Spring 2022

Safe Water for All: A Multi-Modal Approach to North Alabama's Water Resources

Elijah Walker
ewalker2@stu.jsu.edu

THESIS APPROVAL

Candidate:	Elijah Max Walker
Major:	Geographic Information Systems & Technology
Thesis title:	Safe Water for All: A Multi-model Approach to North Alabama's Water Resources

Approval:

Mark Sciuchetti — April 8, 2022
Mark Sciuchetti
Assistant Professor of Geography
Thesis Chair

Daniel McGowin — 10 April 2022
Daniel McGowin
Assistant Professor of Geography

M. Sean Chenoweth — April 8, 2022
M. Sean Chenoweth
Associate Professor of Geography

Channing R. Ford — April 15, 2022
Channing R. Ford
Dean, Graduate Studies

JACKSONVILLE STATE UNIVERSITY

COLLEGE OF SCIENCE AND MATHEMATICS

SAFE WATER FOR ALL: A MULTI-MODAL APPROACH TO NORTH ALABAMA'S WATER RESOURCES

By

ELIJAH MAX WALKER

A Thesis Submitted to the
Graduate Faculty
of Jacksonville State University
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science
with a Major in
Geographic Information Science & Technology

2022

Dedicated to Tracey Walker,

a passionate educator, a science advocator, but most of all a loving mother.

(1969-2020)

ACKNOWLEDGEMENTS

Firstly, I want to express my gratitude towards my thesis advisor Dr. Mark J. Sciuchetti Jr. for guiding me in producing my entire thesis. I appreciate him educating me along the way by providing resources, research etiquette, necessary tools, notifying me of deadlines, and helping with the publication of this work. I hope to continue working together in the future within the field of GIS. I give thanks to my committee for their continued support and encouragement: Dr. Daniel McGowin; Dr. Sean Chenoweth; and Dr. Joe Morgan. I offer my sincere appreciation for the learning opportunities provided by my committee.

My completion of this project could not have been accomplished without the support of my friends and family, Gracie Mae Walker, Colby Sims, Zach Burns, and all who participated in surveys/interviews – thank you for sending out my survey, driving me around the Tennessee River Valley, educating me on Alabama farming practices, and contributing to the study. To my parents as well, Mr. and Mrs. Walker. Encouraging me to always seek the education route and helping to that route, financially.

Finally, to my caring, loving, and supportive "soon-to-be" wife, Juliana: my deepest gratitude. Through the late nights, research endeavors, and geographic lectures, you were always my number one cheerleader. I know with the continuation of this study and no matter where it takes me you will always be by my side giving me full support. Thank you for always going above and beyond in everything that you do.

_____

Elijah Max Walker April 24, 2022

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Environmental degradation is a destructive force produced by the human disturbance of pollution. It is a phenomenon that gradually evolves landscapes over time resulting in irreversible outcomes. Environmental degradation physically affects spaces' resources, objects, and inhabiting humans. This study observes the impacts of pollution beyond physical boundaries and how it affects human identity/sense of place through the utilization of geographic information systems. Specifically, it examines cultural identity developed through human experiences and connections to landscapes containing water resources. Following, pollution contaminates water resources disrupting experiences and connections thus causing the cultural identity to disappear. The case study applied to this research is the Alabama cultural identity connected to the Tennessee River that flows through the northern portion of North Alabama.

Alabama citizens formulate deep connections to landscapes through farming, attaching religious symbolism to the environment through biblical references, and perform Christian practices with objects found in spaces (Tuan, 1974). Due to the contamination in the Tennessee River, this affects utilization of water for farming and Christian practices performed in the river because of the threat pollution poses. As a result, Alabama cultural identity disappears halt of experiences against an unfamiliar landscape degraded by pollution. Testing this hypothesis, this research utilizes a mixed methods approach applying multiple analyses and models.

Participatory observations, surveys, and interviews accomplished the qualitative analysis of Alabama culture. Then, the collection of multiple amounts hydrological data, survey statistics, interviews, poverty data and land use data were inputted into the geographically weighted regression model completing the quantitative analysis of water pollution. The model that was

implemented was the Arc Story Map. Then, Arc Story Map presented the data visually for the public.

CHAPTER ONE

INTRODUCTION

This thesis connects topics of identity and sense of place from cultural geography with the issues of water contamination in the Northern portion of Alabama, including the following counties: Madison, Marshall, Morgan, Jackson, Dekalb, Lauderdale, Lawrence, Colbert, and Limestone (Refer to Figure 1). The research attempts to examine how human identity and sense of place is affected by degraded water resources. Environmental degradation is the destruction of the pristine landscape through anthropogenic forces. This in turn destroys identity and the sense of place for those that are affected by the change in the landscape, especially those who depend upon it. This research examines the flow of pollution into water sources located in North Alabama and observes citizens' identity developed through an interrelation with their places, landscapes, and culture. Our identity as human beings remain tied to our land, to our cultural practices, our systems of authority and control, our intellectual traditions, our concepts of spirituality, and to our systems of resource ownership and exchange.

This thesis offers a new look at environmental degradation of the landscape, with a focus on the spatial identity that is changed or lost because of degradation. The importance of this study is to locate and monitor pollution in the Tennessee River (Refer to Figure 2). According to the Geological Survey of Alabama, groundwater and surface water are hydrologically interconnected together to provide water for public, industrial, agricultural, and recreational use. Water is a necessity to human existence and is utilized by many institutions in Alabama. Contaminated water harms human health, pristine landscape, and wildlife, which are irreplaceable. This work contends that water contamination affects not only human health and the physical landscape but much more, it disrupts a deeper aspect of life, a sense of identity and

place. This research sheds light on the matter of water contamination affecting these geographic concepts publicly.

It is essential to provide a proper definition of the sense of place, religion, identity, and environmental degradation. Defining sense of place and identity will explain how they interrelate with one another and how environmental degradation can destroy the interrelationship of each in a group. Sense of place is strong emotions for a particular location. It is essentially a desired longing for a space. Once humans occupy that space it transitions into a place. Sense of place is one of three elements of the concept, place. Place contains three fundamental components including location, local, and sense of place (Cresswell, 1996). Sense of place is our impression attached to areas based on experiences from an inhabited space. Humans have a sense of place that is a sacred attachment to the land they occupy.

Another element identified in this work is religion. Religion is a cultural system comprising of multiple symbols that humans guide their existence. Religious symbols are tangible notions, abstract experiences fixed in perceptible forms, concrete embodiments of ideas, attitudes, judgments, longings, or beliefs (Geertz, 1993). A further explanation to generate the knowledge of symbols, is when we see a gray cloud, we generalize that it is about to rain this same idea is seen in religion. When religious cultures view a setting sun over a green landscape from a bluff it causes them to think abstractly outside the confides of the horizon. They recognize a higher being's handiwork that produced the landscape. Humans allow religion and symbols of religion to guide their very existence. It establishes power, creates long-lasting moods, and it motivates humans by formulating an order of existence (Geertz, 1993). Viewing religious symbols, humans uphold a sacredness of the landscape or modify it to create emotions. Through religion, we attach spirituality to place and practice to imbue every-day, local realities

with the most profound significance (Thomas, 2001). Alabama's large religious presence enhances citizens' attachment to the landscape. Whether it is rivers, mountains, forests, or beaches citizens sustain almost a religious experience viewing these landscapes offering appreciation to a higher being. That attachment is so impactful that whenever citizens partake in a religious practice, sense of place can come to mind creating a deeper emotion.

Once humans occupy an area for a length of time within a landscape, they begin to develop an entirely different phenomenon known as identity. Sense of place is a sensation to humans. Identity is our identification relative to the landscape from a deep connection to the environment. People develop their identity according to the region and climate conditions they live in. Geographical conditions shape people's view of life, the values they have and their expectations. The identities developed is local, regional, or national identity. Alabama's regional identities are structured along geographical features and conditions. Majority of humans in North Alabama populate along the Tennessee River. Citizens that occupy this region develop identities contrasting to citizens living in the Blackbelt and Gulf Coast region. The rural Northern Alabama identity develops from a landscape of large farming and the Tennessee River (Refer to Figure 3). The midsection of Alabama is the Birmingham metropolitan area and the Blackbelt region, a name associated with the dark prairie soil located in the region (Gibson, 1941). This section of Alabama contains a different cultural identity due to larger black rural population and landscapes containing the large urban settlements of Birmingham and Montgomery. Then, the gulf coast contains a regional identity developed from tourism (Reeves, 2012). Human identity appears different along various spaces but it all stems from the connection to the landscape. That connection develops structures distinguished from other areas culturally, historically, politically,

and socially. If the landscape degrades enough, humans experience the area differently, or even a change in their identity and experience with a change in the landscape

The depletion of landscapes creates unfamiliarity to inhabiting populations and stops utilization of resources. Unable to experience the landscape destroys identity, sense of place, disturbs the pristine environment, depletes resources, and extinction of animal populations. An example of an issue that can cause environmental degradation is pollution. Pollution is the emission of a harmful substance into the environment. It comes from a variety of sources, including vehicle emissions, agricultural runoff, accidental chemical release from factories, and poorly managed harvesting of natural resources (Choudhary et al., 2015). Through participatory observations, pollution produces from multiple sources (i.e., vehicle emission, chemical release, from factories, and from agricultural runoff) flowing into water sources through surface runoff was observed in this study. Utilizing this data and further ADEM data, this research presents the submission into a statistical model. The model connects statistical visuals with nonpoint pollution in the Tennessee River. The human parameters connect with pollution data to display the causes that degrades the environment.

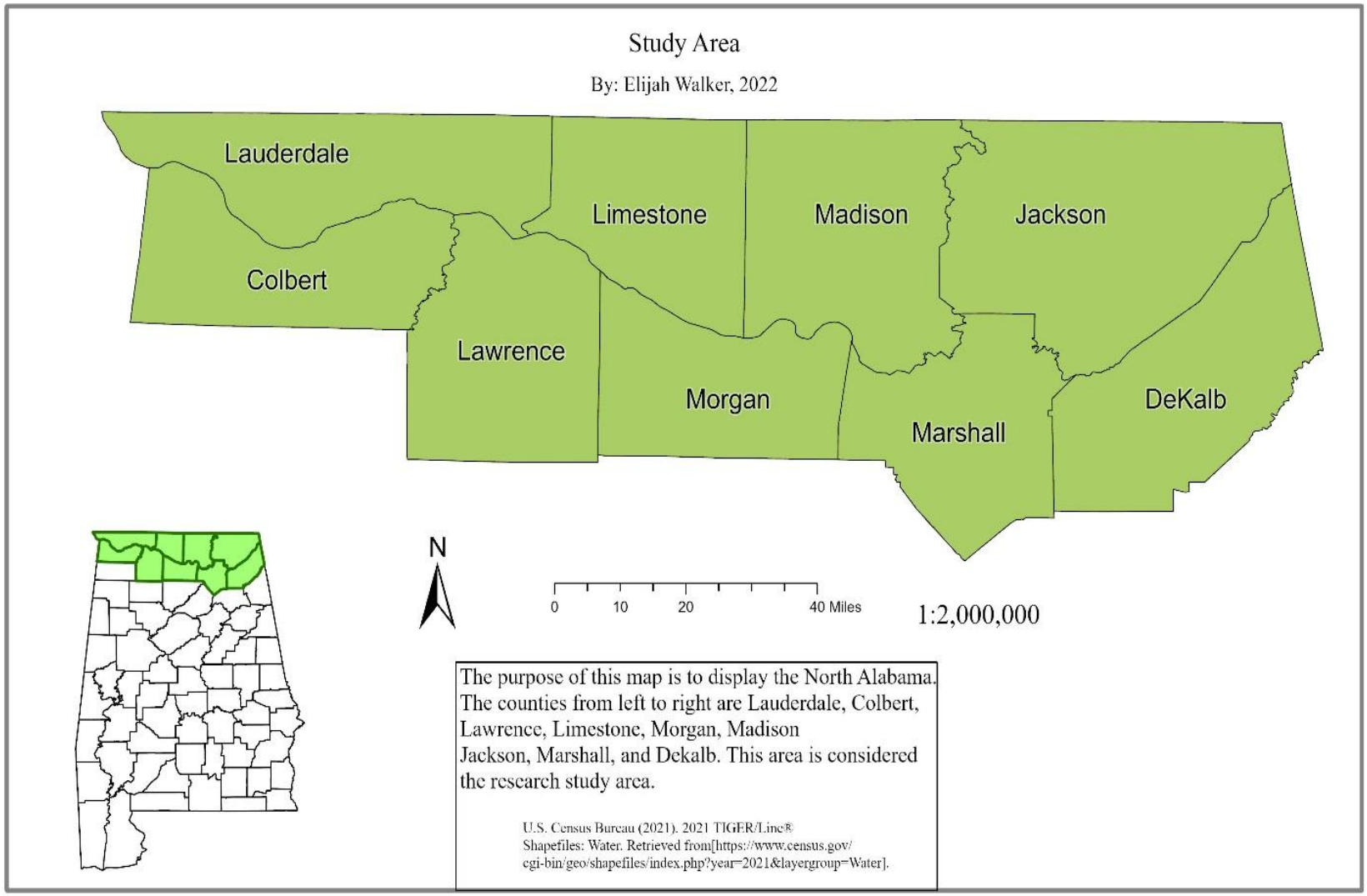


Figure 1. Study Area, North Alabama Counties

The purpose of Figure 1 is to present the study area which comprises the counties in North Alabama. The nine counties selected for this research are as follow: Lauderdale, Colbert, Limestone, Lawrence, Madison, Morgan, Marshall, Jackson, and DeKalb. The Tennessee River flows through these nine counties and influences the lives of citizens and sense of place. These counties and river classify as the landscape within this study. The data accessed to create this map is from the TIGER/Shapefile database on the United States Census website.

The purpose of Figure 2 is to present the main water resource that is observed in this research. The lower Tennessee River basin flows through nine counties in North Alabama. The river is an essential role to the lives of citizens. Citizens utilize it for commerce, recreation, agriculture, and religious practice. As a result, the river develops culture, identity, and sense of place that strongly links to the water source. Unfortunately, the Tennessee River contains large amounts of pollution that develops from different causes and multiple sources. The data accessed to create this map is from the TIGER/Shapefile database from United States Census website.

The context of Figure 3, this map is to display population levels per census tract along the Tennessee River. It visualizes and provides characteristics of the landscape in North Alabama. Pollution is an entirely human-caused phenomenon. The darker tracts indicate the areas where pollution is likely to develop. The data accessed to create this map was from the American Community Survey from United States Census website. The first applied step was the extraction of the table as an Excel spreadsheet and then the removal of all unnecessary data. The next step, uploading the table to ArcGIS Pro and then accessing the tool *Create Feature Class* to create an empty polygon layer titled Poverty layer. Then accessing the *Append* tool, appends the poverty table to the Poverty layer. The final step is the joining of the poverty table to the North Alabama shapefile accessed from the Census website.

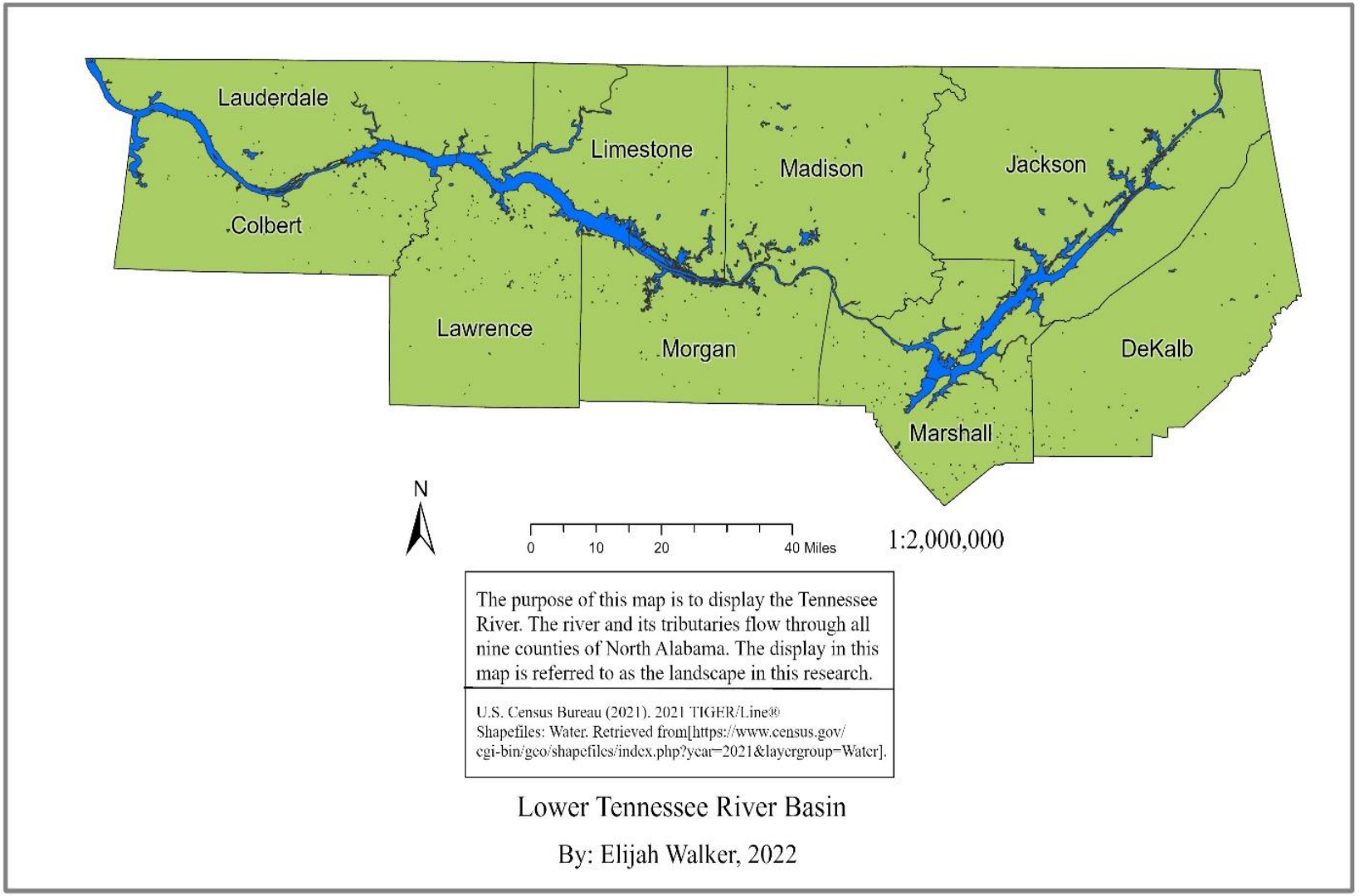


Figure 2. The Lower Tennessee River Basin

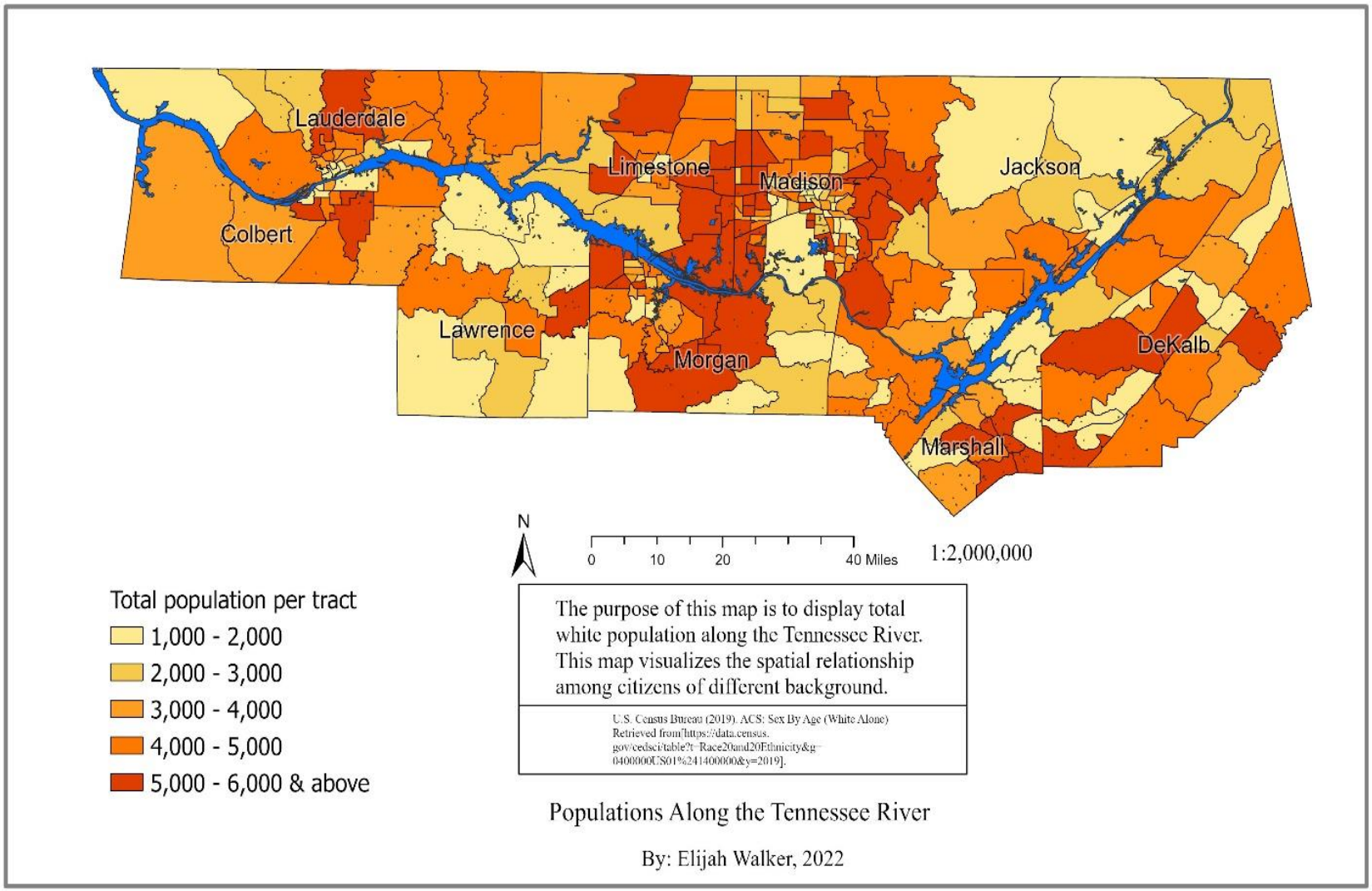


Figure 3. Population Totals for North Alabama in 2020

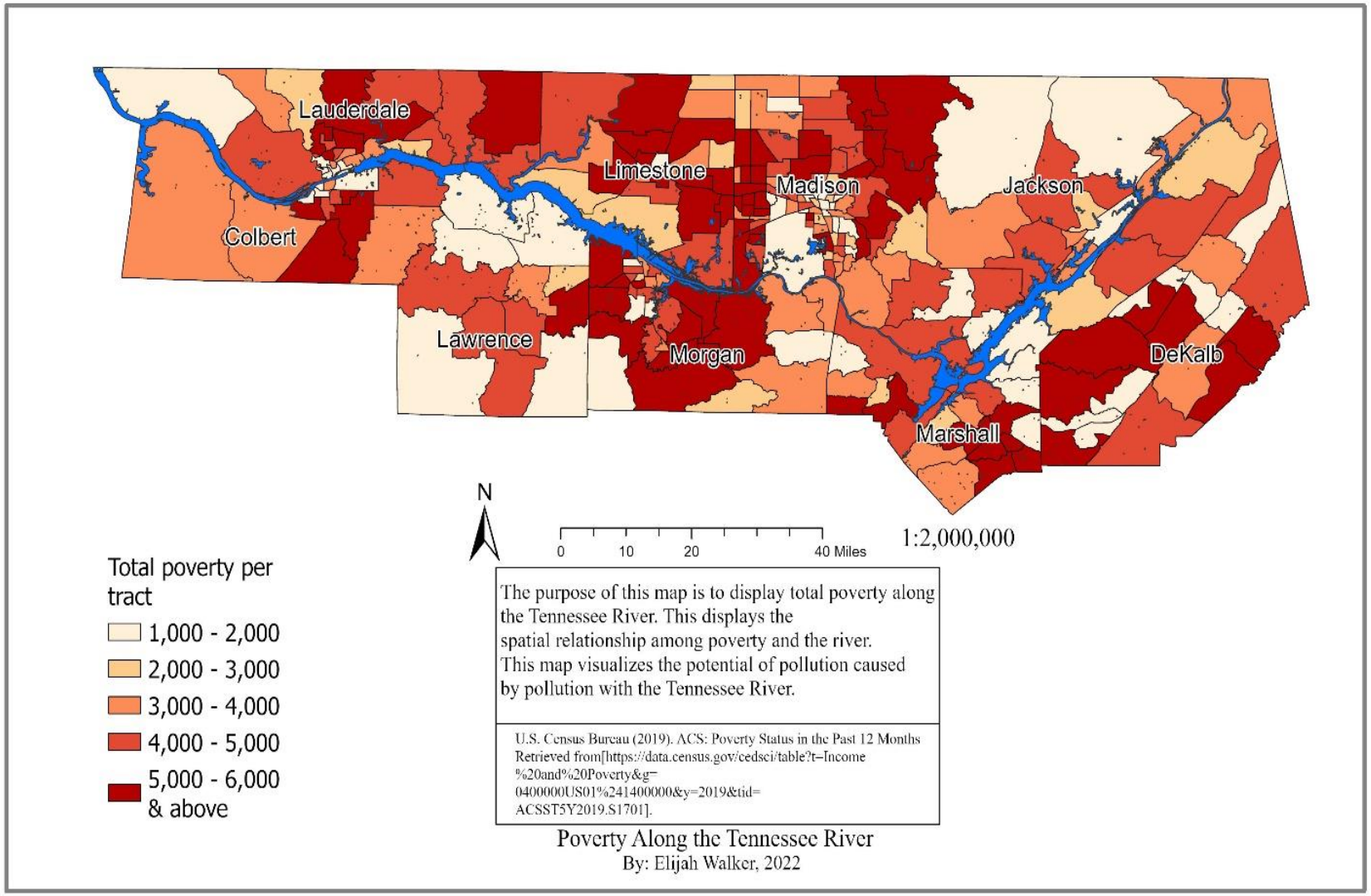


Figure 4. Poverty Totals for North Alabama in 2020

The context of Figure 4, this map is to display total poverty levels along the Tennessee River. It visualizes and provides characteristics of the landscape in North Alabama. This is an important human parameter that this research attempts to link as a cause to pollution in the Tennessee River. Poverty causes the inability to invest in proper sanitation facilities and the capability to maintain them. Then, impoverished people that live in the streets leave their trash and waste on the streets which is carried by surface water into waterways. The accessible data to create this map is from the American Community Survey from United States Census website. First step is the extraction of the table as an Excel spreadsheet and the removal of unnecessary data. Next, uploading the table to ArcGIS Pro and utilizing the *Create Feature Class* tool to create an empty polygon layer titled Poverty layer. Then, the appending of the poverty table to the empty Poverty layer through the *Append* tool. Finally, the joining of Poverty table to a North Alabama shapefile accessed from the Census website results in the completion of this map.

In Figure 5, this map presents the Black and African American population along the Tennessee River. Observations were made on how humans from different backgrounds interact with the river, form different identities/sense of place, and are impacted by environmental degradation. This map introduces where Black and African American citizens that populate along the Tennessee River. The larger populations of Black and African Americans in Morgan, Lawrence, Madison, and Colbert are in urban areas directly next the river, but citizens are located along the Tennessee River in rural areas. The data accessed to create this map was from the American Community Survey from United States Census website. The extraction began with the table as an Excel spreadsheet and removed unnecessary data. next, then the table was uploaded to ArcGIS Pro and used *Create Feature Class* tool to create an empty polygon layer

titled Poverty layer. The *Append* tool appended the poverty table to the Poverty layer. Finally, the poverty table was joined to a North Alabama shapefile accessed from the Census website.

Figure 6 presents the White population along the Tennessee River. This research observes how humans from different backgrounds interact with the river, form different identities/sense of place, and are impacted by environmental degradation. This map introduced me to where White citizens are located along the Tennessee River. The darker tracts are more spread apart compared to the African American populations who are located directly on the river. Indication of denser areas being located away from the Tennessee River does not mean they do not interact with the water. The Tennessee River's tributaries are carved across North Alabama's landscape. Many of the darker tracts are located near branches of the river and in rural locations.

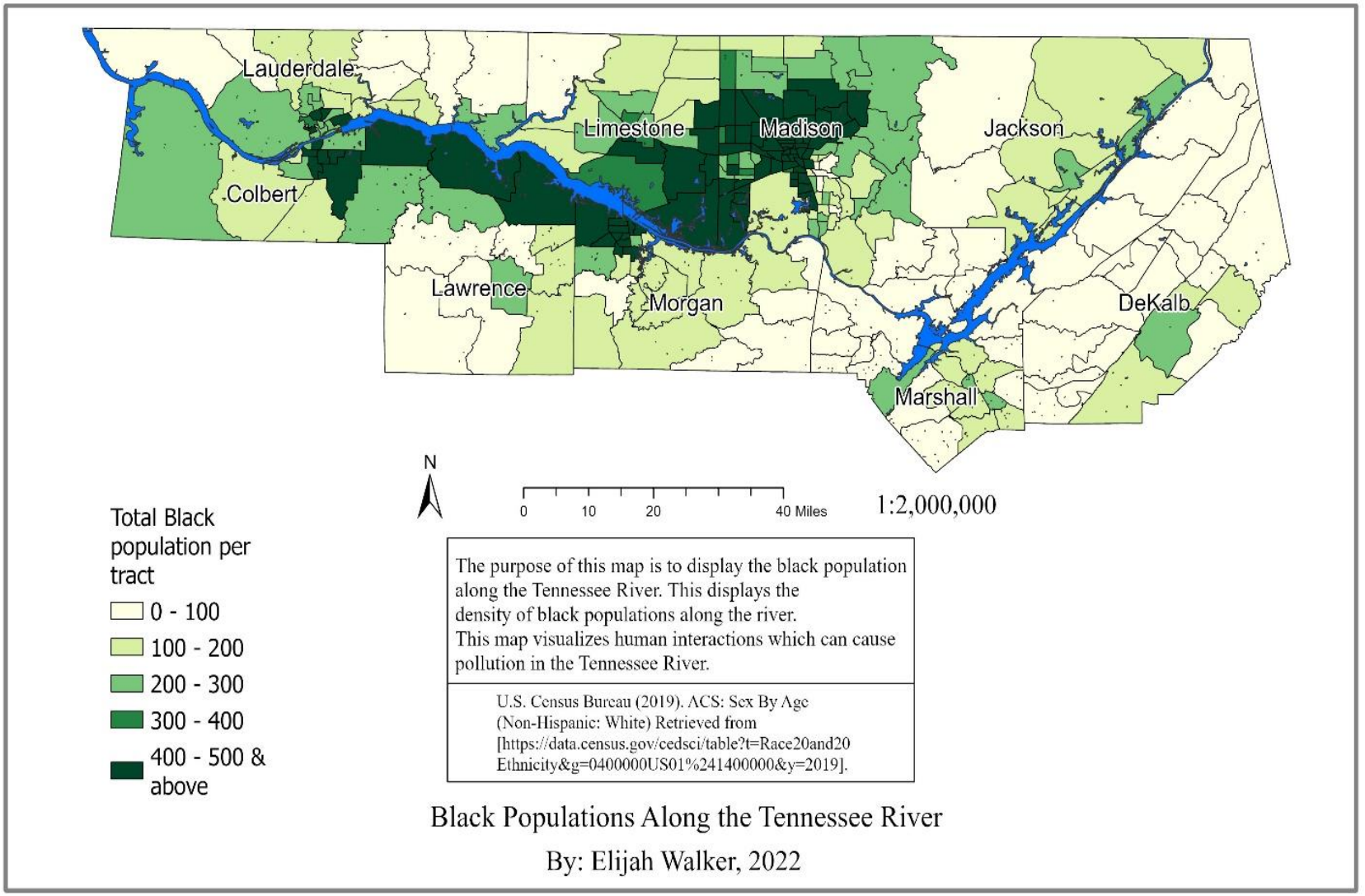


Figure 5. Black or African American Population Along the Tennessee River

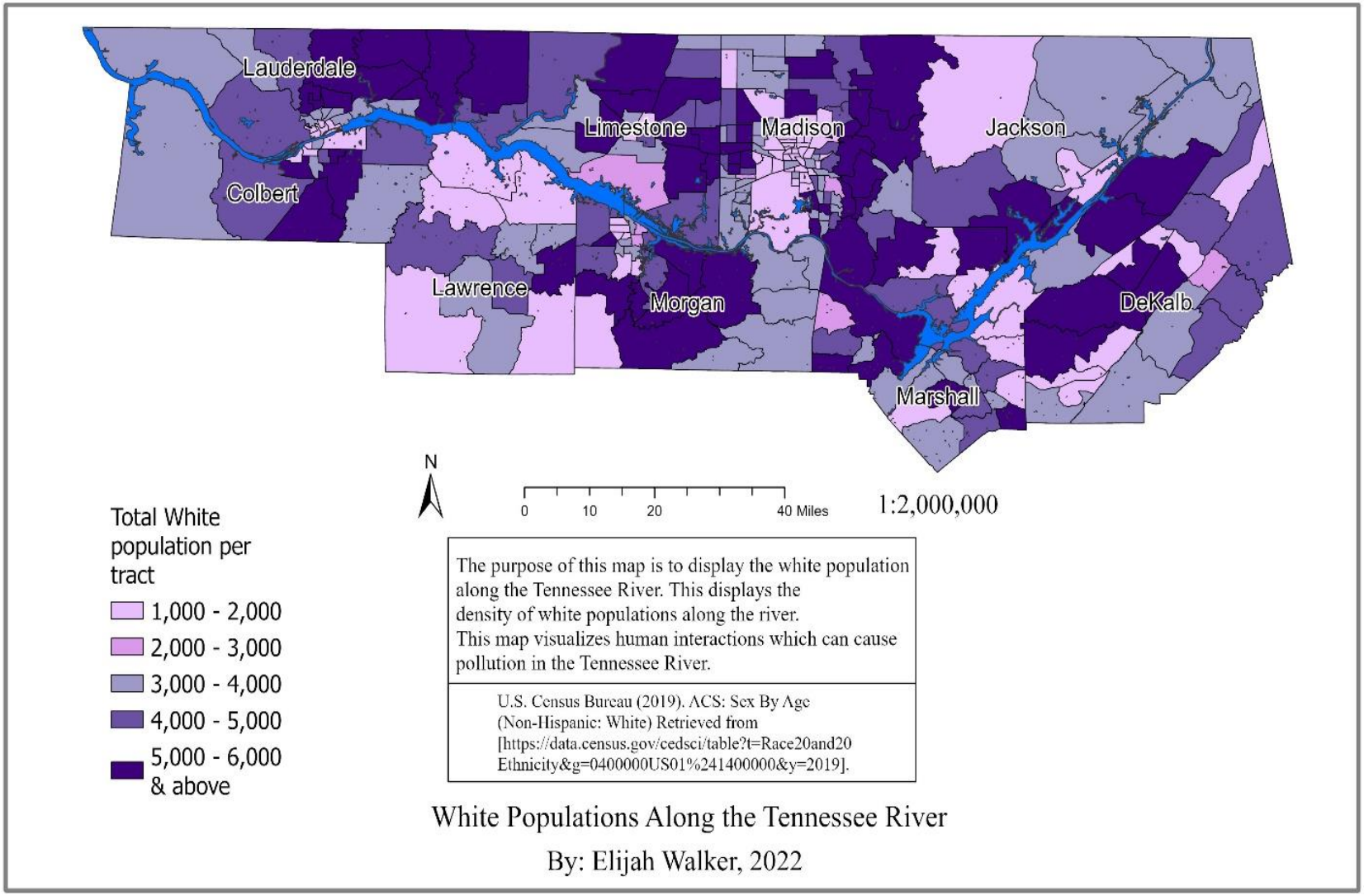


Figure 6. White Population Along the Tennessee River

This thesis observed how water contamination impacts North Alabama through a multi-modal approach of qualitative human geography and GIS modeling. “People are highly affected by the degradation of our planet and these unhealthy practices cause the illnesses, death in children and adults.” (Choudhary et al., 2015, p. 3) Observing the impacts of water contamination explains the severity of environmental degradation not as just the depletion of the environment but as a depletion of a populations sense of place and identity. Ideally, to reduce the severity of water contamination, an investment in environmental protection, such as water sanitation facilities, is required. Impoverished populations struggle to manage the severity of environmental degradation because of the inability to invest in proper sanitation. Unable to obtain adequate water facilities and unable to stop the flow of pollution, poverty worsens the severity of water contamination. Low-income groups pollute because they lack provision of proper sanitation and drinking water facilities (Duraiappah, 1998).

This thesis focuses on poverty-stricken areas in Northeast Alabama to explore identity. Alabama is the United States fifth impoverished state. According to the *2020 Barriers to Prosperity Data Sheet*, 800,000 Alabamians live below the poverty line. “Alabama’s poverty rate of 16.8% remains substantially higher than the national average of 13.1%” (Alabama Possible Staff, 2020, p. 1). Each county represented in this research experience percentages above the 10% average poverty line (see Figure 3). Madison and Limestone counties maintain a poverty rate of 11.9 and 11.4%. This is only over one and a half percent above an average poverty rate. Lauderdale, Marshal, and Jackson counties obtain a higher percentage ranging from 14.0 to 19.7%. The water source chosen for this research is the Tennessee River. The Tennessee River is an important resource for Northeast Alabama. According to the USGS, “Surface water is the primary source of drinking water for the cities located along the main stem of the Tennessee

River and its major tributaries" (United States Geological Survey, 2004, p. 1). Not only does the Tennessee river provide drinking water for Northeast Alabama, but it is also utilized for transportation, recreation, and religious purposes. The river has always been a key to the economic development of the Tennessee Valley and an important mode of transportation for people and products. (Tennessee Valley Authority, 2020). While all societies need water for drinking, cooking, hygiene, agriculture and livestock, some societies also use water for religious ceremonies, exercise, diversion, and even aesthetics (World Health, 2005). Water is essential to Alabama cultural aspects which is agriculture and religion.

Water contamination affects all parts of society, but the impact is different for various members of society. Water contamination is interpreted differently between average citizens, administrators, or even government officials. Since environmental degradation causes health risks or death, understanding the impact from personal accounts can explain the severity of such situations. Monitoring levels of pollution explains the physical level of pollution, but this study added personal accounts in the form of surveys/interviews to explore the effect of this pollution on citizens. The spatial context within which events occur is through attachment to the landscape, which produces identities and existence that are entirely dependent on the landscape.

Water contamination then depletes the landscape along with the identities and sense of place. The objectives of this research are to analyze how the degradation of the of waterways impact the citizens of Northeast Alabama that are at or below the poverty line, to observe how environmental degradation affects identity and sense of place and present a hydrological model that combines the impacts of water contamination and the cultural effects on Northeast Alabamians. More specifically, this work discusses how and why water contamination affects Alabamian's identity and sense of place through presentation of a hydrological model monitoring

pollution. The model to monitor pollution statistics and its relationship with qualitative parameters is a geographically weighted regression model (GWR). GWR is a versatile linear regression model that compares spatial varying relationships (ESRI Staff, 2021). The model requires a human parameter of census data. This being the only human data as an input, cultural information was included in conjunction with the model. The cultural information applied to hydrological not only adds human information, but it enhances the entire model. The hydrological model examines what it does to the landscape and humans physically, but it does not demonstrate how it affects who we are in relation to culture, identity, and place. Users can observe that it impacts agriculture because of the cycle of pollution returning into the cultivation but the cultural analysis added to the model demonstrates that it affects the cultural practice of farming. If the pollution destroys crops, then farmers will change traditional practices to avoid depletion.

The broader impact of this work lies in connecting a physical process of environmental degradation to human aspects of identity and sense of place through mapping. It is understood that landscape's resources create identity and sense of place through experiences, but water contamination affects that experience. In a geographic information system, uncertainty arises when trying to map identity and sense of place. This research maps pollution, contaminated water sources, and depleted landscapes, connecting how identity/sense of place is affected by the mapped phenomenon. This work also joins the scholarship that has been ongoing in the fields of human geography, GIS, ecology, and hydrology. It follows from work done in studies on environmental degradation, culture, sense of place, and identity. This research will be given to Northeast Alabama groups to assess their water quality and possibly offer policy solutions that focus on a ground up model, looking at ordinary people.

The intellectual merit of this research is to join the work that has been done on identity, sense of place, hydrology, and environmental degradation into a larger conversation on the relation to identity. This research will result in cultural analysis of Northeast Alabama from personal autobiographical accounts including participatory observations to study identity and sense of place connected to the landscape. Then a hydrological analysis is applied to study nonpoint source pollution in the Tennessee River to comprehend how an identity connection can become destroyed as water contamination depletes the landscape. This will help researchers to comprehend how we can analyze individual's connections to the spaces they inhabit and the places they create from those spaces.

The utilized methods are surveys through the ESRI product Survey123 discussing water contamination, location of pollution, and its effects on North Alabama citizen. Participatory observations to observe seven specific locations where pollution is prominent, to detect contaminated water/deteriorated landscapes, and observe human responses to the deteriorated landscapes. After the participatory observations, applying a cultural analysis across the surveys, interviews, and participatory observations to provides knowledge on North Alabama culture then how pollution disrupts it. Finally, this research applies a statistical analysis with a geographically weighted regression model.

The structure of chapters in this work are as follow Introduction that defines related terms, introduces the study area, present hypothesis, and provides context of the spaces observed. The second chapter is the Literary Review that introduces previous and guiding literature for this research. Chapter three is the methods, collected data, and introduces the objectives of my research. Chapter four is the analytical applications where GIS methods were applied to the collected data completing my research objectives. Chapter five is the results and conclusions.

CHAPTER TWO

LITERATURE REVIEW

2.1 Geography

The literature found in this section provides a general knowledge of the discipline of geography, modern geographic thought, and geographic information systems. According to Thomas J. Baerwald in *Prospects for Geography as an Interdisciplinary Discipline*, geography builds on major emphases in spatial analysis, human–environment interaction, place-based and regional analyses to encourage communication and interaction between other disciplines (Baerwald, 2010). Specifically, this research emphasizes the human-environment interaction and place-based/regional analysis.

According to Baerwald (2010), Human–environment interaction considers the connections among human and natural systems at a variety of scales. Citizens of North Alabama are connected to their water resources because it provides water for crops, drinking water, and means of recreation. Place-based and regional analyses emphasize the role of place and space as factors that influence human welfare and livelihood as well as human–environment interactions (Baerwald, 2010). Many communities live along the Tennessee River this causes citizens to interact, develop connections, and allow the water system to form their identities. Since these communities are located spatially next to the river and allow it to influence their existence then the Tennessee River being environmentally degraded it will dangerously affect citizens physically and mentally.

When geographers connect space, place, interactions, and dynamics along different spaces and places, it causes geographers to range “far from field’s core and explore the peripheral realms where geographic perspectives and insights intersect with those from other

fields" (Baerwald, 2010, p. 1). How this research utilizes geography as interdisciplinary study by linking hydrology and ecology. This research's scope of study ranges between the physical landscape to different water systems. It requires incorporating the disciplines of hydrology by observing hydrological data and incorporating it into the analysis/model.

Then, the discipline of ecology is added to understand the effects of pollution on the landscape, environmental degradation, and the mitigation to stop the depletion of resources. Both disciplines are linked together through the discipline of geography by observing human relationships, connections, and impacts on the hydrological and ecological data. Geographers are not bound by certain topics and methodological approaches. Geographers explore how different topological domains relate to one another, we welcome multi-model approaches, and develop broader theoretical understandings as well as provide information/insight with practical applications (Baerwald, 2010). Geographers look beyond their own field to explore topics that would seem to lie in other fields has been an inherent trait of geography evolving into a modern discipline.

Examples of looking beyond the boundary of geography is found in the text, *Modern Geographical Thought* by Richard Peet. Peet connects the disciplines of metaphilosophy, philosophy, and social theory connected to the idea of "modern human geographic thought." Metaphilosophy links world views, cultures, and thinking organized around theoretical concerns. "Metaphilosophy is a conduit carrying cultural values into theory. It is active too in carrying theoretical and philosophical persuasion and informed thinking into culture" (Peet, 2006, p. 4). Metaphilosophy structures different philosophies into main themes based on, "historical changes of the standards of truth and efficacy applied to thinking" (Peet, 2006, p. 4). Peet structures the themes of thought by different eras (premodern, modern, to postmodern). Below metaphilosophy

stretches across the multiple eras meaning the way we understand our fundamental existence changes across time. The categories he distinguishes metaphilosophy is God, Meaning, Truth, Emancipation, and Groundlessness. Then, under different categories philosophies range across metaphilosophy containing specific ideas.

Peet defines philosophy as the "abstract way of thinking which employs logic to organize imaginaries, beliefs, and notions of purpose into formal systems of understanding (Peet, 2006). Peet explains that philosophy produces the structures that people employ into the development of their lives. Religion is a philosophical structure that North Alabama citizens allow to develop their lives. They believe that their overall fundamental existence and the spaces that surround them are created by a single being. All the natural phenomenon that happens to them or within the spaces is believed that it was destined by God. This means if an unnatural phenomenon happens like pollution affecting their lives, then it is going to leave a larger impact because they believe it is a test of their faith. The effects caused by pollution on them, or on their spaces tests their philosophical structures because they believe all is given by their supreme being (Peet, 2006).

Social theory strictly involves social, political, and cultural tendencies and characteristics in different societies. Peet states that social theory is a storage and bridging device that stores summarized results of work in one area in the form of ideas that can be transferred across theoretical bridges into other fields (Peet, 2006). In Thomas Baerwald's work he provided context that geography is an interdisciplinary field that can link other disciplines to answer specific research questions. Peet uses social theory as an example to explain how specialized fields overlap into other disciplines. "Specializations overlap and transcend disciplinary boundaries" (Peet, 2006, p. 6). The example Peet uses is when postmodernists upsurge in social-

theoretic interest in space. How social theory is specifically applied is through the mixed-methods approach, combined data from different disciplines, and the use of the Bayesian model.

My research's methodological framework is a mixed-methods approach. This idea automatically uses concepts the of social theory. This research applied different methods qualitative and quantitative methods from across multiple disciplines to form ideas. Following, this research, uses the GWR model to create a theoretical bridge that connects the quantitative hydrological pollution statistics and qualitative demographic/geographic data to explain that this the cause of it. Through the outcomes it creates new ideas that social, political, and cultural tendencies/characteristics causes pollutions or is destroyed by it. Peet then discusses the main purpose of social theory is that it is dedicated to improving the world so that it will be a better place for the poor and oppressed (Peet, 2016). This study is dedicated to human emancipation by providing all citizens of different backgrounds to have safe water. Then, the research attempts to influence policy to help clean the water systems for all organisms, provide better water sanitation guidelines in Alabama, and provide safe water for all.

Finally, Peet links the multiple disciplines to introduced to me a philosophical theme in contemporary geographical thought. Framing this piece of literature into the research, an adoption of radical geographic approach to argue for a change in spatial topics of concern in the direction of urgent issues (Peet, 2016). Water contamination is affecting all facets of North Alabama society and environmental degradation is furthering the overall impeding threat of climate change that is now a matter of when. Both topics are an urgent issue that remains in the dark in the state of Alabama. Stressing the efforts of this research produces an awareness in Alabama of the dangers of water contamination by breaking past the boundaries of physical impacts but a more psychological impact on our identity. As a result of this awareness, the

research educates the regular citizen to political leaders on how pollution depletes cultural institutions along with the environment. This research is a steppingstone to generate discussion towards an overall agenda for improved water quality standards. Peet defines this radical fight for change as "social relevance." Clean water should be provided equally among all citizens instead it is based on city funding. North Alabama does not contain large urban metropolises. Instead, they are rural communities or large-scale suburban towns. They can obtain sanitation facilities that meet the standards for clean water but do not obtain the funding to thoroughly clean the water. Some rural communities contain facilities that contain poor infrastructure causing contaminants to encroach the filtering systems. Through the efforts, the goal is to help bring a statewide change for sanitary water for all societal members and marginalized people of North Alabama. This work attempts to reach the minds of North Alabama citizens by applying a radical approach by presenting the destruction of religious practices, agricultural practices, and the environment from pollution in this work. The research radical means will truly achieve change (Morrill, 1969).

Peet introduced the theory of modern geographical thought while Michael F. Goodchild educated me on modern practices of geographic information systems. Specifically focusing on the analysis aspect of his work *Geographic Information* Systems *and Science: Today and Tomorrow*. Goodchild begins with the traditional goals of GIS during the mid-1960s which were efforts to build comprehensive computer applications to manipulate geographic information. Today, GIS contains multiple innovations that is concerned with user interface. The new forms of representation based on the object-oriented model has improved link between GIS and human's thought about the world (Goodchild, 2015). In this research, through the means of geographic technology attempts to link human's thoughts of attachment to the water resources

and landscapes. Then, taking it a step further it utilizes geographic information systems to observe pollution then link how it affects humans' thoughts towards the depleted landscape.

2.2 Physical Environment and Sense of Place

Yi-Fu Tuan's work *Topophilia: A Study of Environmental Perception, Attitudes, and Values* was a fundamental text that provided a foundation for my research. The main aspect of my research is observing how Alabama citizens perceive, form connections, and develop sense of place/identity through the landscape. In *Topophilia*, Yi-Fu Tuan explains the environment/landscape is not just a natural force that humans have try to adapt to but is a source that provides assurance and pleasure (Tuan, 1974). *Topophilia* introduce ideas not just on love for the landscape but how it is formed through perception, experiences, and attitudes. This means humans develop perceptions of the environment, attitudes towards it, and the environment influence the human values generating a deep attachment. Topophilia is the affective bond between people, place, and settings (Tuan, 1974). The linked elements are through perception which is the sensational response to external stimuli and purposeful activity in which phenomenon are registered.

Tuan introduced the concept of how sense of place is a deep attachment that is generated through perception and experiences. The work written by Nogué and Vincete, *Landscape and national identity in Catalonia*, extends Tuan's idea but places emphasis on the physical landscape as it helps foster's sense of place and identity. Their work analyses the relevant role of landscape in the creation of national identity in Catalonia, from historical and contemporary perspectives. The study defines the elements of landscape through the perspective of the humanized world as a combination of abiotic (geological substrata), biotic (flora and fauna) and

anthropic (human intervention) elements, which convert the whole into a unique entity in continuous evolution (Nogué & Vincente, 2004). Through that continuous evolution, the landscape changes from the natural landscape to a cultural landscape. Humans begin to not only characterize the landscape with material terms (farmland, river, water) but with spiritual, ideological, and symbolic dimensions (survival, holy, pure) (Turri, 1998).

Once the cultural landscape is constructed in the minds of humans' experiences and aspirations are embodied in many different places within the landscape. These locations become centers of meaning, symbols that express different thoughts, ideas, and emotions (Nogué & Vincente, 2004). Now that meaning is attached to the landscape it evokes a sense of belonging to different human groups which they begin to confer as identity. This work specifically utilizes the mountains in Catalonia as an example. Societies that have observed mountains for centuries, they have generated a whole universe of myths, legends, fables, and symbols comparable only in richness and diversity. These types of landscape become true centers of significance and meaning, symbolizing different thoughts, ideas, and emotions. (Nogué & Vincente, 2004).

During the construction of Catalan national identity, the landscape, specifically mountains, played an important role during the historical and contemporary discourses. The mountainous landscapes were an inspiration to Catalan writers and poets. The mountain represented as a pure, virgin, sacred space, an untouched stronghold of the moral values that imprint identity and character on the Catalan people. Bridging the connection to this research, North Alabama citizens view the landscape and the Tennessee River found within it as a fertile, sacred, pure space through farming and religious connections. Once the material aspects begin change through the effects of pollution, the spiritual, ideological, and symbolic dimensions

change with it. The generated sense of place and identity disappears along with evolved landscape.

Humans, through experiences, perceive the physical landscape with cultural symbolism but these abstract views differ based upon different backgrounds. In this research, the qualitative analysis observes interviews and surveys of people across different backgrounds. The results of the analysis constructs how perception and meanings of the landscape differ between race, sex, social statues, etc. Then, the quantitative analysis attempts to bridge human parameters containing different demographic backgrounds with the cause of pollution.

Meinig and Schein produced different works that support the idea that perspectives differ as humans read the landscape. By referencing *The Beholding Eye,* D.W. Meinig (1979) suggested that ten different individuals faced with the same visible scene might perceive ten different landscapes, alternately seeing in the view before their eyes landscape as nature, as habitat, as history, and so forth. Meinig's point was that humans interpret the landscape. Schein geographical connectivity along with temporal change. Landscapes are always in a state of "becoming," and is no longer an unchanging space (Schein, 1997). There is a continuous evolution of the landscape from natural to cultural. The landscape is constantly under scrutiny. Once it is manipulable and manipulated, always subject to change, and everywhere implicated in the ongoing formulation of social life (Schein, 1997).

Schein statement of the landscape is always subject to change connects to Meinig's work stating cultural landscape can itself capture different, even competing, sets of meaning, or independent, thematic networks of knowledge—networks presenting the landscape as nature, habitat, or history and that these really are inherent in each cultural landscape. We can position a particular landscape as a node at the intersection of any number of these knowledge networks.

Humans' analysis and interpret the landscape differently which articulates a series of relatively independent discourses about the perceived spaces (Duncan. 1990, p. 12). defines discourses as "shared meanings which are socially constituted, ideologies, sets of 'common sense' assumptions."

The research *Place attachment, identification, and environment perception: An empirical study* by Rollero and De Piccoli furthers Schein's work by validating human parameters across multiple backgrounds (sex, race, social status, etc.) do perceive the landscape differently. Place attachment an emotional bond between human and place. It is a concept that is used interchangeably with sense of place, and it is highly influenced by an individual's personal experiences with the landscape. Rollero and De Piccoli observed the demographic variables sex, age, education, and more. After the observations they found place attachment and identification differ according to some demographical variables. A few examples of their findings that relate to this personal study were between sex, age, and education.

Men and women show the same levels of place attachment but experienced different forms of connection. Women express stronger affective connections. The attachment to the relational community is higher among women because of their social role: the responsibility for childcare, home management, work which binds them to local spaces within the landscape. Then men, specifically in this research, develop attachment with the landscape through direct outdoor interactions outside of the home boundaries. Regarding identity, there was no difference between local identity but a difference between national (Rollero & De Piccoli, 2010). On a national level, males tend to be more nationalistic compared to females. In conclusion of the study, the paper showed specificities of place attachment and place identification, considering their predictors and their association with the environmental perception. The researchers found that

these two concepts refer to correlated but distinct dimensions and are influenced by different elements. Both place attachment and identification lead to a positive perception, respectively, of the place and its inhabitants.

In this research observes how North Alabama citizens across different backgrounds produce a network of independent discourses. The discourses developed are shared meanings of the river that represents a means of survival for farmers, a sacred site for Christians, or a beautiful recreation area. This work utilizes surveys and interviews to obtain data of citizens from different demographic backgrounds (sex, race, poverty). These methods generate a lens into different perspectives on a local level towards the cultural landscape. The methods demonstrate the connection of previous literature that the cultural landscape is generated from the physical landscape. Citizens contain different discourses of a cultural abstract landscape, but it is generated from experiences of the physical. Then, this research observes how the discourses change when attached spaces become degraded causing the sense of place and local identity to evolve. At this point, the different sense of place and identities across North Alabama backgrounds all disappear.

Finally, Hawthorne et all's work on emotional attachment as mitigation efforts to protect the physical landscape. Their case study in the Indian River Lagoon provides new insights into knowledge of emotional attachment as a measure of sense of place across their study site. It demonstrates that information on landscape attachment can influence future coastal restoration priorities at various scales. How they achieved is through the applications of GIS. The researchers mapped emotional attachment at the broader lagoon scale through KDE (kernel density) and at a localized scale through IDW (inverse distance weighted analysis). The results obtained from the mapping framework allow restorations teams to prioritize the science

communication and education to align human systems data with natural systems data. Following Hawthorne et all's study, this research's goal is to produce an awareness of environmental degradation by presenting its effects on a psychological aspect. This phenomenon is so dangerous that it not only affects humans physically, but it affects our attachment our physical and cultural landscapes.

2.3 Ecology - Environmental Degradation

Plenty of research assesses environmental degradation, but the work developed by Dr. Mahendra Pratap Choudhary, Govind Singh Chauhan, and Yogesh Kumar Kushwah provides a definition, origins, and effects of environmental degradation which is the basis of my research. Their work, *Environmental Degradation: Causes, Impacts and Mitigation,* provides a foundation to understand that environmental degradation is an umbrella term covering issues such as pollution, deforestation, desertification, or global warming. Choudhary, Chauhan, and Kushwah break down the multiple factors of environmental changes but distinguishes the primary cause of environmental degradation which is human disturbance. Choudhary and Chauhan include the effects on the environment along with the definition of environmental degradation. "Degradation occurs when earth's natural resources are depleted. The resources which are affected include water, air, and soil. The degradation also impacts our wildlife, plants, animals, and micro-organisms" (Choudhary et al., 2015, p. 1).

Anantha Duraiappah structures an analysis of the complex web of factors and linkage between poverty and the degradation of the four natural resources. Duraiappah divides the research into four sections for the four elements. One section is on water and the two main issues for degraded water is: shortage and contamination. According to Duraiappah, water

contamination comes in the form of industrial and agricultural pollutants, "The cheap and easy practice of dumping industrial and agricultural effluent in lieu of expensive cleaning systems has made natural water systems a target for pollution" (Duraiappah, 1998, p. 2175). Interpreting the definition of environmental degradation and linking its sources from poverty allowed me to detect a population that faces both issues which is the state of Alabama. Referencing the *2020 Barriers to Prosperity Data Sheet*, "Alabama's poverty rate of 16.8% remains substantially higher than the national average of 13.1%" (Alabama Possible Staff, 2020, p. 1). According to data from 2020, 800,000 Alabamians live below the poverty line. Connecting the information from the article by Duraiappah along with the *2020 Barriers to Prosperity Data Sheet*, low-income groups pollute water systems because they lack provision of proper sanitation and drinking water facilities (Duraiappah, 1998). The lack of sanitation and guidelines allows people to continue activities that pollutes water resources without knowledge because it is a part of their daily lives. This continues to deplete the landscape and deconstructs sense of identity/place.

Detailed examples of different degraded landscapes and Christian interpretations is provided in the *Ecology Crisis: God's Creation & Man's Pollution,* John W. Klotz provides a broad overview of environmental deterioration starting historically with early civilizations in the fertile crescent in the valley of the Tigris and Euphrates rivers. Today, the former vegetative landscape evolved into a baren desert due to increased hillside farming and overgrazing livestock. Following, he references more human impacts on the environment such as the Phoenicians deforesting mountains in modern Lebanon, ancient Central Americans' farming practices destroying fertile tropical soils, and American settlers exploited virgin lands by poor farming practices/gullying rivers. Klotz provides examples of historical pollution then the first-time humans were aware of environmental deterioration. He states that human's first concern

was atmospheric pollution and the example he provides was the Donora killer smog on October 26, 1948, in Pennsylvania. The incident resulted in twenty-two people dead and five thousand nine hundred and ten ill with raspatory issues. From this point forward, humans began to develop an awareness of environmental destruction.

Klotz distinguishes the relationship between humans causing pollution in spaces is due to being spatial unaware. Klotz states the reason that pollution is deteriorating the environment is because humans have failed to recognize that he is a part of the ecosystem (Klotz, 1971). Humans are aware that they occupy a space, but they are unaware of the impactful relationship they have on it. This reason, causes humans to overpopulate, over-utilize, and pollute spaces because of the spatial unawareness. Following the introduction of pollution, the landscape located within becomes depleted causing human relationships to change with the environment because unfamiliarity.

Klotz provides information on the how pollution impacts water/environment, pollution detection, and ideas on how to combat it. According to Klotz, water serves multiple purposes for humans including drinking, industry, irrigation, and agriculture. Water also serves the purpose to remove human and industrial waste (Klotz, 1971). Water is a versatile resource utilized for many purposes, but humans misuse this liberty. Klotz provides multiple examples of polluted water in the northern region, midwestern region of the United States, and western Europe but parallels are found in Alabama. Like in northern areas, industrialized areas arbitrarily decide to remove direct waste into water resources when Alabama citizens need sanitized drinking water (Klotz, 1971).

Klotz's work provided detailed examples of pollution destroying landscapes, but in How To Read Water: Clues and Patterns from Puddles to the Sea by Tristan Gooley lays out a fundamental foundation to interpret patterns in water systems. In Gooley's work, he introduces

examples of water behavior. He goes against previous works by natural historians who categorized water into four different realms: ponds, rivers, lakes, and seas. He states that this categorization is a sensible approach in regarding, if you are focusing entirely on the animals and plants (Gooley, 2016). This research focuses solely on water and its relation to constructing human identity. This work connects to this research on the water aspect because it does not separate water into categories based on organisms, it aims to find patterns that humans can observe from a puddle to a sea, and it is structured to allow the audience to comprehend all the signs in water. It was necessary to include these practices along with my participatory observations. This work is structured to allow researchers to embark on a quest to get to know all the signs. This book will make you ready not only seek individual signs, but to meet water in all forms and in whatever it appears as (Gooley, 2016). After reading this text it provided help to detect patterns in my participatory observations and produced knowledge of what phenomenon in water.

An important aspect linked to my research was his view on water impacting humans philosophically, physiologically, and even spiritually (Gooley, 2016). Detected patterns were discovered in the interviews of humans experience a spiritual/religious emotion when viewing the Tennessee River. In the semi-constructed interviews, personal experiences, and collected Alabama information, the large Christian population view water as sacred representation. Water represents Christ as the living water, Christ was baptized in a river, and Alabama citizens mirror this practice in the Tennessee River. Extending this notion, this research observes how pollution and environmental degradation causes this spiritual emotion to disappear. On this note, Tristan Gooley's research did introduce specific signs to detect pollution in water resources.

Gooley's research provided information that humans could detect pollution based on the movement of water, organisms, and coloration. Traveling to the Tennessee River, for participatory observations, Gooley's work incorporated his information to detect pollution. Then, the reason for these specific examples chosen from the text are examples that were monitored. The distance that water travels upward is influenced by the number of factors, including purity – clean – water rises higher than polluted water (Gooley, 2016). He then discusses that observers can search for organisms in water resources to detect the quality of the water. "The following observations will help you associate the plants and animals you see with the conditions in the water around you" (Gooley, 2016, p. 72). Specific species he classifies are snails, white water lilies, algae, and mayflies.

Out of the examples of organisms the observations focused on vegetation. The observations detected multiple cases involving excessive amounts of this organism in the Tennessee River. Gooley points out that if observers discover white water lilies in a river, then that water resource is very pure, undisturbed, and not more than two yards deep (Gooley, 2016). He continues to discuss other vegetation species such as river algae specifically if there is an excess level of it this means this is an indicator of agricultural runoff. According to Tristan Gooley, "a sudden bloom is a sign of imbalance. Something with lots of phosphates or nitrates in it has entered the water upstream, fertilizer or effluent being likely suspects" (Gooley, 2016, p. 78). Once again, these are specific examples of vegetation in this text, but was an abstract approach meaning it was applied during the participatory observations to capture the quality of water in the Tennessee River.

Another purpose to validate these observations is that citizens usually depend on the government or third parties to determine if the water is sanitary or not (Gooley, 2016). Making

these observations does not require researchers to rely on government information, private corporations, and anyone with conflicting views. The research enabled the development of reports on the water quality based on the organisms and patterns in the water. Mark T. Buntaine, Bing Zhang, and Patrick Hunnicutt observed how local governments failed implement proper water quality standards established federal governments. The case study focuses on China, but the same circumstances are found in the United States. According to the study, officials lack the regular information on pollution, immediate action, and long-term efforts for remediation of water systems (Buntaine et al., 2021).

Tristan Gooley explains that observers can determine the quality of water based on the tint and coloration. In the observations different coloration of the water in Tennessee River was recorded. An alarming color was detected in the river that he distinguishes in his text. In his research he discovered a lake with a bright-green tent and determined the cause of this was due to a neighboring farm. Large farming populations are in my research are along the Tennessee River. These farms range from livestock to crops but all develop pollution that runs into the Tennessee River causing it to have a green tint. Gooley explains this anomaly in his research which is eutrophication, the excessive nutrient enrichment causing the ecosystem to tip over (Gooley, 2016). The water, sunlight, and excess nutrients causes the bloom to produce this alarming color. Eutrophication is exposed into water resources through extreme amounts of phosphates and nitrogen levels produced by humans, animals, and wastes. As a result, eutrophication causes algae and other aquatic plant species to overgrow. The growth of algae chokes the open waters and causes the water to be non-potable (Klotz, 1971). Overall, the balance of the body of water is disrupted. Another pollution impact is the rapid growth of aquatic weeds. Aquatic weeds obstruct water flow, increase evaporation, cause large loss to water levels

through transpiration, and block proper land drainage (Klotz, 1971). Klotz states that the cause of the overgrowth of aquatic weeds are exotics being introduced into water resources. Exotics are referred to as foreign substances such as pollution that cannot be broken down and changes the chemical makeup. Other types of pollution that Klotz covers is animal waste, thermal pollution, solid wastes, herbicides, and pesticides.

2.4 Sense of Place and Identity – Alabama

This section helps observe Alabamians' sense of place and identity. The purpose of this research is to explain how an example of environmental degradation and water contamination impacts Alabama sense of place and identity. Tim Cresswell, author of *Place A Short Introduction,* references political geographer John Agnew who outlined three fundamental aspects of place to develop a "meaningful location." These aspects are location, locale, and sense of place. Cresswell explains that when we reference a place, we are referring to some notion of location (Cresswell, 2015). He continues to explain locale and sense of place. Locale is the material setting for social relations while sense of place is the subjective and emotional attachment people have to a particular place (Cresswell, 2015). The places Alabama citizens are attached to is a modified landscape for agriculture.

This research particularly observes the third element, sense of place. The sense of place developed by Alabama citizens is created through sights, sounds, and smells from generations of farming. According to the *Country Ways: A Celebration of Rural Life,* Alabama rural citizens find the sounds and smells of a farm unmistakable and often beautiful in their own way because they tend the land for survival (Reader's Digest, 1988). Alabamians' sense of place is not produced from random circumstances, but by modifying an agricultural landscape that a majority

has created. The state of Alabama contains large rural and farming populations. According to the Farmland Information Center, 9,793,100 acres out of a total landcover of 33,049,300 was utilized for farming in 2016. Agriculture contains an important position in the development of Alabama sense of identity/place. Utilizing the land for agriculture with a purpose for resources, income, and employment creates an emotional attachment deeply linked to places. The emotional attachment is parallel to a sense of belonging that has endured through generations (Reader's Digest, 1988). Likewise, to sense of place, agriculture is included in the development of Alabama identity along with religion and conflict. Identity is an individual or group's sense of belonging to a region, city, or nation. Agricultural distribution of farms, crops, and livestock plays an important role in the construction of regional geographies (Robinson, 2018). Farming and cultivation are an interaction with the landscape. It is utilizing the landscape to cultivate crops or for producing livestock. The state of Alabama contains large patterns of farms and rural settlement. Ninety-one percent of these farms was operated by families or individuals (Alabama Census, 2019). The identity that is developed for farming and rural life is based on the means of labor. Referencing the *Country Ways: A Celebration of Rural Life*, today men and women should not just be farmers but have a universal identity (Reader's Digest, 1988). Living a rural life utilizing the landscape requires humans to not only just be a plower and a planter, a breeder of hogs, cattle, sheep, chickens, turkeys, but also an electrician, a mechanic handling intricate machinery, a carpenter, a veterinarian, painter, roofer, and often a user of technology. (Reader's Digest, 1988). This research observes how religion influences Alabama identity. Alabama, along with multiple southern states, contain a large Christian population (Pew Research, 2020).

This pattern is classified as the Bible Belt. Brunn et al states that "the term 'Bible Belt,' is a familiar label associated with religion in the South, was coined by journalist H.L. Mencken

following his coverage of the Scopes, 'monkey' trial in Dayton, Tennessee." (Brunn et al., 2011, p. 513) Today, it is referenced to the high presence of religious conservatism and morality. Data collected from the Pew Research Center classifies that 86% of Alabama citizens identify as Christian (comprising of multiple sects or denominations) (Pew Research, 2020). Evidence of this influence is recognized in the Alabama landscape. Majority of communities, towns, and cities contain multiple Christian churches relatively close to one another. Then, citizens allow Christianity to influence politics and business. An example of its influence is that many politicians run on conservative Christian principles and businesses close on Sunday to preserve the holy day of rest (Brunn et al., 2011).

The final theme of identity that my research observes is conflict. Occasionally, humans that share different identities experience conflict through their differences. Kenneth D. Bush and E. Fuat Keyman defines this as identity-based conflicts. "Identity-based conflicts push us to rethink our understanding of collective identity - its formation, mobilization, politicization, and, most importantly, its connection to violence" (Bush & Keyman, 1997, p. 311). Humans that occupy, experiences, and form connections to the landscape believe they have the right of ownership. Sometimes landscapes and its features are shared with humans that have different identities which causes conflict. An example of identity-based and ownership conflict is the Tri-State water wars. According to Southern Environmental Law Center, for decades Alabama, Georgia, and Florida have been in a continuous conflict over the future allocation of two major river basins: the Alabama-Coosa between Alabama and Georgia and all three states fighting over the Apalachicola-Chattahoochee-Flint basin (SELC, 2021). The severity of this conflict has involved local, state, and federal attorneys and the courts. The main issue considered the center of conflict is water sanitation. Georgia located on the upstream of the basins wants enough water

to supply metro Atlanta, Columbus, and agriculture. Alabama believes Georgia will use all the water supply. They believe the demand of water will decrease the supply of water for municipalities, fisheries, and current needs. Then, Florida wants enough freshwater supply to reach Apalachicola Bay for shellfish industry.

To comprehend the scale of impact on both geographical concepts of sense of place and identity, it is essential to explain their interrelation. According to the journal article "Sense of Place and Place Identity," by Shukran Qazimi, sense of place is the way people experience, express, imagine and know the place in which they live (Qazimi, 2014). Experience is how sense of place interrelates with identity. When humans begin to form experiences with the landscape, they create and develop a strong relationship with their place. Then, that place becomes who they are and shapes people's identity (Qazimi, 2014). Yi-Fu Tuan's work "Space and Place: The Perspective of Experience," explains a space is experienced from the objects and places. "Hence space can be variously experienced as the relative location of objects or places, as the distances and expanses that separate or link places, and – more abstractly – as the area defined by a network of places" (Tuan, 1977, p. 12).

My research explains that a degraded environment stops people from experiencing the landscape. Then, how sense of place and identity begins to disappear over time from water contamination. The main themes accessed from the literature for my research all can be significantly impacted by water contamination. It is previously stated that agriculture is a component of Alabama identity and there is a large farming population. A negative effect of a high agricultural population is runoff. Manure and pesticides are collected in runoff and carried into water supplies. This develops e. coli along with increasing nitrogen and phosphorous levels. The contaminated water is eventually cycled back as water supply for consumption, crops, and

livestock. This is harmful to human health, it can destroy crops, and kill livestock. Health, crops, and livestock are essential for farm labor. This research contends that if these depletions caused by water contamination happens then the Alabama farmer loses their livelihood that constructs their identity.

Alabama's religious identity is affected by water contamination as well. Water contamination causes a decline in agriculture. A large majority of the Alabama population resorts to prayer or religious practices in moments of crisis. "Trouble of animals, the problems that rain or the lack of it, or endless bugs, worms, wind, plant diseases, could bring on any day without warning. It was all chance-taking and prayer" (Reader's Digest, 1988, p. 52). Water contamination and pollution results in environmental degradation which is the depletion of the environment and its resources. A contaminated landscape stops the utilization for farming. This is considered a majority of Alabama citizen's source of survival and income. These results can be so drastic that it can result in people leaving landscapes instead of using prayer or give up their religious beliefs altogether. Then, a particular religious practice in Alabama is baptism in waterways. This a southern Christian practice that has survived generations. If the waterways become too contaminated, citizens will resort to baptistry tubs causing this cultural practice to disappear.

2.5 Modeling

The modeling chose for this research is considered a novel approach. The material accessed from these sources provided an informational guide on research already conducted on environmental degradation, water contamination, and sense of identity/place. Scholars have defined it as the depletion of the environment, provided its causes such as water contamination, and monitored it with GIS. Then, they determine how it affects the environment, animals, and

humans physically. My research takes the information on the effects of degradation but analyzes how it affects non-physical concepts of sense of place and identity. GIS modeling of water contamination was combined along with sense of place and identity.

There is uncertainty that arises while conducting this method. How can identity and sense of place be modeled? According to Yi-Fu Tuan experience of space is developed from the objects and place. (Tuan, 1977) Being able to map these objects and places affected by water contamination will allow the connection through attached emotions. The Alabama people view objects and places as sacred due to religious influence and it is where they develop their sense of place and identity. Using GIS technology, this research can utilize the destruction of Alabamians' sense of place and identity as a narrative for degraded locations to be able to map all concepts.

The Sage Handbook of Qualitative Research introduces information on conducting a mixed method approach to understand the impacts of water contamination on humans. According to Sarah Elwood, other areas of research in geography utilizes mixed methods but these approaches are significantly more recent in GIS (Elwood, 2010). The goal of this research is using explanatory power of Alabama narrative obtained through interviews to illuminate the hydrological analysis of pollution. "Qualitative analysis of interviews may potentially illuminate meanings, relationships, and interactions not made visible through quantitative analysis of survey data" (Elwood, 2010, p. 96).

In "Interviewing: Fear and Liking in the Field," by Linda McDowell, she explains that words, stories, and narratives matter to research. It is how we justify our actions (or inaction), and how we present ourselves to others. (McDowell, 2010) The interviews of Alabama farmers and religious leaders provides context for the hydrological data imputed into a selected model. A

model is a representation of a system of ideas or procedures presented through a physical, conceptual, or digital medium. Scholars across different disciplines utilize multiple models to observe and draw conclusions of phenomenon. The versatility of models allows future researchers access previous methodologies to develop the research further or conduct an entirely different process.

In the context of geographic information systems (GIS), models attempt to emulate world processes, between one point in time or over an extended period (Goodchild, 2015). Models are beneficial and multiple GIS applications are applicable. Functionalities can be basic evaluations of numbering waste dumpsites to predicting future degraded landscapes. GIS models can be static, if the input and the output both relate to the same point in time, or dynamic, if the output represents an extended point in time than the input (Goodchild, 2015). GIS models are flexible to incorporate software, hardware, and tools to operate in conjunction with models to enhance the observations phenomenon. This functionality increases the validity of results, conclusions, newly developed data, and theorems.

Geographically Weighted Regression is one of several spatial regression techniques that is useful in the field of geography and GIS (ESRI Staff, 2021). A geographically weighted regression model provides a local model of the variables or process you are trying to predict by fitting a regression equation to every feature within a dataset. The model constructs these separate equations by incorporating the dependent and explanatory variables of features falling within the bandwidth of each target feature. The shape and size of the bandwidth is dependent on user input for the Kernel type, Bandwidth method, Distance, and Number of neighbors parameters. Once the model is implemented, it produces a local form of linear regression utilized to model spatial relationships. This model is considered a popular method used within the field

of GIS. The main idea behind GWR is to explore the relationship between a dependent variable which is pollution (Y), and multiple independent variables poverty, income, race etc. (X), as it varies across the landscape.

Regression analysis allows users to "model, examine, and explore spatial relationships and can help explain the factors behind observed spatial patterns" (Camille, 2019, p. 1). This model can be utilized to predict future patterns. The Ordinary Least Squares (OLS) regression is a popular technique applied in the field. It calculates a global model for the variable you are trying to understand; only one equation is generated for the entire study area. However, the Geographically weighted regression appeared to be the best tool for this study because it provides a local model for the dependent variable. The process of a GWR technique is that a regression equation is calculated for every feature point in the data set then it accounts each feature's nearest neighbors. Unlike, Ordinary Least Squares Regression analysis the GWR analysis observes geographical differences and spatial variations in the relationship between the two variables. In this study it views geographical differences and variations between the pollution size from the ADEM impaired waters data sheets with the human parameters accessed from the census including poverty, race, sex, income, and education.

A linear model is first applied which allows for its analysis/model to vary over space then the geographically weighted regression model extends from prior model. The linear model introduces potential areas where the independent variables have a positive relationship with the dependent variable and displays other variables that may be negative. "By exploring spatial heterogeneity GWR addresses the geographical thinking assumption that spatial phenomenon varies across a landscape" (Camille, 2019, p. 1). The model is not looking at variation over the overall data space. It applies a weighted window over the dataset, analyzing values, and

estimating coefficients at specific points by looking at the surrounding neighbors. Other regression-based models ignore that assumption and thus produces a less accurate explanation of spatially varying relationships. This does not mean other regression models are not appropriate and accurate. Many of these methods lead to a high correlation between the model and estimated values from the independent variables. This study analyzes specific geographic topics, the GWR model is beneficial because the local area increases the accuracy of the model and generally have a higher fitness between the model and reality. Consequently, geographically weighted regressions can be seen as an improvement over using regressions such as OLS. Ordinary least squares regressions model a global relationship whilst GWR use neighboring data values to estimate spatial relationships and thus computes more accurate predictions.

To provide a local model for the explanatory variables, the GWR will fit a regression equation to every feature within the same dataset. The output of this regression provides reliable and relatively accurate statistics for estimating and exploring linear relationships. The linear relationship results as either positive or negative. If the linear relationship is positive the independent variable increases the dependent variable. Then, if the linear relationship is negative it results in the independent variable decreasing the dependent. The final output the Geographical weighted regression yields are maps that enable scientists and researchers to visualize how each independent variable impacts the dependent variable spatially across the landscape (positively or negatively).

CHAPTER THREE

METHODS, DATA, & RESEARCH OBJECTIVES

The data sources for this project are derived from surveys, interviews, watershed data, storm data, cultural information, images, field observations, and political boundary data. The two analytical approaches that will be applied to the collected data are, cultural analysis and hydrological analysis. Utilizing the methods that have been established in qualitative human geography along with the ecological methods of analysis, will facilitate in meeting my research objectives.

How the research objectives were completed were through the application of a mixed method approach for this research. This research observed the flow of agricultural developed pollutants into important water sources in North Alabama through the quantitative method of statistical modeling. Then, it observed how degraded resources affects the Alabamian's sense of identity/place through qualitative methods of surveys, interviews, and participant observations. Surveys provide a way to explore meanings and emotions individuals have to physical phenomena like water contamination. Surveys were produced to explain health impacts, economic issues, and to determine specific locations experiencing water contamination. The first round of survey was submitted on social media outlets. Then, surveys were distributed to citizens of the North Alabama through email forwarded from professors to students. Finally, handouts were printed containing a QR code that linked students to my survey. Qualitative analysis of surveys may potentially illuminated meanings, relationships, and interactions not made visible through quantitative analysis of survey data. Alternatively, quantitative analysis of survey data might reveal patterns helpful in examining broader structural relationships. Then the interviews provided a narrative through the voices of people that live on the river, who have an identity

connected to the river, and experience the effects of pollution daily. This same narrative for my final model to enhance the viewer's experience and understanding of water contamination. The constructed interviews were conducted to achieve personal accounts of life on the Tennessee River, culture practices, farming practices, and examples of pollution.

Being a researcher located in North Alabama allowed participatory observations to be conducted along with applied personal autobiographical accounts. Specific locations were visited to along the Tennessee River that experienced environmental degradation from pollution then was captured collected data in a field journal. The conducted participatory observations allowed for the observation of degraded landscape and people's interactions. During the collection of data, eight different locations including two rural town and an urbanized city along the Tennessee Rive were observed.

The first area observed was the Civitan Park in Guntersville, Alabama on May 12, 2021. Guntersville is a town on a reservoir known as Lake Guntersville. The park is considered a popular public walking trail. The trail is located directly next to the reservoir that the Tennessee River flows in to. One interesting observation captured was that the public road on the other side of the walkway was built on a higher angle that the walkway and contained multiple storm drains that flowed directly into the river. One drainage ditch that presented as a serious threat was one that flowed directly through a protected wetland and into the river. Observing inside the wetland there was large amounts of trash thrown into the vegetation. Buildings located in the surrounding spaces are high income areas and contains a water treatment facility. Then, the people living in this space appear to have higher incomes and direct access to the river. Though this section of the river there was a treatment facility, but the shoreline was covered in garbage. The types of garbage discovered were plastic bottles., clothes, Styrofoam, glass, and rusted metals. Another

thing the shoreline appeared to be degraded full of trash, broken sticks, murky water, algae, and dead fish.

One interesting notion is that the people exercising on the walking trail, bikers, sightseers, and inhabited animals appeared to be unaware the pollution/degradation or chose to not notice it. Evidence of unawareness is that parents allowed children to play along the shoreline, people swam in the water, and people sat on the shoreline. The second location was Hidden Park on the river. No one was at this location, but it experiences high human contact. This area appeared to be very degraded due to this area being a hidden dumping sight. Trash such as tires, plastic bottles, and chemicals were thrown into the water. There was an overgrowth of river weeds in the water. This area contained middle-income residents that were able to build settlement directly on the water while lower income was made to build away from the river.

The third location visited to collect data was Wyeth Drive Park (East Lake) on May 25, 2021. This area is a mix of both low and middle income. An interesting aspect is that the areas are sectioned off from one another based on income. One side of the space is governmental housing with a large factory right next to it. On the other side of the lake is higher middle class income houses. Due to observing a middle-class area, observations were conducted towards the lower income side to observe the condition of the landscape. This area contains a park just like the other locations, but this area is not considered a popular location due to the lower income housing behind the park. It was noticed that a pattern of lower income houses being built away from the river, but it appears the city is modifying the river to accommodate to the higher income residents. The shores of this area were covered in trash it appears there is not regular cleaning in this area compared to Civitan Park where the city picks up the garbage.

The people in this area ignored the trash located on the shore, the color of the water, or were aware that they were near a factory on the water. There was many algae and river weeds choking up to the shoreline. This area contained large amounts of garbage along the shore, but people continued to picnic, swim, and kayak. One important aspect detected at this location was the roaring sound coming from the factory. The humans in this space appeared to not be affected by the sound of the factory.

Traveling to more locations across the city Guntersville allowed for more spots to be detected along the Tennessee River on May 29, 2021, to observe beyond the boundaries of the Guntersville Lake. The first visit was to the Guntersville Dam, a TVA project to produce electrical power during World War II. There, many residents were fishing near the dam. According to a local resident, many citizens make memories fishing at the Guntersville Dam. The water was very murky green tint, there was a foul odor, and trash everywhere. People ignored all these threats and continued to fish. There a resident spoke to me that people prefer to use water from different municipalities who do not draw directly from the river due to fear from contamination.

This area contained people from all different ethnic and demographic backgrounds fishing in this area. Some people were fishing for recreation and others were fishing for food. It appeared that there was a sense of community among the people fishing along the shores next to the dam. A resident informed me that these people were defined as the culture of Guntersville and the people who fish on expensive boats are people who come from other cities. People of different backgrounds, coming together to help one another fish, speak of social affairs of Guntersville, and escape from the realities of life.

Next, was the Guntersville Levee that same day. There were multiple factories built next to the levee. A resident that was interviewed explained that a candidate running for mayor of the city wanted to build a market along the levee if he won the election. Instead, another candidate won the election and built a city harbor containing multiple restaurants. It appears that politicians are using the Tennessee River for political gain. Connecting this to the different ethnicities and social classes, everyone utilizes the river for a different purpose. Humans build settlement, access it for recreation, factories utilize it as a resource, farmers use it to supply crops, and people even dump trash into it. This landscape and the river that flows through it has a connection and prominent in citizens lives because they interact daily. It is evident that North Alabama citizens are attached to the river because cities are modifying the landscape so that lower income residents are pushed away from the river to make room for higher income citizens to build settlement.

The attachment is so deep that conflict was discovered between the social classes and races due to being sectioning along the river. Citizens of Guntersville are sectioned along the Tennessee River based on their race and social status. Then, they identify themselves based where they are located along the river. People that live at East Lake are not called Guntersville citizens but identify as being from East Lake. This section of the river was known for prominent farmers but now is a low-income area and people no longer farm. Another area is called the Hill. This area contains a large African American population along with governmental housing. This area is in the middle of the city, and they do not have any direct access to the river. In this area it is even hard to see the river. Their experiences appear to be less related to the river and the name they identify with is in no relation to water but to the hill that citizens are located on.

The other area is Spring Creek, this area is known as the upper-class area. According to a resident of Guntersville, these are people who can afford boats and most of their experiences are in the middle of the river. Compared to people of East Lake or the Hill their experiences are along the degraded and polluted shorelines. Another evidence of the conflict between classes, during the observations newly built high-priced houses were located directly on the river and behind these houses there was a huge, covered fence blocking the view of the river for trailers who inhabited the area first. It appears the city is blocking low-income citizens and people of different races from experiencing the river by creating barriers or displacing African Americans away from the water.

The seventh location traveled to along the river was Scottsboro, AL on June 9, 2021. In the water large plumes of algae were observed growing in the water. The river weeds were so high that they were sticking out of the water. While traveling on kayak in the water it was difficult to paddle due to the excessive number of weeds in the water. A concerning observation is a closed nuclear plant that is located on the water, large cooling towers from different points along the river were observed. The final location was at Ditto Landing a recreational spot located in Huntsville, AL. There are multiple factories located along the Tennessee River in Huntsville, AL. One side of the river at the location contained a recreation trail and the other side was a residential river community.

Observations were conducted the residential side to collect data regarding river communities. This space contained large crop lands that was located on a higher elevation next to the river. It appears the fields are for large, commercialized farming and not traditional rural farming. An important aspect captured was the houses in these spaces were built on stilts to avoid damage from flooding. This area contains a different identity compared to the citizens who

lived within the urbanized city of Huntsville. It appeared majority of these houses were abandoned and severely damaged. It seems the river communities' identity was abandoned along with the houses. Now the area is covered in commercialized farming, recreation, and factories.

The final model is a story map on ArcGIS Online to provide an interactive online model of my research's results so both citizens of the North Alabama, politicians, and officials may review the flow of contaminated water and understand how degraded land affects the citizens' sense of identity/place. Combining the narratives along with maps of degraded water sources produced a story map that contains the effects of water contamination on a larger scale.

3.1 Data Sources

The qualitative data derived from constructed interviews, surveys, images, and participatory observations. This research conducted semi-constructed interviews with Alabama farmers and citizens from different backgrounds discussing the influence farming and religion has on Alabama identity while discussing how water is essential to their products, lives, and beliefs. Overall, six interviews were conducted. This was a suffice amount because of the quality of the data over the quantity. In these interviews allowed the ability to listen to citizens' (suburban and rural) emotional accounts of their relationship with the Tennessee River. Through these interviews, was the capability to construct mental visuals due to their vivid accounts and connection to the river.

After the interviews, the collected surveys produced data on the effects of water contamination to families, communities, and the region. Then, analyzed for data and information of where specific locations are being affected by water contamination and specific examples of pollution within different boundaries. The results of survey submissions equaled exactly one

hundred and twenty-six participated in the survey. One limitation of the survey results was that some results were outside the study range and the data was not valid because of this.

This research focused on qualitative data collected from survey and images, to better understand how water contamination affects the Alabamians' sense of identity/place. Reviewing the data collected from the survey and images, it determined where citizens are located and where specific locations are affected by contamination the most through georeferencing. During the participatory observations was the utilization of the tool ArcCollector. This tool captured specific locations that contained pollution and degraded landscapes. Then, the app produced a point on a developed map and a photo of pollution. The collected images were attached to each feature so viewers can access a visual of pollution creating an interactive interface.

3.2 Research Objectives

Research Objective 1: Explore how environmentally degraded locations affect people's sense of place/identity.

The first research objective aimed to geolocate areas contaminated by pollution, its effects on Alabama citizens, and how it is interpreted from various parts of society. This section uses the same method surveys but applies a full cultural analysis autobiographical account. Then, analyze written geographical scholarship discussing identity/place while including cultural questions in my surveys. During the analysis of documents, notes was captured on the interrelation of identity and place. This research placed emphasis on how identity develops a sense of place. Being a citizen from Alabama allows me to provide knowledge on Alabama's cultural identity through my personal identity. A personal account of experiences and place

emphasized on the importance of the Tennessee River in my life along with other citizen's accounts.

This was an essential aspect to my research, so specific questions were asked then notes were recorded about Alabama culture and their sacred relationship to their environment within my surveys. The surveys that were produced contained cultural questions as well to understand cultural aspects. Incorporating cultural questions in my survey allowed me to interpret how identity and place is viewed through different lens in various parts of society. Then, the cultural information applied with the geographic concepts of place and identity through a culture analysis for interpretation. This study observed how contaminated water affects identity/place.

This research contended if the space Alabamians inhabit becomes environmentally degraded then they lose their identity and place. Often place is constructed as a location, with a material setting, which provides a sense of place and place is how we make the world meaningful and the way we experience the world. (Cresswell, 1996) If a landscape's material setting becomes degraded its meaning constructed from inhabitants is lost. Citizens that are unable to experience the landscape for its resources or find it aesthetically unpleasing will migrate to different locations to form new interconnections.

Research Objective 2: Analyze how the degradation of water impacts the citizens of North Alabama with a focus on citizens from various parts of society (particularly poverty and race).

Through conducted surveys, this explored data to find how water contamination is interpreted by citizens of Northeast Alabama from various parts of society. Expounding the example above, the research contained surveys with North Alabama citizens to geolocate areas contaminated by pollution, its effects on humans, and how it is interpreted by citizens from

various parts of society (i.e., poor, rural, middle, or suburban). This section of the thesis focused on a human geographical aspect of located environmental hazards.

Surveys are a traditional social science method that targets a larger audience. The large audience allows opportunity to generate social change (Bosco & Herman, 2020). The purpose of conducted surveys with Alabama citizens was to discuss cultural areas such as the Tennessee River, watersheds, and reservoirs contaminated by pollution. The surveys questioned how the river has impacted them on a political and economic scale. After the surveys, as database was generated for storing interview information using word, which will be utilized in the story map narrative. The purpose for survey methodology is to achieve cultural information, effects of water contamination on humans, points of pollution. Interviews and surveys also create awareness of water contamination to Northeast Alabama citizens, policymakers, and officials generating a possible social change. The overall goal of surveys is to locate areas of pollution, observe a deeper cultural purpose of the Tennessee River, its impact on culture, and how environmental degradation can change its cultural significance.

The surveys were both submitted to standard North Alabamians and political leaders, to interpret how the effects of water contamination are interpreted differently among societal levels. Then, there was the development of two surveys using Survey123 from the Ersi ArcGIS website. Once developed, the survey questions were converted into Microsoft Sharepoint so citizens can properly access the survey. The survey created for regular citizens contains demographic and thematic questions. The questions provided for leaders contained legal terminology and in-depth questions. The results were georeferenced locations of settlement, pollution producing locations, and locations degraded by water contamination.

Research Objective 3: Investigate how modeling water flow can explain surface water contamination and its effects on Alabama communities.

For the final research objective, the research utilized a statistical model to observed pollution, county, its sizes, causes, sources, its tributaries, and any reservoirs within North Alabama. To observe the surface water runoff, there was a utilization of a geographical weighted regression model. It will allow me to link pollution statistics with qualitative parameters. Using this model, it will link water pollution statistics with qualitative parameters such race, education, and income.

Collecting the data from surveys and participatory observations I will combine my research elements. The parameters for the geographic weighted regression model demand multiple forms of data. The spatially distributed data that relates to human geography are TIGER lines (census boundaries and detailed roads), urbanized areas, major roads, state boundaries, and county boundaries. This is the only human geographic data required for this hydrological modeling process. Unfortunately, the hydrological analysis and model is not enough to explain the impact on sense of place/identity.

ArcStory Map anticipated the development of a model that bridges the human impacts to the statistical model. This approach allows me to collect all observed and unobserved data to be included into the output. An example of data not imputed in the hydrological model is demographic data. This type of data will still be observed to interpret the outcome of how the impacts of environmental degradation relate to sense of place/identity. Demographic data introduces patterns of identity. It allows me to observe these patterns around places affected by water contamination including income, land use, population, etc. The patterns of identity create a

sense of place interrelated to the landscape. Both impact one another, human identity, and the landscape.

Ersi Story maps combine maps developed in my research along with narrative text, images, and multimedia content to create user-friendly web apps. The data collected from interviews and surveys will be the cultural narrative for my maps. Using the cultural analysis to explain the severing of Alabama identity and place from water contamination will establish a stronger impact in the narrative. Along with my narratives, Arc Storymap allows me to upload any models or maps produced in my research. Using geolocation in my surveys will allow me to produce a residential map located near pollution and contaminated water. The data included photos of pollution in the Tennessee River, degraded land, and contaminated tributaries to enhance my story map. Finally, my model was presented as interactive map to users. Users around the world can monitor my model while obtaining a narrative to enhance the experience.

CHAPTER 4

ANALYTICAL APPLICATIONS

4.1 Tennessee River at Guntersville, AL

Guntersville is a town located seventy-six miles up the Tennessee River in Marshall County. The town was originally occupied by Native Americans who named the area “Tall.” The town was eventually reoccupied and established in 1785 by Welsh settler John Gunter (Guntersville Museum, 2022). At the time, this area contained a small population of farmers and would not grow into a river town until after the American Civil War. Once the railroad was introduced, the town's population began to grow in waves beginning with this event as the first. The second wave was implemented when the Tennessee Valley Authority developed the Guntersville Dam and man-made reservoir (Guntersville Lake) in 1939 (Guntersville Museum, 2022). From there, the town experienced steady growth throughout the 1950s and 1960s. Currently, the rural port town still contains a small population of eight thousand five hundred fifty-three with strong remaining ties to farming.

For generations, the Tennessee River has been regarded as a popular destination for water activities, boating, sightseeing, hiking, and biking for tourists and residents. Recently, the town of Guntersville experienced growth in population and infrastructure. This resulted from the current mayor election, during which both candidates campaigned on this growth and change. The river has already brought many visitors to the area for recreational activities, but the new politicians are changing the landscape. New residential areas and suburbs are being built along the river. Then, the town built a new city harbor that contained new restaurants. These things can be beneficial, but it is causing conflict between the original citizens of Guntersville. New people from out of the area are migrating into the area, politicians are changing the natural landscape,

the river is now experiencing higher human contact, and there is an evident divide between social classes. Increased pollution sources are beginning to impact the natural landscape. Many of these instances were captured in my participatory observations.

Farming and recreation created a cultural identity in North Alabama. In this study, there is a detection of severe pollution in the Tennessee River. This river is a vital resource that has created an abundance of farmland, it is utilized for recreation, and a part of religious practice as a result produces a cultural capital in the region. Pollution, instead of just affecting humans, physically destroys cultural connections that create identity, emotional attachment that forms relationships, and former memories that generates sense of place. The Alabama Department of Environmental Management provides a datasheet titled Impaired Waters (303(d), which lists that water bodies in Alabama do not support their designated uses based upon a review of water quality data and information. The information included in this dataset contains causes and source of water quality impairment for Alabama waterbodies listed. This dataset is submitted and verified by the United States Environmental Protection Agency. The Tennessee River and its tributaries at the town of Guntersville is classified as a Category 5. This classification indicates that the water sources are considered impaired under the Water Quality Report to Congress (305(b) Report). The locations where the samples were extracted are Brown's Creek, the Guntersville Lake Reservoir, Town Creek, Drum Creek, and the Guntersville dam. The causes of pollution are nutrients and pathogens (E. coli) then its sources are atmospheric deposition, animal feeding, pasture grazing, urban runoff, mining, and agriculture (Refer to Figure 7).

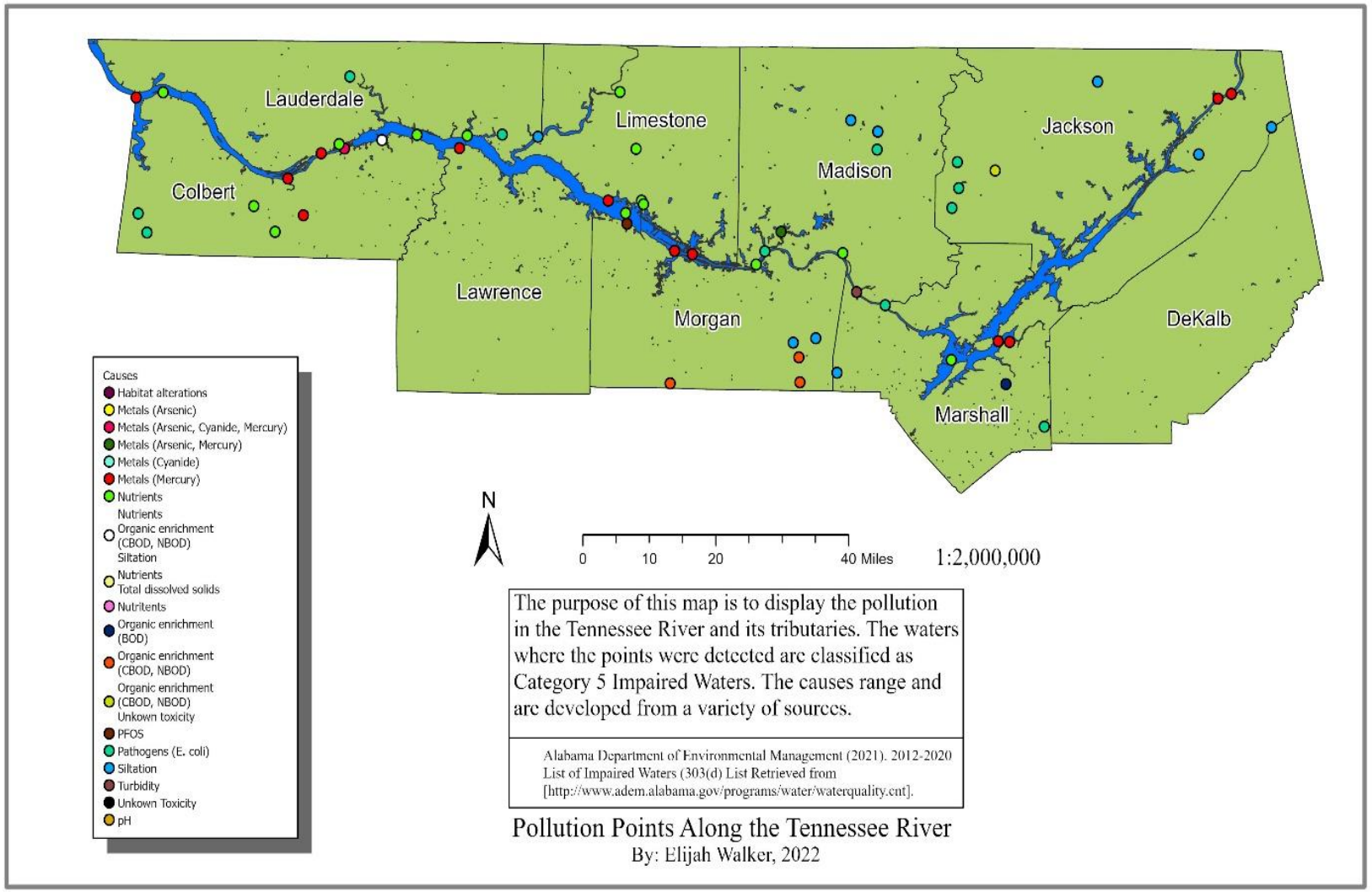


Figure 7. Pollution Points Along the Tennessee River

Figure 7 presents the pollution points along the Tennessee River. The map's symbology is divided by unique color to visual the different causes of pollution. The points that are not along the river a detected in the Tennessee River's tributaries. I created an Excel data table of pollution referenced from a list of impaired waters on the Alabama Department of Environmental Management. Next, I uploaded the table to ArcGIS Pro and used *Create Feature Class* tool to create an empty point layer titled Pollution layer. I appended the pollution table, using the *Append* tool, to the Pollution Point layer. Finally, I used a spatial join on pollution points that intersected on the North Alabama tracts.

4.1.1 Farming

Figure 8. Interview Word Cloud One on Farming

The word cloud in Figure 8 was generated using the application NVivo. I identified words and connected them based on a common meaning. For example, I categorized poultry, practices, and farmers into a single word of farming to represent their commonality. Then, water, contamination, and sewage are represented under the word pollution. Following, I selected my subcategories from the words selected from the generated cloud to analyze. Two subcategories include *Farming* and *Pollution.* Then, I added *Religion* to include another cultural aspect other than farming. The purpose of the analyzed subcategories is to determine the relationship between Farming, Recreation, and Pollution with the constructed data to support it.

Visually, the Tennessee River is a centralized source found at the center of the landscape and the center of North Alabama citizens' lives. "*The Tennessee River is central to the lives of north Alabamians*" (Anonymous female, 2021, qualitative study findings). Surrounding the river is a fertile river valley that humans have utilized for cotton, soybeans, poultry, and livestock farming. Combined with the fertile soil, the river remains the direct resource to sustain North Alabama's agricultural spaces. In 2015, surface water supplied 50 mgd, or 79.4 percent of the total withdrawal for irrigation use in North Alabama (Tennessee Valley Authority, 2018). This percentage is predicted to rise by 40 percent by 2040. Then, the percentage of surface water is accessed to maintain the number of farms (11,231) in North Alabama. Further statistical indication of farming's influence on citizens' identity is represented by 33,049,300 acres of land utilized for farming out of a total land cover of 9,793,100 in 2016 and generations before (Farmland Information Center, 2022).

The river is the center of the landscape and has allowed farming to be a vital economic asset to North Alabama, but its impact is much more. With the economic success provided by the river, farming has persisted for generations allowing a more profound impact on culture.

> *Back when I was younger there on Sand Mountain and down highway 431* (highway that runs across the Tennessee River) *there were three types of people. You had the car dealers, the people involved in agriculture, and you had schoolteachers. And that was pretty much it. Just about everybody knew either of the three* (occupations) (S.D., 2021, qualitative study findings).

From Alabama's early beginnings to modern era, farming remains as a consistent occupation for generations. While this quote provides indication of the impact based upon large percentages of farming, it does not indicate a deeper connection to landscape.

Farmers develop a connection to nature because it is way a living and means for survival (Tuan, 1974). "I think. (Voice gets softer and lighter when reflecting on memories) I always grew up, you know, pretty much on a cotton/poultry farm and it was, you know, it was to me a great way of life. I would like my kids to have a little more participation in" (S.D., 2021, qualitative study findings). The longer the farmer physically connects to his surrounding, the connection runs deeper. These participants' experience with the landscape was so impactful that he wanted his children to not just help but have the same experiences by working with the landscape. "*I think it's a definite* (true) *way of life*" (S.D., 2021, qualitative study findings). The experiences the farmer develops is utilizing the land, the knowledge obtained is about the land, and what determines their existence is the land which all cycles back to the landscape that is sustained by the river.

Since farming is prominent, it has produced a cultural capital for many kinds of citizens in North Alabama.

> *Now let's say you got Mr. Farmer out here that's got a milk cow. He must have somebody in trucking to come get the milk and take it to the market. And you still got to*

> *have somebody in the milk plant that's able to run it, pasteurize it, and get it out in the grocery store. So, there's a lot of people, you know, people involved in farming than the farmer himself*. (S.D., 2021, qualitative study findings).

The last sentence in that quote captures the connection of farming to North Alabama identity. The influence of farming and developed opportunities from the Tennessee river is so prominent that citizens who are not farmers are still "involved," with the occupation. Even, these citizens' have an occupation that is connected to farming. Their lives contain a relation to this cultural aspect that is produced through the utilization of the river. That relationship then influences the development of their identity.

Modifying the fertile river valley's soil into abundant agricultural spaces for generations has not only created a cultural identity but generated a deep sense of place for North Alabama farmers. Sense of place is the subjective and emotional attachment people have to a particular place (Cresswell, 1996). The experiences and memories that North Alabama citizens create with the Tennessee River is through farming, recreation, worship, and observing. This develops a deep emotional response that exposes the brain to the surrealness of nature along with sensitivity of the senses. The landscape is etched into the mind and all five senses experience a memorable sensation. Eventually, whenever a human travels to other locations and experience the memorable sensations that remind them of that space etched into the mind.

> *It makes me think of home but seeing the Potomac does not make me feel like I am home. When I see the trees there and the river, I am like "Ah, I am here."* (Sounded relieved when thinking about this feeling). *For the Potomac it is not that same sense of place. The Potomac reminds me of the sense of place at home* (Tennessee River) (A.R., 2021, qualitative study findings).

To North Alabama citizens, the memory of the Tennessee River brings comfort due to emotions attached and familiarity to the space.

For North Alabama farmers sense of place is developed through the sights, sounds, and smells from generations of farming. Alabama rural citizens find the sounds and smells of a farm or the Tennessee River unmistakable and often beautiful in their own way because they tend the land for survival. Alabamians' sense of place is not produced from random circumstances, but by modifying an agricultural landscape that a majority has created. Farmers become emotionally attached to the landscape due to decades of labor. The emotional attachment is strong sense of "love" for the river because it is seen as home, it supported their livelihood, and they spend majority of their time surrounded by the landscape. The indication of that love was captured by one farmer when he reflected on that thought of growing up on a farm. It brought him a sense of peace and comfort causing his voice to appear lighter while reflecting on the memories. "*I think. (Voice gets softer and lighter when reflecting on memories) I always grew up, you know, pretty much on a cotton/poultry farm and it was, you know, it was to me a great way of life*" (S.D., 2021, qualitative study findings). All the memories are generated from the connected experiences to landscape and having an essential impact on the mind by being surrounded its presence.

4.1.2 Recreation

Recreation requires contact with the river which generates both positive and negative emotions. Citizens across different backgrounds, races, or social status are allowed to utilize the Tennessee River for recreation. From my personal accounts I do not identify as a farmer, but the cultural aspect impacts my experience within the landscape as an ordinary citizen that access the river for recreation. This is evident within my own identity and personal autobiographical

accounts. Autobiography is connected to the discipline of geography. Methodologically, autobiography in geography can be closely linked to qualitative methods (Moss, 2001, p. 8). With this token, potential bias can appear, but a provided narrative is allowed in this research due to personal identification as a North Alabama citizen for my whole life. My personal life was never directly near the Tennessee River, but it has shaped many of my experiences. My attachment to the river generates attachment or as if it was alive. My commutes drove past the abundant farmlands or the river, and it instantly generated aesthetic emotions tied to the view as it was alive shedding its beauty. Days in my life were spent picking up trash along the riverside or while hiking around, then feel negative emotions almost as if the river and its landscape personified an illness due to pollution. A main past time of mine including kayaking the river, which created a sense of determination to overcome its flowing currents. Once again, the river generated a feeling as if it was animated equipping its current as a cunning attempt to test my endurance. My mind experienced a self-realization that the Tennessee River was the centralized object which impacted my experiences.

My personal accounts appear romanticized, but it attempts to introduce how ordinary citizens that did not live directly on the river still develop deep attachments to the landscape from experiences. The emotional ties contain a deep relationship yet ordinary citizens that did not live spatially near the river appear to not have a constructed identity from the river compared to farmers and citizens that lived in river communities. As for myself and other participants contain strong emotional ties, but it does not influence our identity directly. It seems this group's identity is produced from the farmlands that is modified from the river's landscape more than the river. Tuan identifies that a connection through aesthetic appreciation is weak compared to physical contact to the landscape (Tuan, 1974). The patterns I detected within my interviews and surveys

of the citizens that did not live near the river range from containing deep emotional attachments to weak/indifference.

> *When I was a child, my family and I would go there for the fireworks show in Guntersville. We would hang out there on July 4th and I guess it would have a sentimental value to me… I would say to me their lake is pretty and I would use it for fun but other than that it is just a lake to me* (Anonymous, 2021, qualitative study findings).

To this individual, the river is just a water source with no emotional attachment unlike my experiences. More evidence of the same pattern was discovered in my surveys as well. One survey test taker was asked *Do you live near or visit the Tennessee River?* They replied yes (meaning they have visited the river) and stated, "*No significant importance other than a water supply for me.*" (Anonymous, 2021, survey). This individual doesn't live near the river, had interactions, yet only acknowledges it just a source of water to them. Another individual was not located near the river but answered yes to interacting with the river. "*Many family memories have been made camping alongside the river… One of the things I enjoy most about the river is observing the wildlife and the beautiful landscapes along the river*" (Anonymous, 2021, survey). This survey examinee lives nowhere near the Tennessee River but created many memories which produces deep appreciation specifically for the landscapes along the river.

Ordinary citizens that live in the river community of Guntersville generate their identity from recreation. Previously, I stated that citizens who live away from the water source contains deep emotional attachment to the river yet develop our identity from other sources within the landscape. Humans located within river communities develop their identity directly from the Tennessee River. Many of these citizens feel a stronger connection to the river because it has always been present during the development of their lives. "*We have lived here all our lives. I*

am very connected to the river" (Anonymous, 2021, qualitative study findings). This answer is just a narrow example of identity connected to the Tennessee river, but I detected further evidence during my participatory observations.

A local citizen educated me on the culture of Guntersville and drove me to important sites. One site was the Guntersville dam built by the Tennessee Valley Authority. There he informed me that many citizens make memories at the dam through recreation. At the site, many people of different races (black, white, Latino, and Asian) were all fishing together on the riverbank next to the dam. It was interesting discovery because their differences did not appear to be an issue. They were all were citizens enjoying the natural landscape. Not only were multiple races accessing the river, but they all appeared to contain different social backgrounds. The people fishing on the embankment ranged on economic levels between lower to middle income. One citizen was fishing with just a piece of string with a hook on the end. On the opposite end of the social class, away from the bank and towards the middle of the river were people fishing on expensive boats. Citizens of ranging backgrounds means they interact with the river for different purposes. I captured citizens were fishing for just pure recreation and making memories while others were catching for food and survival. A lot of citizens had families there to help the efforts. A local explained to me that he considered the people fishing on the bank represent, "*the true culture of Guntersville*" (C.S., 2021, qualitative study findings). It appeared that the interviewee was right. During my participatory observations I captured many people on the embankment being friendly and helping one another fish. They appeared to contain a genuine sense of community that is helping one another connect to the river then as a result it generates a united identity.

Many mental backdrops in North Alabama contains landscape imagery of the Tennessee River, its tributaries, and farmland. One male survey taker stated "*The river is a special place for me and my family. I visit some form of the Tennessee River system at least once a week"* (Anonymous, 2021, qualitative study findings). The last sentence captures the daily interaction humans have with the river. North Alabama citizens intentionally create memories through direct interactions or unintentionally just by the landscape being within the background. No matter what form of interaction, sense of place is generated from humans creating experiences within the landscape. Indication of this is captured in the previous quote North Alabama citizens visit some form of the Tennessee River system. That system can be the direct source, a tributary, or farms that was produced by that system.

4.1.3 Pollution

Figure 9. Interview Word Cloud Two on Farming and Pollution.

I discussed with local North Alabama farmers about the effects of pollution. From one interview, I generated a word cloud to capture important terms to focus this section on. The three terms heavily focused terms were farming, poultry, and pollution. Connecting the three terms to the section, I first explain how pollution affects farming and other practices that generates identity/sense of place through my observations.

The Tennessee River and its tributaries at the town of Guntersville is classified as a Category 5. This classification indicates that the water sources are considered impaired under the Water Quality Report to Congress (305(b) Report). The locations where the samples were extracted are Brown's Creek, the Guntersville Lake Reservoir, Town Creek, Drum Creek, and the Guntersville dam. The causes of pollution are nutrients and pathogens (E. coli) then its sources are atmospheric deposition, animal feeding, pasture grazing, urban runoff, mining, and agriculture. Beyond accessing online data, I discovered sources of pollution and environmentally degraded locations during my participatory observations.

Halfway through my data collection, local news sources reported an incident in the town of Guntersville regarding the Tennessee River. The Guntersville Water Board allowed 1.7 million gallons of untreated sewage water to spill into the Guntersville Lake since 2017 (Pillion, 2021). During the whole month of March alone more, than 680,000 gallons overflowed into the river. The sewage discharged into the Tennessee River at Lake Guntersville, Big Spring Creek, Browns Creek, or absorbed into ground water. The overflows have allowed untreated sewage to escape from the Eastlake Wastewater Treatment Plant and its collection of poor infrastructure, including manholes, cleanouts, and lift stations.

This is a serious event that did not receive much awareness. During my semi-constructed interviews, I informed local farmers for their safety and to capture their reaction. One rural farmer appeared shocked after receiving this information. "*You know, I would worry more about my overall health more so than the farm. I am more worried about human waste than sheep waste or chicken waste getting in the water*" (S.D., 2021, qualitative study findings). This farmer was more concerned about his overall health than preserving his identity. Majority of modern farming in Alabama has resulted in this same situation of choosing to save money over

traditional practices. "*Farming is a now a big business not a simple way of life like it used to be*" (Z.B., 2021, qualitative study findings).

Safety protocols are very important, but according to North Alabama farmers they are established to save money not necessarily protect the health of consumers. Farming is now a big corporation process with large-scale commercial farms. Majority of the poultry farms in the North Alabama is owned by million-dollar companies.

> "*It seems like it's the, you know, the bigger and "you got to be big." It seems like everything is getting bigger. You know, it sort of rules out a lot of people trying to get an opportunity to get into farming. For one thing, you gotta have a whole lotta money to get in it*" (S.D., 2021, qualitative study findings).

The presence of multiple large commercial farms appears to do the opposite effect the biosecurity programs to stop pollution. Majority of pollution sources in the Tennessee River at Guntersville is due to agriculture or other farming practices. The causes of pollution are nutrients and pathogens (E. coli) and many of its sources are related to animal feeding, pasture grazing, and agriculture.

According to farmers, it is evident that large-commercial farming is replacing the traditional practice. I contend that there is a relationship between the disappearance of North Alabama practices, large-commercial farming, and pollution. As traditional farming decreases, modern farming and pollution coincide and grow increasingly. The Census of Agriculture visualizes the increase in average farm size per acre between the years 1997 to 2017. The average size increased from 191 to 211. The average farm per size in Alabama was 50 to 179 acres which numbered 14,107 (Census, 2017). This accounts for 35 percent. This majorly outweighs the smaller farms (1 to 9 acres) which only number 3,633. Multiple large farms within

an area, increases the development of pollution then transported into water resources causes degradation of the environment. Pollution from improper agricultural practices impairs water quality through direct surface runoff or absorbed into groundwaters. Erosion and sedimentation degrade aquatic habitats, wetlands, drinking, and recreational water supplies. Contaminated surface water transports nutrients, chemicals, and pathogens, increasing water temperature and decreasing oxygen. Once spaces become degraded it causes farms to disappear due to not be able to utilize the landscape. As a result, it affects other cultural institutions and economies. "*If our whole company went that way (meaning if their companies' farms would be contaminated) then would cause chicken prices to become just way, way high*" (S.D., 2021, qualitative study findings).

4.2 Tennessee River at Scottsboro, AL

Scottsboro is a town situated next to the Tennessee River in Jackson County. The town was established after the forced removal of Cherokee and Creek Indians in 1838. The town was named after the early settler, Robert T. Scott. Like Guntersville, Scottsboro grew in waves. The first waves were introduced by the railroad and river commerce on the Tennessee River. The second wave was implemented once the town received international spotlight because of the infamous Civil Rights Scottsboro Boys case in 1931. For generations the main source of income for the city was agriculture and lumber. The town of Scottsboro eventually began a different economic path once the Tennessee Valley Authority surrounded the area in 1933. This introduced the final wave of growth.

The town of Scottsboro contains a historical presence of agriculture, racial issues, industries, and commerce. I selected Scottsboro because these qualities connect to the human

variables in this research, and they connect to the Tennessee River through interactions. Currently in Scottsboro, the town contains a larger population which has introduced a higher human interaction including commercial farming, recreation, religious practice, and industrialization. One example is the abandoned Bellefonte nuclear power plant. It is a unique spatial object found in the landscape, but it has created a lot of concern for citizens due to it being located near the river. Then, many companies have built large industrial complexes directly around the river.

The historical qualities of Scottsboro have created a cultural identity. The Tennessee River played a very important role to the development of that identity by providing economic resources. "*I think community wise everything was based around the water and family wise that is where I have some of the most vivid memories*" (A.R., 2021, qualitative study findings). Through observations and data review, severe pollution was detected the Tennessee River and many tributaries in Jackson County. Pollution, instead of just affecting humans physically, destroys cultural connections that create identity, emotional attachment that forms relationships, and former memories that generates sense of place. The Alabama Department of Environmental Management provides a datasheet titled Impaired Waters (303(d), which lists that water bodies in Alabama do not support their designated uses based upon a review of water quality data and information. The information included in this dataset contains causes and source of water quality impairment for Alabama waterbodies listed. This dataset is submitted and verified by the United States Environmental Protection Agency. The Tennessee River and its tributaries at the town of Scottsboro is classified as a Category 5. This classification indicates that the water sources are considered impaired under the Water Quality Report to Congress (305(b) Report). The locations where the samples were extracted are Higdon Creek, the Tennessee River in Jackson County,

Widow Creek, and Little Coon Creek. The causes of pollution are metals (mercury) and siltation then its sources are atmospheric deposition, pasture grazing, silviculture activities, and crop production.

4.2.1 Recreation

Figure 10. Interview Word Could Three from the Perspective of an Ordinary Citizen.

The main and secondary words were formulated into themes in this section. I focus on how a community shares the same identity that is formed by water. This identity is formed from experiences with water and then forms a personal connection. That connection increases as humans interact more with the river and landscape. The feelings increase and humans become emotionally attached to the spatial objects that relate to them.

Recreation is simply not just water activities. It is important to the people of Scottsboro because it connects them to a beautiful resource that has brought prosperity to their community. "*As a community it brings a lot of value to us. it holds a lot of value in terms of the aesthetics of region and it holds a lot of value in terms of the industrial jobs and all the complex structures it brought to Scottsboro*" (M.E., 2021, qualitative study findings). The river brings opportunity to citizens. Then stemming from that they interact with the river forming a stronger relationship through the development of memories.

> *I think community wise everything was based around the water and family wise that is where I have some of the most vivid memories… I personally feel very tied to it. I know that my family who is from that area and has been from that area feels really (emphasized) tied to it. To them, it is not just something recreational but something that is very cultural. It has a lot of general significance outside of just recreation* (A.R., 2021, qualitative study findings).

It is natural for citizens in Scottsboro and North Alabama to grow up with a life based around the Tennessee River. This lifestyle is passed through generations that causes these interactions to solidify making the connection much deeper.

The daily lives of citizens that inhabit river communities are constantly being shaped by their surroundings. The constant interaction with the Tennessee River it impacts them directly

and indirectly. Even citizens who appear indifferent about the river is still affected by the river. Evidence of this was discovered in my interviews. One interviewee who lives in Scottsboro does not seem interested in the river but acknowledges its impact on his identity. "*The river is something that is directly indirectly affecting me. It is nothing that I think about all the time. It is not on my mind a lot"* (M.E., 2021, qualitative study findings). It may not be on his mind, but the river and its landscape surround him daily. This interviewee has had few memories with the river and contains a critical idea of it due to the pollution in it. The fact that he has a formulated either negative or positive views of the river indicates the impact it has on him. I included these two cases because it represents opposite spectrums of identity. "*I think when you think of a place like Scottsboro, you can't ignore the water. It's just part of it, it's what we do*" (A.R., 2021, qualitative study findings). The main point is to introduce humans form different opinions, contain different interactions, but generates identity from the Tennessee River.

4.2.2 Religion

Religion is important to North Alabamians who identify as Christian. They hold to their faith and find meaning in the world that surrounds them. When they view the landscape or water systems, they develop a deep connection to the natural world because of the idea of a Divine Creator. They believe their Creator created the entire landscape around them and this causes them to feel connected to it because to them the same Divine Being created humans. Now when they go to certain landscapes, they generate a strong sensation that causes them to believe the area is sacred. Specifically, when the landscape generates deep emotional attachment, it becomes etched into the human mind. Then once humans experience certain sensations or phenomenon of

the previous it generates the image of the landscape in the mind. What follows are the emotions attached to that location.

Citizens of North Alabama connect their religious practices to the Tennessee River. To Christians water represents cleansing, renewal, and life. In their story of creation there was water and what arose from it was life. Even their main leader (Jesus Christ) is considered the living water that replenishes their spirit (Bible, English Standard Version, 2001, John 7: 37-39). According to their holy book, Christ was baptized in the river of Jordan. This moment became an important practice in the doctrine of Christianity. Practicing followers still partake in the practice of baptism after the achievement of faith. Baptism represents the shedding of one's wicked self and arising as a cleansed being through their Divine Being (Bible, English Standard Version, 2001, 1 Peter 3: 21). Specifically in the South, the fundamentalist Christians for generations contained a unique practice of performing baptism in rivers. "*Most people I know and most people I grew up with, you know, their parents and grandparents were baptized on the Tennessee River*" (A.R., 2021, qualitative study findings). This indicates the Tennessee River is utilized for much more than economic resources but for important cultural practices.

They perform these practices in landscapes which generates intense attachment to spatial objects located within. The river is now where they believe they received a new form of existence and is considered a holy site. The sense of place that is generated from this experience is unique. When citizens travel to different areas that contain water resources, they sense two different forms of place. They visualize the area where they were baptized, or the river of Jordan where Jesus was baptized. With these correlating thoughts of place, it creates a strong connection to the surrounding landscape. The feelings are so strong that it generates an appreciation that

causes Christians to appraise the creation of the landscape once produces resources, doesn't harm humans, or when one interacts with it thus observing its natural beauty.

4.2.3 Pollution

Pollution drastically degrades the environment. In the sense of water, it contaminates either causing the water to become unlivable for organisms. It can also cause certain organisms to overpopulate such as snake weed which chokes the water of oxygen or it traps aquatic wildlife. Pollution disrupts the natural balance of the environment. According to the ADEM website, particular pollution that was identified in the Tennessee River in Jackson County are metals (mercury) and siltation. The sources of this pollution are atmospheric deposition, pasture grazing, silviculture activities, and crop production. Like many locations in North Alabama, Scottsboro contains a large presence of commercialized farming. Two sources of pollution are from modern agricultural practices of pasture grazing and crop production. Pasture grazing results produces animal waste and chemicals are sprayed on crops which are all carried by surface water runoff into the Tennessee River. The pollution in the Tennessee River creates concern for citizens wellbeing. "*From what I have experienced, the water quality is terrible all around"* (M.E., 2021, qualitative study findings). This is just one voice of concern.

The relationship between pollution and identity. Pollution is a threat to North Alabama's important natural resource. Environmental degradation not only degrades the environment but the humans that are connected to it. The Tennessee River constructed key memories to humans through interactions, it contains religious significance, it provides economic opportunity to river communities, and it sustains the survival for farmers. Pollution poses a threat to all these aspects

of identity because the waters are too dangerous to form experiences. Then, the less experiences the more identity and sense of place disappears.

I informed one interviewee about the 1.7 million gallons of untreated sewage that was dumped into the Tennessee River because it posed a threat to Scottsboro citizens who are downriver. This news caused her to become intensely emotional because it degrades an important resource to her identity. "(Begins to cry) *That made me tear up… Once you told me that I teared up because this is absolutely devastating*" (A.R., 2021, qualitative study findings). Since there is a threat to human's physically, they no longer want to interact with the river directly which it begins to cause their identity to change. Their identity is connected to what was and they block out the potential influence from the river.

> *I remember during the summer people getting the water having fun and I was like "no!" This is because these are people that are not from Scottsboro they are from other areas around Scottsboro. They are just coming in here and NOBODY* (emphasizes twice) *from Scottsboro gets in the water. There may one or two that are brave* (M.E., 2021, qualitative study findings).

This may be a far assumption that no one gets into the water but during my participatory observations I never detected people swimming in Tennessee River at Scottsboro. This indicates that people are becoming less involved with the river due to the threat of pollution.

In relation to sense of place, pollution destroys the attachment to the landscape and spatial objects. Sense of place is generated through intense emotions being associated to a certain location. If this location becomes severely degraded, it generates resentment instead of attachment. The visualization of the landscape in the mind represents what was and no longer what is. When humans observe the new spaces affected by pollution, they do not form

attachment. "*Now I think as pollution increases that sense of place changes as that sense of place as home to 'oh I remember to what it used to look like.' It made me think of home and that sense of place now is violated*" (A.R., 2021, qualitative study findings). To humans, degraded locations are violated and no longer is considered home because it is not the same landscape generated within the minds of North Alabama citizens.

The same phenomenon impacts religious citizens of North Alabama. Their sacred spaces have become violated. Since North Alabama Christians apply meaning to the surrounding world, they can view pollution as evil contaminated their Lord's creation. Then, this causes religious people to not associate with these spaces. The place may contain a religious memory such a certain practice, but it remains there. They don't connect it to the current state of the landscape or spatial objects. The unique Southern Christian tradition of baptizing in the river has changed drastically over the years. When one citizen was asked about the practice he replied, "*I have not seen it recently, but I have seen it in my lifetime*" (M.E., 2021, qualitative study findings). Now it is uncommon to see churches baptize in the river. Most churches have purified running water into a tub where they perform this practice.

4.3 North Alabama

Geographic regression is a series of local regressions. Here 'local' means spatially. A separate regression model is fit at each observation location. The data for each fit are the nearby observations weighted by their distance to the location. This results in a set of regression coefficients at each observation. Here Pollution as it relates to Poverty, Education, Income, and Race was examined. Here pollution is the response variable. Pollution includes nutrients,

phosphor, nitrogen, E. coli, etc. The explanatory variables are Poverty, Education, Income, and Race. The x and y values determine the centroids of the census tracts.

First, the model starts with a linear regression and load in the data for the area. Next, plots were created of the counties that was included in the analysis of pollution in North Alabama. The “spplot()” method was utilized to create a choropleth map of the pollution rates during 2020 (Size). Then, broke the rates into seven equal range bands. Zeros in the data do not exactly mean no pollution, but are areas where data was not collected or was not available. The color ramp was moved to the bottom and included labels. Next a global linear regression was applied of pollution rates for 2020 and then the model was simplified. The final model resulted in a drop of a total population, Hispanic population, and total non-Hispanic population.

The best model was determined based upon the lowest ACI. Next, the model mapped the predicted values from the regression model. The predictions were added to the spatial polygons data frame. The linear regression captures the spatial pattern of pollution across the area, but the predicted values have a smaller range. Also since rates are non-negative transforming them to logarithms might be a good choice. Next, was the creation of a new column in the pollution data slot called logPol20 that is the log of pollution size. The model produced same pollution rates using geographic regression with the same set of explanatory variables. Next, was the selection the bandwidth of the model.

Then fit the models. The model output is saved as a spatial polygons data frame called “model.gwr$SDF.” The model added another column to the output spatial polygons data frame. Then the model figures were mapped. Then, the GWR smoothed the pollution rates across the study area. Geographic regression similarly captures the spatial pattern of pollution across the

area. The spread of predicted values matches the observed spread better than the linear model. The pattern is also a smoother. Next, the coefficients on pollution were mapped.

All values are above zero, but the areas in dark blue indicate where POV plays a stronger role in explaining pollution relative to the other variables. Each variable was ran to determine the best fit which was humans who obtained a master's degree (EDU_MS). Where are pollution rates best predicted by the model? This is answered with a choropleth map of localR2 column in the spatial polygons data frame. Finally, all was exported into a shapefile.

The geographical weighted regression model resulted in only showing a connection between two parameters and pollution. The two parameters were humans who have master's degrees (EDU_MS) and humans who have not completed high school (EDU_NoD). The geographical weighted regression model displays no connection to between pollution and the human parameters. In extending this research, other qualitative parameters will be added to observe a connection including crime, immigration patterns, gender, etc.

CHAPTER FIVE

CONCLUSIONS

This research observed how hydrological systems influence the development of identity and sense of place through the applications of GIS. It utilized different tools, methods, and models to observe how pollution destroys the connection to the landscape. The first research objective aimed to geolocate areas contaminated by pollution, its effects on Alabama citizens, and how it is interpreted from various parts of society. This was completed through extraction and cleaning of data from the ADEM website then uploading it into ArcGIS Pro. The software appended the data to a Create Feature layer then geolocated the pollution points. This section used the same method surveys but applies a full cultural analysis autobiographical account. Analyzed written geographical scholarship discussing identity/place was applied to the cultural questions in my surveys. During the analysis of documents, notes on the interrelation of identity and place was captured. Then this research emphasized on how identity develops a sense of place. Being a citizen from Alabama allows me to provide knowledge on Alabama's cultural identity through my personal identity. Accounted personal experiences was interlinked with citizen's accounts.

The second research objective explored data to find how water contamination is interpreted by citizens of Northeast Alabama from various parts of society. Survey123 geolocated areas contaminated by pollution, its effects on humans, and how it is interpreted by citizens from various parts of society (i.e., poor, rural, middle, or suburban). The submitted surveys range of people along the Tennessee River who differed demographically. This research interpreted how the effects of water contamination differs among societal levels. The survey was developed from Survey123 from the Ersi ArcGIS website. Inside it contained demographic and

thematic questions for regular citizens. The survey results contained georeferenced locations of settlement, pollution producing locations, and locations degraded by water contamination.

My final research objective investigated how modeling water pollution connects on human parameters. The research accessed a statistical model in R to observe the local (spatial) relationship between pollutants in the Tennessee River and human activity. The model accessed was a geographical weighted regression model. This model attempted to link pollution statistics with qualitative parameters. Using this model, it linked water pollution statistics with qualitative parameters such race, education, and income.

The data from surveys and participatory observations combined my research elements. The parameters for the geographic weighted regression model demand multiple forms of data. The spatially distributed data utilized for this model was pollution statistics and census data. Unfortunately, a geospatial analysis and model was not enough to explain the impact on sense of place/identity. For the final model of this research, I created an ArcStory Map to visually connect the qualitative results with the quantitative results.

Ersi Story maps combine maps developed in my research along with narrative text, images, and multimedia content to create user-friendly web apps. The data collected from interviews and surveys will be the cultural narrative for my maps. The cultural analysis explained the severing of Alabama identity and place from water contamination which established stronger impact in the narrative. Along with my narratives, Arc Storymap allowed me to upload any models or maps produced in my research. Using geolocation in my surveys produced a residential map located near pollution and contaminated water. I included photos of pollution in the Tennessee River, degraded land, and contaminated tributaries to enhance my

story map. Finally, the model was enhanced to be interactive to map users. Users around the world can monitor my model while obtaining a narrative to enhance the experience.

For future studies include the extension of this research and add other human parameters that might connect to the development of pollution such as crime, gender, immigration, etc. On the qualitative side of this research, it would include more semi-constructed interviews with in-depth questions and obtain more survey results. During my participatory observations an interesting phenomenon was identified where river communities are pushing back lower income residents and black residents away from the river then building higher income housing around the river. This data was not included in the analysis. Looking towards the future, it will be included because it deals with income and race.

Finally, this research contributed to the knowledge of human development of sense of place and identity. It is also a landscape study of North Alabama that observes how culture develops within the region. Regarding GIS, it displays the practice of conducting research, collecting different sources of data, writing that research, applying robust software, creating models, and how to connect geography topics which is the foundation of the field to modern technology.

APPENDIX A

Institutional Review Board Approval

Institutional Review Board for the Protection of Human Subjects in Research
203 Angle Hall
700 Pelham Road North
Jacksonville, AL 36265-1602

April 13, 2021

Elijah Walker
Jacksonville State University
Jacksonville, AL 36265

Dear Elijah:

Your protocol for the project titled "Safe Water for All: A Multi-Modal Approach to Northeast Alabama" protocol number 04132021-1 has been approved by the JSU Intuitional Review Board for the Protection of Human Subjects in Research (IRB).

If your research deviates from that listed in the protocol, please notify me immediately. One year from the date of this approval letter, please send me a progress report of your research project.

Best wishes for a successful research project.

Sincerely,

Jennifer Mead
Assistant Human Protections Administrator, Institutional Review Board

APPENDIX B

R Code

Elijah Walker

2022-03-01

Geographic regression

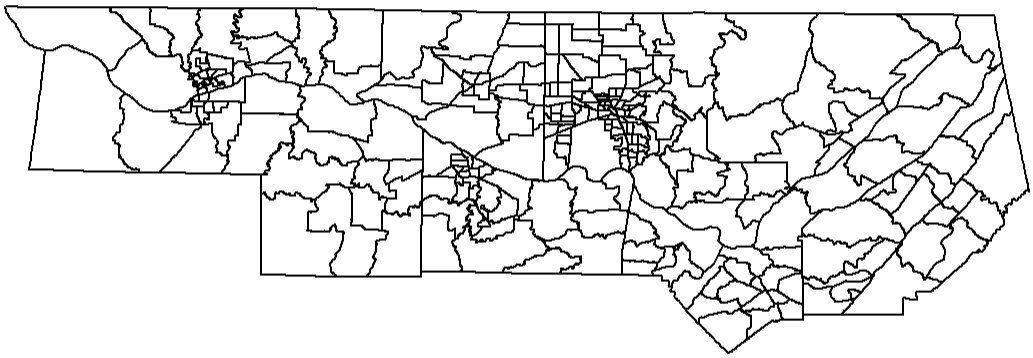
```
pollution = readShapeSpatial(fn = "NorthAlabamaPol")
## Warning: readShapeSpatial is deprecated; use rgdal::readOGR or sf::st_read
## Warning: readShapePoly is deprecated; use rgdal::readOGR or sf::st_read
slotNames(pollution)
## [1] "data"        "polygons"    "plotOrder"   "bbox"        "proj4string"
str(pollution, max.level = 2)
## Formal class 'SpatialPolygonsDataFrame' [package "sp"] with 5 slots
##   ..@ data       :'data.frame':  543 obs. of  46 variables:
##   .. ..- attr(*, "data_types")= chr [1:46] "N" "N" "N" "C" ...
##   ..@ polygons   :List of 543
##   ..@ plotOrder  : int [1:543] 481 483 478 466 471 488 467 472 477 479 ...
##   ..@ bbox       : num [1:2, 1:2] -88.2 34.1 -85.5 35
##   .. ..- attr(*, "dimnames")=List of 2
##   ..@ proj4string:Formal class 'CRS' [package "sp"] with 1 slot
head(slot(pollution, "data"))
##   Join_Count TARGET_FID JOIN_FID       GEOID     ALAND   AWATER    INTPTLAT
## 0          1          1      136 01079979201 173543715 33343864 +34.7177132
```

```
## 1        1        1     137 01079979201 173543715 33343864 +34.7177132
## 2        1        1     139 01079979201 173543715 33343864 +34.7177132
## 3        1        1     140 01079979201 173543715 33343864 +34.7177132
## 4        1        1     142 01079979201 173543715 33343864 +34.7177132
## 5        1        1     143 01079979201 173543715 33343864 +34.7177132
##      INTPTLON       NAMELSAD                                  NAME
## 0 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
## 1 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
## 2 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
## 3 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
## 4 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
## 5 -087.3401349 Lawrence County Census Tract 9792.01, Lawrence County, Alabama
##   POV20 POV20M POV20F S1501_C01_ EDU_NoD EDU_COL EDU_AA EDU_BA
EDU_MS EDU_High
## 0  1745    158    148       156     109     207     76     63     18      896
## 1  1745    158    148       156     109     207     76     63     18      896
## 2  1745    158    148       156     109     207     76     63     18      896
## 3  1745    158    148       156     109     207     76     63     18      896
## 4  1745    158    148       156     109     207     76     63     18      896
## 5  1745    158    148       156     109     207     76     63     18      896
##   EDU_BAP PoPI MeanIn MeanInFu S2001_C01_ ObjectID TotPop PopHis PopNoHis
## 0      81  594  31964    41630     43912      693   1874     31     1843
## 1      81  594  31964    41630     43912      693   1874     31     1843
```

```
## 2     81  594  31964    41630     43912     693   1874    31     1843
## 3     81  594  31964    41630     43912     693   1874    31     1843
## 4     81  594  31964    41630     43912     693   1874    31     1843
## 5     81  594  31964    41630     43912     693   1874    31     1843
##   PopWhite PopBlack PopNative PopAsian PopHawaiia           Unit_ID
## 0      633     1135        6       10         0 AL06030005-0105-100
## 1      633     1135        6       10         0 AL06030005-0105-111
## 2      633     1135        6       10         0 AL06030005-0105-111
## 3      633     1135        6       10         0 AL06030005-0105-100
## 4      633     1135        6       10         0 AL06030005-0105-111
## 5      633     1135        6       10         0 AL06030005-0105-100
##                  Water_Body Type River_Basi   County          Causes
## 0              Big Nance Creek    R  Tennessee Lawrence Metals (Mercury)
## 1 Big Nance Creek\n(Wilson Lake)    L  Tennessee Lawrence Metals (Mercury)
## 2  Big Nance Creek (Wilson Lake)    L  Tennessee Lawrence Metals (Mercury)
## 3              Big Nance Creek    R  Tennessee Lawrence Metals (Mercury)
## 4  Big Nance Creek (Wilson Lake)    L  Tennessee Lawrence Metals (Mercury)
## 5              Big Nance Creek    R  Tennessee Lawrence Metals (Mercury)
##                  Source Year_Liste  Size Unit_Type Shape_Leng Shape_Area
## 0 Atmospheric deposition       2012 24.75     miles  0.6910136 0.02036217
## 1 Atmospheric deposition       2016 44.57     acres  0.6910136 0.02036217
## 2 Atmospheric despositon       2016 44.57     acres  0.6910136 0.02036217
## 3 Atmospheric despositon       2012 24.75     miles  0.6910136 0.02036217
```

```
## 4 Atmospheric despostion      2016 44.57     acres  0.6910136 0.02036217
## 5 Atmospheric despostion      2012 24.75     miles  0.6910136 0.02036217
plot(pollution)
```

vplot(pollution)



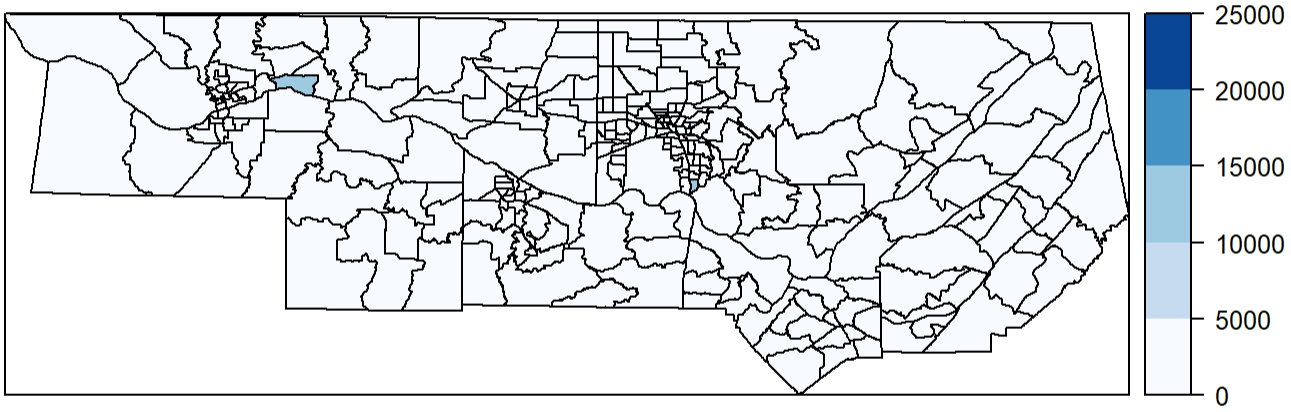
range(pollution$Size)

[1]   0.00 25902.67

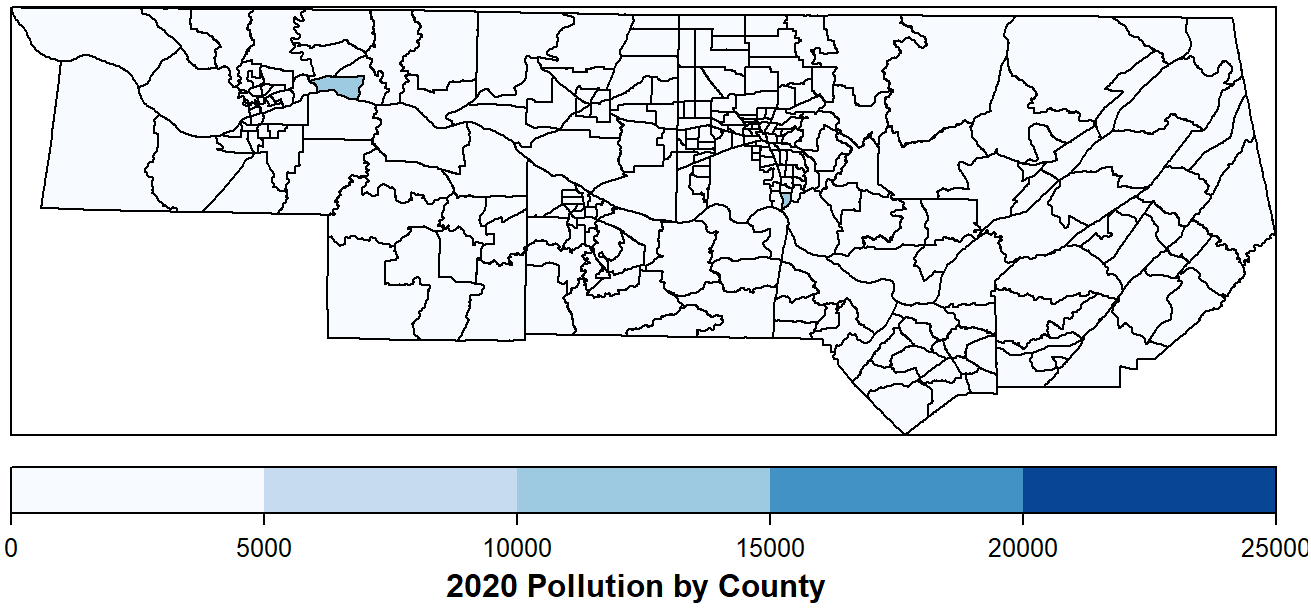
brks = seq(0, 25905, 5000)

cr = brewer.pal(8, "Blues")

```
spplot(pollution, "Size", col.regions = cr, at = brks)
```




```
spplot(pollution, "Size", col.regions = cr, at = brks,
    colorkey = list(space = "bottom"),
    sub = "2020 Pollution by County")
```




```
model.lm = lm(Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS
+ PoPI + MeanIn + MeanInFu + TotPop + PopHis + PopNoHis + PopWhite + PopBlack +
PopAsian, data = pollution)
summary(model.lm)
##
## Call:
## lm(formula = Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA +
##     EDU_MS + PoPI + MeanIn + MeanInFu + TotPop + PopHis + PopNoHis +
##     PopWhite + PopBlack + PopAsian, data = pollution)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9091.3 -2181.6 -1040.4   334.1 22477.1
##
## Coefficients: (1 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.732e+02  1.281e+03   0.525  0.59954
## POV20       -8.970e-01  7.625e-01  -1.176  0.23999
## EDU_NoD      1.249e+01  1.777e+00   7.030 6.41e-12 ***
## EDU_COL      1.801e+00  1.903e+00   0.946  0.34435
## EDU_High    -6.866e-01  1.261e+00  -0.545  0.58618
## EDU_BA       9.097e-01  1.553e+00   0.586  0.55836
## EDU_MS       5.692e+00  2.152e+00   2.645  0.00842 **
## PoPI        -9.586e-01  1.088e+00  -0.881  0.37858
## MeanIn       4.149e-02  5.081e-02   0.817  0.41455
## MeanInFu    -4.719e-03  3.359e-02  -0.140  0.88833
## TotPop      -6.460e-01  3.063e+00  -0.211  0.83306
## PopHis       1.731e+00  3.178e+00   0.545  0.58626
## PopNoHis            NA         NA      NA       NA
## PopWhite     6.622e-01  3.208e+00   0.206  0.83654
## PopBlack     8.327e-01  3.238e+00   0re.257  0.79717
## PopAsian    -3.244e+00  5.274e+00  -0.615  0.53877
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4587 on 528 degrees of freedom
## Multiple R-squared:  0.1457, Adjusted R-squared:  0.123
## F-statistic:  6.43 on 14 and 528 DF,  p-value: 4.973e-12


drop1(model.lm)
## Single term deletions
##
## Model:
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + MeanIn + MeanInFu + TotPop + PopHis + PopNoHis + PopWhite +
##     PopBlack + PopAsian
##          Df  Sum of Sq        RSS    AIC
## <none>                 1.1109e+10 9170.8
## POV20     1   29112789 1.1138e+10 9170.2
## EDU_NoD   1 1039776882 1.2148e+10 9217.4
## EDU_COL   1   18846464 1.1127e+10 9169.7
## EDU_High  1    6242576 1.1115e+10 9169.1
## EDU_BA    1    7216127 1.1116e+10 9169.1
## EDU_MS    1  147157309 1.1256e+10 9175.9
## PoPI      1   16339117 1.1125e+10 9169.6
```

```
## MeanIn    1   14027791 1.1123e+10 9169.5
## MeanInFu  1     415245 1.1109e+10 9168.8
## TotPop    0          0 1.1109e+10 9170.8
## PopHis    0          0 1.1109e+10 9170.8
## PopNoHis  0          0 1.1109e+10 9170.8
## PopWhite  1     896434 1.1109e+10 9168.8
## PopBlack  1    1391099 1.1110e+10 9168.9
## PopAsian  1    7959279 1.1117e+10 9169.2
```

```
model.lm2 = lm(Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA +
EDU_MS + PoPI + MeanIn + MeanInFu + PopWhite + PopBlack + PopAsian, data = pollution)
step(model.lm2, direction = "both")
## Start:  AIC=9168.66
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + MeanIn + MeanInFu + PopWhite + PopBlack + PopAsian
##
##           Df  Sum of Sq        RSS    AIC
## - PopBlack  1        507 1.1147e+10 9166.7
## - MeanInFu  1     577322 1.1147e+10 9166.7
## - PopWhite  1    4402563 1.1151e+10 9166.9
## - POV20     1   10561257 1.1157e+10 9167.2
## - MeanIn    1   10864174 1.1158e+10 9167.2
## - EDU_BA    1   11789421 1.1159e+10 9167.2
```

```
## - PoPI      1   12750546 1.1160e+10 9167.3
## - EDU_High  1   19245701 1.1166e+10 9167.6
## - EDU_COL   1   21497729 1.1168e+10 9167.7
## - PopAsian  1   23077061 1.1170e+10 9167.8
## <none>                   1.1147e+10 9168.7
## - EDU_MS    1  162069223 1.1309e+10 9174.5
## - EDU_NoD   1 1146503189 1.2293e+10 9219.8
##
## Step:  AIC=9166.66
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + MeanIn + MeanInFu + PopWhite + PopAsian
##
##            Df  Sum of Sq        RSS    AIC
## - MeanInFu  1     577370 1.1147e+10 9164.7
## - PopWhite  1    8869214 1.1156e+10 9165.1
## - POV20     1   10641653 1.1158e+10 9165.2
## - MeanIn    1   10867887 1.1158e+10 9165.2
## - EDU_BA    1   11849723 1.1159e+10 9165.2
## - PoPI      1   13641712 1.1161e+10 9165.3
## - EDU_High  1   19538254 1.1166e+10 9165.6
## - EDU_COL   1   21538954 1.1168e+10 9165.7
## - PopAsian  1   24718442 1.1172e+10 9165.9
## <none>                   1.1147e+10 9166.7
```

```
## + PopBlack  1       507 1.1147e+10 9168.7
## - EDU_MS    1  162334017 1.1309e+10 9172.5
## - EDU_NoD   1 1230914164 1.2378e+10 9221.5
##
## Step:  AIC=9164.69
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + MeanIn + PopWhite + PopAsian
##
##           Df  Sum of Sq        RSS    AIC
## - PopWhite  1   10053746 1.1158e+10 9163.2
## - POV20     1   10413923 1.1158e+10 9163.2
## - EDU_BA    1   11386477 1.1159e+10 9163.2
## - PoPI      1   13555597 1.1161e+10 9163.4
## - MeanIn    1   15434245 1.1163e+10 9163.4
## - EDU_High  1   18966756 1.1166e+10 9163.6
## - EDU_COL   1   20967027 1.1168e+10 9163.7
## - PopAsian  1   25612160 1.1173e+10 9163.9
## <none>                  1.1147e+10 9164.7
## + MeanInFu  1     577370 1.1147e+10 9166.7
## + PopBlack  1       556 1.1147e+10 9166.7
## - EDU_MS    1  163571522 1.1311e+10 9170.6
## - EDU_NoD   1 1249174142 1.2397e+10 9220.4
##
```

```
## Step:  AIC=9163.18
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + MeanIn + PopAsian
##
##            Df  Sum of Sq        RSS    AIC
## - MeanIn    1   10036964 1.1168e+10 9161.7
## - PoPI      1   12348444 1.1170e+10 9161.8
## - EDU_BA    1   14816233 1.1172e+10 9161.9
## - POV20     1   17070134 1.1175e+10 9162.0
## - PopAsian  1   25007343 1.1183e+10 9162.4
## - EDU_COL   1   28310976 1.1186e+10 9162.6
## - EDU_High  1   33703431 1.1191e+10 9162.8
## <none>                   1.1158e+10 9163.2
## + PopWhite  1   10053746 1.1147e+10 9164.7
## + PopBlack  1    5345017 1.1152e+10 9164.9
## + MeanInFu  1    1761902 1.1156e+10 9165.1
## - EDU_MS    1  191658988 1.1349e+10 9170.4
## - EDU_NoD   1 1250036439 1.2408e+10 9218.8
##
## Step:  AIC=9161.67
## Size ~ POV20 + EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS +
##     PoPI + PopAsian
##
```

```
##           Df  Sum of Sq        RSS    AIC
## - POV20     1   14100948 1.1182e+10 9160.4
## - PoPI      1   21984317 1.1190e+10 9160.7
## - PopAsian  1   24443989 1.1192e+10 9160.9
## - EDU_COL   1   27198088 1.1195e+10 9161.0
## - EDU_BA    1   28314758 1.1196e+10 9161.0
## - EDU_High  1   31461350 1.1199e+10 9161.2
## <none>                  1.1168e+10 9161.7
## + MeanIn    1   10036964 1.1158e+10 9163.2
## + PopWhite  1    4656464 1.1163e+10 9163.4
## + MeanInFu  1    2083368 1.1165e+10 9163.6
## + PopBlack  1    1992618 1.1166e+10 9163.6
## - EDU_MS    1  246114008 1.1414e+10 9171.5
## - EDU_NoD   1 1263882176 1.2431e+10 9217.9
##
## Step:  AIC=9160.35
## Size ~ EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS + PoPI +
##     PopAsian
##
##           Df  Sum of Sq        RSS    AIC
## - PopAsian  1   29357835 1.1211e+10 9159.8
## - EDU_COL   1   30077058 1.1212e+10 9159.8
## - EDU_BA    1   39673911 1.1221e+10 9160.3
```

```
## <none>                  1.1182e+10 9160.4
## + POV20     1   14100948 1.1168e+10 9161.7
## - PoPI      1   69068378 1.1251e+10 9161.7
## + PopWhite  1    9575250 1.1172e+10 9161.9
## + MeanIn    1    7067778 1.1175e+10 9162.0
## + PopBlack  1    3870120 1.1178e+10 9162.2
## + MeanInFu  1    1199843 1.1180e+10 9162.3
## - EDU_High  1   99775896 1.1281e+10 9163.2
## - EDU_MS    1  278133043 1.1460e+10 9171.7
## - EDU_NoD   1 1346158716 1.2528e+10 9220.1
##
## Step:  AIC=9159.78
## Size ~ EDU_NoD + EDU_COL + EDU_High + EDU_BA + EDU_MS + PoPI
##
##           Df  Sum of Sq        RSS    AIC
## - EDU_COL   1   20697346 1.1232e+10 9158.8
## - EDU_BA    1   23372586 1.1234e+10 9158.9
## <none>                  1.1211e+10 9159.8
## + PopAsian  1   29357835 1.1182e+10 9160.4
## + POV20     1   19014794 1.1192e+10 9160.9
## + PopWhite  1   10211156 1.1201e+10 9161.3
## - PoPI      1   76234406 1.1287e+10 9161.5
## + MeanIn    1    6136824 1.1205e+10 9161.5
```

```
## - EDU_High  1   80386489 1.1291e+10 9161.7
## + PopBlack  1    1165181 1.1210e+10 9161.7
## + MeanInFu  1     421641 1.1211e+10 9161.8
## - EDU_MS    1  248880220 1.1460e+10 9169.7
## - EDU_NoD   1 1349783022 1.2561e+10 9219.5
##
## Step:  AIC=9158.78
## Size ~ EDU_NoD + EDU_High + EDU_BA + EDU_MS + PoPI
##
##           Df  Sum of Sq        RSS    AIC
## - EDU_BA    1   13965278 1.1246e+10 9157.5
## <none>                  1.1232e+10 9158.8
## - EDU_High  1   61125055 1.1293e+10 9159.7
## + POV20     1   20877224 1.1211e+10 9159.8
## + EDU_COL   1   20697346 1.1211e+10 9159.8
## + PopAsian  1   19978123 1.1212e+10 9159.8
## - PoPI      1   63183777 1.1295e+10 9159.8
## + PopWhite  1   16718167 1.1215e+10 9160.0
## + MeanIn    1    5316468 1.1226e+10 9160.5
## + PopBlack  1    4115558 1.1228e+10 9160.6
## + MeanInFu  1     853289 1.1231e+10 9160.7
## - EDU_MS    1  232288258 1.1464e+10 9167.9
## - EDU_NoD   1 1396462017 1.2628e+10 9220.4
```

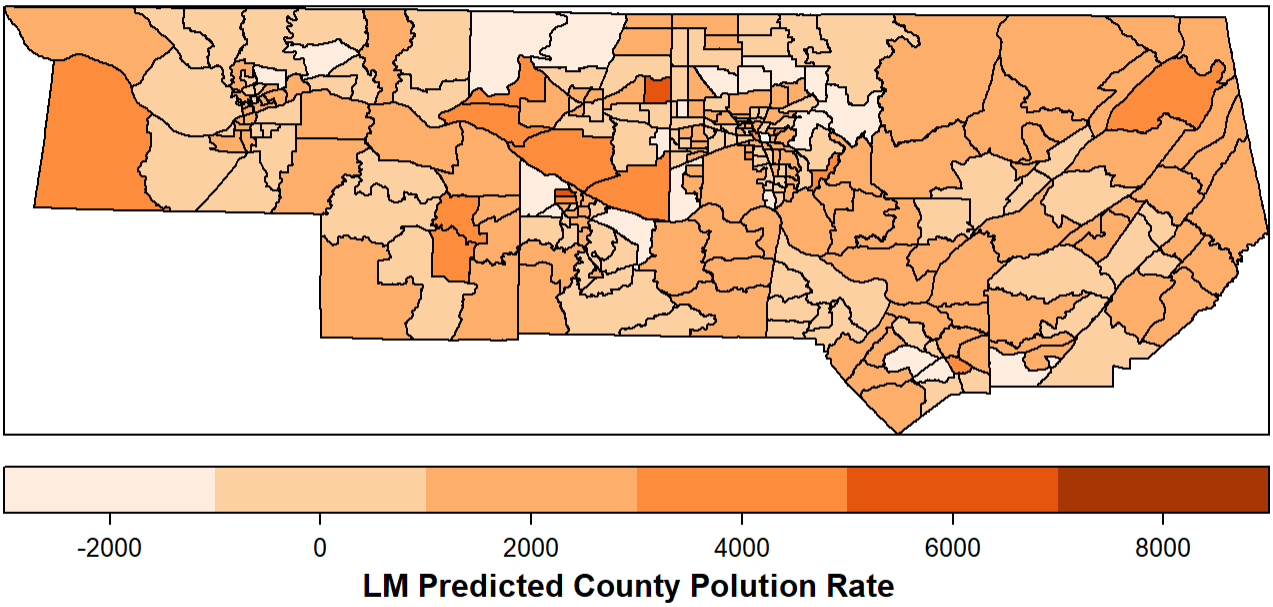
```
##
## Step:  AIC=9157.45
## Size ~ EDU_NoD + EDU_High + EDU_MS + PoPI
##
##           Df  Sum of Sq        RSS    AIC
## <none>                  1.1246e+10 9157.5
## - PoPI      1   53715952 1.1299e+10 9158.0
## - EDU_High  1   54429365 1.1300e+10 9158.1
## + POV20     1   26924199 1.1219e+10 9158.2
## + PopWhite  1   17866761 1.1228e+10 9158.6
## + EDU_BA    1   13965278 1.1232e+10 9158.8
## + MeanIn    1   12654171 1.1233e+10 9158.8
## + EDU_COL   1   11290038 1.1234e+10 9158.9
## + PopAsian  1   10665315 1.1235e+10 9158.9
## + PopBlack  1    5557820 1.1240e+10 9159.2
## + MeanInFu  1    4790810 1.1241e+10 9159.2
## - EDU_MS    1  422091629 1.1668e+10 9175.5
## - EDU_NoD   1 1445802541 1.2691e+10 9221.1
##
## Call:
## lm(formula = Size ~ EDU_NoD + EDU_High + EDU_MS + PoPI, data = pollution)
##
## Coefficients:
```

```
## (Intercept)      EDU_NoD     EDU_High       EDU_MS        PoPI
##    1652.733       11.219       -1.076        6.219       -1.243
```

```
model.lm3 = lm(Size ~ POV20 + EDU_NoD + EDU_High + EDU_MS + PoPI, data = pollution)
step(model.lm3, direction = "both")
## Start:  AIC=9158.15
## Size ~ POV20 + EDU_NoD + EDU_High + EDU_MS + PoPI
##
##           Df  Sum of Sq        RSS    AIC
## - EDU_High  1    4201084 1.1223e+10 9156.4
## - PoPI      1   10333555 1.1229e+10 9156.7
## - POV20     1   26924199 1.1246e+10 9157.5
## <none>                   1.1219e+10 9158.2
## - EDU_MS    1  330432120 1.1549e+10 9171.9
## - EDU_NoD   1 1321122316 1.2540e+10 9216.6
##
## Step:  AIC=9156.36
## Size ~ POV20 + EDU_NoD + EDU_MS + PoPI
##
##           Df  Sum of Sq        RSS    AIC
## - PoPI      1   12856746 1.1236e+10 9155.0
## <none>                   1.1223e+10 9156.4
## - POV20     1   77152480 1.1300e+10 9158.1
```

```
## + EDU_High  1    4201084 1.1219e+10 9158.2
## - EDU_MS    1  350718919 1.1574e+10 9171.1
## - EDU_NoD   1 1548530993 1.2771e+10 9224.5
##
## Step:  AIC=9154.98
## Size ~ POV20 + EDU_NoD + EDU_MS
##
##           Df  Sum of Sq        RSS    AIC
## <none>                   1.1236e+10 9155.0
## + PoPI      1   12856746 1.1223e+10 9156.4
## + EDU_High  1    6724275 1.1229e+10 9156.7
## - EDU_MS    1  348685758 1.1585e+10 9169.6
## - POV20     1  739083206 1.1975e+10 9187.6
## - EDU_NoD   1 1610857052 1.2847e+10 9225.7
##
## Call:
## lm(formula = Size ~ POV20 + EDU_NoD + EDU_MS, data = pollution)
##
## Coefficients:
## (Intercept)        POV20      EDU_NoD       EDU_MS
##    1634.928       -1.265       12.352        5.134


pollution$predLM = predict(model.lm3)
```

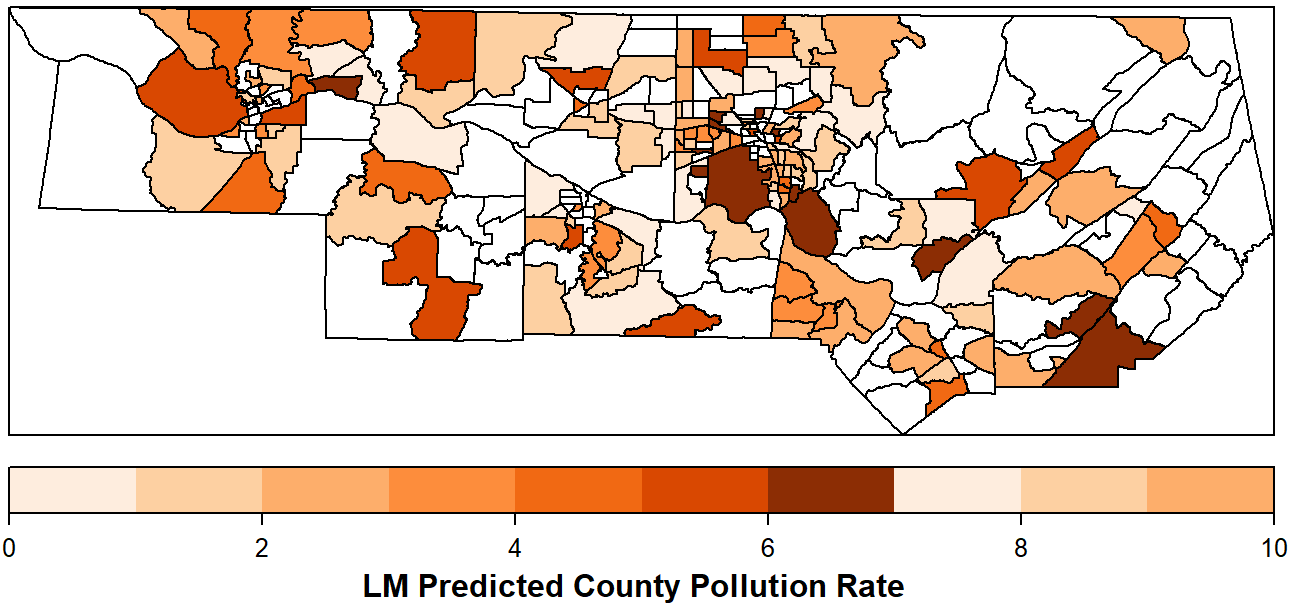
```
range(pollution$predLM)

## [1] -2455.750  9150.611

brks = seq(-3000, 10000, 2000)

cr = brewer.pal(6, "Oranges")

spplot(pollution, "predLM", col.regions = cr, at = brks,

      colorkey = list(space = "bottom"),

      sub = "LM Predicted County Polution Rate")
```




```
pollution$logPol20 = log(pollution$Size)

x = pollution$Size == 0
```

```
mn = min(pollution$logPol20[!x])
pollution$logPol20[x] = mn


model.lm4 = lm(logPol20 ~ POV20 + EDU_NoD + EDU_High + EDU_MS + PoPI, data =
pollution)
summary(model.lm4)
##
## Call:
## lm(formula = logPol20 ~ POV20 + EDU_NoD + EDU_High + EDU_MS +
##     PoPI, data = pollution)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.5105 -2.2728 -0.5609  2.1133  8.9455
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.409e+00  4.207e-01   5.724 1.73e-08 ***
## POV20       -4.436e-04  4.253e-04  -1.043    0.297
## EDU_NoD      1.213e-02  9.924e-04  12.220  < 2e-16 ***
## EDU_High    -1.053e-03  5.883e-04  -1.790    0.074 .
## EDU_MS       4.383e-03  9.518e-04   4.605 5.16e-06 ***
## PoPI        -3.645e-05  6.139e-04  -0.059    0.953
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.011 on 537 degrees of freedom
## Multiple R-squared:  0.2827, Adjusted R-squared:  0.276
## F-statistic: 42.33 on 5 and 537 DF,  p-value: < 2.2e-16
pollution$predLM = exp(predict(model.lm4))
range(pollution$predLM)
## [1] 2.931854e-01 1.336589e+04
brks = seq(0, 10, 1) #Need to alter the bins
cr = brewer.pal(7, "Oranges")
spplot(pollution, "predLM", col.regions = cr, at = brks,
       colorkey = list(space = "bottom"),
       sub = "LM Predicted County Pollution Rate")
```




```
bw = gwr.sel(logPol20 ~ POV20 + EDU_NoD + EDU_High + EDU_MS + PoPI, data =
pollution)
## Bandwidth: 0.9787362 CV score: 4804.47
## Bandwidth: 1.582047 CV score: 4931.438
## Bandwidth: 0.6058694 CV score: 4599.034
## Bandwidth: 0.375425 CV score: 4381.435
## Bandwidth: 0.2330026 CV score: 3997.173
## Bandwidth: 0.1449807 CV score: 3342.323
## Bandwidth: 0.09058014 CV score: 2877.849
```

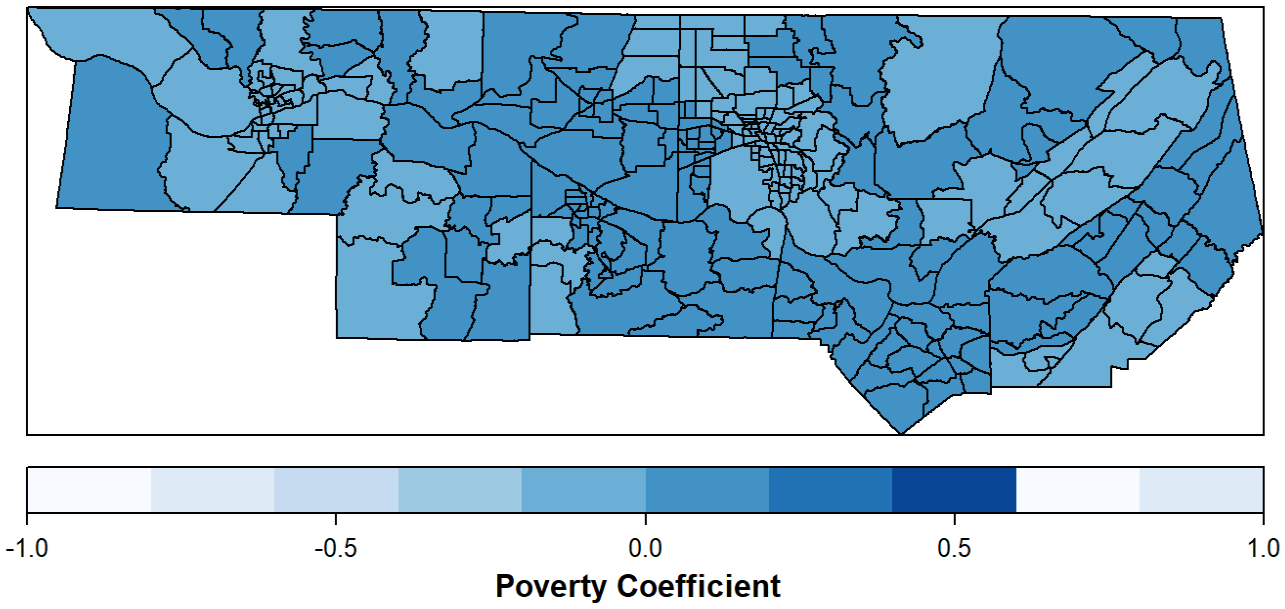
```
## Bandwidth: 0.05695876 CV score: 2553.159
## Bandwidth: 0.03617961 CV score: NA
## Warning in optimize(gwr.cv.f, lower = beta1, upper = beta2, maximum = FALSE, :
## NA/Inf replaced by maximum positive value
## Bandwidth: 0.06980099 CV score: 2644.408
## Bandwidth: 0.04902183 CV score: 2525.554
## Bandwidth: 0.04302837 CV score: 2538.47
## Bandwidth: 0.04868984 CV score: 2524.95
## Bandwidth: 0.04756108 CV score: 2523.441
## Bandwidth: 0.04582974 CV score: 2523.655
## Bandwidth: 0.04681645 CV score: 2523.055
## Bandwidth: 0.04677576 CV score: 2523.051
## Bandwidth: 0.04672812 CV score: 2523.05
## Bandwidth: 0.04638497 CV score: 2523.134
## Bandwidth: 0.04668743 CV score: 2523.052
## Bandwidth: 0.04672812 CV score: 2523.05
```

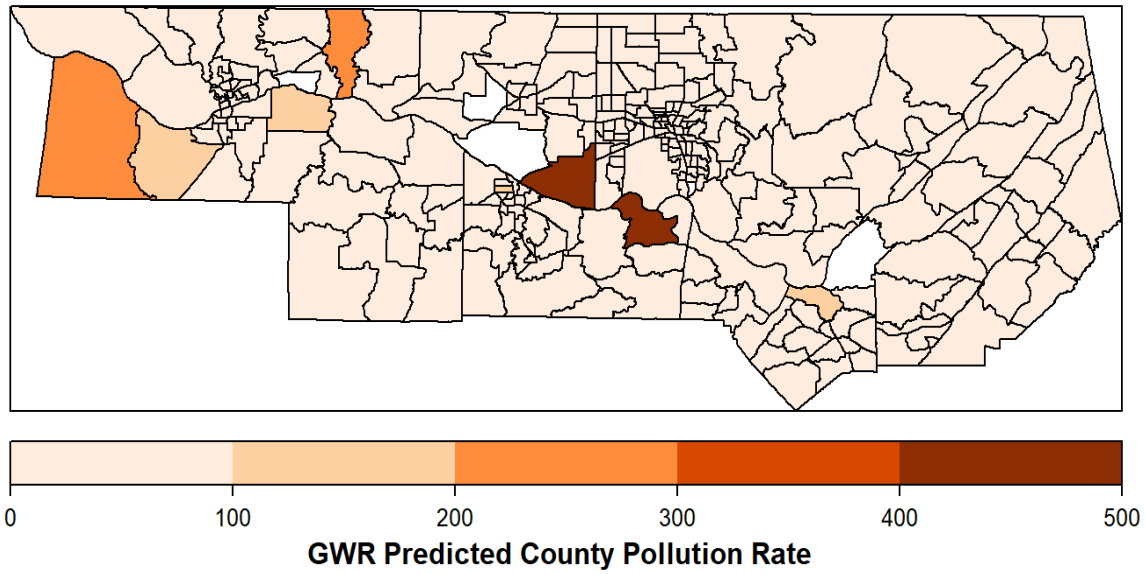
```
model.gwr = gwr(logPol20 ~ POV20 + EDU_NoD + EDU_High + EDU_MS + PoPI, data =
pollution, bandwidth = bw)
```

```
model.gwr$SDF$pred2 = exp(model.gwr$SDF$pred)
```

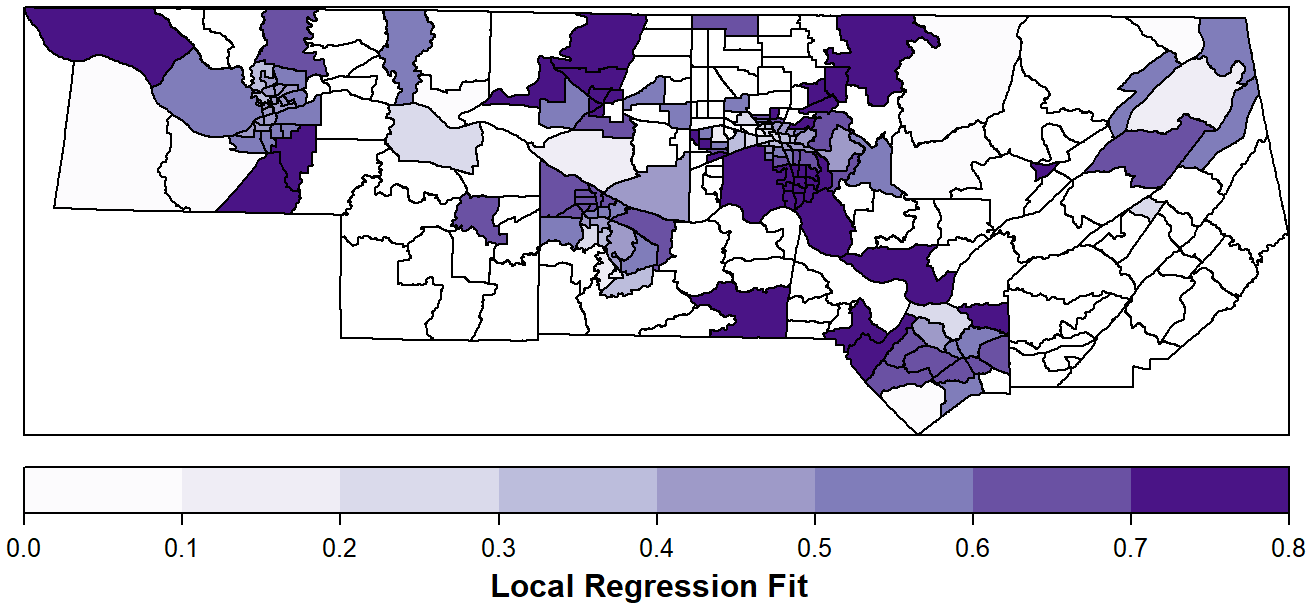
```
range(model.gwr$SDF$pred2)
```

```
## [1] 9.651898e-02 7.940073e+03
brks = seq(0, 500, 100)
cr = brewer.pal(7, "Oranges")

spplot(model.gwr$SDF, "pred2", col.regions = cr, at = brks,
      colorkey = list(space = "bottom"),
      sub = "GWR Predicted County Pollution Rate")
```


-1.0
-0.5
0.0
0.5
1.0
Poverty Coefficient


0
100
200
300
400
500
GWR Predicted County Pollution Rate

```
range(model.gwr$SDF$EDU_NoD)

## [1] -0.1167498  0.2041482

brks = seq(-1, 1, .2)

cr = brewer.pal(8, "Blues")

spplot(model.gwr$SDF, "EDU_MS",

      col.regions = cr, at = brks,

      colorkey = list(space = "bottom"),

      sub = "Poverty Coefficient")



brks = seq(0, .8, .1)

cr = brewer.pal(8, "Purples")

spplot(model.gwr$SDF, "localR2",

      col.regions = cr,  at = brks,

      colorkey = list(space = "bottom"),

      sub = "Local Regression Fit")
```




```
writeOGR(model.gwr$SDF, getwd(), "GWR_Model_Results2", driver="ESRI Shapefile")
```

```
## Warning in writeOGR(model.gwr$SDF, getwd(), "GWR_Model_Results2", driver = "ESRI
## Shapefile"): Field names abbreviated for ESRI Shapefile driver
```

REFERENCES

Alabama Census (2019, May). *Agriculture Census Results Released.* AFLA Farmers website: https://alfafarmers.org/agriculture-census-results-released/

Alabama Possible Staff (2020, May). *2020 Barriers to Prosperity Data Sheet: 800,000 Alabamians Live in Poverty; Alabama Fifth Poorest State.* Alabama Possible website: https://alabamapossible.org/2020/05/21/4480/

Baerwald, J.T. (2010). *Prospects for Geography as an Interdisciplinary Discipline, Annals of the Association of American Geographers, 100(3),* 493-501, DOI: 10.1080/00045608.2010.485443. https://www.tandfonline.com/doi/abs/10.1080/00045608.2010.485443

Bosco, F., & Herman, T. (2010). *Focus Groups as Collaborative Research Performances. The SAGE Handbook of Qualitative Geography* (pp. 193-207). SAGE Publications Ltd, https://dx.doi.org/10.4135/9780857021090.n13

Brunn, S., Webster, G., & Archer, J. C. (2011). *The Bible Belt in a Changing South: Shrinking, Relocating, and Multiple Buckles. Southeastern Geographer*, *51(4*), 513–549. http://www.jstor.org/stable/26228980

Bush, K. D., & Keyman, E. F. (1997). *Identity-Based Conflict: Rethinking Security in a Post–Cold War World. Global Governance*, *3(3),* 311-328. https://digitallibrary.un.org/record/249449?ln=en

Buntaine, M. T., Zhang, B., & Hunnicutt, P. (2021). Citizen monitoring of waterways decreases pollution in China by supporting government action and oversight. Proceedings of the National Academy of Sciences of the United States of America, 118(29), DOI: https://doi.org/10.1073/pnas.2015175118

Camille, A. (2019). *Lab 3 – Introduction to Geographically Weighted Regression*. GIScience: https://blogs.ubc.ca/cpotiergeob479/labs/lab-3-introduction-to-geographically-weighted-regression/

Census of Agriculture (2017). *Census of Agriculture.* USDA website: https://www.nass.usda.gov/Publications/AgCensus/2017/index.php

Cresswell, T. (1996). *In Place/Out of Place: Geography, Ideology, and Transgression*. University of Minnesota Press.

Cresswell, T. (2015). *Place: An Introduction*. Wiley Blackwell.

Choudhary, M. P., Chauhan, G.S., Kushwah, Y.K. (2015). *Environmental Degradation: Causes, Impacts and Mitigation.* [Explaination of environmental degradation, its causes, impacts,

and how to mitigate the issues created from the phenonmenon]. National Seminar on Recent Advancements in Protection of Environment and its Management Issues (NSRAPEM-2015). Kota, Rajasthan, India. https://www.researchgate.net/publication/279201881_Environmental_Degradation_Causes_Impacts_and_Mitigation

Duncan, James S. (1990). *The City as Text: The Politics of Landscape Interpretation in the Kandyan Kingdom*. Cambridge University Press.

Duraiappah, A. K. (1998). *Poverty and Environmental Degradation: A Review and Analysis of the Nexus*. World Development. *26(12),* 2169-2179. DOI: https://doi.org/10.1016/S0305-750X(98)00100-4.

Elwood, S. (2010). *Mixed Methods: Thinking, Doing, and Asking in Multiple Ways*. The SAGE Handbook for Qualitative Research. DOI: https://dx.doi.org/10.4135/9780857021090.

Klotz, John W. (1971). *Ecology Crisis: God's Creation and Man's Pollution*. Concordia.

Farmland Information Center (2022). *Alabama Data and Statistics.* Farmland Information Center website: https://farmlandinfo.org/statistics/alabama-statistics/

Geertz, C. (1993). *Religion as a cultural system*. *The Interpretation of Cultures: Selected Essays*, 87-125. Fontana Press.

Gibson, J. S. (1941). *The Alabama Black Belt: Its Geographic Status. Economic Geography*, 17(1), 1–23. DOI: https://doi.org/10.2307/141741

Goodchild, M. F. (2015). *Two decades on: Critical GIScience since 1993*. Canadian Geographer, 59(1), 3-11. DOI: https://doi.org/10.1111/cag.12117

Gooley, T. (2016). *How To Read Water: Clues & Patterns from Puddles to the Sea*. Hodder & Stoughton.

Guntersville Museum (2020, March). History of Guntersville. Guntersville Museum website: https://www.guntersvillemuseum.org/

McDowell, L. (2010). *Interviewing: fear and liking in the field. In SAGE Handbook of Qualitative Geography* (pp. 156-171). SAGE Publications Ltd, https://dx.doi.org/10.4135/9780857021090.n11

Meinig, D. W., ed. 1979a.The Interpretation of Ordinary Landscapes. New York: Oxford University Press

Morrill, R. (1969). *Geography and the Transformation of Society*. Antipode 1(1), 6-9.

Moss, R. (2001). *Placing Autobiography in Geography.* Syracuse University Pres.

Nogué, J., & Vicente, J.A. (2004). Landscape and national identity in Catalonia. Political Geography, 23, 113-132.

Organization, World Health (2005). *The Right to Water*. United Nations website: https://www.who.int/news-room/fact-sheets/detail/drinking-water

Peet, R. (2006). *Modern Geographical Thought*. Oxford Press.

Pew Research Staff (2020, March). *Religious Composition of Adults in Alabama.* Pew Research website: https://www.pewforum.org/religious-landscape-study/state/alabama/

Pillion, D. (2021). *1.7M Gallons of Sewage Spilled into Lake Guntersville since 2017*; *Riverkeeper to Sue*. AL.com: https://www.al.com/news/2021/06/17m-gallons-of-sewage-spilled-into-lake-guntersville-since-2017-riverkeeper-to-sue.html

Qazimi, S. (2014). Sense of Place and Place Identity. European Journal of Social Sciences Education and Research, 1, 306-310.

Reader's Digest, Editors. (1988). *Country Ways: A Celebration of Rural Life*. Reader's Digest Press.

Reeves, H. (2012). *On Island Time: A Place-Based Identity in Dauphin Island, Alabama.* [Master's thesis, University of Auburn]. AUETD.

Robinson, Guy. (2018). New frontiers in agricultural geography: transformations, food security, land grabs and climate change. Boletín De La Asociación Española De Geografía, (78), 1-48. DOI: https://doi.org/10.21138/bage.2710

Rollero, C., & Piccoli, N.D. (2010). *Place Attachment, Identification and Environment Perception: An Empirical Study.* Journal of Environmental Psychology, (30), 198-205.

Schein, R. H. (1997). The Place of Landscape: A Conceptual Framework for Interpreting an American Scene. Annals of the Association of American Geographers, 87(4), 660–680. http://www.jstor.org/stable/2564404

Southern Environmental Law Center (2021, March). *Tri-State Water Wars (AL, GA, FL).* Research Gate website: https://www.southernenvironment.org/cases-and-projects/tri-state-water-wars-al-ga-fl

Staff, ESRI (2021). *Geographically Weighted Regression (GWR) (Spatial Statistics).* ESRI website: https://pro.arcgis.com/en/pro-app/2.7/tool-reference/spatial-statistics/geographically-weighted-regression.htm.

Tennessee Valley Authority (2018, March). *Water Use in the Tennessee Valley for 2015 and Projected Use in 2040.* TVA website: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/managing-the-river/2015-water-use-report_2040-projections.pdf?sfvrsn=25cd3bba_0

Tennessee Valley Authority (2020, March). *Navigation on the Tennessee River*. TVA website: https://www.tva.com/environment/managing-the-river/navigation-on-the-tennessee-river.

Thomas, S. M. (2001). Faith, History and Martin Wight: The Role of Religion in the Historical Sociology of the English School of International Relations. International Affairs (Royal Institute of International Affairs 1944-), 77(4), 905–929. http://www.jstor.org/stable/3095601

Tuan, Yi-Fu. (1974). *Topophilia: A Study of Environmental Perception, Attitudes, and Values*. University of Columbia Press.

Tuan, Yi-Fu. (1977). *Space and Place: The Perspective of Experience*. University of Minnesota Press.

Turri, E. (1998). *Il paesaggio come teatro. Dal territorio vissuto al territorio rappresento*. Marsilio Press.

United States Geological Survey. (2004) *Water Quality in the Lower Tennessee River Basin Tennessee, Alabama, Kentucky, Mississippi, and Georgia, 1999–2001*. USGS website: https://pubs.usgs.gov/circ/2004/1233/pdf/circular1233.pdf