ABSTRACT

YOUTH, MICHAEL DAVID. Gentrification and Community Gating around Sub/urban Drinking Water Supply Reservoirs in North Carolina, USA. (Under the direction of Dr. George Hess).

To achieve sustainability, the utilitarian tendency toward “the greatest good for the greatest number” must be tempered by a concern for justice. Infrastructure intended to serve the public good frequently has environmental justice implications, meaning the infrastructure often plays a role in inducing or advancing demographic processes of concern: Persistent poverty or segregation, gentrification, wealth or white flight, and community gating.

Sub/urban drinking water supplies in North Carolina, USA, have regularly been secured by constructing dams to impound drinking water supply reservoirs. Though intended to serve the public good, these reservoirs appear to implicate one or more demographic processes of concern. We used higher resolution, publicly available US Census data and an area-weighted GIS analysis to explore whether 66 sub/urban drinking water supply reservoirs in North Carolina have induced gentrification in lakeside communities. Our principal findings include: (1) The ratio of white people to non-white people was significantly higher in communities within 0.5 mile of reservoirs’ shorelines than in more distant communities; and (2) even as North Carolina overall became less white from 1990 to 2010, the ratio of white people to non-white people within the 0.5 mile areas increased relative to the overall ratio in the State. These tendencies are consistent with the proposition that our sample of North Carolina sub/urban drinking water supply reservoirs have induced racial gentrification in the past and are continuing to have a gentrifying or community gating effect. These tendencies raise environmental justice and social sustainability concerns that should, at a minimum, be taken into account in planning and building new North Carolina drinking water supply reservoirs.
Gentrification and Community Gating around Sub/urban Drinking Water Supply Reservoirs in North Carolina, USA

by
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BIOGRAPHY

Michael Youth was born in Chapel Hill, North Carolina, and grew up on Long Island, New York. He received both his undergraduate degree in Classical Civilizations and a law degree from the University of North Carolina at Chapel Hill. The son of a Jewish father and a Catholic mother, Michael’s interest in environmental justice for minorities and the poor is actually a self-interest, a kind of social banking intended to ensure that he never finds himself in the type of situation described by World War II-era clergyman Martin Niemoller:

*First they came for the Socialists, and I did not speak out --*

*Because I was not a Socialist.*

*Then they came for the Trade Unionists, and I did not speak out --*

*Because I was not a Trade Unionist.*

*Then they came for the Jews, and I did not speak out --*

*Because I was not a Jew.*

*Then they came for me -- and there was no one left to speak for me.*
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CHAPTER 1: Literature Review

Section 1: Introduction

Our increasingly sub/urban society has come to rely on infrastructure, such as drinking water supply reservoirs, to sustain itself. Paradoxically, if this same infrastructure is perceived as unjust, it can induce social unrest and thereby undermine the very sustainability it was designed to bolster. For this reason, infrastructural issues require decision-makers to engage in a delicate balancing of economic, environmental, and social burdens and benefits. Environmental justice (EJ) researchers are particularly interested in the relationships between infrastructural decision-making and demographics. Sections 2 through 4 of this paper provide a brief overview of EJ’s origins and theoretical underpinnings. Urban ecologists are becoming increasingly interested in infrastructure-related social impacts because, as Haberl et al. (2006) have noted, “Changes in societies are closely intertwined with ecological transformations” (p. 261). EJ researchers and urban ecologists alike should aim to provide decision-makers with as much information as possible about the social burdens and benefits of various classes of infrastructure.

Such infrastructural social impact assessment research ideally involves a two-step approach. First, as described in Section 5 below, researchers should look for patterns – spatial associations at a fixed point in time between classes or pieces of infrastructure and a demographic, such as race or income. Section 6 identifies some of the methodological issues that can complicate this first step. Section 6 also makes the argument that, once a point-in-time pattern is established, researchers should expand their analysis to additional points in time in order to try to establish a process – an explanation of how and why the observed
pattern evolved. Quantitative longitudinal analyses help to explain how patterns evolved; qualitative place-based historical analyses help to explain why. These temporal analyses come with their own complications.

Finally, in Section 7, I hypothesize that a simple matrix I have designed can contextualize much of the existing quantitative and qualitative longitudinal research and help drive future hypothesis development. The matrix serves to focus research on four basic infrastructure-related demographic processes that can take place in a community and merit EJ attention: Persistent poverty, gentrification, white flight, and community gating. In this section, I also propose – as an example of matrix-driven hypothesis development – that reservoirs built in North Carolina to impound drinking water supplies fit into the matrix as a class of infrastructure that tends to induce gentrification, a proposal I test in Chapter 2. Ultimately, if the matrix proves adequate in accommodating research results, it can be used to assist decision-makers in conceptualizing the social implications of their infrastructural decisions, including helping them better grasp the longer-term ramifications of their drinking water supply reservoir planning decisions.

Section 2: Environmental Justice

The environmental justice movement has contributed to a re-conceptualization of what we mean when we say “the environment” (Sandler and Pezzullo 2007). The environment used to be limited to places “untouched” by humans – distant wildernesses accessible only to the few and needing to be protected from the many. EJ has promoted an alternative understanding, one which challenges whether places “untouched” by humans even exist, and thus questions the exclusion of any place from “the environment.”
Proponents of EJ understand the environment to encompass not only the distant wildernesses but also the places – including our cities – in which humans live, work and play (Floyd and Johnson 2002; Mohai et al. 2009). As the term EJ itself suggests, this re-conceptualization of “the environment” is where the EJ movement begins; its ultimate goal, however, is justice within the environment.

In the United States, sub/urban areas are home to almost 80 percent of the population (Pickett et al. 2001). The residents of these areas demand services, such as waste removal and storage, clean drinking water, and recreational opportunities. Infrastructure is required to meet these demands. For purposes of this paper, “infrastructure” is defined broadly to encompass both physical constructs, such as waste sites, and non-physical constructs, such as environmental laws and land use regulations that have physical ramifications. Infrastructural “improvements” – like waste sites, drinking water reservoirs, parks, and zoning laws – arguably accommodate the overall sub/urban populace to some degree, but they rarely accommodate all segments of the populace equally. It was opposition to discriminatorily unequal accommodation that galvanized the modern EJ movement almost 30 years ago (Sandler and Pezzullo 2007). Such opposition remains the movement’s tentpole issue to this day.

**Section 3: Origins of the EJ Movement**

In 1982, the city of Afton in Warren County – one of North Carolina’s poorest, predominantly black counties – was chosen as the site for a landfill that would store 32,000 cubic yards of soil contaminated with polychlorinated biphenyl (PCB) (Floyd and Johnson 2002).[1] Neither the PCB nor the soil was from within Warren County. The serious health
risks associated with PCB caused the community to coalesce in active opposition to the landfill. Floyd and Johnson (2002) noted that with the arrests of more than 500 protesters including a congressman drawing national media attention, “[m]any consider this event . . . the flashpoint in the emergence of the environmental justice movement” (p. 65).

As a direct result of the Afton protests, the U.S. General Accounting Office (GAO) conducted a study and concluded that three of the four examined communities containing large commercial hazardous waste landfills were predominantly black, with all four landfills being in communities with at least one quarter of the population below the poverty line (Floyd and Johnson 2002; GAO 1983). This study in turn prompted the United Church of Christ (UCC) to conduct a seminal nationwide study of the siting of waste treatment, storage and disposal facilities (UCC 1987). The 1987 study concluded that zip code areas without waste facilities were only 12.3% minority while zip code areas with one or more waste facilities were 24%-38% minority (Floyd and Johnson 2002; UCC 1987).

Given the apparent inequality – called environmental racism by some – in the siting of waste facilities, the First National People of Color Environmental Leadership Summit (Summit I) was held in 1991. At Summit I, 17 “Principles of Environmental Justice” were drafted and adopted by people of color.[2] In 1994, President William Clinton signed an executive order, entitled “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (Executive Order 12898, 1994). The order mandates in pertinent part that

[t]o the greatest extent practicable and permitted by law, . . . each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and
activities on minority populations and low-income populations in the United States (italics added).

This brief history – from Afton to the executive order – is perhaps best referred to as the popular narrative of the origin of the EJ movement. It does not, however, adequately explain the deep roots from which the EJ movement sprang. The movement is appropriately conceived of as a confluence with many pre-1982 “tributaries of which the civil rights movement is one, the antitoxins movement is another, and Native American struggles, the labor movement, traditional environmentalism, and the findings of academics are others” (Allen et al. 2007 p. 108).[3] The quest for justice in the places within which we live, work, and play is age-old.

Section 4: What Does Justice Mean in the EJ Context?

There is no universally agreed-upon definition of EJ, likely because there is no universally agreed-upon definition of justice. Definitions do, however, exist. Examining several will enable us to distill several constituent parts of justice that appear to be common denominators across the EJ movement. The U.S. Environmental Protection Agency (2012) defines EJ as follows:

Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EPA has this goal for all communities and persons across this Nation. It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work.

By way of contrast, the Energy Justice Network (2012) prominently defines EJ on its website as follows:
Environmental racism is the disproportionate impact of environmental hazards on people of color. Environmental justice is the movement’s response to environmental racism. “Environmental equity” is not environmental justice. “Environmental equity” is the government’s response to the demands of the environmental justice movement. Government agencies, like the EPA, have been coopting the movement by redefining environmental justice as “fair treatment and meaningful involvement,” something they consistently fail to accomplish, but which also falls far short of the environmental justice vision. The environmental justice movement isn’t seeking to simply redistribute environmental harms, but to abolish them.

Together, these two definitions illustrate how the “justice” in EJ has multiple components: distributive justice, corrective justice, procedural justice, and productive justice.

The EPA definition’s phrases “fair treatment” and “the same degree of protection from . . . hazards” capture in essence the concepts researchers call distributive justice and corrective justice (see, e.g., Floyd and Johnson 2002). Distributive justice encompasses the idea that the environmental burdens and benefits of infrastructural decisions should not disproportionately affect any one segment of society. Rather, they should be fairly distributed. Often the focus of distributive justice is on environmental burden. For example, minorities or the poor should not disproportionately bear the health, community, and economic burdens of waste sites, incinerators, and manufactory emissions (Sandler and Pezzullo 2007). The fair distribution of environmental benefits is, however, beginning to receive more attention (Floyd and Johnson 2002; Landry and Chakraborty 2009). Where unfair treatment exists, there is a need for corrective justice – the rectifying or mitigating of a distributive injustice (Sandler and Pezzullo 2007).

The EPA definition’s use of the terms “meaningful involvement” and “equal access to the decision-making process” captures the spirit of a concept researchers call procedural justice (see, e.g., Floyd and Johnson 2002). Procedural justice – sometimes called
participatory justice – encompasses the idea that all segments of society should have a voice in the decision-making process (Sandler and Pezzullo 2007). Having a voice does not, of course, ensure distributive justice. Nonetheless, it is an important safeguard because exclusion of a segment of society from the decision-making process certainly increases the likelihood of distributive injustice.

The Energy Justice Network definition introduces the concept of productive justice (Sandler and Pezzullo 2007). With regard to environmental burdens, productive justice is EJ’s highest aim. Foundationally, productive justice is a challenge to the concept that “someone’s got to bear the burden;” productive justice envisions the wholesale elimination of environmental burdens. With hazardous waste, for example, productive justice seeks to “abolish” the production of waste and thereby obviate the need to determine how to distribute it fairly.

This paper does not concern itself with corrective or productive justice for a rather simple reason. This paper focuses on the EJ researcher’s role in the identification of environmental inequalities and injustices. Neither corrective justice nor productive justice is concerned with such identification; instead, discussions involving these two types of justice presuppose the earlier identification of a distributive or procedural injustice.

**Section 5: Two Spatial Patterns of Interest**

EJ researchers have played a critical role in advancing the EJ movement. Researchers have collected data and developed methodologies for analyzing the data in order to test for evidence of inequality and injustice (see, e.g., Mohai and Saha 2006). EJ researchers’ initial investigations were limited to looking for a relationship at a single point in time between a
class of infrastructure and demographics such as race and income (see, for example, GAO 1983; UCC 1987).

Today, there are two point-in-time spatial patterns or relationships between infrastructure and demographics that are of particular interest to EJ researchers. In a recent review, Mohai et al. (2009) traced the history of the first relationship – the tendency of disamenities or locally unwanted land uses (LULUs), such as waste sites, to burden communities that are disproportionately minority or low-income. In contrast, the second relationship involves presumptive amenities or locally desirable land uses that tend to benefit communities that are disproportionately white or higher-income (Landry and Chakraborty 2009; Wells et al. 2008). These two relationships can be expressed as points on a graph, the x-axis of which represents time and the y-axis of which represents a demographic range, such as low-income to high-income (Fig. 1a). Expressed in this way, it becomes apparent that a point in isolation cannot tell the story of how or why the relationship it represents evolved.

To the researcher interested in how a demographic “landscape” came to be, a single current point begs to be joined to an additional point (or, better yet, additional points) in the past (Fig. 1b). The absence of such additional points permitted critics of the early point-in-time or “snapshot” EJ research that associated minorities and hazardous waste sites to challenge the conclusion that intentional discrimination caused the observed spatial pattern; after all, it was possible that the sites were there first and that the minorities “moved to the nuisance” for a variety of reasons, including affordable housing (Pastor et al. 2001). Such which-came-first questions serve to highlight that “present places have past roots” (Pickett et al. 2011 (citing Harris 1978 p.123)).
Pickett et al. (2011) recently reiterated that today’s demographic landscapes represent “accumulations of past processes – including human decision-making” (p. 328). Just as importantly, tomorrow’s landscapes will represent accumulations that take into account decisions made today. By understanding how we arrived at today’s landscape, we equip ourselves with knowledge that will enable us to craft a fairer future landscape. Accordingly, EJ researchers (see, e.g., Bullard et al. 2007; Mohai and Saha 2007) have called for, and in some instances conducted, analyses that look not only for one of the two point-in-time patterns or relationships but also for an answer to the question: How did any perceived pattern come into being?

Section 6: Moving From Pattern to Process

Numerous researchers have advocated use of a place-based historical approach to connect the present landscape to the past and thereby expose process (see, e.g., Boone et al. 2009; Wells et al. 2008). The place-based historical approach generally seeks to couple snapshot quantitative data that raises distributive justice concerns with historical qualitative data that explains the snapshot in procedural justice terms. This approach is unquestionably valuable because it helps answer the question, “Why is the present landscape the way it is?” It does have limitations though. The historical approach’s greatest asset is also its greatest liability: it is place-based. The researcher’s choice of “place” – be it a single park, all the parks in a city, or all the hazardous waste sites in a state – tends to dictate what historical scale is viewed as driving process. Thus, for example, when Wells et al. (2008) examined the history of Carroll Park in Baltimore, they focused on the highly local original minutes of Baltimore’s Board of Public Park Commissioners (BPPC)
meetings, newspapers—including a prominent African American weekly—and other historical sources to explore how access to Carroll Park was shaped by issues of race and ethnicity during the first half of the twentieth century (p. 152).

Similarly, when Boone et al. (2009) examined parks in Baltimore, they focused primarily on history at the city-scale, and when Saha and Mohai (2005) examined hazardous waste sites in Michigan they focused primarily on the larger scale history of federal policy and general anti-toxics sentiment. These various foci are understandable, particularly in light of the fact that, as noted by Boone et al. (2009), this type of historical research requires a substantial time commitment. Though a more comprehensive multi-scalar history of any of these places is certainly possible, it would take considerably more time and could quickly become too voluminous to condense into an article. The practical inability to comprehensively explain process solely by reference to qualitative data means these historical studies will always be vulnerable to attacks suggesting they have left out some critical driver of process. The qualitative historical approach thus often provides insight into the why of a specific landscape but fails to provide a “hard numbers” perspective of exactly how the demographic landscape changed (or did not change) over time (Mohai and Saha 2007).

Quantitative longitudinal research is better suited to answer the how question. It is also helpful in testing how generalizable the results of place-based studies are (Mohai and Saha 2007). For these reasons, it is an ideal complement to place-based research (Floyd and Johnson 2002:72). Quantitative longitudinal research is, however, a rarity.

The methodological innovation of examining a series of snapshots was made in the mid-1990s. Bowen (2002) dated the innovative leap to circa 1997: “The primary contribution of Been and Gupta’s research was in taking a longitudinal approach” (p. 8
(referring to Been and Gupta 1997). Saha and Mohai (2005) did not dispute the general
date of the leap but indicate others might be due credit (p. 618). Regardless of the exact date
or the identity of the innovators, it is clear that EJ researchers have been aware of the
longitudinal approach for over 15 years. And yet, surprisingly few researchers have moved
temporal dimension” (p. 1160). Noonan’s review analyzed 110 EJ studies and found only 18
– or roughly 16% – engaged in any sort of temporal analysis (p. 1155 n.2). It is unclear why
quantitative longitudinal studies are rare.

Noonan acknowledged that the difficulty of temporal analyses may account for their
rarity. He speculated that the lack of longitudinal analyses may be the result of EJ
researchers purposefully avoiding such research because policy advocates have
communicated to them that it is unnecessary and may even undermine the movement’s
positions (Noonan 2008 p. 1164). I am skeptical that EJ researchers would *en masse*
compromise their academic integrities – especially when longitudinal analysis can provide
strong support for the movement’s positions (see, e.g., Bullard et al. 2007) – and therefore
will focus on some methodological problems that might account for the scarcity of
quantitative longitudinal EJ studies.

The methodological hurdles that present problems for snapshot research also
complicate the assembling of series of snapshots. Questions for which there are no agreed-
upon answers include:

- Which demographics should be analyzed (e.g., race, income, sex, age, etc.)
  (see, e.g., Downey 1998; Mohai et al. 2009)?
- At what U.S. Census resolution should the analysis be conducted (e.g., county, zip code area, tract, block group, block) (Bullard 1996; Noonan 2008)?

- How will the analysis be conducted (e.g., 50% areal containment, centroid containment, boundary intersection, areal apportionment) (Mohai and Saha 2006)?

- What buffer distance will be used to represent “proximity” for analyzing the data (e.g., ½ mile, 1 mile, 2 miles, 3 miles, or 1-3 kilometers) (Mohai and Saha 2006)?

- Which statistical tests will be used to analyze the data (Bowen 2002)?

A longitudinal study adds the following questions to the foregoing list:

- What timeframe should be examined (i.e., must the timeframe extend back to before the infrastructure was even anticipated)?

- How many snapshots should be taken within the timeframe (i.e., must researchers use more than two snapshots to establish a trend)?

- How comparable are the snapshots (e.g., is U.S. Census data available at the same resolution for each snapshot; have the boundaries of U.S. Census geographic units changed from one snapshot to the next)?

- How should the snapshots be compared?

It is possible that these problems discourage the majority of EJ researchers from conducting quantitative longitudinal analyses. Thankfully, the problems do not discourage all researchers. Though relatively rare, quantitative longitudinal research is being conducted (see, e.g., Bullard et al. 2007; Eckerd 2011; Gamper-Rabindran and Timmins 2011), and elements conducive to this type of research are increasingly present. Improved GIS software and more readily available GIS data will make longitudinal research less and less time-intensive going forward. Additionally, some of the problems set out above are proving less significant barriers with the passage of time. More solutions are being proposed for
adoption. For example, for comparing different areal extents over time, Mohai and Saha (2006) have proposed GIS buffering coupled with area weighting to address the problem caused by changing U.S. Census geographic boundaries at sub-county scales from one decadal census to the next. The use of this method, in turn, dictates that higher resolution U.S. Census geographies be used so as to minimize the error associated with the assumption of homogeneous population distribution across the geographic unit. Similarly, while the ideal analysis will extend far back enough in time to capture pre-infrastructural demographics, this approach will not always be feasible given the difficulty of collecting adequate quantitative data, which may not go back 100 years or more. Research should not be – and is not being – stymied by imposing the ideal as a stringent requirement (see, e.g., Eckerd 2011). Nor do EJ researchers feel obligated to compromise and agree on one method; instead, a variety of approaches is seen as adding value as academics increasingly embrace the concepts of multi-scale and cross-scale data collection and analysis (see, e.g., Redman et al. 2004).

**Section 7: Toward Greater Contextualization**

Unfair infrastructure can induce social unrest, which presents a threat to a sub/urban area’s overall sustainability. If we wish to stave off the threat, we cannot be reactive. Distributive justice, corrective justice, procedural justice, and productive justice require advocacy. EJ researchers have a foundational role to play in enabling advocacy.

Researchers need to identify for advocates the classes or pieces of concerning infrastructure and provide an understanding of how and why they came to be.[4] To this end, more quantitative longitudinal research coupled with place-based historical research is needed.
Such research will build a catalog of unfair infrastructures and the processes by which they evolved. EJ researchers’ work does not, however, end there. In order for the understanding gleaned via additional temporal analyses to be communicable to and utilizable by decision-makers, researchers need to construct a simple contextualizing framework into which concerning infrastructures can be fitted. Here, I advocate the use of a specific contextual framework.

Data live in context. They are neither viable nor relevant until they have been nested in a framework that places and makes sense of them (Bruner 1998). As EJ research has broadened in scope from its initial focus on waste site placement to encompass, first, disamenities in general and, now, amenities as well, it is critically important that we develop a framework to contextualize the research in the field. Such a framework is essential if decision-makers are to make some sort of “global” sense of the EJ implications of infrastructure.

In connection with our quantitative longitudinal study of demographics around North Carolina drinking water reservoirs (see Chapter 2 infra), I developed such a framework (Fig. 2). I constructed a simple matrix taking into account the racial and income demographic character of communities both pre-infrastructure and post-infrastructure. The matrix yields four potential processes at work in communities that are (or should be) of concern to EJ researchers.

Based on the matrix, I propose four temporal relationships between infrastructure and demographics that should cause concern: Persistent poverty/persistent segregation, gentrification, wealthy flight/white flight, and community gating (Fig. 3). Persistent poverty/
persistent segregation is a newly coined term for the process in which communities characterized by lower white population (%) or lower per capita income “attract” infrastructural disamenities – for example, hazardous waste sites – which perpetuate or even exacerbate the pre-existing character of the communities (see, e.g., Bullard et al. 2007; Mohai and Saha 2007; Saha and Mohai 2005). Gentrification is an existing term used both in environmental justice literature and elsewhere (see, e.g., Eckerd 2011). The term traditionally focuses on land values and rents. We use the term to describe a process in which infrastructure – for example, redeveloped brownfields – sited in communities with lower white population (%) or lower per capita income precipitates a change in the pre-existing character of the communities, from lower to higher white population (%) or per capita income (see, e.g., Gamper-Rabindran and Timmins 2011). Wealthy flight/white flight is also, in part, an existing term used both in environmental justice literature and elsewhere (see, e.g., Crowder and South 2008). White flight traditionally focuses on race rather than other attributes. We use the term “wealthy flight/white flight” to describe a process in which certain infrastructure – for example, the conversion of large private estates to public parks – sited in communities with higher white population (%) or higher per capita income precipitates a change in the pre-existing character of the communities, from higher to lower white population (%) or per capita income (see, e.g., Boone et al. 2009). Finally, community gating is a second newly coined term for the process in which infrastructural amenities – for example, street trees – are sited in higher white population (%) or higher per capita income communities and perpetuate (or even strengthen) the pre-existing character of the communities (see, e.g., Landry and Chakraborty 2009).
The framework I have designed can help drive hypothesis development. For example, before beginning the research described in Chapter 2, I knew reservoirs tended to be sited in lower income communities and communities of color and displace these communities from the areas (Colchester 2000; Egre and Senecal 2003; World Commission on Dams 2000); at the same time, anecdotal evidence seemed to bear out that over time reservoirs prove to be an amenity attracting higher income or racially dominant residents to the lakeside communities. The matrix helped me to articulate a hypothesis: North Carolina sub/urban drinking water supply reservoirs induce gentrification. I test this hypothesis in Chapter 2.

Beyond hypothesis development, the framework’s greatest potential is for contextualizing a broad array of infrastructure-related demographic research. The matrix is simple enough for decision-makers to quickly understand the infrastructural “playing field” and yet is flexible enough to accommodate complexity, such as intra-community dynamics. For example, gentrification may occur in several ways – through an increase in overall population in an area via “in-migrants” who are disproportionately white or high-income individuals and who serve to skew the overall community character, or through a turn-over in population in which the poor or minorities are “out-migrants” replaced by high-income or white “in-migrants” (Ellen and O’Regan 2010).

The matrix and these relationships enable us, in turn, to begin to hypothesize about the inter-community dynamics related to unfair infrastructure. For example, using the matrix’s four processes, we can visualize how wealthy flight/white flight “out-migrants” from one community can, as “in-migrants,” contribute to the gentrification or gating of a
neighboring community. We can also begin conceiving of longer-term cycles within a single community consisting of all four processes tied to successional infrastructural improvements: Gated communities become wealthy flight/white flight communities become persistently impoverished/persistently segregated communities become gentrified communities and so on. We are already seeing research suggesting that the persistent poverty/persistent segregation associated with waste sites – one class of physical infrastructure – can elide into gentrification once laws – a form of non-physical infrastructure – prompt clean-up of the brownfields (Gamper-Rabindran and Timmins 2011).

Ideally, this framework’s four boxes can be populated with classes and pieces of infrastructure associated with each process as various temporal analyses – both quantitative and qualitative – yield results. Geography, demographics, U.S. Census data resolution, and timeframe can be noted. Where a class of infrastructure is associated with different processes in different geographic areas, it can be placed in two or more boxes. Where study results are disputed, notations can be footnoted.

Section 8: Conclusion

Infrastructure is critical to overall sub/urban sustainability. To ensure that we do not persist in or embark anew on a socially unsustainable course, decision-makers must be provided with the best information possible for the delicate balancing of economic, environmental, and social burdens and benefits. Environmental justice (EJ) researchers have long understood that infrastructure affects demographics and therefore imposes social burdens in addition to benefits. Urban ecologists are quickly coming to understand that the demographic patterns of interest to EJ researchers also have ecological ramifications. EJ
researchers and urban ecologists thus have similar incentive to provide decision-makers with information critical to evaluating the social burdens and benefits of various classes of infrastructure.

To advance both EJ and sub/urban socio-ecological research, we need to move from simply identifying patterns to understanding processes. To this end, EJ researchers and urban ecologists should expand their demographic analyses to cover multiple points in time to try to explain how and why observed patterns evolved. Increased emphasis on quantitative and qualitative longitudinal analyses will help to determine whether various classes of infrastructure can be associated with the four infrastructure-related demographic processes of concern: Persistent poverty/persistent segregation, gentrification, wealthy flight/white flight, and community gating. For example, I hypothesize that reservoirs built in North Carolina to impound sub/urban drinking water supplies fit into the framework as a class of infrastructure that tends to induce gentrification over time. My longitudinal research, as set out in Chapter 2, generally supports the hypothesis.

If most infrastructure that raises social justice concerns can similarly be placed within the simple contextualizing framework I designed, it can be used as a tool to help decision-makers conceptualize the social implications of their infrastructural decisions, including helping them better grasp the longer-term ramifications of their drinking water supply reservoir planning decisions.
Chapter 1 Endnotes


[3] Prior to Afton, the predominantly black 100-year old Crest Street community in Durham, North Carolina, USA, was threatened with destruction by a highway project. The community came together in opposing the highway plan and ultimately – through utilization of civil rights-era legislation and constructive collaboration – was successful in preserving itself. Though the key events in the Crest Street story pre-date Afton, the Federal Highway Administration nevertheless now points to the case as a model for mitigating environmental injustice (case study accessible at http://www.fhwa.dot.gov/environment/ejustice/case/case3.htm) (viewed 12 May 2012).

[4] Because land value is often derivative of residential demographics, EJ researchers would do well to review hedonic analyses of various classes and pieces of infrastructure, such as greenways (Nicholls and Crompton 2005), to get ideas for types of infrastructure to subject to quantitative longitudinal EJ study.
Several “snapshot”s taken at different points in time can be strung together to begin to tell the story of how the observed relationship came to be and how it might evolve going forward. For example, assembled snapshots can help to establish that Point A is the result of Trend 1 rather than Trend 2, or that Point B is the result of Trend 4 rather than Trend 3.

**Figure 1a** – A “snapshot” in time showing a class or piece of infrastructure in relation to the demographics of the neighboring community can be depicted as a point. For example, Point A can represent the relationship in 1990 between Miami’s public street trees and community “whiteness;” Point B likewise can represent the 1990 relationship between hazardous waste sites and community “whiteness.” Neither point assists in explaining how the observed relationship came to be.

**Figure 1b** – Several snapshots taken at different points in time can be strung together to begin to tell the story of how the observed relationship came to be and how it might evolve going forward. For example, assembled snapshots can help to establish that Point A is the result of Trend 1 rather than Trend 2, or that Point B is the result of Trend 4 rather than Trend 3.
Figure 2 – A Simple Temporal Framework. Prior to infrastructure construction, a community had either a lower or higher per capita income (or it was a lower or higher percentage white community). Similarly, after infrastructure construction, the community has either a lower or higher per capita income (or it was a lower or higher percentage white community). The matrix above yields four potential processes at work in communities that are of concern to environmental justice researchers: (1) Persistent poverty/persistent segregation, (2) gentrification, (3) wealthy flight/white flight, and (4) community gating.
Figure 3 – The Four Processes of Concern. The four processes are represented graphically (using white population percentage or income as the demographic of interest).
CHAPTER 2: Gentrification and Community Gating around Sub/urban Drinking Water Supply Reservoirs in North Carolina, USA

Section 1: Introduction

To achieve sustainability, the utilitarian tendency toward “the greatest good for the greatest number” must be tempered by a concern for justice. In the United States, the sub/urban areas that house almost 80 percent of the population (Pickett et al. 2001) need reliable supplies of drinking water to be sustainable. To meet this need, dams are often built to impound drinking water supply reservoirs. Such reservoirs clearly confer a general benefit to the areas they serve; but they also impose a range of social costs, which need to be better understood if they are to be mitigated or avoided. With anywhere from 40 million to 80 million people worldwide having been displaced by reservoirs since 1950 (World Commission on Dams 2000), it is not surprising that displacement is the most thoroughly documented social “cost” associated with reservoirs. It is not, however, the only cost that merits research. A new sub/urban drinking water supply reservoir also affects the communities surrounding it that were not displaced but now find themselves situated near a lake.

In this regard, sub/urban drinking water supply reservoirs are no different than a host of other infrastructures – for example, parks and hazardous waste storage sites – that have become basic components of our increasingly sub/urban world. Few researchers, however, have examined the relationship between such sub/urban infrastructure and demographics through time. Most research to date has involved single point-in-time snapshots. Noonan (2008) analyzed 110 environmental justice studies and found only 18 – or roughly 16% –
engaged in any sort of temporal analysis (p. 1155 n.2), leading him to conclude that environmental justice studies rarely incorporate a temporal dimension (p. 1160). The relatively small body of longitudinal environmental justice literature evidences that different classes of infrastructure affect local demographics in different ways through time (see, e.g., Been and Gupta 1997; Boone et al. 2009; Mohai et al. 2009; Wells et al. 2008). Based on this literature, we developed a simple framing matrix that takes into account the character of affected communities both pre-infrastructure and post-infrastructure (Fig. 1). The matrix yields four infrastructure-related processes at work in these communities that are (or should be) of concern to environmental justice researchers: Persistent poverty or segregation, gentrification, wealth or white flight, and community gating (Fig. 2).

Persistent poverty or segregation is a newly coined term for the process in which communities characterized by lower white population (%) or lower per capita income “attract” infrastructural disamenities – for example, hazardous waste sites – which perpetuate or even exacerbate the pre-existing character of the communities (see, e.g., Bullard et al. 2007; Mohai and Saha 2007; Saha and Mohai 2005). Gentrification is an existing term used both in environmental justice literature and elsewhere (see, e.g., Eckerd 2011). The term traditionally focuses on land values and rents. We use the term to describe a process in which infrastructure – for example, redeveloped brownfields – sited in communities with lower white population (%) or lower per capita income precipitates a change in the pre-existing character of the communities, from lower to higher white population (%) or per capita income (see, e.g., Gamper-Rabindran and Timmins 2011). Wealth or white flight is also, in part, an existing term used both in environmental justice literature and elsewhere
(see, e.g., Crowder and South 2008). White flight traditionally focuses on race rather than other attributes. We use the term “wealth or white flight” to describe a process in which certain infrastructure – for example, the conversion of large private estates to public parks – sited in communities with higher white population (%) or higher per capita income precipitates a change in the pre-existing character of the communities, from higher to lower white population (%) or per capita income (see, e.g., Boone et al. 2009). Finally, community gating is a second newly coined term for the process in which infrastructural amenities – for example, street trees – are sited in communities with higher white population (%) or higher per capita income and perpetuate or even strengthen the pre-existing character of the communities (see, e.g., Landry and Chakraborty 2009).

Before conducting our research, we speculated that sub/urban drinking water supply reservoirs might be tied to gentrification in lakeside communities. We knew that reservoirs tend to be built where low-income people and people of color live and that this is as true in the United States as it is elsewhere (Egre and Senecal 2003; World Commission on Dams 2000). Colchester (2000), for example, noted that poor black sharecroppers bore the brunt of the social impacts of the federal dam building program undertaken in the southeastern United States from 1933 to 1946 (p. 16). Beyond tending to be sited in low-income communities and communities of color, anecdotal evidence in North Carolina suggested that reservoirs induce demographic changes, proving over time to be an amenity attracting higher income or white residents to the lakeside communities. Despite the anecdotal evidence, we found that almost no research has focused on the demographic changes that occur in these communities (Scudder 1997).
In the only study we found of such communities, Burby et al. (1973) surveyed more than 400 people to explore how U.S. Congressional authorization of two North Carolina dams – eventually impounding Jordan and Falls Lakes near Raleigh, NC, USA – affected the communities within three miles of the proposed reservoir shorelines. Covering the period of time from five and six years before Congressional authorization to five and six years after authorization, the study found that blacks comprised 9.3% of the Jordan Lake and 6.4% of the Falls Lake pre-authorization landowner samples, but only one black land purchaser fell into the post-authorization samples (pp. 96-97). The study also found that pre-authorization landowners were more likely to have much lower annual incomes than post-authorization landowners (pp. 98-99). Given the study’s limited post-authorization temporal scope and the fact that neither lake was actually impounded within the study’s timeframe, the study serves more than anything else to emphasize the need for a greater understanding of reservoirs’ social impacts over time.

Based on our matrix and Burby et al.’s (1973) research, we developed four hypotheses – two pertaining to race and two pertaining to income – to help us explore our core inquiry: Are North Carolina’s sub/urban drinking water supply reservoirs associated with any spatial patterns or temporal trends that indicate they may induce demographic changes in lakeside communities? Our first two hypotheses are spatial in nature:

(1) White population percentage is significantly higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply reservoirs than in the areas 0.5 – 1 mile, 1 – 3 miles, and 3 – 5 miles away from the reservoirs.

(2) Per capita income is significantly higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply reservoirs than in the areas 0.5 – 1 mile, 1 – 3 miles, and 3 – 5 miles away from the reservoirs.
Our second two hypotheses are temporal in nature:

(3) White population percentage is significantly higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply reservoirs in 2010 than in 2000 and in 2000 than in 1990.

(4) Per capita income is significantly higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply reservoirs in 2000 than in 1990.

A greater understanding of the effect of sub/urban drinking water supply reservoirs on lakeside communities will enable advocates and decision-makers to more fully analyze the benefits and costs of such reservoirs and evaluate their place in a sustainable society (Tilt et al. 2009). Our research also contributes a tile to and offers an organizing principle for the relatively small but growing mosaic of longitudinal studies exploring the relationships between sub/urban infrastructure and environmental justice.

**Section 2: Study Area**

*Overview of Race in North Carolina.* North Carolina’s racial demography is overwhelmingly a story of black and white (Fig. 3) and the State’s mountain, piedmont and coastal plains regions figure prominently (Fig. 4). The enslavement of blacks was legalized in North Carolina in 1715 (Larkins 1944); slavery quickly became concentrated in the coastal plains and piedmont regions, where the plantation system prevailed (Johnson 1937; Larkins 1944).

In 1860, free blacks comprised 3.3% of the State’s total population and 8.4% of the State’s total black population. Thirty-six of the State’s then-85 counties contained more than two-thirds of the total slave population (Johnson 1937). The slave population density was greatest in the State’s northeastern counties, along the Virginia border (Larkins 1944).
Sixteen counties contained more slaves than whites and all but three were situated in the coastal plains region (Johnson 1937). The demographics were quite different to the far west – the mountain counties were overwhelmingly white with relatively few slaves (Larkins 1944). Sandwiched between the coastal plains and the mountains, the piedmont region served as a demographic transitional area between the two extremes. The free black population distribution generally followed that of the slave population, with the largest numbers of free blacks residing in the counties having the largest slave populations (Johnson 1937). Only 10.5% of the free black population and a very small percentage of enslaved blacks lived in sub/urban areas.

At the close of the U.S. Civil War, the Thirteenth Amendment to the U.S. Constitution permanently abolished slavery throughout the USA. The discriminatory legacy of slavery nonetheless endured in North Carolina. It was not a passive endurance. Laws designed to maintain differential treatment of whites and blacks (i.e., “Jim Crow” laws) evidenced a desire by the post-Reconstruction white majority to perpetuate the racist status quo ante bellum. Consequently, it is unsurprising that in 1940, 75 years after the abolishment of slavery, most of North Carolina’s black population remained concentrated in approximately 47 counties located in the piedmont and coastal plains regions. In nine eastern counties, blacks constituted more than 50% of the total population (Larkins 1944). At the same time, the mountain region contained less than one-fifth of the total black population: 24 counties in the mountain region of the State had black populations of less than 10% of the total county population. Though the general distribution of blacks throughout the State had not changed significantly between 1860 and 1940, blacks had begun to move into sub/urban
areas. By 1940, 30.7% of the individuals classified as urban dwellers in North Carolina were black (Larkins 1944).

Since the early 1960s, the civil rights movement has made strides in curbing discrimination in the USA. Nevertheless, the vestiges of slavery-era North Carolina are still detectable. The extreme western mountain counties continue to have lower proportions of blacks to whites while the counties in the coastal plains, where plantations took root, continue to have higher proportions of blacks to whites; and the piedmont counties generally remain a middle ground (Fig. 5). During this modern era, North Carolina’s black population has continued its transformation from an overwhelmingly rural population to an overwhelmingly sub/urban population. There were few black sub/urban dwellers in 1860; by 1940, 30.7% of the black population lived in sub/urban areas; as of 2010, 36% of the State’s black population lived in just six cities – Charlotte, Durham, Fayetteville, Greensboro, Raleigh and Winston-Salem – and 68% (1,392,351 out of 2,048,628 individuals) lived in the State’s 222 cities and towns with populations greater than 2,500 (LINC 2011).

Overview of Income in North Carolina. North Carolina’s income demographics paint a less strikingly clear portrait. Per capita income in the State appears to be somewhat correlated with urbanization. From 1969 to 1999, counties situated in the piedmont-based crescent of urbanization – a swath extending north from Charlotte to Winston-Salem and east to Raleigh – have consistently had per capita incomes in the State’s top quartile (Fig. 6). During this same period, the less urbanized mountain and interior coastal plains counties have tended to have per capita incomes in the lowest two quartiles. Given North Carolina’s history of slavery, it should be unsurprising that a racial disparity persists to this day in per
capita income in the State. In 2008, the overall per capita income in the State was $23,803; for blacks it was $16,356 (DeShay 2011) (citing 2009 American Community Survey data).

**Overview of Sub/Urban Drinking Water Supplies in North Carolina.** North Carolina recently made the transition from a predominantly rural populace to a predominantly sub/urban populace (Fig. 7). The State’s sub/urban population is concentrated in the piedmont region (Howells 1989). North Carolina has only 15 major natural lakes, and they are all situated in the State’s coastal plains region (Drake and Bromley 1997). Consequently, the sub/urban population relies primarily on reservoirs for its drinking water supply (Burgess 2009). As of 2008, North Carolina contained more than 5,000 dams; 162 of these dams impound at least 1,000 acre-feet of water (Moreau 2008).

Not only is the State’s sub/urban population concentrated in the piedmont area, it is growing (Fig. 7). This growth has resulted in a diminishing per capita reservoir capacity (Moreau 1992a). This in turn has raised reliability concerns, particularly in light of the uncertainty expected to accompany global warming. Climate change is predicted to cause boom-and-bust hydrological cycle swings that will challenge the United States’, including North Carolina’s, present water supply resources (Burgess 2009). A recent U.S. Environmental Protection Agency endangerment finding (2009) concluded that climate change will increasingly put the stability of US water supplies at risk (pp. 66532-33).

One would expect North Carolina’s sub/urban areas to enhance their resiliency to these anticipated cycle swings by taking measures to address declining per capita reservoir capacities. Better management of existing supplies is an option, but building smaller dams may prove a more politically feasible alternative – even in the face of a substantial anti-dam
movement (Glennon 2009; Moreau 2008) – and thus is a possibility North Carolina should plan for (see, e.g., McCully 2001; Routhe et al. 2005; Shah and Kumar 2008) and in fact is planning for. N.C. Session Law 2011-374 (2011) dictates that the State’s Clean Water Management Trust Fund should, among other things, “be used to preserve lands that could be used for water supply reservoirs.” This long-term reservoir planning should take into account not only the anticipated demographic impacts of the reservoirs but also pre-existing demography – particularly those demographic trends associated with race or income which have proven persistent in North Carolina.

Section 3: Methods

Data Collection and Analysis. We acquired publicly available U.S. Census data for North Carolina, including (1) race data at the block level (the highest resolution Census data publicly available) for the years 1990, 2000 and 2010; and (2) per capita income data at the block group level (the highest resolution at which this dataset is publicly available) for the years 1990 and 2000.\[1\] We were temporally limited to the three most recent decadal Census years because high-resolution block level Census data are not publicly available for North Carolina prior to 1990. We acquired the tabular, numeric data and geographic information system files containing the Census geographic units from the Minnesota Population Center (http://www.nhgis.org), the Missouri Census Data Center (http://mcdc2.missouri.edu), and Log Into North Carolina (LINC) (http://linc.state.nc.us).

For each Census year, we used a geographic information system (ArcGIS) to create a spatial dataset based on US Census blocks. For each block, we calculated an overall population density and a white population density. Because per capita income is not publicly
available at the block level, we assigned each block the per capita income of the block group within which it nested. We called the resulting shapefiles “Census baselayers.”

We used a 2006 report submitted to the State’s Environmental Management Commission to identify the 66 North Carolina sub/urban drinking water reservoirs situated in more developed Class III, IV or V watersheds (Fig. 8) (EMC 2006; North Carolina Administrative Code Chapter 15A, Section 2B.0301 2011).

Having identified a near-census sample of these reservoirs, we secured existing geographic information system boundary files – relying primarily on data released by North Carolina’s Department of Environment and Natural Resources – or we created new boundary files using GoogleEarth. We then used ArcGIS v.9.3.1 to create four buffers around each reservoir (Fig. 9). These buffers, based on distances commonly used in environmental justice research and the 0.5 and 5 mile distances used in North Carolina water quality regulations, extended (1) from the reservoir shoreline to 0.5 mile out; (2) 0.5 mile out to 1 mile out; (3) 1 mile out to 3 miles out; and (4) 3 miles out to 5 miles out (Mohai and Saha 2006; North Carolina Administrative Code Chapter 15A Sections 2B.0202 (20) & (53) 2011). It is worth noting that the referenced North Carolina regulations became effective in 1992, at approximately the same time as the beginning of our study period (Dehring and Depken 2010; Moreau 1992b).

Once the buffers were created, we populated each buffer with information from our Census baselayers and used area weighting[2] to estimate the overall population and white population of each block (or portion thereof) in the buffer. The population numbers for the blocks and partial blocks were then aggregated to yield buffer-level estimates of overall

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population and white population.

Deriving a buffer-level per capita income estimate involved several additional steps. First, the per capita income for each block (or portion thereof) in the buffer layers was multiplied by the area-weighted overall population for the block (or portion thereof) to yield an estimated total income for each block in the buffer layers. These income estimates were aggregated to create buffer-level income estimates, which were then divided by the buffer-level population estimates, resulting in buffer-level per capita income estimates.

We used an Excel spreadsheet to capture (1) data for each reservoir – including year built, reservoir surface area, geographic region, and whether the reservoir has a regulatory critical area or accommodates primary recreation such as organized swimming – and (2) the results of our ArcGIS analysis for each buffer for each Census year. We then used SAS v.9.2 with Enterprise Guide 4.2 to run analyses of variance (ANOVAs). Our ANOVAs analyzed the impact of buffer distance from a reservoir on race and, separately, income, and in all cases took into account the variation among the 66 reservoirs.

Section 4: Results

Race and Income. Correlations between white population (%) and per capita income in 1990 and 2000 ranged from a high r-value of 0.37000 in the 0-0.5 mile buffer in 2000 to a low of 0.14142 in the 1-3 mile buffer in 1990. Though these are not strong correlations, there is an interesting relationship between the two variables. Generally, as white population (%) increases, the upper range of observed per capita incomes also increases (Fig. 10). Nonetheless, the absence of a strong correlation between the two supported our separate treatments of race and income.
Testing the Spatial Race Hypothesis. Though the demographics around the 66 reservoirs we examined were highly variable, the overall white proportion of the populations living within 0.5 mile of the reservoirs was significantly higher than the white proportions of those living in the areas 1 to 5 miles from the reservoirs ($\alpha=0.05$). This was true for each of the years examined (Table 1; Fig. 11).

The disparity between the white population (%) in the 0-0.5 mile buffer and the other buffers displayed regional differences. Without exception, the regional means for each of the buffers grew higher as one moved from coastal plains to piedmont to mountain region (Table 2). In the coastal plains, we found no significant differences in mean white population (%) between any buffers regardless of year. In the piedmont, we saw significantly higher mean white populations (%) in the 0-0.5 mile buffer compared to each of the other buffers for each of the three Census years examined; we also saw a significantly higher mean white population (%) in the 0.5–1 mile buffer compared to the 1 to 5 mile buffers for 2000 and 2010. Finally, in the mountains, there were significantly higher mean white populations (%) in the four 0–5 mile buffers compared to the surrounding counties in 1990 and 2000, and between the 0–1 mile buffers and the surrounding counties in 2010.

Twenty-six reservoirs in our sample accommodate primary recreational use such as organized swimming (EMC 2006). For these 26 lakes, there was a significantly higher mean white population (%) in the 0-0.5 mile buffer compared to the 1–5 mile buffers in each of the three years examined (Table 3). The same significant difference exists between the 0-0.5 mile buffer mean and the 1–5 mile buffer means for the 40 reservoirs that do not accommodate primary recreational uses, though the means for these 40 lakes skew lower
across the board.

Lastly, we examined the 49 reservoirs in our sample that had regulatory critical areas as of 2006 (EMC 2006). The critical area for a reservoir can be roughly defined as within 0.5 mile of the drinking water supply reservoir (Dehring and Depken 2010; North Carolina Administrative Code Chapter 15A Section 2B.0202 (20) 2011). New residential development in a critical area is subject to a two-acre minimum lot size (Dehring and Depken 2010). Parsing the reservoirs in this way revealed the familiar spatial pattern of higher white population (%) in the buffers closer to the reservoirs (Table 4) and did not alter the consistent, significant difference between the 0-0.5 mile lakeside buffer area and the 1-5 mile buffer areas.

*Testing the Spatial Income Hypothesis.* Unlike our white population (%) results, our results related to income did not yield a clear pattern. There were no significant differences in per capita income between the lakeside 0-0.5 mile area and other areas in 1990. In 2000, the only other year examined due to the lack of 2010 per capita income data at the block group level, the mean per capita income of those living within 0.5 mile of the reservoirs was significantly higher than the mean per capita income of those living in the areas 1 to 5 miles from the reservoirs ($\alpha=0.05$) (Table 5). This latter spatial pattern for per capita income mirrors the white population (%) pattern found in 1990, 2000, and 2010 (Fig. 12).

*Testing the Temporal Race Hypothesis.* Contrary to what we expected, the white proportion living within 0.5 mile of the reservoirs decreased through time. This was true in all buffers regardless of distance from the reservoirs and is consistent with the 1990 to 2010 trend in the overall State population. However, when we standardized the white proportions
using the following equation

\[
\frac{\text{white population (\%) for buffer} - \text{mean white population (\%) for the State}}{\text{mean white population (\%) for the State}} \times 100 = \text{percent above State mean,}
\]

it became evident that the white population (%) in the 0-0.5 mile lakeside area was not decreasing as quickly as it was in the buffers more distant from the reservoirs (Fig. 13). This slower decline in mean white population (%) was significant in the 0-0.5 mile buffer between 1990 and 2000.

**Testing the Temporal Income Hypothesis.** With regard to per capita income, we noted a significant increase in income between 1990 and 2000 within each of the buffers. Once we standardized using the following equation

\[
\frac{\text{per capita income for buffer} - \text{per capita income for the State}}{\text{per capita income for the State}} \times 100 = \text{percent above or below State per capita income,}
\]

it became evident, however, that per capita income grew between 1990 and 2000 at a faster rate in the 0-0.5 mile buffer than in any other buffer (Fig. 14).

**Section 5: Discussion**

**Interpreting Our Results.** The demographic changes around the sub/urban drinking water supply reservoirs we examined raise potential social justice concerns. Our race-based results are generally consistent with the proposition that North Carolina sub/urban drinking water supply reservoirs have induced gentrification in lakeside communities and may now be associated with community gating. Most black North Carolinians live in the piedmont and coastal plains regions of the State. This current distribution reflects the pre-U.S. Civil War prevalence of slaves in each region. This legacy effect does not, however, explain the tendency for mean white population (%) in each of the regions to increase consistently with
proximity to the 0-0.5 mile buffer. In other words, legacy does not account for the fact that 
blacks and other non-whites tend to be under-represented in the communities living within 
0.5 mile of sub/urban drinking water supply reservoirs.

Our race-based spatial results reveal a consistent tendency toward numerical 
inequality or disproportionality: The mean white population percentage is significantly 
higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply 
reservoirs than in the areas 1–5 miles away from the reservoirs.[3]

Our race-based temporal results are more difficult to decipher because they are 
susceptible to at least two interpretations. On the one hand, in absolute terms, there was a 
downward trend from 1990 to 2010 for mean white population percentage in the 
communities within 0.5 mile of a sub/urban drinking water supply reservoir. This trend runs 
counter to what one would expect to see in gentrifying communities. On the other hand, the 
communities within 0.5 mile of the lakes became whiter relative to the State as a whole. In 
other words, the difference between the mean white population percentage in these 
communities and the mean white population percentage in the State actually increased 
Census year over Census year. This trend could be viewed as indicative of ongoing 
gentrification. These two trends together may reflect an example of gentrification 
transitioning into community gating.

While the mean white population percentage actually fell during the twenty year 
period between 1990 and 2010 for all of the examined buffers, it is possible that the 
traditional gentrification process (i.e., a marked increase in mean white population 
percentage over time) expresses itself quickly and prominently and our research simply did
not go back far enough in time to capture this expression. Several points suggest this possibility is a likelihood. Reservoirs generally tend to be built in areas occupied by minorities (see, e.g., Egre and Senecal 2003; World Commission on Dams 2000). Our race-based spatial results consistently indicated a significantly higher white population percentage in the 0-0.5 mile lakeside communities than in the communities a mile or more from the reservoirs. These two facts, taken together, strongly suggest that at some point whites moved into the North Carolina lakeside communities in disproportionate numbers. As of 1990, the mean age of the fully constructed dams we examined was 43 years. Burby et al. (1973) noted an apparent demographic shift within just a few years of dam authorization, prior even to complete construction of the dams. On the whole, these points suggest that not only may whites have moved into the North Carolina lakeside communities in disproportionate numbers, but they may have done so fairly quickly after the dams were authorized and constructed.

If one assumes that the 0-0.5 mile lakeside buffer areas, on average, began gentrifying prior to 1990, our difficult to decipher race-based temporal results can be explained as representative of gentrified areas that are now being “gated” against the racial integration taking place more generally in the State. Land use laws designed to ensure clean drinking water may be having the unintended consequence of contributing to community gating. North Carolina’s reliance on dammed reservoirs has manifested itself in fairly recent, far-ranging regulatory action – including land use restrictions – designed to ensure the quality of these impounded waters (Dehring and Depken 2010; Moreau 1992b). The creation of “critical” areas around 49 of the 66 reservoirs that restrict how small (and thus how
inexpensive) a residential parcel can be may be serving to gate these gentrified communities.

Further Study. Our ANOVAs analyzed the impact of buffer distance from a reservoir on race and, separately, income, and in all cases took into account the variation among the 66 reservoirs. Our research was designed to examine white population percentage and per capita income as separate dependent variables. Our study design did not lend itself to an analysis of white population percentage and per capita income as independent variables. Consequently, we were unable to conduct a reliable analysis of whether race, income, or both would generally serve as the best predictor of distance from a North Carolina reservoir. Researchers interested in this latter type of analysis will have to design their research differently and will likely need to gather their distance data in continuous form using transects rather than in categorical “buffer” form.

The most optimistic explanation of our race-based spatial and temporal results is that cultural preference accounts for them rather than any process of concern. Environmental justice researchers should be able to test this explanation through future survey work. However, such survey work may itself introduce new questions and complexities. During our research, we learned from Larkins (1944) that, as of 1943, there were only five North Carolina communities that provided recreational swimming pools and parks for “Negroes” – High Point, Raleigh, Durham, Greensboro, and Winston-Salem (p. 47). We also encountered research from the mid-1960s regarding the drivers of developers’ decisions to establish lakeside communities. Burby (1967) hypothesized that the “site cannot be located in a low income area or adjacent to Negro residences” (p. 49). Though the evidence collected by Burby was insufficient to support his hypothesis, the hypothesis itself says something about
cultural expectations at the time. Such data provide a foundation for asking questions such as: Even if today’s blacks/non-whites do not, for example, perceive access to recreation such as swimming to be a significant amenity and consequently prefer not to live in lakeside communities, this preference might be a derivative of their forebears having been excluded from opportunities to develop the opposite preference. In other words, one could reasonably ask: Is this cultural preference the result of thoughtful deliberation or mere acquiescence to past discrimination, and what does it mean if it is mere acquiescence?

Less optimistically, we may have to answer the question of how we, as a society, should respond if we learn that cultural preference does not account for our research results.

Section 6: Conclusion

Racially, our results evidence a numerical inequality or disproportionality around North Carolina sub/urban drinking water supply reservoirs. This numerical inequality is consistent with gentrification or community gating. However, until further research accounts for cultural preference, we cannot foreclose the possibility that our results need not concern social justice advocates.

Even if we were able to rule out any cultural preference effect, we would still hesitate to conclude based on this research that an injustice is occurring. Our results serve principally to draw attention to what appears in aggregate to be a societal cost associated with sub/urban drinking water supply reservoirs. It is for advocates and decision-makers to weigh the complex costs and benefits of a particular dammed reservoir and determine on a case-by-case basis whether an injustice is occurring. The balancing should, at a minimum, take into account a reservoir’s social benefits such as (1) providing a reliable drinking water supply for
a sub/urban area, including the poor and minorities living therein, and (2) where applicable, providing flood protection for downstream communities, including the poor and minorities living there. It should also take into account a reservoir’s social costs such as (1) displacement of the poor and minorities, (2) the likelihood of gentrification of poorer or minority lakeside communities, and (3) any disproportionate regulatory burden, such as restrictions on land use, being borne by upstream communities, including the poor and minorities living there, to maintain the drinkability of water supplies they do not use.

Our work contributes meaningfully to any discussion of the following two questions: (1) Have existing reservoirs produced an injustice in North Carolina lakeside communities and, if so, are corrective measures merited; and (2) can future reservoirs be built in the State in such a way that they create reliable and fair supplies of drinking water? The infrastructure we examined – North Carolina sub/urban drinking water supply reservoirs – may by its very unmitigated existence turn poorer or minority communities into higher-income or whiter communities. Additionally, the regulatory infrastructure society chooses to maintain the quality of the impounded drinking water may effectively be erecting a barrier or “gate” to proportionate integration of the poor and minorities into the lakeside neighborhoods. Absent further research, we cannot rule out the possibility that reservoirs as a class are working an injustice in North Carolina lakeside communities. More generally, our research contributes to any discussion about the interaction between infrastructure and demographics in the sub/urban setting. If we, as a society, believe that “the fairest good for the greatest number” is integral to the social sustainability of sub/urban areas, then we have an obligation to pursue clarification of the social impacts of sub/urban drinking water supply reservoirs and other
sub/urban infrastructure.
Chapter 2 Endnotes

[1] U.S. Census data are based on individuals’ “usual residence” (US Census Bureau 2011) and thus the demographics of owners of vacation homes will not be attributed to the location of the vacation home. Around lakes, the incidences of this type of under-counting may be more frequent than they would be elsewhere. However, based on anecdotal evidence suggesting there are more high-income whites who own such vacation homes, we do not believe this inherent inaccuracy invalidates our results; rather, we believe it likely means our analysis yielded conservative estimates.

[2] While area weighting is based on the assumption that individuals residing in a delineated geographic area are evenly distributed throughout the area, the extent of the assumption diminishes as the size of the delineated geographic area diminishes. It was in an effort to minimize the error associated with the assumption that we utilized the smallest geographic Census units publicly available – blocks.

[3] Our income-based results do not reveal such a clear tendency. Although we did note a significant difference between the communities within 0.5 miles of the shoreline and those communities 1 – 5 miles out in 2000, no such difference was noted for 1990. Consequently, we do not find sufficient evidence exists to state that per capita income consistently tends to be significantly higher in the areas within 0.5 mile of North Carolina sub/urban drinking water supply reservoirs than in the areas farther away from the reservoirs. Further research involving additional years may alter this opinion.
Table 1 – Results of ANOVAs for Mean White Population (%) in the Buffers (1990-2010). An ANOVA comparing mean white population (%) for each buffer for a given Census year (right column) to the other three buffers and to the immediate surrounding counties for that year (top row) yielded a number of significant differences at $\alpha=0.05$, denoted in the table by double asterisks. The 0-0.5 mile buffer was consistently significantly different from the 1-5 mile buffers and the surrounding counties throughout the 20 year period. The 0.5-1 mile buffer became increasing less like the 1-5 mile buffers over the course of the 20 year period.

<table>
<thead>
<tr>
<th>Mean White Population (%)</th>
<th>All Reservoirs (n=66)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 0.5 mi</td>
</tr>
<tr>
<td></td>
<td>86.6% (1990)</td>
</tr>
<tr>
<td></td>
<td>84.8% (2000)</td>
</tr>
<tr>
<td></td>
<td>81.2% (2010)</td>
</tr>
<tr>
<td>0 - 0.5 mi</td>
<td>86.6% (1990)</td>
</tr>
<tr>
<td></td>
<td>84.8% (2000)</td>
</tr>
<tr>
<td></td>
<td>81.2% (2010)</td>
</tr>
<tr>
<td>0.5 – 1 mi</td>
<td>82.4% (1990)</td>
</tr>
<tr>
<td></td>
<td>80.2% (2000)</td>
</tr>
<tr>
<td></td>
<td>76.5% (2010)</td>
</tr>
<tr>
<td>1 – 3 mi</td>
<td>79.4% (1990)</td>
</tr>
<tr>
<td></td>
<td>76.0% (2000)</td>
</tr>
<tr>
<td></td>
<td>71.6% (2010)</td>
</tr>
<tr>
<td>3 – 5 mi</td>
<td>78.3% (1990)</td>
</tr>
<tr>
<td></td>
<td>74.4% (2000)</td>
</tr>
<tr>
<td></td>
<td>70.3% (2010)</td>
</tr>
</tbody>
</table>
Table 2 – Mean White Population (%) in the Buffers by Region (1990-2010). Generally speaking, throughout the 20 year period examined, the mean white population (%) in the four buffers and in the immediate surrounding counties is highest in the mountain region followed by the piedmont region and then the coastal plains region.

<table>
<thead>
<tr>
<th>Mean White Population (%)</th>
<th>Coastal Plains Reservoirs (n=11)</th>
<th>Piedmont Reservoirs (n=46)</th>
<th>Mountain Reservoirs (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 - 0.5 mi</td>
<td>0.5 – 1 mi</td>
<td>1 – 3 mi</td>
</tr>
<tr>
<td>1990</td>
<td>71.5%</td>
<td>70.6%</td>
<td>67.4%</td>
</tr>
<tr>
<td>2000</td>
<td>65.2%</td>
<td>63.9%</td>
<td>60.7%</td>
</tr>
<tr>
<td>2010</td>
<td>59.9%</td>
<td>58.0%</td>
<td>55.6%</td>
</tr>
</tbody>
</table>
Table 3 - Mean White Population (%) in the Buffers by Recreation Classification (1990-2010).

<table>
<thead>
<tr>
<th></th>
<th>0 - 0.5 mi</th>
<th>0.5 – 1 mi</th>
<th>1 – 3 mi</th>
<th>3 – 5 mi</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reservoirs Accommodating Primary Recreation (n=26)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>91.9%</td>
<td>86.9%</td>
<td>85.2%</td>
<td>83.1%</td>
<td>79.3%</td>
</tr>
<tr>
<td>2000</td>
<td>92.0%</td>
<td>86.6%</td>
<td>82.9%</td>
<td>80.0%</td>
<td>75.8%</td>
</tr>
<tr>
<td>2010</td>
<td>90.4%</td>
<td>84.2%</td>
<td>79.1%</td>
<td>75.8%</td>
<td>72.6%</td>
</tr>
<tr>
<td><strong>Reservoirs Not Accommodating Primary Recreation (n=40)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>83.2%</td>
<td>79.5%</td>
<td>75.7%</td>
<td>75.2%</td>
<td>75.9%</td>
</tr>
<tr>
<td>2000</td>
<td>80.2%</td>
<td>76.0%</td>
<td>71.5%</td>
<td>70.8%</td>
<td>71.8%</td>
</tr>
<tr>
<td>2010</td>
<td>75.2%</td>
<td>71.5%</td>
<td>66.7%</td>
<td>66.8%</td>
<td>67.7%</td>
</tr>
</tbody>
</table>
Table 4 - Mean White Population (%) in the Buffers for Reservoirs with Critical Areas (1990-2010).

<table>
<thead>
<tr>
<th>Reservoirs with Critical Areas (n=49)</th>
<th>0 - 0.5 mi</th>
<th>0.5 – 1 mi</th>
<th>1 – 3 mi</th>
<th>3 – 5 mi</th>
<th>County</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>89.8%</td>
<td>84.5%</td>
<td>79.7%</td>
<td>78.5%</td>
<td>77.6%</td>
</tr>
<tr>
<td>2000</td>
<td>87.2%</td>
<td>82.1%</td>
<td>75.8%</td>
<td>74.0%</td>
<td>73.6%</td>
</tr>
<tr>
<td>2010</td>
<td>83.0%</td>
<td>77.5%</td>
<td>70.8%</td>
<td>69.3%</td>
<td>69.5%</td>
</tr>
</tbody>
</table>
Table 5 – Results of ANOVAs for Mean Per Capita Income in the Buffers (1990-2000). An ANOVA revealed significant differences in 2000, at $\alpha=0.05$, denoted in the table by double asterisks.

<table>
<thead>
<tr>
<th>Buffer Distance</th>
<th>Mean Per Capita Income (Year 2000$)</th>
<th>ANOVA Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5 mi</td>
<td>$17,873 (1990)$</td>
<td>0.9381</td>
</tr>
<tr>
<td></td>
<td>$22,467 (2000)$</td>
<td>0.2047</td>
</tr>
<tr>
<td>0.5 – 1 mi</td>
<td>$17,558 (1990)$</td>
<td>0.9664</td>
</tr>
<tr>
<td></td>
<td>$21,401 (2000)$</td>
<td>0.2902</td>
</tr>
<tr>
<td>1 – 3 mi</td>
<td>$17,292 (1990)$</td>
<td>0.9954</td>
</tr>
<tr>
<td></td>
<td>$20,428 (2000)$</td>
<td>0.7945</td>
</tr>
<tr>
<td>3 – 5 mi</td>
<td>$17,136 (1990)$</td>
<td>0.2707</td>
</tr>
<tr>
<td></td>
<td>$19,870 (2000)$</td>
<td>0.3001</td>
</tr>
</tbody>
</table>
Figure 1 – A Simple Temporal Framework. Prior to infrastructure construction, a community had either a lower or higher per capita income (or it was a lower or higher percentage white community). Similarly, after infrastructure construction, the community has either a lower or higher per capita income (or it was a lower or higher percentage white community). The matrix above yields four potential processes at work in communities that are of concern to environmental justice researchers: (1) Persistent poverty/persistent segregation, (2) gentrification, (3) wealthy flight/white flight, and (4) community gating.
Figure 2 – The Four Processes of Concern. The four processes are represented graphically (using white population percentage or income as the demographic of interest).
Figure 3 – North Carolina White and Non-White Population (1790-2010). While the non-white/non-black populations in North Carolina have grown from 1.4% to 10% of the total population during the last 20 years, the white and black populations comprised close to 100% of the total population for more than 200 years and still comprise 90% of the total population (Parker 2010; U.S. Census Bureau).
Figure 4 – The Regions of North Carolina. North Carolina’s 100 counties have been assigned to the State’s three landscape-based regions: Mountain (light grey), piedmont (middle grey) and coastal plains (dark grey).
Figure 5 – Black Population (%) in North Carolina by County (1970-2010). White fill indicates 0-5% of the county population was black; light grey fill indicates 6-25% black; dark grey fill indicates 26-50% black; and black fill indicates over 50% black population (LINC 2011). The lower percentages in the mountain region and higher percentages in the coastal plains have persisted since the State’s slavery-era more than 100 years ago.
Figure 6 – Per Capita Income in North Carolina by County (1969-1999). Black fill indicates county’s per capita income is in the top quartile in the State; dark grey fill indicates second quartile; light grey fill indicates third quartile; and white fill indicates lowest quartile (LINC 2011). The counties with the highest per capita incomes have consistently been clustered in the piedmont, while the interior coastal plains have consistently had lower per capita incomes.
The total population of North Carolina, USA, has been growing at an increasing rate. In or around 1990, the State’s urban population crossed over the 50% urban/50% rural population line and has since been more urban than not in what had traditionally been a rural southern state (Parker 2010; U.S. Census Bureau).
Figure 8 – The 66 Sub/Urban Drinking Water Supply Reservoirs. The 66 drinking water reservoirs we examined include: Apex Reservoir, Badin Lake, Bear Creek Reservoir, Belews Lake, Bonnie Doone Lake, Buckhorn Reservoir, Carthage City Lake, Cedar Cliff Lake, Falls Lake, Fontana Lake, Glenville Lake, Harris Lake, High Point Lake, High Rock Lake, Hyco Lake, Jordan Lake, Kannapolis Lake, Kernersville Lake, Kings Mountain Reservoir, Kornbow Lake, Lake Benson, Lake Brandt, Lake Concord, Lake Corriher, Lake Fisher, Lake Gaston, Lake Hickory, Lake Higgins, Lake Hunt, Lake James, Lake Lee, Lake Mackintosh, Lake Michie, Lake Monroe, Lake Norman, Lake Ramseur, Lake Reese, Lake Rhodhiss, Lake Sequoyah, Lake Thom-A-Lex, Lake Tillery, Lake Townsend, Lake Twitty, Lake Wheeler, Lake Wilson, Lake Wylie, Lookout Shoals Lake, Mayo Reservoir, Mintz Pond, Mountain Island Lake, Newton City Lake, Oak Hollow Lake, Old Town Reservoir, Pittsboro Lake, Reidsville Lake, Roanoke Rapids Lake, Roberdel Lake, Rockingham City Lake, Rocky River Reservoir, Salem Lake, Tar River Reservoir, Thorpe Reservoir, Tuckertown Reservoir, W. Kerr Scott Reservoir, Wiggins Mill Reservoir, and Wolf Creek Reservoir.
Figure 9 - An Illustration of the Buffers Around a Reservoir.
Correlation of Per Capita Income and White Population (%) Across the 66 Reservoirs

Figure 10 – Correlation of Per Capita Income and White Population (%) Across the 66 Reservoir Buffers (1990-2000). The 1990 graph (left) and the 2000 graph (right) depict the correlation between per capita income and white population (%) across all 66 reservoirs, with a plotted data point (n=264) for each buffer around each reservoir.
Figure 11 – Results of ANOVAs for Mean White Population (%) in the Buffers (1990-2010). In the graphs above, bars which are not topped with the same letter are significantly different (α=0.05). For each of the three years – 1990, 2000, and 2010 – the proportion of whites living within 0.5 mile of the 66 examined reservoirs was significantly higher than the proportion living in areas 1 to 5 miles away and, in 2000 and 2010, was significantly higher than the proportion living 0.5 to 1 mile away as well.
Figure 12 – Results of ANOVAs for Mean Per Capita Income in the Buffers (1990-2000). In the graphs above, bars which are not topped with the same letter are significantly different ($\alpha=0.05$). In 1990, there were no significant differences between the lakeside and more distance areas. In 2000, there were – the lakeside area had a significantly higher per capita income than the areas 1 to 5 miles away.
Figure 13 – Mean White Population (%) in the Buffers Over Time (1990-2010). The non-standardized graph (left) illustrates how the mean white population (%) decreased between 1990 and 2010 in each of the buffers we examined and in the State as a whole. We standardized our results to show the degree to which mean white population (%) in each buffer exceeded the white population (%) for the State (see Methods for details). The standardized graph (right) illustrates how, despite the overall trend, the mean white population (%) in the communities within 1 mile of a reservoir tends to be decreasing at a slower rate so that the gap between these communities and the overall State mean has actually increased over time. The only significant increase took place in the 0-0.5 mile buffer between 1990 and 2000.
Figure 14 – Mean Per Capita Income in the Buffers Over Time (1990-2000). The non-standardized graph (left) illustrates how the mean per capita income significantly increased between 1990 and 2000 in each of the buffers we examined and in the State as a whole. We standardized our results to show the degree to which mean per capita income in each buffer exceeded the per capita income for the State (see Methods for details). The standardized graph (right) illustrates how, even with the overall trend, the mean per capita income in the communities within 0.5 mile of a reservoir increased at a faster rate so that, as of 2000, these communities tended to have per capita incomes approximately 6 percent above the State per capita income.
REFERENCES CHAPTER 1


Mohai, P. and R. Saha. 2006. “Reassessing Racial and Socioeconomic Disparities in


REFERENCES CHAPTER 2


University of North Carolina.


US Census Bureau.

