-minority communities and environmental conditions in new municipalities through a quantitative analysis, which includes the use of a bivariate independent T-test and multivariate regression modeling, comparing new Cities of Color and recently incorporated white municipalities. The study hypothesizes that Cities of Color will experience poorer environmental conditions compared to new majority white municipalities as a result of environmental racism, locally unwanted land uses and municipal underbounding, which have all been shown to be rationales for seeking incorporation by majority-minority communities. This study does not attempt to determine if these rationales were the reason for a community of color to seek incorporation. Rather, the research seeks to determine if environmental inequalities exist amongst new municipalities. As highlighted in previous studies, environmental indicators levels of hazards are higher in Cities of Color compared to majority white municipalities, but the differences were not statistically significant.

Introduction

The establishment of a new municipality is a complex and uneven process. Municipal incorporation is the establishment of a new local government entity from previously unincorporated territory. New cities have a multitude of implications for the region in which they are birthed, for existing municipalities and for the residents of the newly formed cities. Historically, new municipalities have been largely viewed as wealthy, white suburban enclaves on the fringes of major metropolitan cities that seek to exclude communities of color from their borders (Teaford 1979, Weiher 1991, Burns 1994, Musso 2001, Pulido 2006). However, recent research has dispelled this myth and highlighted the incorporation of Cities of Color (CoCs) (Hunter and Robinson 2018, Smith 2018, Smith and Waldner 2018, Smith et al. 2016). These CoCs can be found across the country and consist of majority Black, Hispanic, and Asian populations, but a majority of them are located in the Southeastern part of the United States and include Green Level, NC and Sedalia, NC. As Carter (2009) observes, "a large part of being raced is being placed" (p. 476).

Research on why new municipalities have been formed has historically centered on a limited number of rationales including defensive incorporations that seek to fend off the annexation advances of an

existing municipality, preserving community character, the provision of needed public services (e.g., water, sewer, parks, etc.) and fiscal concerns (i.e., taxes, grants, redistributive revenues) (Rigos and Spindler 1991, Smith and Debbage 2006, Rice, Waldner and Smith 2014). However, this research has tended to look at municipal incorporation as a monolith, in which all new municipalities are treated the same and has not considered the potential alternative rationales for incorporating that might be offered by communities of color. To this end, Smith and Waldner (2018) recently conducted a content analysis which examined the rationales for the incorporation of communities of color and determined that differences do exist between CoCs and majority white Newly Incorporated Municipalities (NIMs).

Specifically, Smith and Waldner (2018) determined that Cities of Color form as a result of several race/racism specific rationales including: environmental racism, unwanted land uses, lack of delivery of public services to the community, and municipal underbounding. Smith and Waldner (2018) state,

> "Race also indirectly drives the creation of majority-minority cities. When compared to all new cities, majority-minority cities are far more likely to form to combat environmental racism or other nuisances, such as an undesirable land use like a hog farm or hazardous waste plant" (161).

Many additional scholars have highlighted the relationship between the siting of noxious and hazardous land uses and minority communities (Pulido, Sidawi, and Voz, 1996, Sidawi, 1997, Boone and Modarres, 1999, Pulido, 2000, Boone, 2002, Bolin, Grineski, and Collins, 2005, Mennis and Jordan, 2005, Ueland and Warf, 2006, Buzzelli, 2007, Sicotte, 2008, Grinesk et al., 2010, Golub et al., 2013). These studies link race and poorer environmental conditions in numerous case studies across the United States. In the end, this literature clearly shows that communities of color are disproportionately impacted by environmental justice issues (Bullard and Johnson 2000, Taylor 2009).

This study seeks to determine if Cities of Color have poorer environmental conditions compared to new white municipalities. To explore this, the study quantitatively explores environmental conditions in new Cities of Color and recently incorporated white municipalities to determine if statistically significant differences between the two groups exist along a select group of environmental indicators. The study hypothesizes that Cities of Color will experience poorer environmental conditions compared to new majority white municipalities resulting from past environmental injustices. Environmental Protection Agency (EPA) Environmental Justice Indicators are utilized to compare environmental conditions in newly formed Cities of Color against new majority White municipalities.

Literature Review

At the center of this study are two seemingly unrelated geographic phenomena – municipal incorporation and environmental justice. The first provides a political mechanism by which unincorporated territory can be converted into a municipality, with a wide variety of legislative powers at its disposal. The second term centers on the discriminatory practice of disproportionately placing environmental ills in or near communities of color. Below is a brief examination of the scholarly literature on each topic. This literature review seeks to provide the reader with a fuller understanding of these concepts and their connection to this research.

Municipal Incorporation

Municipal incorporation is the legal process by which a previously unincorporated community seeks to be officially recognized by the state in which it is located as a local government unit (Smith 2018). The majority of states have similar standards for incorporating which include minimum population and density thresholds, minimum distance away from existing municipalities, minimum number of services offered and minimum tax rate (Smith 2018). However, it is important to note that the general requirements and minimums can differ quite dramatically by state.

Past research on the creation of new cities has focused on understanding the location and frequency

of incorporation activity (Hawley 1959, Stauber 1961, Schmandt 1965, Smith and Debbage 2011). Rigos and Spindler (1991) advanced the understanding of municipal incorporation by conducting a nationwide quantitative analysis on the factors that influence new city formation and determined that lax state regulations have a large influence on incorporation proceedings at the state level. Rigos and Spindler (1991) also coined the term "defensive incorporation" for municipalities that incorporate as a result of fear of an impending annexation by an existing municipality.

Over the last decade, the scholarship on municipal incorporation has continued to evolve. Studies that have explored the socio-economic differences between new municipalities and existing cities (Smith and Debbage 2011) and new majority white cities and CoCs (Smith et al. 2016) have been completed. Leon-Moreta (2015a, 2015b) focused on empirically studying the formation of new municipalities in the United States and determined that "income heterogeneity raises the probability of municipal incorporation" (Leon-Moreta 2015a, 3160). Leon-Moreta (2015b) also explored the influence of socio-economic factors on municipal incorporation and found that population growth, nonrestrictive land use regulations and municipal revenue also influenced municipal incorporation proceedings.

Originally identified by Hawley (1959) and Stauber (1961) more than half a century ago, new city clusters continue to be explored by scholars (Smith, 2008, Waldner, Rice and Smith 2013, Smith 2014, Waldner and Smith 2015, Smith 2018). This research has identified a herd mentality that leads to the incorporation of multiple NIMs in close geographic proximity. Waldner and Smith (2015) identified a "pioneer NIM" in the clusters they examined that paved the path to incorporation success for future NIMs. Additional research on new municipalities has sought to explore the relationship between municipal incorporation and other forms of local government boundary change including annexation, secession, and consolidations/mergers (Smith and Afonso 2016, Smith and Fennell 2012, Smith 2011).

Most recently scholars have identified the creation of majority minority NIMs and have begun the process of exploring these unique geographic phenomena (Smith 2018, Smith and Waldner 2017, Smith et al. 2016). These studies have highlighted the socio-economic differences between Cities of Color and majority white NIMs along several key variables including population size, household size, educational attainment and median value of homes (Smith et al. 2016). Other recent research on CoCs revealed that the genesis for why these communities incorporate has less to do with traditional incorporation triggers (i.e., annexation and community identity) and more to do with the role of direct and indirect racism in the form of municipal underbounding, siting of unwanted land uses and the need for public services (Smith and Waldner 2017).

Finally, according to a recent survey of these new majority-minority municipalities, the dire financial situations portrayed by many prior to incorporation have not come to fruition and almost 90% of CoCs reported budget surpluses or balanced budgets (Smith 2018). The research on CoCs is in its infancy and more scholarship examining these unique local government boundary change manifestations, like that included within this study, is warranted.

Environmental Justice

Environmental justice and the Environmental Justice Movement (EJM) seeks to remediate instances of environmental racism and is seen as an outgrowth of the Civil Rights Movement, in which communities of color began grassroots efforts to educate, remediate and prevent a myriad of harmful and discriminatory environmental practices against communities of color. Environmental racism is described as the "processes that resulted in minority and low-income communities facing disproportionate environmental harms" compared to other groups (Taylor 2014, 2) and was first utilized in the United Church of Christ Commission for Racial Justice report "Toxic Wastes and Race in the United States". Holifield (2001) offers a thorough review of these terms and an overview of recent empirical research related to environmental justice. Holifield's work highlights the wide geography that scholars have covered exploring issues of environmental justice and racism and provides a thoughtful discussion on the need for concrete definitions in the field of environmental justice.

Warren County, NC is often credited with being the birthplace of the US EJM due to a 1982 community protest against the dumping of contaminated soil in a minority community (Agyeman 2005). The results of the protests were a report generated by the General Accounting Office (GAO) of the US Government on the location of four hazardous waste landfills in the Southeast US. The study determined enough evidence of environmental racism existed for there to be concerns about inequalities in the siting of these facilities (GAO 1983).

Following this watershed moment in the fall of 1982, a multitude of scholars have explored issues of environmental justice and their impact on communities of color (Bullard 1990, Bullard et al. 2008, Taylor 2014). These studies have sought to draw qualitative and quantitative connections between environmental justice issues and communities of color. Beginning with Bullard's (1983) examination into the siting of waste dumps in Houston and continuing through today, scholars and activists have made the connection between race/ethnicity and place. Pulido, Sidawi and Voz (1996) provide an analysis of the evolution of polluting practices against communities of color in the Los Angeles region.

Meanwhile, other scholars have tackled similar issues related to the siting of locally unwanted land uses, pollution and transportation in a variety of geographies stretching across the United States (Boone and Modarres 1990, Bowen et al. 1995, Boone 2002, Bolin, Grineski, and Collins, 2005, Mennis and Jordan, 2005, Ueland and Warf, 2006, Buzzelli, 2007, Sicotte, 2008, Grineski, Staniswalis, and Peng, 2010). In sum, these studies have sought to establish a relationship between the spatial arrangement of environmental ills and minority communities. However, it should be noted that Bowen's (2002) review of more than 40 empirical environmental justice related studies determined that "little can be said with scientific authority regarding the existence of geographical patterns of disproportionate distributions and their health effects on minority, low-income and other disadvantaged communities" (3). Even if the health impacts are not scientifically indisputable – the siting and fear of these facilities are real.

In the end, the literature on environmental racism and environmental justice is clear -- these issues are issues of race, ethnicity and poverty. Bullard and Johnson (2000) state, "Environmental protection is a right, not a privilege reserved for a few who can 'vote with their feet' and escape or fend off environmental stressors" (558). Since these affected and inflicted upon communities can not follow Tiebout's (1956) hypothesis and "vote with their feet" to find a more desirable location, that meets their needs, in which to reside – could it be possible that these communities are turning to municipal incorporation as a mechanism by which to achieve spatial justice and combat environmental injustice?

Goel et al. (1988) assert that very idea in an examination of two black majority communities. Municipal "incorporation represents an opportunity for black communities to exercise an amount of self-determination" (477) and that "the strategy seeks to undertake the unfinished business of the civil rights movement" (479). Goel et al. (1988) viewed municipal incorporation as "the only vehicle left open for a segregated and powerless black community to use to empower itself" (423). However, municipal incorporation does not always generate the desired results. DeHoog, Lowery and Lyons (1991) found the incorporation of a majority black community in Kentucky resulted in poorer services and a fewer number of services for the new community largely as a result of substantial economic and racial segregation which placed additional burdens on the new city. However, this paper seeks to build upon the notion that municipal incorporation can be utilized by communities of color in an attempt to improve their communities and specifically the environmental conditions found within their borders

Research Methods

Do Cities of Color have poorer environmental conditions compared to new white municipalities? To answer this question, an analysis of majority-minority cities established in the United States between January 1, 1990 and December 31, 2009 was conducted to explore differences in environmental outcomes. The null hypothesis holds that no statistically significant difference would exist between majority-minority cities and majority white

NIMsamong a select group of environmental justice indicators. In contrast, our hypothesis is that majority-minority cities are more likely to have elevated levels of many different environmental pollutants than majority white NIMs based on the recent content analysis completed by Smith and Waldner (2017).

To determine if this hypothesis and the limited literature on this subject are correct, a multi-variate regression analysis was performed to examine the relationship between the new municipalities established in the United States between 1990 and 2010 and a group of select variables. A review of the existing literature on municipal incorporation formed the basis for choosing the majority of these variables. Upon completion of the collection of the data, SPSS was utilized to conduct a multiple regression analysis to examine if there is a relationship between environmental justice indicators and type of municipal incorporation (i.e., majority white NIMs or majority minority NIMs). All data was obtained through three principal sources: the US Census Bureau's Boundary and Annexation Study, the EPA's EJSCREEN database, and the US Census Bureau's American Community Survey (ACS).

A review of the U.S. Census Bureau's Boundary and Annexation Survey (BAS) revealed the incorporation of 435 newly incorporated municipalities between 1990 and 2009.[1] These 435 NIMs were designated either majority-minority cities (n=44) or White NIMS (n=391) based on an analysis of the race/ethnic composition of each community utilizing 2010 U.S. Census data. For the purposes of this study a majority-minority community is defined as a municipality (i.e., city, town or village) where the combined Black, Hispanic, Asian and/or Native-American population is at least 50% of the total population. White NIMs are new municipalities with a non-Hispanic White population or greater than 50% according to 2010 Census data. Since the dataset included unequal sample sizes, a bivariate independent t-test was employed to compare CoCs with majority White NIMs.

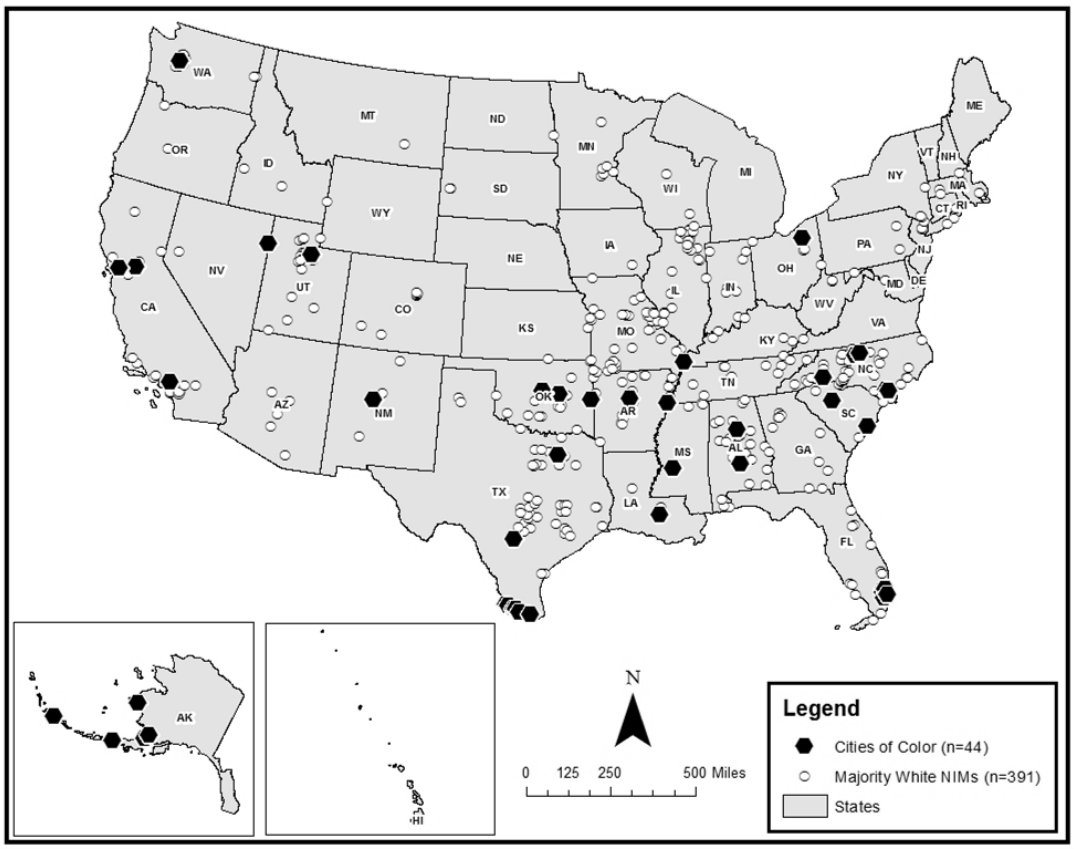

Figure 1. Cities of Color Incorporated in the United States, 1990 – 2010, Data Source: U.S. Census Bureau

[1] United States Census Bureau (2013) Boundary and Annexation Survey (BAS). http://www.census.gov/geo/partnerships/bas/bas_newannex.html (last accessed 15 August 2013).

Next, the study collected data from the EPA's EJSCREEN Mapper, an online mapping program which provides a variety of environmental justice related data for different geographies, for the 435 new municipalities incorporated between 1990 and 2010. The following variables were collected from the EJSCREEN Mapper: National-Scale Air Toxics Assessment (NATA) Air Toxics Cancer Risk, NATA Respiratory Hazard Index, NATA Diesel Particulate Matter, Particulate matter, Ozone, Traffic Proximity and Volume, Lead Paint Indicator, Proximity to Risk Management Plan (RMP) sites, Proximity to Treatment Storage and Disposal Facilities (TSDFs), Proximity to National Priorities List (NPL) sites, and Wastewater Dischargers Indicator (Stream Proximity and Toxic Concentration).[2] Table 1 provides a summary of the environmental justice indicators.

Table 1. Summary of Environmental Justice Indicators and Data Source

Indicator	Expected Relationship	Key Medium	Details	Source	Data Year
National-Scale Air Toxics Assessment (NATA) air toxics cancer risk	+	Air	Lifetime cancer risk from inhalation of air toxics	EPA NATA	2011
NATA respiratory hazard index	+	Air	Air toxics respiratory hazard index (ratio of exposure concentration to health-based reference concentration)	EPA NATA	2011
NATA diesel PM	+	Air	Diesel particulate matter level in air, µg/m3	EPA NATA	2011
Particulate matter	+	Air	PM2.5 levels in air, µg/m3 annual avg.	EPA, Office of Air and Radiation (OAR) fusion of model and monitor data	2013
Ozone	+	Air	Ozone summer seasonal avg. of daily maximum 8-hour concentration in air in parts per billion	EPA, OAR fusion of model and monitor data	2013
Traffic proximity and volume	+	Air/other	Count of vehicles (AADT, avg. annual daily traffic) at major roads within 500 meters, divided by distance in meters (not km)	Calculated from 2014 U.S. Department of Transportation (DOT) traffic data, retrieved 2016	2014
Lead paint indicator	+	Dust/ lead paint	Percent of housing units built pre-1960, as indicator of potential lead paint exposure	Calculated based on Census/American Community Survey (ACS) data, retrieved 2015	2011-2015
Proximity to Risk Management Plan (RMP) sites	+	Waste/ air/ water	Count of RMP (potential chemical accident management plan) facilities within 5 km (or nearest one beyond 5 km), each divided by distance in kilometers	Calculated from EPA RMP database, retrieved 03/2017	2017
Proximity to Treatment Storage and Disposal Facilities (TSDFs)	+	Waste/ air/ water	Count of TSDFs (hazardous waste management facilities) within 5 km (or nearest beyond 5 km), each divided by distance in kilometers	Calculated from EPA RCRA Info database, retrieved 01/2017	2017
Proximity to National Priorities List (NPL) sites	+	Waste/ air/ water	Count of proposed or listed NPL - also known as superfund - sites within 5 km (or nearest one beyond 5 km), each divided by distance in kilometers	Calculated from EPA CERCLIS database, retrieved 12/05/2016	2016
Wastewater Dischargers Indicator (Stream Proximity and Toxic Concentration)	+	Water	RSEI modeled Toxic Concentrations at stream segments within 500 meters, divided by distance in kilometers (km)	Calculated from RSEI modeled toxic concentrations to stream reach segments, created 01/2017	2017

Source: US Environmental Protection Agency. (2018). EJSCREEN Environmental Justice Mapping and Screening Tool: EJSCREEN Technical Documentation

[2] United States Environmental Protection Agency (USEPA) (2018) EJSCREEN. Retrieved April 18, 2018 from www.epa.gov/ejscreen

Additional variables included in the multi-variate regression analysis included: total population, median family income, college attainment, median value of owner-occupied housing units, percentage of housing owner occupied, metropolitan status (yes or no), and clustering status (more than 1 new municipality located within the same county or not). These variables were included within the analysis to control for variation in new cities population size, income and education level and home ownership rates. These variables have been determined to be important differentiating variables among existing cities and new cities (Smith and Debbage 2011) and white NIMs and Cities of Color (Smith et al. 2016).

One limitation of this study is the time difference between when some of the new municipalities incorporated (as early as 1990) and the age of the environmental datasets. The environmental indicators show pollution levels and other environmental hazards from a period after incorporation of the cities studied. As a result, it is difficult to draw definitive conclusions about the environmental conditions within each new municipality. With that said, this is the best statistical analysis that can be conducted given this limitation.

Findings

Data on environmental indicators was available for 413 out of the 435 new municipalities. Table 2 includes the descriptive statistics for each of the environmental indicators. Next, we compared the 44 Cities of Color to the other 391 majority white municipalities on each of the environmental indicators. Table 3 contains the results of the independent t-tests for each of the environmental indicators.

There are some large, substantively important differences that were not statistically significant in the categories of Traffic Proximity and Wastewater Discharge Indicators. Traffic Proximity and Volume are about 50% higher in the CoCs than in the majority white municipalities. However, there is a large amount of variability in Traffic Proximity and Volume within CoCs and also a large amount of variability in Traffic Proximity and Volume within White NIMs. Select municipalities in New York and California each had levels of Traffic which were more than ten times as high as the average traffic level. The presence of these outliers makes the differences in mean traffic proximity between CoCs and NIMs not statistically significant.

There are statistically significant differences in the categories of RMP Proximity and Ozone. Other than Ozone, in each category where there is a difference, levels of the environmental hazard are higher in the Cities of Color than in the majority White municipalities. According to the EPA, leading causes of Ozone include industrial facilities, electric utilities, motor vehicle exhaust, gasoline vapors and chemical solvents, which may be found in greater quantities in larger urban settings. Cities of Color have a larger mean population (approximately 13,000) compared with majority white NIMs (approximately 9,000) and as a result were expected to have higher level of Ozone when contrasted with majority white NIMs. A potential explanation for this result comes from Reames and Bravo's (2019) study which determined that blacks were less likely to be exposed to Ozone than Whites because higher ozone levels tend to be found in more suburban and rural areas with high tree canopies.

These results highlight the vulnerability of majority minority communities to the siting of pollution emitting industries and the physical geography of locating in lowlands, where wastewater treatment plants are usually located in order to accommodate gravity feed sewer systems. Historically, minority communities have been pushed to some of the most vulnerable lands within a region, which can also be some of the least expensive property (Cutter 2012). These lands are prone to flooding, downwind from polluting factories, in close proximity to transportation facilities and/or in locations that best accommodate wastewater treatment plants. The combination of market economics and environmental vulnerability put these locations at higher environmental risk than other geographies and have led to the concentration of minority residents in these spaces (Bullard 1993; Cutter 2012; Taylor 2014).

Table 2. Descriptive Statistics of Environmental Indicators

		Particulate Matter (PM 2.5 in ug/m3)	Ozone (ppb)	NATA Diesel PM (ug/m3)	NATA Air Toxics Cancer Risk (risk per MM)	NATA Respiratory Hazard Index	Traffic Proximity and Volume (daily traffic count/distance to road)	Lead Paint Indicator (% pre-1960s housing)	Superfund Proximity (site count/km distance)	RMP Proximity (facility count/km distance)	Hazardous Waste Proximity (facility count/km distance)	Wastewater Discharge Indicators (toxicity-weighted concentration/m distance)
N	Valid	413	413	419	419	419	419	419	419	419	419	413
	Missing	22	22	16	16	16	16	16	16	16	16	22
Mean		8.842	39.000	0.507	36.253	1.439	159.803	0.162	0.077	0.302	0.052	3.019
Median		9.120	38.500	0.404	37.000	1.300	36.000	0.120	0.038	0.160	0.032	0.000
Std. Deviation		1.480	3.975	0.373	9.238	0.760	394.689	0.150	0.131	0.409	0.085	27.744
Skewness		-0.805	0.530	1.521	-0.118	3.307	6.219	1.726	4.673	4.122	7.580	12.891
Minimum		4.170	29.000	0.000	13.000	0.210	0.000	0.000	0.001	0.003	0.001	0.000
Maximum		12.200	53.800	2.100	61.000	9.000	4600.000	0.890	1.100	4.500	1.200	460.000
Percentiles	25	8.175	36.200	0.255	30.000	1.000	11.000	0.055	0.019	0.085	0.016	0.000
	50	9.120	38.500	0.404	37.000	1.300	36.000	0.120	0.038	0.160	0.032	0.000
	75	9.800	41.400	0.651	42.000	1.700	120.000	0.230	0.074	0.340	0.057	0.007

Source: US Environmental Protection Agency. (2018). EJSCREEN Environmental Justice Mapping and Screening Tool: EJSCREEN Technical Documentation

Table 3. Bivariate Independent T-Test Results by Indicator

	Particulate Matter (PM 2.5 in ug/m3)	**Ozone (ppb)**	**NATA Diesel PM (ug/m3)**	**NATA Air Toxics Cancer Risk (risk per MM)**	**NATA Respiratory Hazard Index**	**Traffic Proximity and Volume (daily traffic count/ distance to road)**	**Lead Paint Indicator (% pre-1960s housing)**	**Superfund Proximity (site count/km distance)**	**RMP Proximity (facility count/km distance)**	**Hazardous Waste Proximity (facility count/km distance)**	**Wastewater Discharge Indicators (toxicity-weighted concentration/m distance)**
Cities of Color	8.416	37.373	0.486	35.79	1.515	231.46	0.131	0.086	0.518	0.054	1.165
Majority White NIMs	8.885	39.166	0.510	36.31	1.431	151.61	0.167	0.076	0.277	0.052	3.207
Statistically Significant	No	Yes	No	No	No	No	No	No	Yes	No	No

Source: US Environmental Protection Agency. (2018). EJSCREEN Environmental Justice Mapping and Screening Tool: EJSCREEN Technical Documentation

The next step in our analysis was to perform a multivariate analysis to test whether the differences we observed at the bivariate level still exist after including relevant control variables. Table 4 shows the results of multivariate model predicting levels of ozone. Percent owner occupied had a negative impact on the amount ozone, and the years since incorporation also had a negative impact on the level of ozone. Status as a City of Color was statistically related to the level of ozone once the control variables were included. Table 5 shows the results of the multivariate model predicting Proximity to RMP facilities.

No multivariate tables are presented for the other environmental indicators which were not statistically associated with status as CoC in the multivariate analysis. However, Status as a CoC was significantly related to levels of Ozone and to RMP Proximity (see table 5). Cities of Color had lower levels of Ozone and significantly higher levels of RMP Proximity.

The significantly higher levels of RMP Proximity means that residents of Cities of Color were more likely to live close to a Risk Management Plan facility than residents of majority White municipalities. EPA regulations require a company to develop an RMP for facilities that handle one or more of over 250 regulated substances under section 112(r) of the Clean Air Act. These substances include a wide range of chemicals that have been shown to cause a wide variety of medical conditions for individuals who come to contact with them.

Table 4. Multivariate Regression Model Predicting Levels of Ozone (ppb)

	Coefficients	Std. Error	t	Sig.
(Constant)	**44.09**	**1.458**	**30.243**	**0.000**
Minority NIM (1 = Yes)	**-2.044**	**0.696**	**-2.935**	**0.004**
Percent Owner Occupied (2010)	**-0.045**	**0.014**	**-3.186**	**0.002**
College Attainment	-0.017	0.011	-1.558	0.120
Median family income (dollars)	-3.17E-07	0.000	-0.030	0.976
Total Population (2010)	2.00E-06	0.000	0.197	0.844
Median value owner occupied housing units	1.07E-06	0.000	0.505	0.614
Population under Age 5	0.015	0.078	0.187	0.852
Years Since Incorporation	**-0.062**	**0.028**	**-2.214**	**0.027**

Dependent Variable: Ozone (ppb)

Table 5. Multivariate Regression Model Predicting Proximity to RMP Facilities (Facility Count per Km of Distance)

Coefficients	Coefficients	Std. Error	t	Sig.
(Constant)	0.008	0.142	0.06	0.952
Minority NIM (1 = Yes)	**0.264**	**0.069**	**3.846**	**0.000**
Percent Owner Occupied (2010)	**0.003**	**0.001**	**2.283**	**0.023**
College Attainment	0.001	0.001	1.192	0.234
Median family income (dollars)	-5.00E-07	0.000	-0.459	0.647
Total Population (2010)	**2.60E-06**	**0.000**	**2.462**	**0.014**
Median value owner occupied housing units	-1.00E-07	0.000	-0.334	0.739
Population under Age 5	-0.009	0.008	-1.092	0.275
Years Since Incorporation	0.003	0.003	0.944	0.346

Dependent Variable: RMP Proximity (facility count/km distance)

Conclusion

Numerous previous studies have highlighted the link between environmental injustices and communities of color (Bullard 1983, United Church of Christ 1987, Bowen et al. 1995, Pulido, Sidawi and Voz, 1996, Bell and Ebisu 2012). This study confirms these earlier results and found that for most of the environmental indicators, levels of hazards are higher in Cities of Color compared to majority white municipalities. Interestingly, while levels of hazards were higher in CoCs, they were not determined to be statistically significantly different compared to majority white municipalities. A potential explanation for this is Cutter's assertion on the ambiguity in research on environmental discrimination related to the threat under examination, the geographic scale for analysis, subpopulation chosen, and time frame (1995).

There were two types of environmental indicators where the differences were significant even after considering relevant control variables: Ozone and RMP proximity. Ozone levels were actually lower in CoCs, but RMP Proximity was higher for CoCs. For Ozone, the length of time since incorporation was associated with lower levels of Ozone. This may be a sign that residents of the new municipalities gain more influence, and their efforts to reduce pollution take effect gradually. One example of a strategy that municipalities could enact to reduce emissions is

requiring installation of vapor recovery nozzles at gasoline pumps.[3] Decreases in ozone may also be linked to regulation of ozone under the National Ambient Air Quality Standards (NAAQS) in differing geographies.

Meanwhile, RMP facility proximity is higher in Cities of Color than in other municipalities. This result potentially highlights the continuation of environmental racism associated with the siting of unwanted land uses that need Risk Management Plans within communities of color. For example, St. Gabriel, LA incorporated in 1994 following a proposal to locate another chemical plant in the community. The parish (i.e., county) in which St. Gabriel was located was already home to 19 chemical plants and issues of environmental racism were studied by President Clinton's U.S. Commission on Civil Rights in 1993 prior to incorporation. These majority minority communities may utilize municipal incorporation as a tool to tackle issues of environmental racism associated with the siting of facilities that need Risk Management Plans within their communities and as a result, experience higher rates of environmental hazards within their communities.

The connection between Cities of Color and Environmental Justice indicators is complex. The municipal incorporation process that birthed these new majority-minority municipalities may have been decades in the making and as a result can impact the statistical results of this study. Likewise, the EJ indicators are from current datasets and could influence the impact these factors have on new Cities of Color, especially when the CoC has been incorporated for several decades. This study does provide the first empirical analysis that explores the relationship between the incorporation of a majority-minority community and environmental concerns. Previous research, based on a review of newspaper accounts of incorporation proceedings, highlighted the role of environmental racism/environmental justice in the incorporation of new cities of color (Smith and Waldner 2018). The work represented in this study advances this area of scholarship by completing the first quantitative analysis of environmental conditions in newly incorporated municipalities.

The implications of this work include the finding that while not all variables were statistically significant in the multivariate analysis, Cities of Color do have much higher rates of environmental harms for several indicators (as measured by the environmental justice indicators from the EPA) compared to majority white NIMs. This highlights the need for "just sustainability" and a move towards "spatial justice" that more equitably and fairly allocates and disperses environmental assets and ills across a region and moves beyond the environmental sustainability focus of protecting the natural environment (Agyeman 2005, Soja 2010). Agyeman et al. (2003) argue for the inclusion of race and class into the sustainability lexicon as a means to achieve a more "just sustainability" for all. Meanwhile Soja's call for spatial justice could be realized through local government boundary change actions such as municipal incorporation (Soja 2010). This is especially critical for urban areas that face a multitude of environmental pressures that are often dumped into poor and minority communities. By connecting environment injustices (spatial injustices) and sustainability, communities may begin to plan for a more equitable and fair future.

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Conference Report: NC Geographical Society Annual Meeting - 2021

University of North Carolina at Greensboro (UNCG)
March 12, 2021

Philip Beach
Sage Ecological Services

Introduction

This report provides a brief overview of the proceedings of the 2021 NCGS (Society) Annual Meeting. The virtual meeting was hosted by the UNC Greensboro (UNCG) and was the second consecutive meeting hosted by the university and twenty-fourth annual meeting since the inception of the organization in 1970. Recent annual meetings were held at Winston Salem State University, (WSSU), NC Central University (NCCU), and as previously mentioned, UNCG.

Program

The program commenced with an introduction by Vice President (VP) Jesse Lane (UNCG). Following the introduction, a series of presentations with break-out poster sessions followed. Presenters represented several UNC Schools including East Carolina University (ECU), UNCG, UNC Pembroke (UNCP), and UNC Chapel Hill (UNCCH). Following the presentations and break out session, Jeff Dequattro, Director of Restoration, Gulf of Mexico, Nature Conservancy provided the keynote speech.

Proceedings

Kelley De Polt, Eastern Carolina University, "Compound Coastal Water Event Risk within Eastern North Carolina,"

The combination of multiple climatic drivers across spatial and temporal scales is referred to as a compound event. Flood events result from the coincidence of drivers that are typically climatic in nature. Three distinct flood drivers: pluvial (precipitation-based), fluvial (river-based), and coastal (tidal-based) have the potential for causing damages on their own, but if these drivers occur concurrently or in close succession, this is called a Compound Coastal Water Event (CCWE) and the adverse consequences of the hazards can be exacerbated leading to substantial impacts. Within Eastern North Carolina, Hurricanes Florence and Matthew are examples of CCWE, where floods occurred outside the predicted flood zone boundaries. When considering flood risk, current studies and applications for risk assessment have used univariate or bivariate approaches, typically leaving out the influence of the pluvial driver, leading to an underestimation of risk during these events. The use of multivariate statistical analysis of the three drivers included in CCWE has not yet been explored. In this project, a copula-based approach is introduced that can be used to obtain multivariate probabilistic assessments of CCWE drivers and their corresponding return periods. It has been hypothesized that the joint distributions will yield a greater hazard risk and smaller return period for each variable compared to their univariate distributions. Analyzing all drivers will provide a better understanding of CCWE and how to respond to these events.

Dennis J. Edgell, University of North Carolina at Pembroke, "A Fair Candlemas,"

This presentation represents the second in my geographical education series "Meteor-ology and Myth". The purpose of the series is to develop teaching modules which bridge topics in geography and meteorology with topics in art, folklore, religion, and culture. One question that students in my introductory "Weather and Climate" class would inevitably ask was if the "Groundhog Day" predictions are true. Although a groundhog and its shadow cannot predict the weather several weeks in advance, I found that there was a unique teaching opportunity within the folklore. Although the legend does not make short-term meteorological sense, there may be long- term upper-atmosphere circulation patterns, which have allowed this folk myth to arise in Europe, then diffuse to America. The lessons are not designed to "prove" if the Groundhog Day folk predictions are true. The point is to explain the relevant meteorological processes and cultural geographies in an interesting and accessible manner. Throughout this series, vivid and evocative imagery are used to make the atmospheric concepts engaging and memorable for general education students. Students were assessed on their ability to answer holistic questions such as "What is the cultural significance of Candlemas?" and "How will global warming lead to more severe winters?"

Poster Presentation (Room 1): Julia Cardwell, University of North Carolina, Chapel Hill, "Trends in NFIP (National Flood Insurance Program) Participation after Major Hurricanes in North Carolina,"

As the intensity and frequency of extreme events like flooding increase due to climate change, there must be an increasing focus on preventing these events and mitigating the damages when they occur. The National Flood Insurance Program offers federally backed flood insurance for at-risk homeowners. This study examines absolute and comparative novel insurance uptake in counties with and without federal disaster declarations after six major hurricane years in North Carolina to determine whether these major events were associated with an increase in policy uptake, and finds conflicting patterns depending on the year and the storm. In addition, it explores the impact of residential participation in hurricane recovery programs, like FEMA's Individual Assistance Program, on insurance uptake after Hurricane Florence in North Carolina. The study models participation in disaster assistance as it compares to insurance uptake after Florence and finds that participation in disaster assistance is positively associated with insurance uptake.

Poster Presentation (Room 2): Jahmina Ollison, University of North Carolina at Greensboro, "Dasymetric Mapping of 2016 Population of Washington, D.C. Using Hyperspectral Imagery,"

Dasymetric mapping has been utilized since the early nineteenth century for thematic cartography. As one of the most popular methods of thematic cartography, Choropleth mapping is often used to map to display statistical data, like demographic information. Compared to choropleth mapping, dasymetric mapping is a more accurate representation for displaying population data (Holt et al. 2004). This project aimed to use dasymetric mapping methods to display the 2016 population of Washington, DC using a very high-resolution hyperspectral sensor. The sensor, E0-1 Hyperion, collects 220 unique spectral channels ranging from 0.357 to 2.576 micrometers with a 10-nm bandwidth. ENVI was used to classify the hyperspectral image of the study area using the Spectral Angle Mapper (SAM) classification method. ArcGIS was utilized to overlay the classification with census data to model the distribution of the data. The overall classification accuracy was 83.08%.

Keynote Address: Jeff Dequattro, Director of Restoration, Gulf of Mexico, The Nature Conservancy, "Non-Traditional Career Pathways"

Keynote Speaker Jeff Dequattro is the Director of Restoration in the Gulf of Mexico for the Nature Conservancy. He currently works in Mobile, Alabama and specializes in coastal resilience, oyster restorations, and water use. He earned a degree in environmental studies from UC Santa Cruz and has worked for The Nature Conservancy since 2009. He was initially hired to manage a 3-million-dollar Recovery Act project to restore 1.5

miles of oyster reef in Mobile Bay but quickly took on a leadership position in the organization after the BP Deepwater Horizon oil spill devastated marine and aquatic life in the Gulf of Mexico. Since then, he has been an integral part of habitat restoration projects throughout the Gulf.

His presentation highlighted the work he was doing to improve local ecology in the Mobile Bay with several environmental restoration projects. A major highlight to his work is the coastal resilience project headed by Christine Shephard, Science Director in the Gulf of Mexico Program. Dr. Shephard guides the scientific planning projects in the Gulf of Mexico and Mr. Dequattro works to implement those projects through contracts and grant proposals. One of their main projects is the restoration of natural coastlines. They implement these projects by working with local communities and stakeholders to improve coastal resilience and help underrepresented communities avoid ecological disasters. One way that Mr. Dequattro works with underrepresented communities is through GulfCorps, a conservation program designed to provide restoration jobs for local young adults. Each crew works to redesign and restore natural features in prominent conservation land in the Mobile Bay and Gulf Coast regions.

Business Meeting

NCGS members discussed plans for the North Carolina Geographer, the biannual newsletter, and the financial situation with the organization. For more information on the Business Meeting, go to our website at: https://ncgeography.org/.

The North Carolina Geographer

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