FROM CLASSICAL TO CRITICAL: ADDRESSING THEORETICAL AND METHODOLOGICAL GAPS WITHIN ENVIRONMENTAL JUSTICE RESEARCH

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DISSERTATION ABSTRACT

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Title: From Classical to Critical: Addressing Theoretical and Methodological Gaps within Environmental Justice Research

In this dissertation, I argue classical quantitative environmental justice research has three limitations: 1) overemphasizes the role of corporate actors and market forces in forming environmental hazards; 2) assumes homogeneous racial projects for non-white groups; and 3) focuses on singular social dimensions (i.e. race versus class) to understand environmental inequalities. Critical environmental justice research addresses these limitations with the following four pillars: 1) emphasize the overlapping dimensions of racism, classism, patriarchy, heteronormality, ableism, and speciesism; 2) include multiscalar frameworks; 3) incorporate the role of state power; and 4) focus on racial and socioeconomic indispensability. In this dissertation, I use a critical environmental justice perspective to address the theoretical and methodological gaps from classical quantitative environmental justice research with three empirical studies.

Chapter 2 is a case study of Las Vegas, Nevada and uses the theoretical frameworks of environmental justice, racial capitalism, and the treadmill of destruction to argue the U.S. Military as part of the racial state within racial capitalism and as a result plays a direct role in forming environmental health disparities. Chapter 3 is a national-level study evaluating whether there are differences in environmental health disparities

across spatial and temporal dimensions of Latinx destinations. Chapter 4 presents a theoretical and methodological approach to understanding intersectionality happening at higher ecological levels of the neighborhood with the eco-intersectional multilevel modeling approach. This dissertation fulfills the four pillars of environmental justice in the following ways: 1) this dissertation acknowledges overlapping systems of oppression by incorporating theoretical frameworks of racial capitalism and intersectionality; 2) this dissertation takes a multiscalar approach of examining environmental health risk from air toxics with a case study of Las Vegas and national studies; 3) this dissertation incorporates the racial state; and 4) this dissertation focuses on racial and social justice.

This dissertation contains previously published and unpublished co-authored material.

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Este disertación está dedicada a mi mamá, Maria Margarita Huerta Serna.
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CHAPTER I

INTRODUCTION

I. Introduction

Nigeria Falls, New York and Warren County, North Carolina are most cited as critical starting points to the environmental justice movement in the United States (Bryant and Mohai 1992; Capek 1993; Pulido 1996; Taylor 2014; Mohai, Pellow, and Roberts 2009).[1] The first case occurred in the 1970s when the residents of the city of Nigeria Falls organized against corporate and state officials. Many of the residents were experiencing health problems and recent reports revealed their homes and schools were built on a hazardous landfill. This event is also referred to as Love Canal and is part of the anti-toxics movement consisting of mostly white, working class communities. The second event occurred in early 1980s, when Black[2] residents in Warren county, North Carolina organized against attempts to locate a toxic landfill of polychlorinated biphenyl (PCB)-laced soils in their community and this event was one of the first events to frame the issue as environmental racism (Pulido 1996; Taylor 2014; Mohai, Pellow, and Roberts 2009). Despite the organizing efforts in Warren county, the landfill was built and residents continue to organize for action to mitigate additional hazardous contamination (McMurty 2000). These events emphasize how the environmental justice movement arose to address

[1] Recent historical work documents earlier events of environmental justice movements organizing around urban environmental activism (see Taylor 2009).

[2] Throughout this dissertation, I capitalize “Black.” I agree with scholars W. E. B. DuBois, Kimberlé Crenshaw (1988), and Cherly Harris (1993) who argue: “When using ‘Black,’ I shall use an upper-case ‘B” to reflect my view that Blacks, like Asians, Latin[x]s, and other ‘minorities,’ constitute a specific cultural group and, as such, require denotation as a proper noun. … (noting that ‘Black’ should not be regarded ‘as merely a color of skin pigmentation, but as a heritage, an experience, a cultural and personal identity, the meaning of which becomes specifically stigmatic and/or glorious and/or ordinary under specific social condition’)” (Crenshaw 1988: 1332 I changed Latinos into Latinxs). Furthermore, throughout this dissertation I use the gender nonconforming term “Latinx” instead of gendered “Latino” (see Vidal-Ortiz and Martínez 2018).

social equity and public health because the mainstream environmentalist movement failed to do so (Pellow and Brulle 2005).

Environmental justice research began in response to environmental justice social movements in 1970s and 1980s, and has grown into an interdisciplinary, expansive field (Pellow and Brulle 2005). Quantitative environmental justice research focuses on using statistics to understand environmental inequalities which are defined as historically marginalized communities across racial/ethnic and socio-economic statuses dimensions are disproportionally affected by environmental outcomes, such as hazardous sites (e.g. pollution or toxic sites) or environmental amenities (e.g. parks or grocery stores). Since the first studies of environmental injustices, several case studies show the disproportional health risk for communities with more racial/ethnic minorities, lower-socio economic statuses, Indigenous peoples, and immigrants (see Taylor 2014; Sze and London 2008; Brulle and Pellow 2006). Previous research highlights the importance of social and systematic factors and has employed advanced methodologies to understand environmental inequalities. However, the following three limitations exist within quantitative environmental justice research. First, previous research overemphasizes the role of corporate actors and market forces in decisions of environmental inequalities (Kurtz 2009). Second, quantitative environmental justice research for the most part assumes homogeneous racial projects for non-white groups. Third, popular debates within classical quantitative environmental justice research focus on singular systems of oppressions (i.e. class versus race) (Pulido 1996; Pellow 2018). Critical environmental justice offers a lens to expand classical quantitative environmental justice research.

A critical environmental justice framework includes the following four pillars: examine the intersectional dimensions of race, class, gender, sexuality, ability, and species, acknowledge the multitude of scales involved in environmental injustices, incorporate the role of state power in forming and neglecting environmental injustices, and focus on racial and socioeconomic indispensability (Pellow 2018). Classical quantitative environmental justice research can expand into critical environmental justice through the following: incorporating theoretical frameworks of the racial state especially with a focus on the U.S. Military, expanding on the assumptions of the Black/white binary by focusing on Latinx racial formations, and developing an explicit methodological and theoretical framework of intersectionality at the community-level. Addressing these theoretical and methodological gaps can provide a fuller understanding of critical environmental justice and explain inner mechanisms of environmental inequalities. This dissertation aims to address these issues with three empirical studies.

II. Classical quantitative environmental justice

Anthropogenic climate change is related to a multitude of environmental problems including the growing accumulation of landfills and extractive industries of mining and deforestation. The increase of CO_2 emissions into the atmosphere has led to drastic ecological changes of ocean temperatures (Cheng et al. 2019) and rainfall amounts in cyclones (Patricola and Wehner 2018). A long line of environmental sociological research focuses on the drivers of anthropogenic climate change such as economic growth, militarization, and social inequality (York, Rosa, and Dietz 2003; Jorgenson and Clark 2015; Knight, Schor, and Jorgenson 2017). This research supports the treadmill of production which is a political-economic framework arguing that the fundamental logic of growth and accumulation of the economy (i.e. capitalism) is tied to social and environmental degradation because through the production expansion and capital surplus the system produces environmental withdrawals (e.g. natural resource extraction) and additions (e.g. pollution) (Schnaiberg 1980). While the mainstream environmentalist movement in the United States has fought for the environment's rights, environmental justice movements arose to address overlooked issues from environmentalists.

Environmental justice movements were a response to the environmentalist movement lack of focus on public health and social equity (Pellow and Brulle 2005). As mentioned earlier, environmental justice movements began with events like Love Canal and Warren County, North Carolina (Capek 1993; Pulido 1996; Bryant and Mohai 1992; Mohai et al. 2009; Taylor 2014). Central to the struggle against environmental injustices is to challenge decisions of hazardous facility placement in communities with racial/ethnic minorities, Indigenous peoples, and poor residents also referred to as environmental disparities. Environmental justice research succeeds the U.S. environmental justice movements organizing around issues of equal access to clean environments, workplaces, and communities (Taylor 2014; Mohai et al. 2009). Following the public awareness of environmental justice issues, subsequent studies were published to show that hazard disparities including one of the first reports on environmental inequalities published by the United Church of Christ *Toxic Wastes and Race in the United States* (Chavis 1987) showing unequal placement of landfill sites in zip codes with higher percentages of Black and Latinx and poor residents. Benjamin Chavis on of the authors of the report defines environmental racism as an extension of racial discrimination to environmental policies through lack of enforcement and targeting communities of color for toxic facilities and placement thereby exposing them to more risk (Chavis 1987). Despite the intentionality of the disparities, environmental inequalities are forms of environmental racism (Pulido 2016). While environmental justice research encompasses many types of research and topics, there are two major debates within classical quantitative environmental justice studies: race versus class and "minority-move in" versus facility move-in (Pulido 1996; Brulle and Pellow 2005). The debates highlight the limitations of theoretical frameworks and methodological approaches within environmental justice research (Pulido 1996).

The race versus class debate focuses on whether environmental racism is conflated with class and can be explained through socio-economic forces instead of racial discrimination (Anderton et al. 1994; Bowen 2002). The facility move-in versus "minority move-in" debate focuses on whether hazardous facilities move into areas with more racial/ethnic minorities or racial/ethnic minorities move into areas with hazardous facilities. Both these debates assume singular social dimensions (e.g. racism or classism) to understand environmental injustices. The debates have led to an expansion of sophisticated methodologies including distance decay and longitudinal models (Brulle and Pellow 2006). Distance decay methods focus on establishing an exposure buffer for hazardous facilities in order to attribute less hazard (i.e. decaying hazardous risk) with further distance. While this method highlights the physical geographies of environmental health risk, it is not quite clear what the method does theoretically for environmental justice research. Longitudinal models focus on facilities and social demographics of areas to address theoretical concerns of causation. Moving forward, these debates should incorporate a nuance understanding of racism because their shortcomings are "viewing racism as a clearly demarcated set of actions, not recognizing racism as an ideology, and a denial of the existence of multiple forms of racism" (Pulido 1996: 149). Failure to recognize racism as an ideology reveals only a partial understanding of how race interacts with political, cultural, and the economic institutions.

Critical environmental justice can address the limitations within classical quantitative environmental justice research (Pellow 2018). There are four pillars to critical environmental justice: 1) focus on the intersectional dimensions of race, class, gender, sexuality, ability, and species; 2) focus on the multitude of scales involved in environmental injustices; 3) re-focus on the role of state power in forming and neglecting environmental injustices; and 4) focus on racial and socioeconomic indispensability. The first pillar emphasizes the approach to put systems of oppressions that carry "logic of domination and othering as practiced by more powerful groups" (19) across social dimensions of race, class, gender, sexuality, ability, and species at the forefront. Pellow does not use the word intersectionality because intersectionality theory is not the only theory that focuses on overlapping systems. The second pillar builds on the importance to understanding the interrelated cycles of environmental injustice by highlighting mutliscalar analyses. Multiscalar approaches focuses on linkages across temporal and spatial dimensions to interconnect the causes and consequences of environmental injustices. The third pillar focuses on previous research overlooking the state's role in forming and producing environmental injustices. The fourth pillar of critical environmental justice emphasizes that analyses focus on racial and socioecological indispensability, in other words, racial and social justice be the center of the research and actions.

Given the importance of moving from classical to critical quantitative environmental justice, this dissertation addresses theoretical and methodological gaps in classical environmental justice with critical environmental justice. Purely economic explanations to environmental inequalities ignores the roles the racial state as historical and active agent in environmental racism (Pulido 2017). Furthermore, given the rich theoretical approaches in sociology of race, it is imperative to incorporate theories of racialization to expand assumptions of the Black/white binary within environmental inequality research. Finally, quantitative methodologies of environmental health disparities have not addressed how to incorporate intersectionality into their methods. Accordingly, this dissertation aims to address these specific gaps within classical quantitative environmental justice by pursuing theoretical and methodological frameworks of the racial state, Latinx studies, and intersectionality. There are three major gaps within environmental justice research: 1) the role of militarism within the racial state and racial capitalism on forming environmental inequalities in urban spaces; 2) an integration of the push and pull factors of Latinx racial formation in forming Latinx environmental health vulnerability; and 3) a theoretical and methodological approach to evaluating intersectional environmental health threats at the neighborhood level.

A. Racial State

Classical environmental justice research overlooks the role of the state and focuses on economic explanations to environmental inequalities (Kurtz 2009; Pellow 2018; Pulido 2017). Economic explanations emphasize that market forces led to locally undesirable land use (e.g. hazardous facilities, highways) and historically marginalized communities move into areas with lower property values (Mohai and Saha 2015). Quantitatively, economic explanations are operationalized through variables of median household income or median housing value. A recent national longitudinal study of hazardous facilities and demographic characteristics of a neighborhood between 1966-1996 found that hazardous facilities go to non-white, poor neighborhoods more often than non-white, poor residents go to neighborhoods with hazardous facilities (Mohai and Saha 2015). The results found racial composition of the neighborhood has a stronger effect than socioeconomic characteristics. These findings emphasize an overlooked dimension within the economic explanations of environmental inequalities—the racial state. The racial state plays a central role in racialized spaces of residential segregation, restrictive covenants, and zoning practices that influence placement of hazardous facilities (Taylor 2014; Ducre 2012). The racial state is central to racial discrimination in housing and yet these studies do not constitute the racial state into their theoretical frameworks.

In critical race theories, the racial state is "[t]he state is composed of *institutions*, the *policies* they carry out, the *conditions and rules* which support and justify them, and the *social relations* in which they are embedded" (Omi and Winant 1994: 83). The racial state can include governmental policies and agencies that form racial divisions among populations (Omi and Winant 1994). Regulations of administrative policies enforced by the state effects social dimensions of housing, labor, and education. The social dimensions of housing, labor, and education are central to empirical findings of environmental inequalities. A recent national study found urban census tracts with higher levels of Black/white residential segregation have higher levels of industrial air toxics (Ard 2016). Housing processes of suburbanization and decentralization enacted through the racial state via homeowner loans and the construction of highways are central to creating racialized environmental inequalities in rural/urban spaces (Omi and Winant 1994; Puldio 2000). In addition to housing, the racial state takes part in the racialized division of labor. A case study of Houston found that Blacks and Latinx residents were not only more likely to reside in more hazardous spaces, but to work in more hazardous spaces than white residents (Elliot and Smiley 2017). The racial state produces environmental inequality by not actively enforcing environmental protection regulations (Pulido 2017), furthermore the racial state takes an active role in creating environmental disparities with the military. Case studies show the detrimental effect militaries actively enacts on Indigenous communities and periphery nations especially in nuclear testing and mining (Kutez 1998; Hooks and Smith 2004; Frey 2013). Since the racial state takes part in racial formations, it is imperative to incorporate the role of the state within research as Kurtz (2009) wrote: "Given that the meaning of EJ is being negotiated in the field of action between EJ activists and the state, it is important for EJ scholars to theorize and investigate the state as a robust, complex and interested actor" (701).

i. What can Las Vegas teach us about the racial state?

Previous research demonstrates elements of the racial state such as residential segregation (Ard 2016) and militarism (Kutez 1998) are linked to environmental health disparities. Yet, theoretical frameworks are missing acknowledgment of the racial state. Critical environmental justice calls for more attention to the racial state (Pellow 2018). Las Vegas is known for its tourism economy, but also has a militarism legacy. One of nation's largest air force base is just a few miles north of the famous "Las Vegas Strip." Furthermore, Las Vegas is a diverse city with over fifty percent of its population are racial/ethnic minorities, in part to its location in the southwest, but also its large service and tourism economy. In chapter 2, I use the theoretical frameworks of environmental justice, racial capitalism, and the treadmill of destruction to emphasize that the military is part of the racial state and produces environmental health disparities putting racial/ethnic minorities and poor communities more at risk.

B. Black/white Binary

Racialized environmental inequalities in the United States encompasses intentional and unintentional political and socio-economic acts to non-white groups including, but not limited to, Blacks, Indigenous peoples, Asians, and Latinxs. Non-whites includes various intra- and inter- racial/ethnic groups and a popular misconception is to assume all non-white racial/ethnic groups within a Black/white binary where racial/ethnic minorities groups are situated between whites and Blacks (Perea 1997). Assumptions of the Black/white paradigm is found in environmental inequality research when not incorporating sociology of race theories and not unpacking the nuances within racial formations. A number of scholars (Almaguer [1994] 2009; Perea 1997; Kim 1999; Pulido 2006; O'Brien 2008) raise issue about the limitations of the Black/white paradigm and argue for research to expand understanding of racial/ethnic minority groups.

In search of expanding the Black/white paradigm, scholars have presented various race relational work including different racialization (Almaguer [1994] 2009; Pulido 2006), racial hierarchy (Almaguer [1994] 2009; Pulido 2006), racial triangulation (Kim 1999), racial middle (O'Brien 2008), and tri-racial society (Bonilla-Silva 2004). Each framework highlights important facets to expanding the Black/white paradigm. Different racialization and racial hierarchy demonstrates that inequalities among racial/ethnic minorities groups can be viewed on a Black-white continuum. While racial triangulation brings up the importance of understanding relations of whites and non-whites to include relations between racial/ethnic minorities to other racial/ethnic minorities. Thus, highlighting the role racial/ethnic minorities play in the racial formation of other racial/ethnic minority groups. The racial middle and tri-racial society framework hone in on the racial dynamics in the racial hierarchy framework by discussing whether racial/ethnic minority groups are between Blacks and whites; or will racial/ethnic minorities expand whiteness or brownness? Of course, it important to emphasize the role of intersectionality theory when thinking about expanding the binary because racialized dynamics encompass other forms of oppression including classed and gendered.

Spatial and temporal factors play an important role in understanding various racialized processes. In particular, researchers demonstrate in the southwest of the United States the limitations of understanding other racial/ethnic minorities groups under the Black/white paradigm. Almaguer ([1994] 2009) research on different racialization and racial hierarchy in the southwest is one of the first studies to demonstrate the limitations of the Black/white paradigm by demonstrating the “race relations” among various racial/ethnic minorities groups in California (2). It is important to examine the assumptions and reasons underlying the Black/White paradigm because it reveals key facets of the social construction of race such as the role of the state and legal actions in the construction of whiteness (Omi and Winant 1994; Pulido 2000). As racial formation and critical race theories argue the history of legal cases and access to resources play a crucial role in creating whiteness and thus inequalities. Spatial and temporal factors are important in understanding the racial processes and formation and can help complicate the Black/white binary (Pulido 2006). The Black/white paradigm is a powerful taken-for-granted assumption that underlies much of environmental inequality research and discussions of race in the United States.

i. How can Latinx destinations expand the Black/white binary?

Previous research demonstrates Latinx communities experience a great amount of exposure to environmental hazards (Morello-Frosch, Pastor, and Sadd 2001; Grineski, Bolin, and Boone 2007). Still, there is intra-categories within the Latinx communities that encompasses various nationalities and class privileges. Recently environmental inequality researchers (Collins 2011 et al.; Grineski, Collins, and Chakraborty 2013) have disaggregated the Latinx intra-ethnicity by country of origin and found environmental inequality can vary based on Latinx nationality and migration. Liévanos (2015) has found English-speaking abilities within Latinx communities is a significant indicator of exposure risk. Within sociology of race and ethnicity, one line of research uses the conceptual framework of Latinx destination to examine spatial and temporal dimensions of Latinx communities. In Chapter 3, I use the Latinx destinations framework to examine Latinx vulnerability and its connection to political economic context. Latinx destinations is way researchers examine nuances within the Latinx communities throughout the United States and expand assumptions of the Black/white binary by focusing on Latinx racial formation.

C. Intersectionality

Intersectionality theory expands the framework of oppressions and privileges to incorporate multiple and corresponding forms systems of power (Collins 2015). Intersectionality is from Black, feminist scholarship and emphasizes the overlapping relations across social dimensions forming a myriad of oppressions and privileges. To understand the positionality of a Black woman is not simply the additive dimensions of Black + woman but instead a more complicated interaction of Black x woman. Collins (2015) defines intersectionality as "references the critical insight that race, class, gender, sexuality, ethnicity, nation, ability, and age operate not as unitary, mutually exclusive entities, but as reciprocally constructing phenomena that in turn shape complex social inequalities" (2). Intersectionality is a dynamic process of being and enaction that forms through institutional processes (i.e. residential segregation and racialized division of labor) (Collins [2000] 2009) and individual perspectives and experiences (i.e. "outside within perspective"). The framework is about identity as much as it is about structure and the interaction between identity and structure.

Intersectionality encompasses many approaches of understanding the interconnection between systems of power. McCall (2005) argues for there are three main approaches: anticategorical, intercategorical, and intracategorical. Anticategorical approach focuses on unpacking and deconstructuring social categories to hone in on the power dynamics of fixed categories. Intersectional quantitative researchers have focused on the intercategorical approach of intersectionality which recognizes analytical categories as anchor points to understanding inequality among groups and the changing dynamics of inequality among various and conflicting dimensions. The intracategorical approach attempts to understand the structural relationship of inequality with "systematic comparison" and how groups are relational to each other (McCall 2005:1790). Intersectionality has a lot to contribute to various disciplines and issues. However, in terms in quantitative methods intersectional approaches have been limited given the complexity of the theory. Environmental justice scholars (Malin and Ryder 2018) argue to incorporate intersectionality into analyses to further understand environmental inequality disparities.

i. What does an eco-intersectional multilevel approach entail?

Intersectionality adds a unique perspective to quantitative environmental justice literature of combining the overlapping systems of power and understanding how they are interlinked. Furthermore, environmental justice research has a unique perspective of examining higher ecological levels of neighborhoods or geographical location. The synthesis of an intersectional environmental justice would examine the overlapping social dimensions at higher ecological levels such as the neighborhood. Recent innovations in quantitative methods use multilevel methods as a way to evaluate complex social clustering. In Chapter 4, I present an eco-intersectional multilevel modeling as a novel approach to evaluate environmental health disparities intersectionality.

III. An Empirical Approach

Given the limitations of classical quantitative environmental justice, there are three pathways to move forward by incorporating approaches with the racial state, expanding the Black/white binary, and including intersectionality. This dissertation aims to address these gaps to continue the conversation forward.

In Chapter 2, I present theoretical frameworks of racial capitalism and the treadmill of destruction to argue militarism as part of the racial state forms environmental health disparities. In order to understand environmental health disparities in Las Vegas, there must be discussion about militarism. Las Vegas presents itself as an important case study to examine environmental health gaps among racial/ethnic and economic dimensions of neighborhoods as well as proximity to the military bases. In Chapter 3, I incorporate theories of environmental inequalities and spatial assimilation to examine the push and pull factors of Latinx destination in the entire United States. A version of Chapter 3 has been previously published in the journal *Socius* with my coauthor, Kathryn G. Norton-Smith (Alvarez and Norton-Smith 2018). My co-author and I analyzed the results and wrote the introduction and conclusion. In Chapter 4, I argue for a theoretical and methodological approach of understanding intersectionality happening at higher ecological levels of the community. I extrapolate recent statistical innovations in population health to evaluate eco-intersectional environmental health risks. I present the eco-intersectional multilevel modeling as a novel approach to examine intersectional environmental health risk. Chapter 4 is unpublished co-author material with my co-author, Dr. Clare Rosenfeld Evans. My co-author and I analyzed the results. This dissertation moves forward in unpacking overlooked dimensions of classical quantitative environmental justice and adds empirical studies to the ongoing discussion of a critical environmental justice.

CHAPTER II

MILITARY, RACE, AND URBANIZATION: LESSONS OF ENVIRONMENTAL INJUSTICE FROM LAS VEGAS

I. Introduction

Environmental justice research focuses on issues of equal access to clean resources and a healthy environment (Taylor 2014). Previous research demonstrates environmental hazards or privileges are disproportionally distributed where areas with more historically marginalized residents across social dimensions of race and ethnicity, class, and gender are expose to more hazards and less privileges (Pulido 1996; Brulle and Pellow 2006; Sze and London 2008; Mohai, Pellow, and Roberts 2009). Classical environmental justice research has focused on economic explanations of hazardous disparities, including the race versus class debate and racial/ethnic "minority move-in" hypothesis (Pellow and Brulle 2005). This is surprisingly, considering the amount of research demonstrating the detrimental effect the U.S. Military has had on Indigenous communities (Kutez 1998; Hooks and Smith 2004) and marginalized communities aboard (Clark and Jorgenson 2012; Jorgenson, Clark, and Givens 2012). Recent efforts of environmental justice scholars incorporate the theoretical framework of racial capitalism to argue the racial state is a central mechanism to the formation of environmental disparities (Kurtz 2009; Pulido 2016; Pellow 2018). This line of critical work has yet to explicitly discuss the ways in which the U.S. Military is part of the racial state and produces environmental inequality. In this regard, the environmental sociological framework of the treadmill of destruction (Hooks and Smith 2004; 2005) has a lot to offer because it explicitly argues the U.S. Military and other national militaries are major contributors to environmental destruction. In this chapter, I use the theoretical frameworks of environmental justice, racial capitalism, and the treadmill of destruction to emphasize the U.S. military as part of the racial state produces environmental health disparities putting racial/ethnic minorities and poor communities more at health risk. I use Las Vegas as a case study to contextual this framework.

Las Vegas presents an important case study to environmental justice research because it is a metropolitan area adjacent to an active U.S. Military base, Nellis Air Force. Las Vegas has two million residents and the area has several sociological challenges, including housing issues, environmental problems, and racial/ethnic inequalities (Futrell et al. 2010). Before the economic recession of 2007-2009, the city had many population growth spurs and a growing unregulated housing market contributing to urban sprawl and uneven development (Gottdiener, Collins, and Dickens 1999; Batson and Monnat 2015). A recent report from the American Lung Association (2018) reported Las Vegas as the 12th most polluted city in ozone--a carcinogen harmful to people and animals. The people most likely to be affected from housing and environmental issues are racial/ethnic minorities and poor residents. Las Vegas presents itself as an important environmental justice case study to examine military presence in an urban setting and hazard disparities.

This chapter evaluates environmental health risk disparities from air toxics of census tracts in Las Vegas metropolitan area and their relation to proximity to military bases, percentage of racial/ethnic minority residents, and percentage of economic status of residents using spatial error regression models. Results show census tracts in closer proximity to the military bases have higher environmental health risk even when controlling for proximity from highways and the amount of high-intensity development. Census tracts with higher proportion of poor and Latinxs residents are most at risk, independent of each other and military base proximity. This is not found for other racial/ethnic minority groups and suggests a poor, Latinx vulnerability in Las Vegas. An interaction of percentage of Latinx residents and proximity from military base demonstrates a marginal effect that areas in closer proximity to the military base and with higher Latinx percentage have an additional health risk. Findings suggest that housing dynamics of uneven development (Gottdiener et al. 1999) and environmental privilege (Pulido 2000) regulated through the state and the market have made the northeast side of Las Vegas more at risk especially with Latinx vulnerability. Furthermore, in order to understand environmental injustice in Las Vegas, one needs to include discussion of the role of state in additional to market forces. This chapter demonstrates environmental justice issues of Las Vegas to emphasizes the importance of military bases in urban spaces and Latinx vulnerability while addressing gaps of incorporating the racial state into classical quantitative environmental justice research.

II. Background

Environmental sociological research demonstrates the military as a significant contributor to environmental impacts (Hooks and Smith 2004; 2005; Jorgenson and Clark 2015; Alvarez 2016), and yet in most recent sociological discussions of environmental justice, the military is rarely referenced except when discussing Indigenous communities (Kutez 1998; Vickery and Hunter 2016) or cross-national global analyses (York 2008; Jorgenson and Clark 2015). Those studies demonstrate the influential role the military takes part in environmental destruction; however, they are limited in local specificity such as accounting for military bases in urban spaces or the military's role in forming environmental inequalities for Black and Latinx communities. The U.S. military occupies several urban spaces with active military bases such as a naval and air force bases in San Diego and military bases in the national capital's of Washington D.C.. Given that environmental justice research shows communities of color bear more hazard risk, it is important to examine how the racial state uses the military in producing hazard disparities. Here, I argue the theory of the treadmill of destruction can be incorporated into environmental justice frameworks to explain the military as part of the racial state within racial capitalism. I begin by discussing environmental justice then move into racial capitalism and then the treadmill of destruction.

a. Environmental Justice

The field of environmental justice came from the efforts of communities organizing against environmental inequalities (Sze and London 2008). In the most general sense, environmental inequality is that areas with more historically marginalized communities across race, class, gender, and nationality are exposed to more environmental hazards risk as compared to other areas (Brulle and Pellow 2006; Mohai, Pellow, and Roberts 2009). Environmental inequality is at its core not fair and even further people exposed to environmental hazards are at higher risk of having adverse health problems including birth defects, respiratory illnesses, and even death (Brink et al. 2014). Environmental justice research focuses on issues of environmental inequalities such as equal access to non-toxic resources and healthy environments in homes, communities, and workplaces. The field encompasses many research foci including, but not limited to, demonstrating environmental inequalities, the historical construction of environmental inequalities, and participant-observation of social movements working against inequities (Taylor 2014).

Central to the environmental justice movement and research is to explain the mechanisms that cause environmental inequality. Most sociological research focuses on three mechanisms: economic, sociopolitical, and racialized (Ash et al. 2012; Kravitz-Wirtz et al 2016). The economic mechanism is a market-based explanation in that environmental hazards are placed in areas with lower property or rent values (Logan and Motloch [1987] 2007). Thus, following rational economic choice logic, areas with lower housing or land value are more accessible to groups that have been historically deprived from economic resources and hazardous facilities. Statistical research focusing on environmental inequality operationalize economic statuses by including variables of median household income, median housing value, and percent of renters. The economic explanation is limited in understanding the complexity of capitalism including state intervention with residential segregation or racialized spaces such as restrictive covenants (Ducre 2012; Taylor 2014). The second mechanism is the socio-political explanation and argues hazardous facilities are placed in areas with the least resistance (i.e. political power or social capital) (Taylor 2014). There are many ways to operationalize political power and social capital including bonding, bridging, and political participation (Ard and Fairbrother 2017). The socio-political perspective ignores the shortcoming of policies to enforce environmental justice legislation and discrimination intent (Pellow and Brulle 2005; Pulido 2017). The third mechanism to environmental disparities is the racial discrimination explanation. The racial discrimination explanation aligns with the environmental racism literature in that areas with more racial/ethnic minorities are not valued (Morello-Frosch 2002). This is tied to the racialization of housing market with residential segregation and suburbanization (Pulido 2000; Taylor 2014). The racial discrimination highlights racial inequality but does not emphasize the racial state as an integral part of racial disparities (Kurtz 2009). To think of environmental justice issues in these discrete dimensions is self-defeating to the ultimate purpose of understanding environmental inequality and moving to alleviate it (Pulido 2017). A theoretical framework that takes a more holistic approach is racial capitalism and within the racial capitalism framework is a focus on the racial state.

b. Racial Capitalism

More recently, scholars have incorporated racial capitalism as a more inclusive approach to highlight the economic, socio-political, and racial discrimination mechanisms of environmental inequality because it recognizes the relationship between capitalism and racism as well as emphasizes the role of racial state (Pulido 2016; 2017). The framework of racial capitalism is racism is the logical structure of capitalism (Robinson 2000; Melamed 2015). Critical ethnic studies scholar Jodi Melamed explains:

> "Capital can only be capital when it is accumulating, and it can only accumulate by producing and moving through relations of severe inequality among human groups--capitalists with the means of production/workers without the means of subsistence, creditors/debtors, conquerors of land made property/the dispossessed and removed. These antinomies of accumulation require loss, disposability, and the unequal differentiation of human value, and racism enshrines the inequalities that capitalism requires" (Melamed 2015: 78).

Racial capitalism emphasizes that the oppressive ideology of racism enforces capitalistic inequalities such as accumulation and appropriation, in other words, capitalism relies on racism to produce the economic, material, and social inequalities it needs to sustain itself. The ideologies and material consequences of racial capitalism produces environmental injustices (among other inequalities) through "racial difference" and the corresponding "relative valuation" to those racial disparities (Pulido 2017). For example, the historical and legal "justifications" of appropriation of non-white land to whites and furthermore the administrative and economic gaps tied to the radicalized labor force (Pulido 2017). A unique and important part of racial capitalism is that the state is not a neutral force and works as an active agent of racial violence including the environmental racism gap (Pulido 2017). As scholars suggest, environmental justice research needs to address the state's role in order to work towards alleviating the problem (Pulido 2017; Pellow 2018). With a racial capitalism approach to environmental justice, the state takes the role of being an agent in forming and legitimating environmental inequality instead of seeing the state as part of the solution to environmental injustice (Pulido 2017). Policy efforts such as Executive Order 12898 have failed to account for environmental justice practices within their agencies and private practices (Pulido 2017). Previous research has shown that government inspections are less likely to happen in areas with more non-white residents and lower-income (Konisky 2009a; Koniskya 2009b; Opp 2014; Spina 2015). Socio-political frameworks argue it may be racial or class discrimination while others argue it is because lower political power to organize to fight against hazard placement. Regardless of intent, the state is not working to protect those who need the most protection. The racial state acts through various institutions, and in this chapter, I focus on the military as an arm of state.

Environmental justice research that has focused on military's relation to environmental inequalities has solely focused on Indigenous communities (Vickery and Hunter 2016; Kutez 1998) and global research (Jorgenson and Clark 2015; York 2008).

Environmental justice has shown the detrimental effects military has on Indigenous communities especially in nuclear testing and mining (Kutez 1998; Hooks and Smith 2004). Indeed, global research has shown the military is a major contributor to global CO_2 emissions, energy consumption, ecological footprint, and freshwater withdrawals (Jorgenson and Clark 2015; Alvarez 2016). This research is limited to understanding the military in an urban setting and non-white communities. To explain the military's role in racial capitalism, the treadmill of destruction can shed light into the military as a mechanism of environmental inequality.

c. Treadmill of Destruction

Before discussing the treadmill of destruction, it is essential to review the treadmill of production. The treadmill of production argues a growth coalition of capital, state, and labor work to accumulate profits and surplus at the expense of social equity, labor protections, and the environment (Schnaiberg 1980; Gould, Pellow, and Schnaiberg 2004; Gould, Pellow, and Schnaiberg 2008; Pellow, Schnaiberg, and Weinberg 2000; Schnaiberg and Gould 1994; Schnaiberg, Pellow, and Weinberg 2002). The political-economic framework emphasizes that capital uses increasingly technological- and energy-intensive practices to make environmental destruction with environmental withdrawals (e.g. natural resource extraction) and additions (e.g. pollution). The state works with capital in subsidizing economic projects at the expense of social programs and not actively regulating environmental justice policies. The declining power of labor has led itself to work with capital and the state in pursuing its goals. The treadmill of production emphasizes the role of capital to environmental destruction because competing theories such as ecological modernization argue capital can be integrated for environmental mitigation.

Hooks and Smith (2004; 2005) developed the treadmill of destruction as a supplement to the treadmill of production to emphasize the role of the military in environmental destruction in a capitalist society. They argue that the military operates in different logic than capital through coercive polity and geopolitical power. Furthermore, the actions of the state cannot be reduced to logic of capital. The treadmill of production puts emphasizes on capital while the treadmill of destruction acknowledges the state and military as working with capital to be active contributors to environmental destruction. Through the pursue of arms race and geopolitical power, the military produces vast amounts of environmental harm. The treadmill of destruction has been used to explain the sacrifice zones created on Indigenous' peoples land throughout the United States and the world (Clark and Jorgenson 2012; Jorgenson et al. 2012). There is a natural connection between the treadmill of destruction and racial capitalism because they both emphasize the role of the state in enforcing racial violence. While racial capitalism focuses on racial state, it does not unpack the harms of the military as an arm of the racial state which is central to the treadmill of destruction.

The racial state within the framework of racial capitalism acknowledges state-sanctioned violence on communities of color (Pulido 2017). In the most general sense, the racial state is "[t]he state is composed of *institutions*, the *policies* they carry out, the *conditions and rules* which support and justify them, and the *social relations* in which they are embedded" (Omi and Winant 1994: 83). The racial state includes governmental policies and agencies that form racial divisions among populations (Goldberg 2001). The

U.S. military is an arm of the racial state that participates in state-sanctioned violence with creating environmental injustices in the United States and around the world including poisoning Indigenous sacred land (Kutez 1998) or the usage of Agent Orange in Vietnam (Frey 2013). Even further, Jung and Kwon (2013) summary of the U.S. as a racial state concludes that sociologists should aim to examine U.S. as an empire-state because since its inception has colonialize and imperialism lands and peoples. The military is used to enforce and reproduces the empire-state of the U.S.. Through that same lenses, the U.S. Military takes part in polluting urban spaces and communities of color. Ultimately, by focusing on the military, this research aims to emphasize the military's role in environmental destruction in an urban area. Less is known about the military's environmental harms to other communities of color in urban setting even though many prominent military sites occupy or are adjacent to urban spaces. In this chapter, I focus on the U.S. military in the city of Las Vegas.

III. Las Vegas History

Las Vegas was originally Paiute land and the Paiute peoples cultivated the area and grew community in an area whites deemed barren, harsh, and dry (Goldberg and Valley 2015). Throughout its western colonial history, Las Vegas has served as a trade and travel stop between California and the rest of the United States (Gottdiener et al. 1999). The interest in the political-economic value of the area started in 1826 when Spanish colonialists appropriated the land in order to have a shorter path between New Mexico and California also known as the Old Spanish Trail (Gottdiener et al. 1999). The United States took possession of the area through the Treaty of Guapalupe Hidalgo of 1848 which ended the Mexican-American War with the United States gaining nearly half of Mexican territory (Anderson 2019). The economic spatial value of Las Vegas grew as a sanctuary in the desert climate for white travelers going west for gold mining (Gottdiener et al. 1999). In the late 19th and early 20th century, Las Vegas gained a railroad spot and mining camps began to grow. Railroad and real estate capitalist William Clark managed the new railroad and auctioned 1,200 adjacent land plots (Gottdiener et al. 1999). In 1905, Las Vegas was officially declared a city and the local economy consisted of railroad, mining, and warehousing.

Las Vegas historian Eugene Moehring (2000) argues the "federal trigger," the assistance of the federal government, is central to the modern development of Las Vegas (Moehring 2000). The "federal trigger" included state senators Key Pittman and Pat McCarran who lobbied for New Deal funding to the state of Nevada to build a water dam and city infrastructure (Gottdiener et al. 1999). The first federal economic boost for Las Vegas was the construction of Hoover Dam between 1931 to 1936 because it provided southern Nevada with water, energy, and economic resources (Parker and Feagin 1992). The construction of Hoover Dam brought tourists as well, is it estimated an annual of 300,000 visitors came to Las Vegas when it only had 8,000 residents (Gottdiener et al. 1999). Pittman and McCarran secured additional funds from the Works Progress Administration to build a post office, war memorial building, and street and sewer infrastructure (Gottdiener et al. 1999). National state actions supported real estate and tourism in southern Nevada including Interstate Highway Act (Gottdiener and Hutchison 2010). The "federal trigger" encompasses financial support for civilian projects and military operations in Nevada.

Similar to other cities in the southwest, Las Vegas has federal military sites within and near the city including the Nellis Air Force, the Nevada Test Site, and the Tonopah Test Range. In the 1940s, the U.S. Army decided to build the Las Vegas Army Air Corps Gunnery School about eight miles north of downtown because of the area's sunny weather, vacant land, and proximity to coast (Whitaker 2016). In 1950, the Department of Defense renamed the base Nellis Air Force Base (Gottidiener et al. 1999). During 1950s, the Nevada Test Site served as the location to prepare and test atomic bombs and the area remains under federal control. The closest military base to Las Vegas is Nellis Air Force and along with its military operations it houses military families and has shopping amenities (Whitake 2016). In present day, Nellis Air Force base is an important part of the U.S. Military operations. There are designated trailers in Nellis Air Force Base where pilots control drones aboard in Iraq and Afghanistan (Kaplan 2006). The pilots operating the unmanned aerial vehicles are in communication with military persons in other locations in the US and with personnel on the ground (Kaplan 2006). Furthermore, the Nellis Air Force hosts Reg Flag combat classrooms where officials from other countries practice in a war stimulated practice in the Nevada desert. The presence of militarism in the Las Vegas and Nevada shows how the racial state through the military takes place and it is important to evaluate those effects.

Today, Las Vegas is world-renowned for tourism. After World War II is when the hospitality and gambling industry in Las Vegas make a concerted effort to grow the tourism industry (Gottdiener et al. 1999). Between 1940s to 1960s, capitalists pushed for Las Vegas to become a major tourist destination by investing into casino and hotel developments (Gottdiener et al. 1999). Many residents come to Las Vegas for employment opportunities, and tourism industry has many service-based jobs such as servers, housekeepers, and food preparers. Las Vegas has a significant large multi-racial union with over 60,000 members. Nationally, about 43.3% of the leisure and hospitality workers are racial/ethnic minorities (Bureau of Labor Statistics 2019). The tourism industry is connected to diversity populations in Las Vegas.

Las Vegas is a diverse city with more than 50% residents of color. Historically, Indigenous and Mexicans were exploited in southern Nevada to help with exploration and mining and railroad development. This created a system of discrimination and poverty among Indigenous peoples by depraving water sources on Indigenous lands, suppressing Native culture, and denying access to education (Forbes 1993). After the Mexican-American War, Mexicans were placed in "labor-repressive system" and stratified to work at lower wages in mining and railroad (Mirranda 1997:47). African-Americans came to Las Vegas as part of the great migration where southern Blacks left the south for better opportunities. However, African-Americans were discriminated in jobs and housing in Las Vegas **(**Gottdiener et al. 1999**)**. The African-American population in the city has declined while the Latinx and Asian populations have increased. Latinx residents are the largest racial/ethnic minority group in Las Vegas. The majority of Latinxs in Las Vegas are Mexican-origin (Pew Research Center 2013).

The Las Vegas metropolitan area consist of several municipal and unincorporated areas including the city of North Las Vegas, the unincorporated area of Paradise, the city of Henderson, and Summerlin in the Clark county. Some of these areas started separate for example, the cities of Las Vegas and Henderson and over time as the area urbanized the cities met to become a larger Las Vegas Metropolitan area. For the past decades, the city has experience numerous growth spurts. Between 1990 to 2000, Las Vegas grew 85.6% with 634,000 people and from 2000 to 2008, the city experienced a 35.6% population increase with about 490,000 new residents (U.S. Census 2010). Along with population increases, a number of housing units increased with the growing population. From 2000 to 2008 there was an increase of 250,000 housing units added or 44.9% increase (U.S. Census 2010). Las Vegas had a large concentration of subprime mortgages where subprime lending practices targeted financially-vulnerable consumers by ignoring traditional financial checks such as examination of credit history, proof of income, and offering lower down payments. Las Vegas had many of the urban drivers of the subprime mortgage crisis including a large racial/ethnic population, mid-level credit scores, presence of new housing construction, and high unemployment rates (Rugh and Massey 2010). After the 2007 recession, Las Vegas had nearly 70,000 foreclosed housing units. Batson and Monnot (2015) show the effects from the foreclosure crisis had an impact on neighborhood satisfaction and quality of life. Today, the real estate market has improved steadily.

IV. Hypotheses

Given the theoretical background and history of Las Vegas, I present three hypotheses this chapter will evaluate. The hypotheses are based on racial capitalism, environmental justice, and the treadmill of destruction. The environmental justice hypothesis states that census tracts with higher percentages of racial/ethnic minorities and/or poor residents are more at higher environmental health risk. The treadmill of destruction hypothesis states census tracts in closer proximity to military bases have higher environmental health risk. Finally, the racial capitalism hypothesis synthesizes the environmental justice and the treadmill of destruction hypotheses to state that census tracts in closer proximity to military bases and have higher percentages of racial/ethnic minorities face additional environmental health risk.

environmental inequality hypothesis

H1: Census tracts with high percentage of residents of color and poor residents will have more environmental health risk.

treadmill of destruction hypothesis

H1: Census tracts in closer proximity military base have higher environmental health risk.

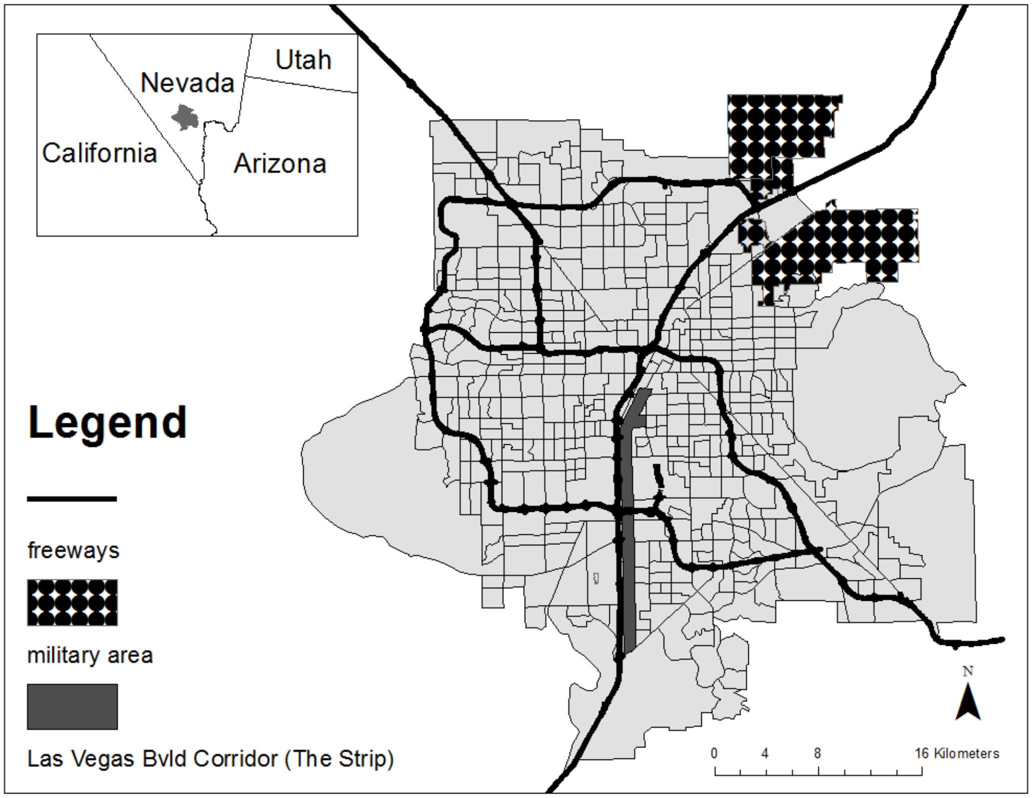
racial capitalism hypothesis

H3: Census tracts in closer proximity to military bases and with higher percentage of racial/ethnic minorities residents have higher health risk.

V. Unit of analysis

Figure 2.1 shows a map of the area of study of Las Vegas which is within Clark county in Nevada. Clark county consist of many census tracts outside of the Las Vegas metropolitan, and I excluded census tracts with very low population and very large area in the far periphery. Twenty-five census tracts in Clark county were excluded in the analysis. Nevada is a state full of rural and urban relationship and the dynamics should not be confused. This study focuses on the urban dynamics. There was a total of 463 census tracts included in the study.

Figure 2.1 Map of Census Tracts Included in Las Vegas Study



VI. Data

To assess the relationships of environmental inequality and militarism in the Las Vegas area, I use a variety of national and county-level datasets. The dependent variable of estimated human health risk from air toxics is from the U.S. EPA's National Air Toxics Assessment (NATA 2019). The EPA publishes NATA reports to evaluate air toxics in the United States and the report includes air toxics data on emissions, estimates of ambient concentrations, and human-health risks. Over the last three decades, six reports have been published for the years: 1996, 1999, 2002, 2005, 2011, and 2014. NATA reports are a “snapshot” of national air quality and health risks because a nationwide monitoring system does not exist (Office of Air Quality Planning and Standards 2018). To produce NATA reports, EPA does a series of complex, rigorous steps. NATA methods include the general risk assessment framework from the EPA's guidelines which are consistent with the National Research Council. The reports include 187 hazardous air pollutants from the 1990 Clean Air Act and also include the following types of air toxics emissions: point (e.g. factories and large waste incinerators), nonpoint (e.g. commercial cooking and commercial solvents), mobile onroad (e.g. roads and highways), nonroad (e.g. trains and aircraft), biogenics, fires, secondary, and background.

The first step for estimation is to compile a nationwide national emissions inventory (NEI) of air toxics emissions. NEI is collected through a variety of state, local, and tribal air agencies. The estimates are collected at various levels depending on the emissions source, for example point sources are collected at the facility level while onroad emissions are collected at the county level. After the NEI is collected, the EPA conducts a series of air quality models to estimate ambient concentrations multiscale air quality (CMAQ) and atmospheric dispersion (AERMOD) models. In most cases the air toxics are estimated through one model. A few air toxics are used in a hybrid model combining CMAW and AERMOD. Air quality modeling consist of mathematical equations including emission data, meteorological data, and other information to simulate air toxics in the atmosphere. Finally, based on ambient concentrations data, the EPA uses models of inhalation exposures to estimate human health risks. Information on cohorts and daily activities are used to formulate risk characterization for outdoor exposure to air toxic emissions. The EPA provides risk assessment of cancer and chronic health effects based on exposure in a lifetime (70 years).

The dependent variable in this chapter is estimated lifetime cancer risk from air toxics in a lifetime of 70 years per million persons at the census tract level. Since the measurement is per million persons, it is a standardized measured that can be compared across population sizes and census tract areas.

The demographic variables are from the U.S. Census American Community Survey (ACS) 5-year wave of 2010-2014 and were downloaded from the NHGIS website which offers free Census and ACS data (Manson et al. 2018). The ACS collects more in-depth demographic estimates (e.g. income and housing characteristics) at various geographic levels more frequently than the decennial census. The main variables of interest include percentages of racial/ethnic minorities groups, median household income, and percentage of occupational workers. I included percentage of the labor force in manufacturing and retail.

The analyses include a number of spatial variables from the Clark County Comprehensive Planning GIS files and the National Land Cover Database (Clark County

GIS Management Office 2019 and Homer et al. 2015). I included distance-based measures from the census tract's centroid to freeways and military bases. First I created a centroid for each census tract and then measured the distance in kilometers to closest freeway and military base. The freeways included were I-15, Clark County 215, Nevada Highway, and ramps. The military bases included were Nellis Air Force Base, Northern Readiness Center, and Las Vegas Readiness Center. I created a developed area variable from the National Land Cover Database's raster land cover data. I used the 2011 National Land Cover Database category of highest impervious surface to represent high-intensive developed areas. Within ArcMaps, I calculated the population density as the census tract population divided by census tract area of square kilometer.

VII. Methods

I used spatial regression analysis because ordinary least squares regression does not control for spatial correlation. Spatial regression models incorporate spatial auto-regressive structures into linear regression to control for spatial correlation (Rogerson 2010). The first step in spatial regression is to decide on a spatial weight matrix. I decided to use a distance-based weight given the range of census tract areas. With a distance-based spatial weight, smaller tracts would include neighboring tracts and larger tracts would be more likely just to only include themselves. I tested five different distance-based spatial weights from .5 km to 3km and observed their residual errors for spatial dependence and goodness of fit statistics. The best spatial weight out of the five was 1.5 km.

The second step to spatial regression is to choose the most appropriate model for analysis (Anselin 2004). Spatial econometrics researchers use Lagrange Multiplier tests statistics to evaluate which model type is the most appropriate: spatial error or spatial lag model (Anselin 2004). A spatial lag model incorporates a spatial autoregressive term of the dependent variable (e.g. lagged dependent variable) into the model in order to account for areas that are near each other are more likely to be similar (Rogerson 2010). On the other hand, a spatial error model incorporates the spatial autoregressive term into the error term to account for the influences of unmeasured independent variables by accounting for the spatial clustering of error terms (Rogerson 2010). The test diagnostics for my data showed a spatial error model is most appropriate and so I proceed with that model. After running the spatial error models, I examined the Moran's I of the residuals to check if there was still existing significant spatial correlation, and after all the controls are included, there was not.

VIII. Results

Table 2.1 shows the descriptive statistics of the all the variables and Table 2.2 is the correlation table of all the variables. The average of estimated lifetime cancer risk of the area of study is about 37 people in one million while the national average of 31. The area of study has about 53.58% people of color including 30.30% Latinxs and 10.28% Blacks and not Latinx. The average median household income in the study site is about $55,220.30.

Table 2.1 Descriptive Statistics

	mean	sd	median	min	max
cancer risk	37.19151	5.371447	38.08269	26.93404	50.73491
white (%)	46.42098	20.06299	46.49159	3.646973	90.67982
Black, not Latinx (%)	10.2775	8.541349	8.121059	0	63.14864
Latinx (%)	30.29739	19.77794	24.53878	1.137576	91.53902
people of color (%)	53.57902	20.06299	53.50841	9.320175	96.35303
median household income	55220.3	21620.05	53885	15739	153133
distance to nearest military base (km)	10.9537	5.4419	10.8256	0	23.5588
distance to nearest highway (km)	2.0258	1.5988	1.7148	0.0061	10.072
high-intensity development (%)	16.06108	14.48551	12.32634	0.033384	76.29756
population density (pop/sq km)	3.2779	8.9151	1.525	0.3537	120.6555
manufacturing workers (%)	3.197852	2.171298	2.883263	0	11.14152
retail workers (%)	11.883	4.667985	11.56337	1.126972	25.28409

Table 2.2 Correlation Table of Variables

	1	2	3	4	5
1. cancer risk	1				
2. people of color (%)	0.5142	1			
3. Black, not Latinx (%)	0.2163	0.4821	1		
4. Latinx (%)	0.5829	0.8432	0.0967	1	
5. median household income	-0.6248	-0.6191	-0.3613	-0.6045	1
6. manufacturing (%)	-0.0052	0.0756	-0.0235	0.1584	0.0082
7. retail (%)	0.0848	0.0482	0.0337	0.0462	-0.1525
8. distance to highway (km)	-0.1011	0.0149	-0.0295	-0.0081	0.0834
9. distance to military base (km)	-0.3775	-0.553	-0.178	-0.4518	0.2485
10. population density (pop/kmsq)	0.2952	0.4983	0.1181	0.4911	-0.4446
11. high-intensity developed area (%)	0.6318	0.3043	0.178	0.293	-0.5701

Table 2.2 Correlation Table of Variables (continued)

	6	7	8	9	10	11
1. cancer risk						
2. people of color (%)						
3. Black, not Latinx (%)						
4. Latinx (%)						
5. median household income						
6. manufacturing (%)	1					
7. retail (%)	-0.0331	1				
8. distance to highway (km)	0.1053	-0.0213	1			
9. distance to military base (km)	-0.0734	0.0199	-0.2517	1		
10. population density (pop/kmsq)	-0.0001	0.0914	-0.0524	-0.1598	1	
11. high-intensity developed area (%)	-0.1271	0.0586	-0.2447	-0.1024	-0.1587	1

Table 2.3 has the series of spatial error regression models for estimated cancer risks regressed on the independent variables. Model 1 examines the relationship between census tract's environmental health to percentage of people of color, median household income, distance from nearest military base, distance from nearest highway, and urbanization. Surprisingly, the results for percentage of people of color of a census tract are marginally positive significance which does not support the environmental inequality hypothesis. Class or median household income has a negative significant effect meaning census tracts' with higher affluence have better environmental health which support environmental inequality hypothesis. A census tract's proximity to military base has a negative significant effect meaning the further distance a tract corresponds to a lower estimated cancer risk from air toxics and supports the treadmill of destruction hypothesis. Interestingly, proximity to highways is not found to be significant. The amount of urbanization or high-intensive development is positive and significant thus showing that areas with more impervious surface have more estimated cancer risk. Finally, population density is not found to be significant.

Table 2.3 Spatial Error Models of Estimated Cancer Risk from Air Toxics in Las Vegas

	Model 1			Model 2		
	coeff.	se	p-value	coeff.	se	p-value
constant	36.6354	0.9237	0.0000	36.3206	0.8209	0.0000
people of color (%)	0.0157	0.0087	0.0736			
Latinx (%)				0.0397	0.0090	0.0000
Black, not Latinx (%)				0.0070	0.0144	0.6256
median household income (10,000s)	-0.1867	0.0625	0.0028	-0.1616	0.0636	0.0111
distance to nearest military base (km)	-0.1760	0.0361	0.0000	-0.1725	0.0341	0.0000
distance to nearest highway (km)	-0.0247	0.0799	0.7576	-0.0259	0.0789	0.7426
highly developed (%)	0.0646	0.0104	0.0000	0.0671	0.0104	0.0000
retail (%)						
manufacturing (%)						
population density (pop/km sq)	-0.0001	0.0001	0.3292	-0.0001	0.0001	0.0956
military*Latinx (interaction)						
lambda	0.8437	0.0172	0.0000	0.8323	0.0182	0.0000
log likelihood	-1043.5892			-1035.8208		
AIC	2101.1800			2087.6400		
Schwarz	2130.1400			2120.7400		
Moran's I (9999 permutations)	0.0221		0.2643	0.0127		0.3543

Table 2.3 Spatial Error Models of Estimated Cancer Risk from Air Toxics (continued)

	Model 3			Model 4		
	coeff.	se	p-value	coeff.	se	p-value
constant	36.2572	0.8492	0.0000	35.7427	0.9050	0.0000
people of color (%)						
Latinx (%)	0.0390	0.0091	0.0000	0.0653	0.0197	0.0009
Black, not Latinx (%)	0.0064	0.0145	0.6561	0.0088	0.0144	0.5397
median household income (10,000s)	-0.1630	0.0639	0.0108	-0.1650	0.0634	0.0093
distance to nearest military base (km)	-0.1736	0.0341	0.0000	-0.1195	0.0495	0.0157
distance to nearest highway (km)	-0.0295	0.0794	0.7099	-0.0328	0.0788	0.6772
highly developed (%)	0.0669	0.0104	0.0000	0.0658	0.0104	0.0000
retail (%)	0.0037	0.0168	0.8232			
manufacturing (%)	0.0191	0.0401	0.6341			
population density (pop/km sq)	-0.0001	0.0001	0.1017	-0.0001	0.0001	0.1199
military*Latinx (interaction)				-0.0026	0.0018	0.1420
lambda	0.8328	0.0181	0.0000	0.8347	0.0180	0.0000
log likelihood	-1035.6851			-1034.7517		
AIC	2091.3700			2087.5000		
Schwarz	2132.7500			2124.7400		
Moran's I (9999 permutations)	0.0119		0.3608	0.0166		0.3329

Given the results of percentage of people of color, I decided to disaggregate the people of color variable and examine percentage of Latinx and Black, not Latinx residents. I decided to do this because Latinx is the largest non-white in Las Vegas at 30% and Blacks, not Latinx is the second largest non-white in Las Vegas at 10%. Model 2 has the same variables as Model 1, but instead of people of color percent there is a percent of Latinx and percent of Black, not Latinx. In Model 2, percentage of Latinx is positive and significant meaning census tracts with higher percentages of Latinx residents have higher environmental health risk. Percentage of Black, not Latinx residents is not found to be significant. The direction and significance of the previous variables are maintained. In Model 3, I added industry variables of percent of workers in retail and manufacturing to see if the story of environmental inequality changes for Latinx and Black vulnerability. The retail and manufacturing variables are not found to be significant. The results support the environmental inequality and treadmill of destruction hypotheses for Latinx communities.

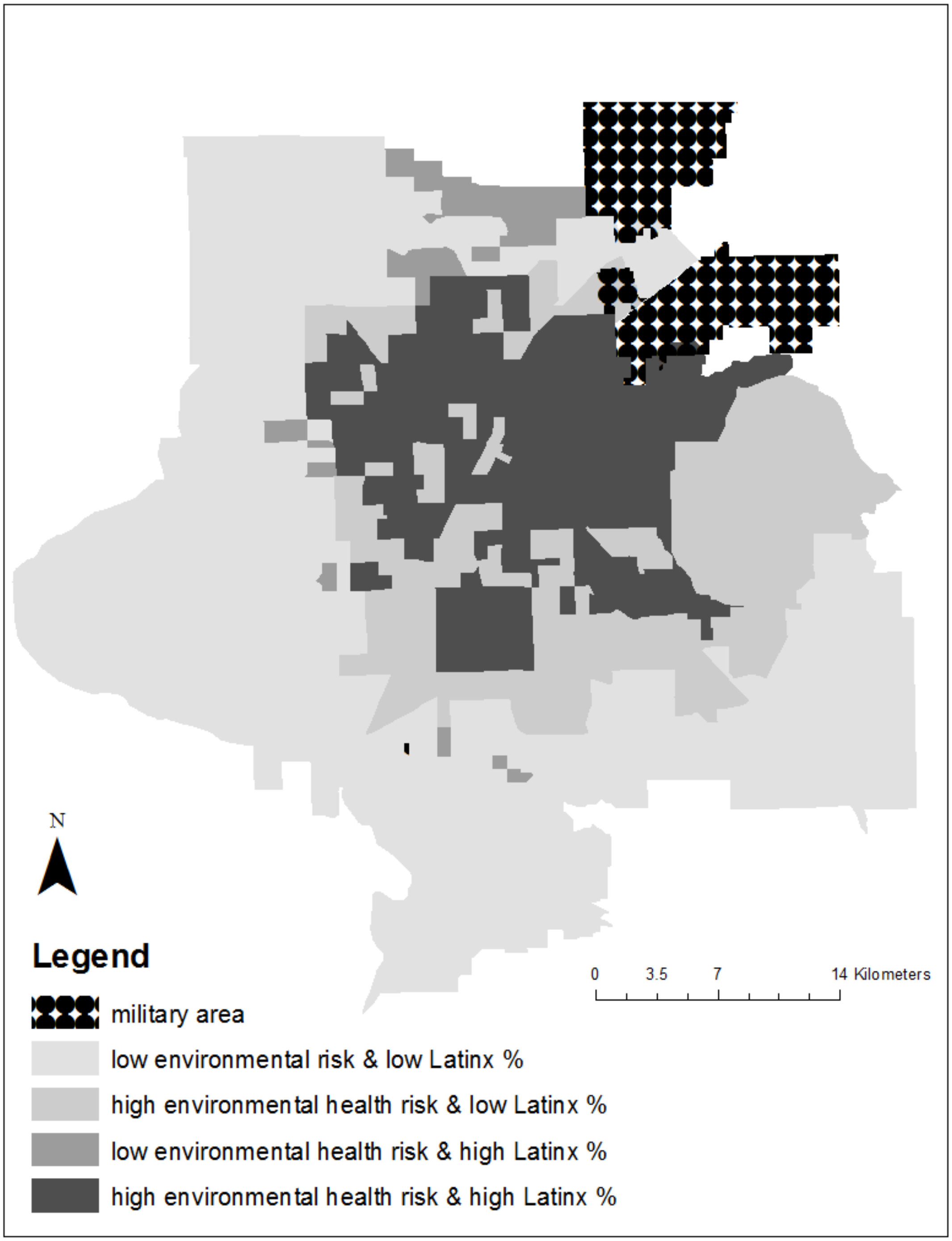
Since percentage of Latinx residents and proximity to military base are important as additive variables in the model, I decided to examine the relationship between the two with an interaction. The interaction examines whether distance to military intensifies the environmental health risk of census tracts with more Latinx residents. Model 4 includes all the variables from Model 2 in addition to an interaction of proximity to nearest military base and percentage of Latinx residents. Variables from previous models remain the same in direction and significance. The interaction is negative and only marginally significant thus suggesting there is a marginal additional environmental health risk for census tracts in closer proximity to military bases and with higher percentage of Latinx residents.

The results did not support the environmental inequality census tracts with higher percentages of people of color in Las Vegas. However, when we disaggregate the percentage of color to percentage of Latinx and Black, not Latinx, the results showed that census tracts with higher percentage of Latinx are at higher environmental health risk[3]. Results support the environmental inequality hypothesis for census tracts with higher percentage of Latinx and poor residents. These results suggest a poor, Latinx vulnerability in Las Vegas. The results support the treadmill of destruction hypothesis because census tracts in closer proximity to military bases have worse air quality. Since the environmental inequality and the treadmill of destruction hypotheses were both supported, then the racial capitalism hypothesis is support demonstrating the racial state through militarism creates hazardous areas for Latinx and poor residents.

Figure 2.2 visualizes the racial capitalism hypothesis by showing the overlap between environmental health risk and percentage of Latinx. I created a binary variable based on the average of estimated cancer risk from air toxics with "high environmental health risk" as at or above the average and "low environmental health risk" as below the average. For the Latinx category, I created a binary variable based on the average percentage of Latinx residents with "high Latinx %" meaning at or above the average and "low Latinx %" percentage meaning below the average. The map shows the areas with "high environmental health risk" and "high Latinx %" are adjacent to the military area and thus showing visual support of the racial capitalism hypothesis.

[3] Even though the models do not show vulnerability for non-Latinx, non-white groups, this does not prove that those groups are not oppressed. Simply, more research in a different format is necessary.

Figure 2.2 Map of Environmental Health Risk and Percentage of Latinx in Las Vegas



IX. Discussion & Conclusion

Classical quantitative environmental justice research has largely focused the economic causes such a facility placement tied to the economic value of land and the socioeconomic value of a neighborhood (Pellow 2018). This perspective ignores the role of racial state in the formation of environmental injustice even though previous research shows the state through the military has detrimental effect on socio-ecological problems including increasing the rate of carbon emission dioxide and in creating hazard risk on Indigenous communities (Kutez 1998; Kurtz 2009; Clark and Jorgenson 2012; Jorgenson, Clark, and Givens 2012; Vickery and Hunter 2016). Given that many urban spaces in the United States have military bases, including Houston, San Diego, and Washington D.C., it is important to evaluate the role of military in forming urban environmental health hazards. The purpose of this chapter was to synthesize theoretical frameworks of environmental justice, racial capitalism, and the treadmill of destruction and contextualize that framework with an environmental health disparities analysis of military bases and environmental racism in Las Vegas. Although researchers have studied various cities in the southwest including Phoenix, El Paso, and Los Angeles (Pulido 2000; Grineski, Bolin, and Boone 2007; Collins et al 2011), Las Vegas provides important lessons to environmental injustice including Latinx vulnerability and military in cities.

First, the findings did not support the environmental inequality hypothesis for areas with higher percentages of residents of color, however, when the percentage of people of color was disaggregated to percentage of Latinx and Black, not Latinx residents, only areas with higher percentage of Latinx residents were found to have worse environmental health risk. Previous research on Latinx migration within the United States suggests that poor, Latinx residents are moving from traditional Latinx destinations (e.g. states adjacent to the Mexico-United State border) to new Latinx destinations (e.g. states not adjacent to the Mexico-United States border) to escape stricter immigration enforcement from other areas and for lower cost of living. For example, during the Immigration Reform Control Act (IRCA) and post-IRCA eras the increases in Mexican migration in Nevada: from 2% in 1970, 5.1% in 1980, 8.3% in 1990 and 12.8% in 1996 (Durand, Massey, and Charvet 2000). Local statistics show that most residents moving to Las Vegas are from the California (City of Las Vegas 2013) and this suggest that those residents are looking for lower cost of living or employment opportunities. The findings in this chapter suggest that in Las Vegas, Latinxs are more likely to reside in areas with higher environmental health risk than other racial/ethnic minorities even though this is not found in national-level analyses (Zwickl, Ash, and Boyce 2014). The push and pull factors of people outside and within the United States is tied to system of racial capitalism.

Second, the findings support the theoretical framework of racial capitalism with the racial state using the military to form environmental health disparities for everyone but those historically oppressed communities including communities of color and low-income face additional risk. All the findings showed that the proximity to military base worsens environmental health risk and the proximity to highways was not found to contribute to hazard risk. Areas in closer proximity to military bases have higher environmental health risk from poor air quality. Although marginal support was found for those areas in closer proximity of military bases and with higher percentage of Latinx residents will have an additional burden of health risk. The findings emphasize the racial state through the use of the military bases in creating hazard disparities. Previous work by environmental justice suggests that the state is an agent of positive change towards environmental inequality mitigation, instead these findings suggest the state is active agent of environmental injustice (Pulido 2016). The findings are especially important now when the United States national administration is performing actions to increase the military state. Even though it may seem that military bases in urban spaces are harmless because of their proximity to front lines of wars, this is not the case in a time when military capacities are transformed with technology. Drones in the middle east are control in Nellis Air Force Base just miles north of the Las Vegas strip (Kaplan 2006). Finally, it is important to understand that residents of color are exposed to higher rates of hazard exposure in urban spaces and military bases in urban spaces add an additional harm to residents of color. The case study of Las Vegas offers an important lesson to environmental justice research of the racial state through militarism produces environmental health risk disparities across race and class in urban spaces.

Future research should investigate other cities where active military spaces occupy urban spaces. In addition, future research can expand the findings by exploring the historical development of spatial areas in Las Vegas that are most disadvantage such as the city of North Las Vegas. Finally, future research should incorporate residential mapping to figure out how residents use the spaces around them.

CHAPTER III

LATINX DESTINATIONS AND ENVIRONMENTAL INEQUALITY: ESTIMATED CANCER RISK FROM AIR TOXICS IN LATINX TRADITIONAL AND NEW DESTINATIONS

A version of this chapter was published in *Socius* with Kathryn G. Norton-Smith (Alvarez and Norton-Smith 2018). I initialed the idea of applying Latinx destinations framework to examine environmental health risk disparities in the United States. I wrote the environmental inequality sections within the literature review and hypotheses. I gathered and cleaned the data. I ran the models to find the results. I wrote the methods, data, and results sections. My co-author wrote the spatial assimilation section. My co-author and I analyzed the results and wrote the introduction and conclusion together.

I. Introduction

Between 1990 and 2000, the foreign-born population in the United States increased by over 57% (Singer 2004). This influx of immigration does not follow the settlement patterns of previous groups. One new pattern noted by demographers is the changing spatial migration patterns of Latinxs in the United States. While the post-1980s Latinx migration was concentrated in traditional destinations of Los Angeles, Miami, and New York City, Latinx growth in the 1990s and 2000s occurred in new destinations like Denver, Charlotte, and Seattle. As such, as settlement patterns change, scholars have begun to examine inequality between these traditional and new destinations (See: Park and Iceland 2011). These new destinations pose an opportunity to examine how, and to what extent, theories of spatial assimilation and environmental inequality can capture more recent Latinx population growth.

While previous research examines corresponding spatial changes of Latinx population growth on residential segregation, health insurance rates, and crime rates (Park and Iceland 2011; Shihadeh and Barranco 2013; Monnat 2017), less is known about corresponding health risks. We expand on this literature by examining health risks across Latinx destinations by employing two theories of spatial inequality: spatial assimilation and environmental inequality. Spatial assimilation theory proposes that, overtime, collective increases in human capital allows for geographic mobility (Massey 1985), translating into population growth in areas with less exposure to environmental hazards. On the other hand, theories of environmental inequality argue that areas with higher proportion of racial/ethnic minorities and/or less economic privileged experience greater exposure to hazards and environmental risk (Brulle and Pellow 2006; Taylor 2014). For example, a recent national study found that neighborhoods with a higher proportion of Blacks and Latinxs and a median household income below $25,000 had greater exposure to industrial air toxics at varying geographical degrees of risk (Zwickl, Ash, and Boyce 2014). This hints at spatial differences that may correspond to differences in racial, socio-political, economic, and environmental histories. Case studies of hazards in southern California, Phoenix, and El Paso -- all Latinx traditional destinations -- document greater risk in areas with higher proportions of Latinxs (Morello-Frosch, Pastor, and Sadd 2001; Grineski, Bolin, and Boone 2007; Collins et al. 2011). Disaggregating the intra-ethnicity of Latinxs by country of origin in the El Paso and Miami metro areas, research demonstrates that nationality and migration are indeed significant indicators to spatial hazard exposure (Collins et al. 2011; Grineski et al. 2013). While these studies offer important insight into micro-level economic (e.g. median household income) and racial (e.g. proportion of racial/ethnic minorities) indicators of environmental risk, they fail to examine structural-level economic and political drivers that place vulnerable populations at risk. As waves of migration are often connected to economic and labor market dynamics (See: Gouveia and Saenz 2000), it is imperative to examine major polluting industries in addition to measures of economic well-being. We address this gap with a national study of Latinx destinations and estimated cancer risk from air toxics at the county-level.

This chapter asks the following question: Is there a difference in county-level health risk between Latinx destinations and nondestinations? Furthermore, is there a county-level difference in estimated health risk among disaggregated destination types? Using county-level data with spatial lag regression analyses, our findings support theories of environmental inequality as Latinx destination counties have higher estimated cancer risk than nondestinations counties. When Latinx destinations are disaggregated based on temporal periods of Latinx growth, we find that early new destinations (defined by counties with Latinx growth in the 1990s) and recent new destinations (defined by counties with Latinx growth in the 2000s) have higher estimated cancer risk from air toxics than established and nondestination counties. Our results remain significant when controlling for county-level general economic well-being indicators, county-level Latinx economic well-being indicators, and county-level economic dependency. Thus, we do not find evidence supporting spatial assimilation theory. Out of all the control variables, the economic dependency indicators have the largest effect on the destination coefficients, nonetheless, the destination coefficients remain significant. Our findings show that counties with recent Latinx population growth have higher estimated cancer risk from air toxics. This complements existing research showing that Latinx growth in the 1990s and 2000s is associated with labor-demands in manufacturing and agriculture (Kochhar et al. 2005; Haverluk and Trautman 2008), industries that contribute to air pollution. This is particularly important as counties with recent Latinx growth may lack institutional support to assist marginalized groups in addressing hazards and health risks. These findings demonstrate the need for institutionalized efforts that work with vulnerable populations in new destinations to address health-related concerns. We conclude by stressing the importance of waves of Latinx growth within the formation, experience, and location of environmental hazardous.

II. Background

In the decades following the 1965 Immigration and Nationality Act, immigrants migrated to established gateway cities like New York City, Chicago, Houston, Miami, and Los Angeles. In traditional gateways, immigrants would often move into existing ethnic enclaves. These metropolitan areas served as "assimilation machines" providing a buffer between new immigrants and native-born U.S. citizens (Massey 2008). These traditional gateways have social institutions and non-immigrant populations that are more familiar with immigrant-specific needs and issues. Since the 1990s, changes in migration patterns have resulted in a new era of Latinx growth in new destinations. New destinations tend to be more suburban than traditional immigrant gateways and lack established ethnic enclaves. These new destinations also have different migration histories and lack government and nonprofits institutions that have experience working with the problems associated with immigration (Waters and Jimenez 2005:118).

Waves of migration are often connected to economic and labor market dynamics (See: Gouveia and Saenz 2000). For example, Monnat (2017) demonstrates important economic, political, and labor market distinctions between new destinations among the 1990s and 2000s. The counties with Latinx growth in the 1990s were largely located in the mid- and southwest regions where Latinxs filled low-wage jobs in manufacturing, service, and agriculture. These industries, and their associated labor markets, were negatively impacted by the economic recession of the 2000s. On the other hand, the counties with Latinx growth during the 2000s occured in the context of an economic recession and growing anti-immigration sentiments. In order to sustain Latinx population growth, it is likely that these recent new destinations offered better economic opportunity than the 1990s destinations (Monnat 2017). Building on Monnat's typology, we examine differences in estimated cancer risk across destination types, taking into account the speed and timing of Latinx population growth.

a. Spatial Assimilation

Various theoretical models outline differences in the relocation patterns of non-dominant groups. According to the spatial assimilation model, the spatial distribution of an ethnic group results from group-level characteristics and human capital (Massey and Denton 1985). On the micro level, this model assumes that, overtime, as families acquire resources (income, wealth, and education), they will move to locations with more amenities and services (Massey and Denton 1985). Collectively, groups with longer residential histories will move into the American mainstream with geographic mobility. We argue that, by extension, because Latinxs have a longer residential history in the United States, if spatial assimilation theory is correct, the geographic mobility associated with increases in human capital will translate into Latinx population growth in counties with less exposure to environmental hazards. However, the spatial assimilation model has been less successful in determining residential outcomes based on non-White populations (Fong and Wilkes 1999) and more recent waves of Latinx growth. The spatial assimilation theory differs from existing environmental inequality and migration literature by demonstrating that locations with higher non-White groups and less economic privileges have higher hazard exposure. We examine this contradiction by positioning spatial assimilation against theories of environmental inequality, thus examining spatial relations and place-based inequalities in environmental hazard and risk.

b. Environmental Inequality

Environmental justice refers to the notion that all people and communities are entitled to equal protection by environmental health laws and regulations (Brulle and Pellow 2006; Sze and London 2008; Mohai, Pellow, and Roberts 2009; Taylor 2014). Central to this research is the examination of environmental inequality or the disproportional distribution of environmental hazards among marginalized communities. Evidence from governmental, local, and national reports shows that air pollution and toxic hazards are disproportionately located near marginalized groups (Brulle and Park 2006; Taylor 2014). While there is limited data sources for temporal comparisons of air quality, Ard (2015) examined industrial air toxics over 1994-2004 and found that air quality has improved for all racial/ethnic groups, however exposure is still higher for Blacks as compared to Whites and Latinxs. Researchers have disaggregated intracategorical and intra-ethnic within the Latinx category from the American Community Survey to hone in on Latinx racialization and migration (Collins et al. 201l; Grineski et al. 2013). For example, Collins et al. (2011) find that in El Paso, Latinx intracategorical dimensions of foreign-born, citizenship, and English proficiency have statistical differences in the vulnerability to air toxics cancer risk. Furthermore, Grineski, Collins, and Chakraborty (2013) find divergent patterns among Latinxs country of origin with Cuban and Colombian neighborhoods experiencing higher estimated cancer risk from air pollution than Mexican neighborhoods in the Miami metro. While environmental inequality demonstrates areas with higher proportion of racial/ethnic minorities with less class privilege are more likely to experience environmental injustice, it is important to note the racial and economic formations (including migration patterns) that have subsequent spatial effects. We contribute to this conversation by integrating waves of Latinx growth into an analysis of hazard location.

III. Hypotheses

Based on theories of spatial assimilation and environmental inequality, we formulate two hypotheses to examine Latinx growth and hazard location. H1 supposes that Latinx destination counties will have higher estimated cancer risk than nondestination counties. H1 follows the traditional environmental inequality hypothesis where areas with higher proportion of racial/ethnic minorities and/or less economical privilege have higher risk from environmental hazards. In this hypothesis, we include all Latinx destination types--established, early new, and recent new destinations--against nondestinations. Latinx destinations are defined as counties with a Latinx population higher than the national average in 1990.

H2 evaluates the spatial assimilation hypothesis by supposing that places with higher recent Latinx growth (i.e. early new and recent new destinations) will have lower estimated cancer risk than places with more established Latinx communities (i.e. established destinations) and places with low Latinx population (i.e. nondestinations). The rationale of H2 is that overtime, as Latinxs collectively accrue more capital and move closer to the mainstream, they will relocate to counties outside traditional ethnic enclaves with less county-average estimated cancer risk.

Environmental Inequality Hypothesis:

H1: Latinx destination counties (established, early new, and recent new destinations) have higher county-average estimated cancer risk from air toxics than nondestination counties.

Spatial Assimilation Hypothesis:

H2: Early new and recent new Latinx destination counties have lower county-average estimated cancer risk than established Latinx destination and nondestination counties.

IV. Data

To assess the relationship between Latinx destinations and estimated cancer risk, we use county as our unit of analysis. We use county-level data for a number of reasons: First, county-level data examines regional level effects and is large enough to capture structural dynamics and economic dependency. Second, county-level analysis captures exposures to hazards that occurs at home and at work. Research comparing hazard exposure between home and work has found that people experience more exposure to hazards at work (Elliott and Smiley 2017) and individuals are more likely to live and work in the same county than they are to live and work in the same neighborhood. Finally, county boundaries remain the same over time therefore we can compare the Latinx population changes recorded by the decennial Census. Due to these factors, we argue it is more appropriate to examine the distribution of health risk at the county-level than the neighborhood-level. We include all counties in the United States in order to examine the effects of Latinx growth among urban and rural places. We excluded counties with any missing variables. The total sample size was 2,886 counties.

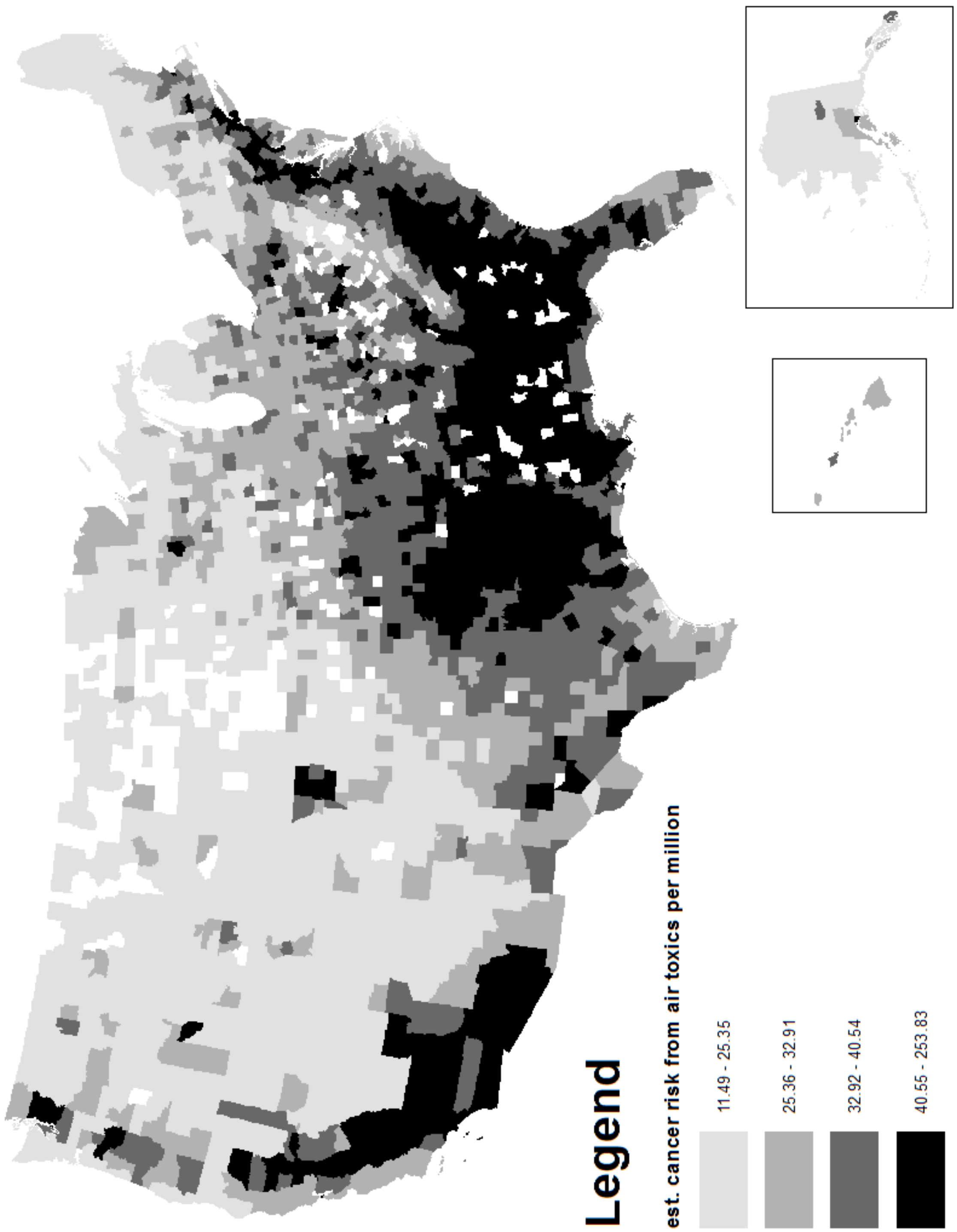
a. Dependent Variable: Estimated Cancer Risk from Air Toxics

The dependent variable is estimated lifetime cancer risk from air toxics and comes from the Environmental Protection Agency's (EPA) National Air Toxics Assessment (NATA) from 2011. Estimated lifetime cancer risk from air toxics is a common variable in analyses of environmental inequality (See: Collins et al. 2011; Liévanos 2015). The EPA's NATA has released a total of 5 reports: 1996, 1999, 2002, 2005, and 2011. As the methodology improves with each subsequent report, the EPA recommends not to compare assessments. For this reason, we use estimated cancer risk from air toxics data from 2011 to reflect the most accurate toxics assessment. The NATA is an evaluation of air toxics in the United States and includes estimates on emissions, ambient concentrations, and human health risks. NATA includes the following primary air toxics emissions: point (e.g. factories and large waste incinerators), nonpoint (e.g. commercial cooking and commercial solvents), mobile onroad (e.g. roads and highways), nonroad (e.g. trains and aircraft), biogenics, and fires. The report includes 187 hazardous air pollutants from the 1990 Clean Air Act. To generate the report, the NATA collects an inventory of these identified air toxics and based on that data, they conduct air quality models and models of inhalation exposures. Exposure is estimated among cohorts in each census using the EPA Hazardous Air Pollutant Exposure Model (HAPEM). Using tract-level data, HAPEM uses probability distributions to model indoor and outdoor microenvironments. The NATA technical support document notes that racial/ethnic minorities and low-income populations are not well-represented within the activity data.

Risk assessment of cancer and chronic health effects are estimated for exposure in a lifetime of 70 years and estimated cancer risk is based on the upper bound of estimated lifetime individual cancer risk. The dependent variable represents the number of people with estimated cancer risk per one million people in a lifetime of 70 years.

Figure 3.1 illustrates a U.S. county-level map of estimated cancer risk from air toxics. The map demonstrates there is a strong concentration of hazards in the southern and coastal areas of the U.S. which is consistent with previous research (Ard 2015).

Figure 3.1 County-Level Averages of Estimated Cancer Risk from Air Toxics per Million Persons



b. Independent Variables

We include a number of independent variables as variables of interest and control variables. Demographic variables of counties come from the 2007-2011 wave of the American Community Survey including percent non-Latinx Black, percent non-citizenship, general economic well-being variables, and Latinx well-being variables. The variables from the U.S. Census and the American Community Survey were Hispanic labeled variables, however, we prefer to use Latinx and will refer to them as Latinx hereon. The general economic well-being and Latinx well-being variables were adopted from Monnat's (2017) study on Latinx destinations and health insurance disparities to control for class indicators at the Latinx-group and general population levels. The general economic well-being measure includes percent below poverty, percent unemployment, percent of adults with a college degree, median household income, and percent renters. The Latinx economic well-being measures include percent Latinxs below poverty, percent Latinx unemployment, percent of adult Latinxs with a college degree, Latinx median household income, and percent Latinx homeownership.

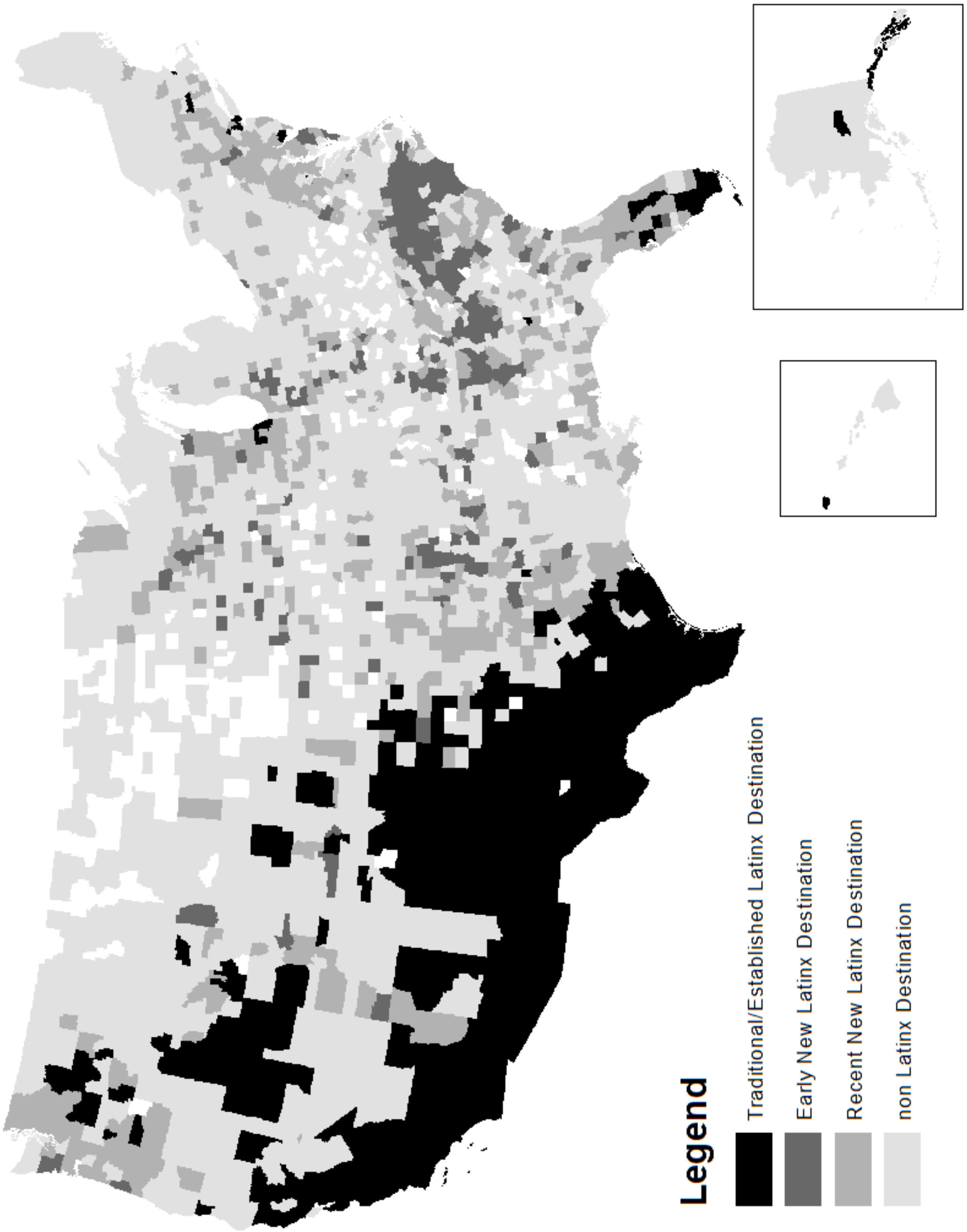
We include economic dependency measures to control for regional economic industries. The economic dependency indicators came from United States Department of Agriculture (USDA) Economic Research Service (USDA ERS 2015) and includes manufacturing, farming, and mining. Additionally, from the USDA Economic Research Service, we use the metro/non-metro indicator. The economic dependency and metro measures were adopted from Monnat (2017) to control for economic dependency and urban/rural at the county level.

c. Defining Destination Categories

We use data from the 1990, 2000, and 2010 decennial U.S. censuses to categorically group counties into four mutually exclusive Latinx destinations based on Latinx population size and growth: established destinations, 1990s early new destinations, 2000s recent new destinations, and nondestinations (see: Monnat 2017). Established destination counties are those with a Latinx population at, or above, the national average in 1990. Early new destinations include counties with a 1990 Latinx population below the national average that experienced at least 150 percent Latinx population growth between 1990 and 2000. Recent new destinations include counties with a 1990 Latinx population below the national average that experienced at least a 150 percent population growth between 1990 and 2010. For both early new and recent new destinations, adjustments were made for smaller counties with populations of less than 20,000. In these cases, counties were classified as early or recent new if their Latinx population exceeded the national average percent of Latinxs in 2000 (12.5 percent) and 2010, respectively (16.3 percent). The remaining counties were defined as nondestination.

In our sample, we had 399 established destinations, 219 early new destinations, 549 recent new destinations, and 1,779 nondestinations. Figure 3.2 illustrates a county-level map of the United States across Latinx destination types. The map illustrates that established destinations were largely located in the southwest. This is consistent with previous research findings in that the southwest is important to Latinx migration particularly to Mexican-descent (Pulido 2017; Saenz, Cready, and Morales 2007). Throughout the United States, there are spatial-temporal changes in Latinx migration and growth due to human capital and political-economic structures (Gouveia and Saenz 2000). In particular, there is a large concentration of early new destinations (growth of Latinxs in 1990s) in North Carolina, South Carolina, and northern sections of Mississippi, Alabama, and Georgia. Researchers have termed this region as the "New Latinx South" (Kochhar, Suro, and Tafoya 2005) and argue Latinxs migrate there to work in manufacturing and construction including meatpacking of poultry and pig processing plants (Haverluk and Trautman 2008). Finally, recent new destinations (growth of Latinxs in 2000) are more dispersed throughout the northwest, midwest, south and northeast.

Figure 3.2 Latinx destination by county



V. Methods

Given the spatial importance of the data and questions, we employ a spatial regression analysis. We use a contingency-based Queen first-order spatial weight that includes all county-neighbors of each county including corner neighbors. The Moran's I of all the variables was statistically significant thereby demonstrating that there is significant spatial dependence among the variables. Spatial econometrics researchers (Rogerson 2010) use a series of tests including Lagrange Multiplier tests statistics to determine which spatial model to employ: spatial error or spatial lag. The two models have similar mathematics but have slight differences. The spatial lag model uses lagged dependent variable while a spatial error model accounts for the influences of unmeasured independent variables by looking at the clustering of error terms. The model diagnostics had more favorable results for spatial lag, therefore we choose to proceed forward with spatial lag models. After running the spatial lagged models, we tested the residuals' Moran's I to assess for the presence of spatial dependence. All residuals of the models had non-significant Moran's I thus concluding that our models have sufficiently controlled for spatial dependence.

VI. Results

Table 3.1 shows the summary differences across destination types of all the variables included in the analyses. In general, there are higher rates of estimated cancer risk for Latinx destinations than nondestinations. Among the disaggregated Latinx destination types, early new destination counties have the highest estimated cancer risk than other destination types at 39.80 people with cancer risk from air toxics per million people followed by 2000s recent new destinations at 36.91, established destinations at

32.34, and nondestination at 31.14. Established destinations have the lowest percent of metro counties, the lowest percent of non-Latinx Black, the highest percent of non-citizenship, the highest percent of poverty, the highest percent of unemployment, the highest percent of renters, the lowest percent of Latinx unemployment, the highest percent of Latinx adults with a college degree, the highest percent of Latinx homeownership, and the lowest economic dependency on manufacturing. Early new destinations have the highest percent of non-Latinx Black, the highest percent of Latinx poverty, the lowest Latinx median household income, and the lowest economic dependency on farming and mining. Recent new destinations have the highest median household income, the highest percent of adults with a college degree, and the highest percent of Latinx adults with a college degree. Nondestinations have the highest percent of metro counties, the lowest percent of non-citizenship, the lowest percent of unemployment, the lowest percent of adults with a college degree, the lowest percent of Latinx unemployment, and the highest dependency on manufacturing, farming, and mining.

Table 3.1 Comparison of Estimated Cancer Risk from Air Toxics and All Independent Variables Across Destination Type

	Established (n=339)	1990s Early New (n=219)	2000s Recent New (n=549)	Nondestination (n=1,779)
estimated cancer risk from air toxics per million	32.35	39.80	36.91	31.14
metro	11.17	11.95	29.67	47.21
% Black, not-Latinx	4.46	14.49	10.13	8.44
% non-citizenship	8.54	5.24	3.66	1.51
General economic conditions				
% below poverty	17.67	16.31	14.13	15.68
% unemployment	31.22	29.83	28.26	25.74
% adults aged ≥ 25 with 4-year college degree	19.73	21.99	23.43	18.11
median household income	$46,382.25	$46,547.16	$51,058.34	$44,043.49
% renters	31.22	29.83	28.26	25.74
Latinx general economic conditions				
% Latinx below poverty	25.31	32.16	27.36	27.16
% Latinx unemployment	3.33	4.47	4.21	4.07
% Latinx adults aged ≥ 25 with 4-year college degree	7.86	9.31	13.03	11.95
Latinx medan household income	$38,201.11	$35,797.69	$40,857.81	$39,973.62
% Latinx homeownership	59.76	45.94	49.17	52.64
Economic dependency type				
manufacturing dependent	3.48	15.54	19.22	61.76
farming dependent	21.08	0.00	4.88	74.04
mining dependent	29.44	2.16	11.26	57.14

Figure 3.3 is a county-level map showing the strong overlap of Latinx destination counties and counties with an estimated cancer risk for air toxics above the national average. The majority of these counties are located in the southern and coastal regions of the country. Table 3.2 evaluates the environmental inequality hypothesis (H1) with a spatial lag model by comparing estimated cancer risk between all Latinx destinations and nondestinations. Results show Latinx destination counties have significantly higher estimated cancer risk from air toxics than nondestination counties even when controlling for economic wellbeing indicators among the general and Latinx-specific populations. Thus Table 2 supports the environmental inequality hypothesis (H1) demonstrating that counties at or above the 1990 national Latinx average (established destinations) and those that have since 1990 experienced significant Latinx growth (early new and recent new destinations), have higher cancer risk from air toxics than counties with a Latinx population below the national average (nondestinations). Now, we move to examine H2.

Figure 3.3 Estimated cancer risk in Latinx destinations by county

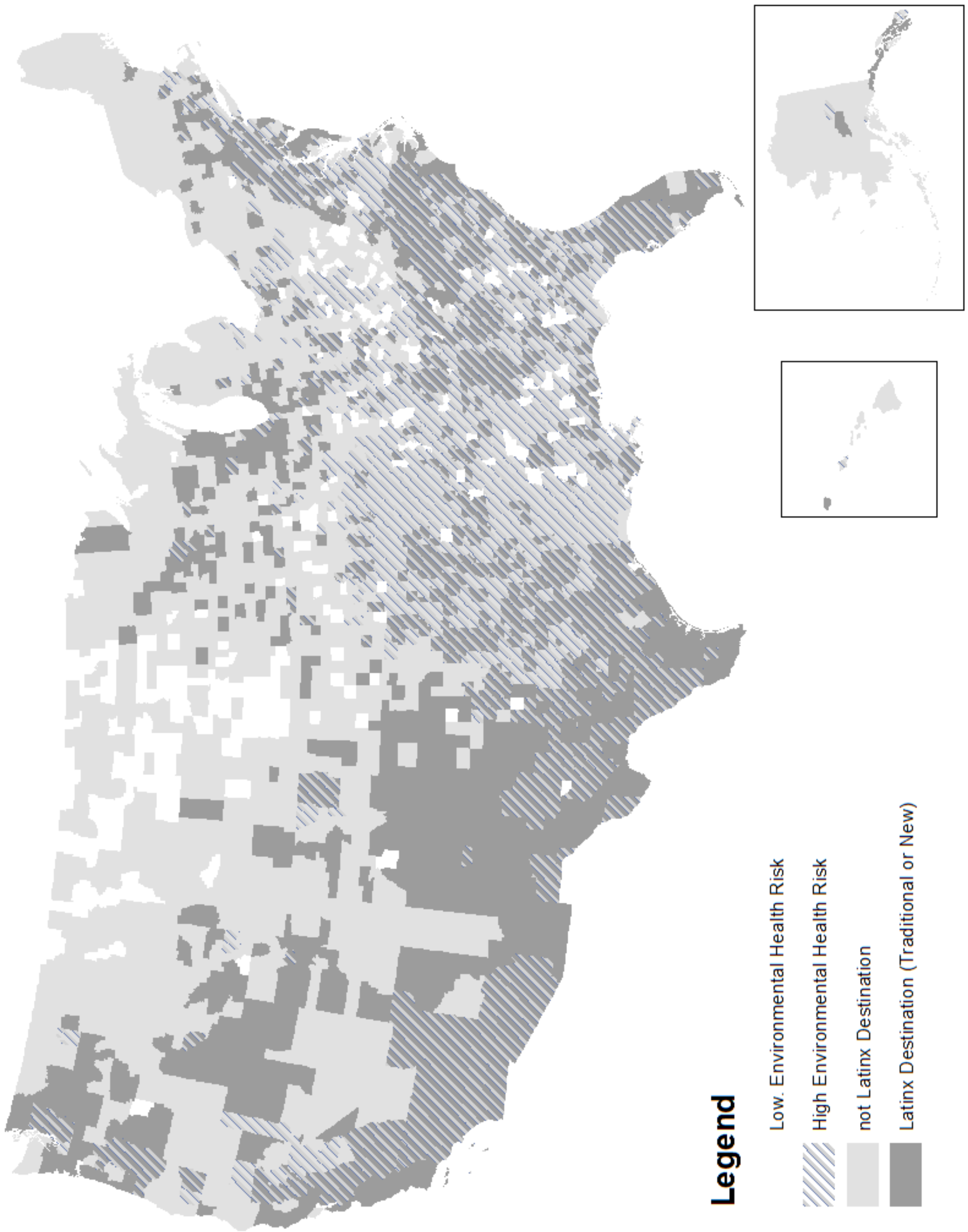


Table 3.2 Spatial Lag Regression with 1st Order Queen Spatial Weight of County-Level Estimated Cancer Risk From Air Toxics Between All Latinx Destinations Versus Nondestinations

	b (SE)
destination	0.579 (0.269)*
metro	2.319 (0.260)***
% non-Latinx Black	0.128 (0.013)***
% non-citizenship	0.152 (0.037)***
General economic conditions	
% below poverty	-0.035 (0.037)
% unemployment	-0.134 (0.070)
% adults aged ≥ 25 with 4-year college degree	0.075 (0.022)***
median household income	0.000 (0.000)
% renters	0.155 (0.021)***
Latinx general economic conditions	
% Latinx below poverty	0.006 (0.008)
% Latinx unemployment	0.602 (0.131)***
% Latinx adults aged ≥ 25 with 4-year college degree	0.002 (0.011)
Latinx median household income	0.000 (0.000)
% Latinx homeownership	0.010 (0.005)
Economic dependency type	
manufacturing	0.687 (0.293)*
farming	-1.978 (0.349)***
mining	0.331 (0.421)
constant	12.199 (1.613)***
spatial lag	0.526***
R^2	0.755
log likelihood	-9015.67
AIC	18169.3

Notes: N = 2,886 counties. All models include state dummies to control for spatial autocorrelation. Excludes counties with any independent missing values. *p<.05; **p<.01; ***p<.001; two-tailed tests

To examine H1 further, we disaggregate Latinx destinations to assess if there are significant differences among Latinx destination types. Table 3.3 shows the results of the spatial lag models for the disaggregated Latinx destination types and tests the spatial assimilation hypothesis (H2). Model 1 is the null model with only the main variables of interest. Here, early new and recent new Latinx destinations are both positive and significant thus showing early new and recent new Latinx destinations have higher estimated cancer risk than established Latinx destinations and nondestinations. As expected, metropolitan status, percent of non-Latinx Blacks, and percent of non-citizenship have higher significant risk. Model 1 does not support the spatial assimilation hypothesis (H2) because early new and recent new destinations have higher estimated cancer risk than established destinations and nondestinations. Spatial assimilation theory assumes that Latinxs collectively as a racial/ethnic minority group should overtime accrue economic resources and human capital that would translate into more favorable residential outcomes, in our case, less environmental hazard. We find an opposite relationship; counties with early new and recent new Latinx destinations have higher estimated cancer risk than established Latinx destinations and nondestinations.

Table 3.3 Spatial Lag Regression with Queen 1st Order Spatial Weight of County-Level Estimated Cancer Risk from Air Toxics Across All Destination Types

	Model 1 null model b (SE)	Model 2 general economic model b (SE)
destination type (established = reference)		
1990s early new destination	2.662 (0.621)***	2.477 (0.613)***
2000s recent new destination	1.898 (.0522)***	1.813 (0.518)***
nondestination	0.509 (0.516)	0.959 (0.509)
metro	2.937 (0.236)***	2.371 (0.258)***
% non-Latino Black	0.149 (0.011)***	0.100 (0.012)***
% non-citizenship	0.266 (0.036)***	0.167 (0.038)***
General economic conditions		
% below poverty		-0.059 (0.036)
% unemployment		0.140 (0.049)**
% adults aged ≥ 25 with 4-year college degree		0.061 (0.020)**
median household income		0.000 (0.000)
% renters		0.173 (0.020)***
Latino general economic conditions		
% Latino below poverty		
% Latino unemployment		
% Latino adults aged ≥ 25 with 4-year college degree		
Latino median household income		
% Latino homeownership		
Economic dependency type		
manufacturing		
farming		
mining		
constant	16.161 (1.201)***	11.617 (1.627)***
spatial lag	0.525***	0.532***
R^2	0.737	0.75
log likelihood	-9116.05	-9044.99
AIC	18348.1	18216

Table 3.3 Spatial Lag Regression with Queen 1st Order Spatial Weight Analysis of County-Level Estimated Cancer Risk from Air Toxics and Disaggregated Destination Types (continued)

	Model 3 Latino economic well-being model b (SE)	Model 4 full model b (SE)
destination type (established = reference)		
1990s early new destination	2.237 (0.615)***	1.761 (0.617)**
2000s recent new destination	1.612 (0.520)**	1.278 (0.520)*
nondestination	0.824 (0.509)	0.595 (0.508)
metro	2.232 (0.260)***	2.299 (0.260)***
% non-Latino Black	0.125 (0.013)***	0.126 (0.013)***
% non-citizenship	0.175 (0.038)***	0.172 (0.038)***
General economic conditions		
% below poverty	-0.028 (0.038)	-0.031 (0.037)
% unemployment	-0.114 (0.071)	-0.124 (0.070)
% adults aged ≥ 25 with 4-year college degree	0.062 (0.021)**	0.066 (0.022)**
median household income	0.000 (0.000)	0.000 (0.000)
% renters	0.175 (0.021)***	0.160 (0.021)***
Latino general economic conditions		
% Latino below poverty	0.005 (0.008)	0.005 (0.008)
% Latino unemployment	0.645 (0.130)***	0.570 (0.131)***
% Latino adults aged ≥ 25 with 4-year college degree	0.006 (0.011)	0.003 (0.011)
Latino median household income	0.000 (0.000)	0.000 (0.000)
% Latino homeownership	0.011 (0.005)*	0.010 (0.005)
Economic dependency type		
manufacturing		0.624 (0.294)*
farming		-1.874 (0.350)***
mining		0.316 (0.420)
constant	9.860 (1.686)***	11.454 (1.709)***
spatial lag	0.529***	0.524***
R^2	0.753	0.755
log likelihood	-9029.83	-9011.36
AIC	18195.7	18164.7

Notes: N = 2,886 counties. All models include state dummies to control for spatial autocorrelation. Excludes counties with any independent missing values. *p<.05; **p<.01; ***p<.001; two-tailed tests

Previous environmental inequality literature stresses the importance of class indicators on hazard exposure (Taylor 2014), thus Model 2 includes control variables measuring county-wide general economic well-being. In Model 2, significant variables from Model 1 remain significant. We find that percent of unemployment, percent of adults with a college degree, and percent of renters are all significant. Percent of poverty and median household income were not found to be significant. Overall, most of the general economic well-being measures indicate--with the exception of poverty rates and median household income--that higher percent of unemployment, lower percent of adults with a college degree, and higher percent of renters indicate higher countywide estimated cancer risk from air toxics.

Model 3 includes Latinx-specific economic well-being measures to assess whether risk remains significant when controlling for Latinx economic wellbeing. Within Model 3, only percent of Latinx unemployment and percent of Latinx homeownership were found to be significant, thus showing that counties with higher percent of Latinx unemployment and higher percent of Latinx homeownership have higher estimated cancer risk. Percent of Latinx poverty, percent of Latinx adults with a college degree, and Latinx median household income are not found to be significant. Within the general economic well-being measures, only percent of adults with a college degree and percent of renters remain significant thus indicating that counties with higher percent of adults with a college degree and higher percent of renters experience cancer risk higher than the national average. Destination type, percent of non-Latinx Blacks, and percent of non-citizenship remain highly significant throughout all the models.

Finally, Model 4 represents the full saturated model and includes economic dependency measurements for manufacturing, farming, and mining. Interestingly, the addition of the economic dependency measurements shrinks the destination coefficients from Model 3 to Model 4 nonetheless the destination coefficients remain statistically significant. Counties that are manufacturing dependent have higher significant cancer risk from air toxics and counties that are farming dependent have lower cancer risk from air toxics. The significance from previous models remains robust with the exception of percent of Latinx homeownership.

VII. Discussion & Conclusion

Our findings demonstrate that environmental hazards vary among Latinx growth waves as early new (1990s) and recent new (2000s) destinations have higher estimated cancer risk than established Latinx destinations and nondestinations. These results add an important nuance to the traditional environmental inequality framework: it is not simply that environmental risk is located in all counties with a Latinx population greater than the national average. Rather, that the location of environmental inequality varies based on waves of Latinx growth and Latinx destination type. Finally, the findings contribute to the emerging research focus on Latinx-specific indicators of environmental hazards by focusing on the role of Latinx destinations and the location of environmental risk (Collins et al. 2011; Grineski et al. 2011).

Waves of Latinx migration have corresponding political-economic contexts that shape inequality processes (Gouveia and Saenz 2000). As discussed by Monnat (2017), there are distinct socioeconomic, labor market, and geographic differences between the faster-growing, early new Latinx destinations and more new recent, slower-growing

Latinx destinations. In order to examine the differences between these destination types, we use the categories previously discussed: established destination, early new destination, new recent destination, and nondestination. Based on county-wide Latinx growth varying in time, we find that new destinations in the 1990s and 2000s have higher cancer risk than established and nondestinations. These findings remain consistent when controlling for general economic wellbeing indicators for the county general population and Latinx population. Out of all the control variables, economic dependency indicators have the largest effect on the destination coefficients nonetheless the destination coefficients remain significant. Thus highlighting the important role of Latinx destinations even when controlling for class and industry-dependency. This shows that the push and pull of migration are subsequently locating Latinxs into counties with greater estimated cancer risk. Previous research (Kochhar et al. 2005; Haverluk and Trautman 2008) notes that counties with high Latinx growth in 1990s and 2000s are economically dependent on manufacturing and agriculture, industries that contribute to air pollution.

According to contemporary theories of spatial assimilation, spatial distribution results from group-level characteristics and human capital (Massey 1985). Following this reasoning, because Latinxs have a longer residential history in the United States, if spatial assimilation theory is correct, the geographic mobility associated with increases in human capital will translate into Latinx population growth in counties outside of traditional ethnic enclaves such as traditional destination. This geographic mobility means access to services and resources, more opportunities, and less exposure to environmental hazards. While we do find that Latinx recent new destinations have higher proportion of educational attainment and household income than 1990s early new destinations, these counties continue to experience statistically significant levels of estimated cancer risk from air toxics. While the risk is less than 1990s early new destinations, it is larger than the risk in established destinations. Our examination of estimated cancer risk of air toxics contradict the assumed pattern of spatial assimilation: as Latinxs collectively increase in human capital (i.e. educational attainment) and income and migrate from established destinations to new destinations, they move to counties with higher estimated cancer risk relative to established destinations and nondestinations. We argue that, while increases in group-level income and human capital may increase migration to new destinations, the political and economic forces contributing to this migration relocates Latinxs to counties with environmental hazards absent in established destinations. As previously discussed, new Latinx destinations typically lack the existing infrastructure that accompanies established ethnic enclaves. Furthermore, new Latinx destinations are more economically dependent on major air polluters industries such as manufacturing. The increased exposure to environmental hazards we document in new destinations, paired with lack of established networks of community-support, leaves these areas without avenues to address this manifestation of environmental inequality.

While this project presents an important contribution to existing dialogue, it is not without limitations. In response, we hope to spark future research linking migration, assimilation, and environmental inequality. Future research should extend the analysis to different toxics and other forms of environmental hazards and environmental privileges across destination type. Furthermore, future research can build on the current analysis by comparing hazard exposure and migration within- and between-counties. From a regulatory perspective, future research should examine state and EPA regional policies that impact air toxics distribution. Finally, qualitative research can also provide an examination of differences in community-level and Latinx-specific responses to environmental inequality across Latinx destinations.

CHAPTER IV

INTERSECTIONAL ENVIRONMENTAL JUSTICE AND POPULATION HEALTH INEQUALITIES: A NOVEL APPROACH

This chapter contains unpublished co-authored material with Dr. Clare Rosenfeld Evans. I initialed the idea of applying Dr. Evans et al. (2017) multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA) methodology to geographical census tracts to examine intersectional neighborhood environmental health disparities. I wrote the data and methods section. My co-author and I wrote the literature review, introduction, and conclusion. I gathered and cleaned the data. I ran the models to find the results. My co-author and I analyzed the results.

I. Introduction

Poor and racial/ethnic minority communities are often disproportionately exposed to numerous sources of environmental health hazards (Lerner 2010; Nixon 2011; Taylor 2014). Often labeled as "fenceline" communities or "sacrifice zones" (Lerner 2010), the health of residents in these neighborhoods is undervalued in pursuit of the production, resource extraction, and waste management demanded in the capitalist, modern world (Pulido 2017; Pellow 2018). This concentration of hazards in certain communities is recognized as a key mechanism in the social production of health inequalities along racial/ethnic and class lines (Institute of Medicine Committee on Environmental Justice 1999; Krieger 1994; Krieger 2011), as well as of geospatial inequalities in health (Pearce 2010). Environmental justice, as both a social movement and a research agenda, was sparked in response to this institutionalize treatment of marginalized communities. Environmental injustices happen intersectionality meaning that disparate outcomes are produced through interlocking systems of power and place (Crenshaw 1991; Collins [2000] 2009; Ducre 2012; Ducre 2018). Historically, intersectional environmental justice research has relied heavily on powerful case studies to document the injustices taking place (Collins et al. 2011; Sicotte 2013; Grineski, Collins, and Chakraborty 2013; McKane 2018). At least in part this is due to a desire to distinguish the local particularities of the environmental hazards. As Lerner observed in *Sacrifice Zones*, "communities in which environmental quality is good have much in common…while the contaminated ones are each distressed in their own special ways" (Lerner 2010, p.7). While this approach is valuable for its specificity, as well as its power in humanizing abstract processes, it has the unfortunate side effect of making it appear that these cases may be exceptions rather than the norm in communities across the country. Environmental justice scholarship that makes use of national data sources and attempts to document the systematic, ubiquitous nature of these injustices have typically opted either to focus on whether the issue is "really" one of racism or classism/socioeconomic inequality (Mohai and Bryant 1992; Anderton et al. 1994), or else have embraced an additive framework that considers both separately (Ash et al. 2013; Zwickl, Ash, and Boyce. 2014). Neglected in explicit terms, though occasionally alluded to implicitly (Malin and Ryder 2018), is the issue of the intersectional nature of this discrimination. These gaps in the literature on environmental justice center on two key questions: To what extent are some communities disproportionately burdened by environmental health hazards across the entire United States? And, are these structural forms of environmental injustice intersectional?

Intersectional scholars have long implicated structural- and institutional-level social processes in the production of intersectional experiences and intersectionally patterned outcomes (Creshaw 1989; Collins [2000] 2009; McCall 2005; May 2015). Intersectionality's concordance with theories of the social determinants of health, including social production/political economy of health (Doyal 1981), fundamental causes (Link and Phelan 1995; Phelan and Link 2015), and ecosocial theory (Krieger 1994; 2011), has contributed to its growing use in studies of population health inequalities (Warner and Brown. 2011; Bauer 2014; Green, Evans, and Subramanism 2017; Evans et al. 2018). However, while the mechanisms producing environmental health risks operate at the level of neighborhoods or communities, much of the intersectional health inequalities literature focuses on the effects of these processes on individual-level outcomes. In recognition of this, the field has increasingly called for greater attention to structural-level processes in order to explain the observed social and geospatial patterning of inequalities, as well as for methodological innovations that will enable this (McCall 2005; Nash 2008; Bauer 2014; Evans 2019).

In this chapter, we address these key questions and advance a novel analytic approach: Eco-Intersectional Multilevel (EIM) Modeling. This approach explicitly draws on the traditions of environmental justice, intersectionality and social determinants of health for its framing and interpretation. An eco-intersectional multilevel approach treats neighborhoods as the primary unit of analysis, with the intersectional nature of these places measured using multiple axes of demographic and urbanization characteristics. In this treatment, we explicitly recognize that place is racialized (Lipsitz 2011; Ducre 2012), gendered (Hayden 2003), classed, and urbanized (Wacquant 2016). Nesting census tracts in the United States within intersectional neighborhood social strata defined by racial/ethnic composition, percent female headed households, educational attainment, median household income level, and metro/non-metro, and combining data from the American Community Survey and the EPA's 2014 National Air Toxics Assessment of cancer risk from air toxics, we demonstrate a novel approach for estimating the intersectional effects of environmental health hazards across over 72,000 census tracts within the United States.

Our results tell an intersectional national story of census tracts with higher percentages of Black and Latinx, higher percentage of single mothers, lower percentage of educational attainment privileges, and located within a metro area have the highest rates of estimated cancer risk from air toxics. The expendability of these communities is connected to the intersectional privilege of neighborhood with higher percentage of white, lower percentage of single mothers, higher educational attainment, and not located within a metro area having lower environmental health risk. These results mirror findings from previous case studies, while generalizing those results to national-level patterns. Our findings are robust to exclusion of outlier census tracts with particularly high estimated cancer risk. EIM is an innovative and promising approach for examining geospatial, intersectional inequalities that re-emphasizes the structural nature of the processes involved in constructing risks to population and environmental health.

II. Theoretical Orientation

At least three distinct scholarly traditions have converged on the issue of inequalities in environmental health threats, and so we explicitly position our present work within these: environmental justice, intersectionality, and the social determinants of population health inequalities. Our use of these approaches naturally orients us toward a critical perspective on the placement of environmental hazards.

a. Environmental Justice

Environmental justice research arose with the environmental justice movement which aims to address the gaps of the mainstream environmental movement by focusing on issues around of public health, workplace safety, and environmental inequalities (Taylor 2014; Mohai, Pellow, and Roberts 2009). Central to the struggle against environmental injustices is to demonstrate the overlap of hazards in communities of color, Indigenous, and low-income also referred to as environmental disparities. Over the last decades, environmental justice research has published hundreds of studies evidencing hazard and privilege disparities (Taylor 2014), beginning with the landmark study *Toxic Wastes and Race in the United States* (Chavis 1987). While environmental justice research encompasses many types of research and topics, classical environmental justice studies has focused on debates of race versus class and minority-move in versus facility sitting (Brulle and Pellow 2006). The race versus class debate is centered on whether environmental racism is conflated with class and thus environmental racism can be explained through socio-economic forces (Anderton et al. 1994; Bowen 2002) arguing in other words, environmental discrimination is based on poverty instead of racial bias.

In a meta-analysis of sixteen studies, Mohai and Bryant (1992) found race to have a stronger effect than poverty on environmental hazards. In more recent research, scholars acknowledge the importance of race and class, but are limited in quantitative research approaches of additive and interaction terms (Ash et al. 2013). For example, Zwickl et al. (2014) find regional differences in air toxic exposure across racial and economic dimensions and they demonstrate there is a larger exposure gap among Blacks and Latinxs in lower economic areas than in higher economic areas by employing various discrete fixed effects models and comparing them. These scholars are explaining intersectional effects but are limited to traditional analyses of fixed effect models. Similarly, the other popular debate in environmental racism is known as the chicken and egg debate which discusses who came first?: the hazardous facilities or marginalized communities. Similar to the "race versus class" discussion, the chicken and egg debate emphasizes the role of racial bias and market-forces. It focuses on whether disproportional sittings is explained through either hazardous facilities go to areas with lower property values or less socio-political capital; or historically less privileged communities across racial and economic dimensions "move-in" to locations with lower property values (Been and Gupta 1997). This debate overlooks that overlapping push and pull factors of residency and hazardous placement that include governmental policies and the economy. Recent calls from critical environmental justice research calls for further incorporation of examining various overlapping systems of oppressions such as intersectionality theory (Malin and Ryder 2018; Pellow 2018). We build on calls from critical environmental justice studies to move pass these classical debates and re-focus environmental justice issues by focusing on multi-dimensional or intersectional dimensions of environmental injustices (Pellow and Brulle 2005; Pellow 2016; Pellow 2018). Environmental justice research has traditionally emphasizes place level factors such as the neighborhood or community level due to the geographical nature of environmental hazards (Ducre 2012). Here, we are extending the field environmental justice into intersectionality and population health to explicitly focus on the social processes at the community level.

b. Intersectionality

Intersectionality is a theoretical framework originating in Black feminist scholarship (Crenshaw 1991; Collins [2000] 2009) that draws attention to the interlocking, mutually constituted nature of systems of oppression and privilege such as racism, sexism, and socioeconomic inequality (Hancock 2007; Choo and Ferree 2010; May 2015). Intersectionality examines overlapping oppression and privileges at a variety of levels from the individual to the structural, emphasizing the interconnection between them. Intended originally as a mechanism for critiquing single-axis modes of thought that focused on race(ism) and gender/sex(sim) as separate axes of marginalization, thus rendering invisible the experiences of multiply marginalized populations such as Black women, intersectional scholarship today has expanded to encompass a variety of approaches, all unified by this original critical perspective. In her oft-sighted work, McCall (2005) identifies three major approaches to intersectionality: the anti-categorical, the intracategorical, and the intercategorical. Anti-categorical approaches focus on the "deconstruct[ion] of analytical categories" while intracategorical approaches "focus on particular social groups at neglected points of intersection…in order to reveal the complexity of lived experience within such groups" (McCall 2005:1773-4). Intercategorical approaches, on the other hand, are typically quantitative and involve "provisionally adopt[ing] existing analytical categories to document relationships of inequality" (McCall 2005:1773).

Concerns have emerged about whether intersectionality should (or even can) be evaluated quantitatively (Hancock 2013; Bauer 2014; May 2015). Of particular concern has been the tendency to construct *atheoretical* descriptive exercises that lose track of the social processes and systems of power at work across multiple ecological levels in generating observed inequalities (May 2015; Evans 2019). As May (2015) argues, this treatment of intersectionally serves to "flatten its complex vision" and "blunt its critical edge and transformative aims" (141). Intersectional studies of intercategorical inequalities have tended to document outcomes at the individual level, whereas the processes generating these inequalities frequently lie at higher levels. For instance, in her seminal work ***Black Feminist Thought***, Collins stressed the importance of structural factors to intersectionality: “Moreover, the institutionalized racism that African-American women encounter relies heavily on racial segregation and accompanying discriminatory practices designed to deny U.S. Blacks equitable treatment” (Collins [2000] 2008:26). An important future direction for the field is the development of intercategorical methods that will enable analytic attention to be directed to structural-level processes.

c. Social Determinants of Population Health Inequalities

Population health is an interdisciplinary area of research focused on addressing the social determinants of unequal distributions of health and illness in society. In sociology this focus on population health dates back to works of some of the earliest sociologists, including Emile Durkheim, Erving Goffman, and Talcott Parsons. Key theories that have emerged in the field today include social production/political economy of health (Doyal 1981), fundamental causes (Link and Phelan 1995; Phelan and Link 2015), and ecosocial theory (Krieger 1994; 2011REF). We focus on Krieger’s ecosocial theory because it is arguably the broadest and most comprehensive of them, interweaving these approaches with others, such as theories of psychosocial stress-response pathways, and addressing many of their limitations in scope (Krieger 2001; 2011). Ecosocial theory asks “Who and what drives current and changing patterns of social inequalities in health?” (Krieger 1994). *Embodiment* is one of the core constructs of ecosocial theory, which refers in this context “to how we literally incorporate, biologically, in societal and ecological context, the material and social world in which we live" (Krieger 2011:214). Relevant social determinants of health have been identified across numerous ecological levels, but particularly concerning are those that operate at structural/institutional levels (Krieger 2011; Bauer 2014). This includes processes involved in determining the placement of environmental hazards in communities. Krieger identifies exposure to exogenous hazards, including toxic substances and hazardous conditions, as one of the key pathways through which embodiment occurs and health inequalities are generated.

A rich area of research in population health concerns the geospatial patterning of health risks and adverse outcomes, including a broad literature on neighborhoods and health (Kawachi, Ichiro and Lisa F. Berkman. 2003). Multilevel (random effects) models (Leyland and Goldstein 2001) and spatial approaches such as GIS (Pfeiffer et al. 2008) are frequently used in this area of work. Such approaches are adept at identifying that inequalities exist across geographical spaces, or in other words, that clustering or "hotspots" of risk occur. However, the linking of these spatial inequalities to social determinants such as residential segregation by race/ethnicity or socioeconomic status have tended to address these axes of marginalization in additive, rather than intersectional terms (Willliams and Sternthal 2012). Furthermore, these studies often examine the spatial patterning of health outcomes measured at the individual-level. The role of mediating processes in producing the observed outcomes, such as the presence of emissions sources, is rarely included in the analyses.

Intercategorical intersectionality is rapidly becoming a popular framework in the study of population health (Bauer 2014; Green et al. 2017; Evans et al. 2018). As in intersectional scholarship in general, more descriptive applications have had the unfortunately tendency to be atheoretical in orientation (Bauer 2014). However, there is a natural congruence between intersectionality and theories of population health. For instance, ecosocial theory and intersectionality are highly compatible (Evans 2019), and their joint use helps to ensure that the critical edge of intersectional thought is not lost in translation when it is applied to population health. Increasingly, scholars have called not just for greater theoretical and critical engagement with intersectional theory, but also for new approaches that will enable the modeling of social processes generating these inequalities (Bauer 2014).

Recent quantitative methodological advancements in intercategorical intersectional methods have improved on conventional interaction models, including classification tree approaches, mediation analyses using decomposition techniques, and intersectional Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy (intersectional MAIHDA) (Evans et al. 2018). This literature is rapidly developing, and holds considerable promise for answering calls in environmental justice, intersectionality, and population health scholarship for approaches that integrate the shared concerns of these fields.

d. A Brief Note on Terminology

Because of the complexity of interweaving these rich literatures, we pause briefly to offer a note on terminology. While a variety of terms have emerged to describe the environmental injustices inflicted on marginalized communities and the social resistance organized to contest this treatment, we have found that no single term is sufficient to adequately capture all aspects of meaning we might wish to evoke. Though we make use of terms such as “environmental risk” and “environmental hazards” in order to refer with specificity to the physical presence of health-harming substances or industries in proximity to human bodies, these terms are agnostic to the social construction of these risks through the operation of interlocking systems of power, privilege, marginalization, and inequality.

The term “environmental racism” has gained prominence because of its clarity in implicating the structural and institutional nature of racial discrimination, the mechanisms at work in perpetrated this discrimination (placement of environmental hazards) and the target of this discrimination (racial/ethnic minorities). Furthermore, the term recognizes that environmental risk is *inflicted* by society on minority populations, even if individual culprits cannot be identified (Pulido 2016), through choices about zoning laws and emissions regulations. However, the term also inevitably provokes disagreement around the prominence given to race over class (e.g., “environmental classism”) (Nixon 2011), overlooks other potentially relevant dimensions of marginalization such as the concentration of gendered family structures (e.g., single-mother families) (Ducre 2012), and fails to highlight the intersectional nature of this discrimination.

“Environmental justice” is non-attributional with respect to axes of marginalization, and therefore serves intersectional purposes as well as single-axis ones. It also nicely highlights the positive framing of the issue, bringing to mind concepts such as social capital and cohesion, community organizing and resistance, and social justice. In doing so it also implies the existence of perpetrator(s) of injustice. On the other hand, environmental justice describes the goal of organized resistance against the injustices being perpetrated, not the injustice itself. The existence of an injustice does not imply that resistance naturally springs into existence.

Terms such as “environmental trauma” and “ecological trauma” are evocative though less frequently encountered. They serve to describe both the *action* of inflicting the trauma (implying, therefore, that someone or something is doing the inflicting) and the effect of the action on communities. The terms also resonate with related literatures on historical traumas (Brulle and Norgaard. 2019) and the pathways through which traumas, past and present, become embodied.

We fully recognize the complexity of meanings attached to these terms, and will at times alternate between them while acknowledging their individual advantages and short-comings. In introducing the term “eco-intersectionality” to describing the analytic approach we propose, we are well aware that this may be deemed unnecessary by intersectional scholars. As noted previously, intersectionality has long focused on the structural, institutional and ecological-level processes involved in the production of intersectionally patterned discrimination, experiences, and outcomes. Why, then, the new term? We introduce this term in order to differentiate our modeling approach from analyses of individual-level data, such as the emerging MAIHDA approach (Multilevel Analysis of Individual Heterogeneity and Discriminatory Accuracy) (Evans et al. 2018). We acknowledge and stress, however, that we are merely applying intersectional theory to an ecological and multilevel analysis framework, not inventing a new form of intersectional theorizing.

III. Toward an Eco-Intersectional Multilevel Perspective

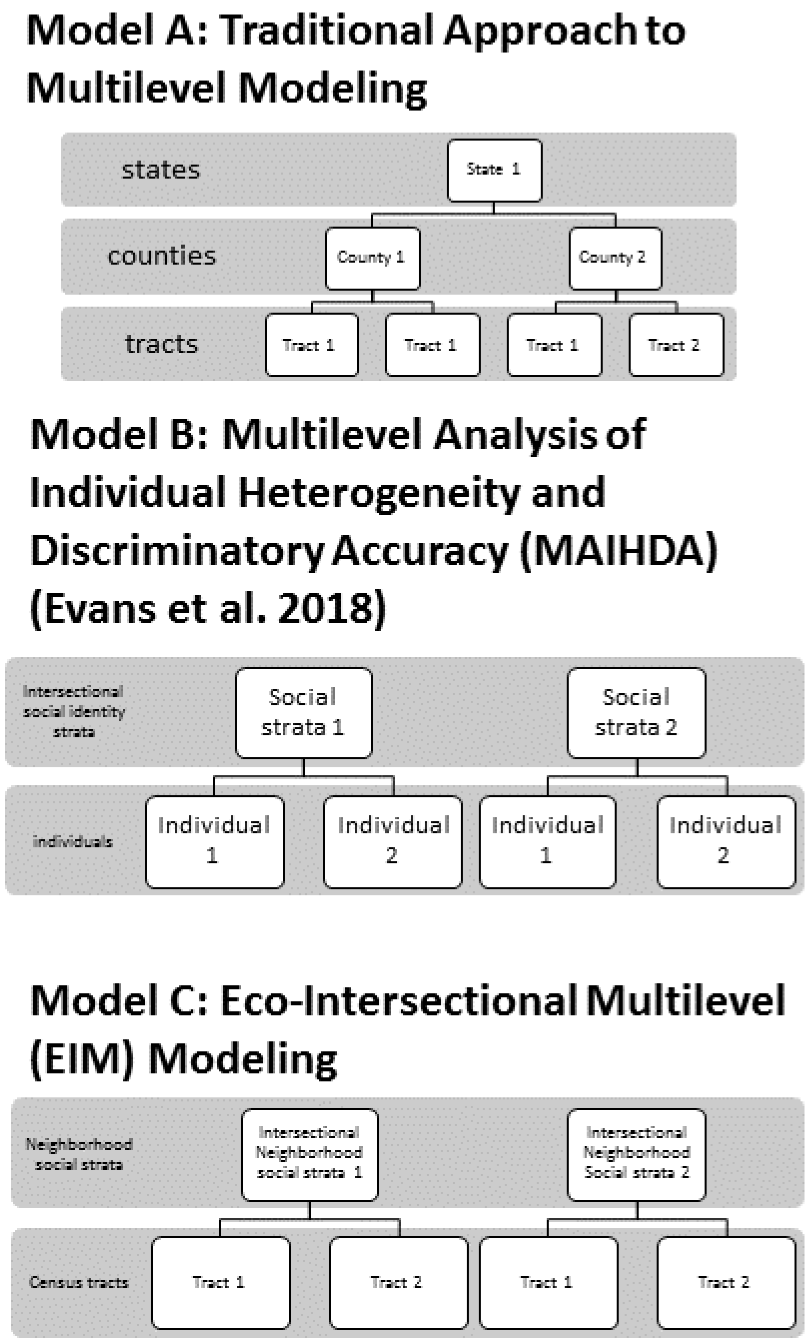
Scholars in environmental justice, intersectionality, and population health have called for new analytic approaches which will enable modeling of social processes that generate environmental threats to population health and distribute these threats unequally across society. In this study we advance an eco-intersectional multilevel (EIM) modeling approach to examine intersectional experiences of environmental injustice at the community level.

While most intercategorical intersectional analyses treat individuals as the unit of analysis, an eco-intersectional multilevel approach treats neighborhoods (or similar communities) as the unit of analysis. When addressing environmental threats this shift in unit of analysis is sensible, because it is the community level at which exposure is determined. While individuals who are multiply marginalized may be more likely to experience these hazards on average and may be less likely to deal with the adverse consequences of exposure once it occurs, the mechanisms at work do not operate in such a way that they selectively target individuals. If a community is multiply (intersectionally) marginalized, discriminated against (or at least not the recipients of public concern), under-resourced, low in available time for mobilizing, and/or lacking in power/social capital, then this can result in harmful production and other environmental health hazards in their communities. Furthermore, having less social and political capital makes it more difficult for residents to push back against the construction of new hazards in their communities and makes it difficult to organize to remove or mitigate existing threats (Taylor 2014). The end result is residents in these communities being disproportionately exposed to externalities from production, waste treatment, or other hazardous processes. Along those same lines, those same structural mechanisms creating disadvantage are formed through privileging communities based on racialized, classed, and gendered systems of power (Pulido 2000).

Thus, rather than examining intersections between aspects of identity, social position, or resources measured at the individual level, such as gender, race/ethnicity, or socioeconomic status, the EIM framework addresses axes of marginalization at the neighborhood/community level. These might include racial/ethnic composition, percent female headed households, educational attainment, median household income level, and metro/non-metro locale.

EIM builds on the recent innovation in intercategorical intersectional methods known as intersectional MAIHDA (Evans et al. 2018). Figure 4.1 compares the unit of analysis and nesting structure of traditional multilevel modeling, MAIHDA, and EIM. Traditional multilevel modeling would cluster unit of analyses in administrative groups (e.g. administrative geographic boundaries). An example of this is nesting census tracts (level 1) within census counties (level 2) within states (level 3) (Model A in Figure 4.1). Intersectional MAIHDA (Model B in Figure 4.1) involves nesting individual respondents (level 1) within intersectional social strata (level 2) defined by categorizations of gender, race/ethnicity, socioeconomic status, sexual identification, and other axes of marginalization or inequality. We expand the MAIHDA approach from the individual-level to the census tract-level. Statistically, EIM modeling (Model C in Figure 4.1) nests census tracts (level 1) within intersectional neighborhood strata of census tracts (level 2). Whereas conventional multilevel approaches enable us to examine the extent to which geographic units vary with respect to risk levels, the EIM approach enables us to examine the extent to which different *types* of communities, defined in intersectional terms, vary with respect to risk levels.

Figure 4.1 Comparison of Multilevel Modeling Approaches



While the unit of analysis in the EIM approach is that of neighborhoods (or communities), it is also essential to recognize that these are but a single level embedded within a multilevel framework of interacting ecological levels, and that consequently they are shaped by processes at other levels, including policies, programs, economies, and social movements at the city-, state-, national-, and international-levels. The placement of environmental hazards in particular locales is thus shaped not only by decision making processes within organizations, but also by factors such as the cost of land, city-level zoning laws, and national/state laws governing the behavior of polluters. The present analysis is concerned with documenting the environmental health inequalities that are the end result of processes operating across all ecological levels.

The eco-intersectional multilevel approach answers calls from scholars in critical environmental justice (Pellow 2018), intersectionality (May 2015), and population health (Evans 2019) for innovative methods capable to modeling the complex, multilevel and intersectional nature of social processes creating threats to the health of residents in fenceline communities and other "sacrifice zones." The EIM approach: (1) brings intersectional methods into greater alignment with theory by re-emphasizing the role of the community/structural level; (2) provides a new perspective on geospatial and social patterns of health inequalities; (3) expands on current efforts in the environmental justice literature to more explicitly incorporate intersectional theorizing; and (4) it generalizes questions examined previously in case studies to test whether multiply marginalized communities are systematically exposed to excess environmental threats across the United States.

IV. Data

The National Air Toxics Assessment (NATA) is a “state of the science screening” for national air quality by the Environmental Protection Agency (EPA) (Office of Air Quality Planning and Standards 2018). Over the past two decades, the EPA has produced six reports for the years: 1996, 1999, 2002, 2005, 2011, and 2014. The purpose of NATA is to evaluate and identify air toxics to human health by reporting estimates air quality and human health risks for the entire U.S. down to the census tract level. The EPA produces NATA reports in rigorous multi-stage manner. The first step is to create National Emissions Inventory (NEI) starting by compiling an inventory of 181 air toxics including those from the Clean Air and Water Act such as benzene, formaldehyde and acrolein, diesel particulate matter. The NEI consist of air toxics from the sources of point, nonpoint, onroad, nonroad, fires, biogenics, secondary, and background. In order to estimate ambient air concentration of air toxics, the EPA uses the data from the NEI and additional sources in two models: 1) an atmospheric dispersion model known as the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) and 2) a photochemical model known as the Community Multiscale Air Quality (CMAQ). All air toxics included in NEI are AERMOD to produce detailed estimates down to “spatial granularity” (Office of Air Quality Planning and Standards 2018:2). Only 52 air toxics are modeled in the CMAQ to estimate the secondary formation of hazardous air pollutants (HAP) in the atmosphere such as formaldehyde, acetaldehyde and acrolein. CMAQ models also calculate the biogenics and fire emissions in all areas except Alaska and Hawaii. The EPA uses special procedures for estimating HAP, fires, and bioegnics concentrations. For air toxics included in both models, an average annual concentration is used. To estimate human health risk, the concentration estimates are placed in the Hazardous Air Pollutant

Exposure Model (HAPEM7) to model human outdoor activity for exposure concentrations at the census tract level.

All other variables, except for metro, were from U.S. Census Bureau American Community Survey (ACS) 2009-2014, five year wave at the census tract level. The ACS data was downloaded from the National Historical Geographic Information System (Manson et al. 2018). The ACS was created to fill the need for current and detailed population and housing data beyond the decennial census. The ACS is administrated by collecting monthly surveys in order to estimate annual data. Similar to NATA, the ACS is conducted over a series of rigorous stages. The first phase of sampling is divided into a main stage done in September/October and a supplement stage done in January (U.S. Census 2014). The first stage of the ACS assigns each census block to one of the 16 sampling strata. The first stage of the ACS is the Census Bureau divides addresses within a county into five subframes and the subframes remain consist throughout the multi-year sample collecting process. The subframe are representative and consist of roughly 20% of the total frame. New addresses are randomly included into one of the five groups. The next stage is to randomly select addresses within each sub-frame and to survey them over the course of 12 months. The ACS conducts survey via internet, mail, phone, and personal visit. The topics included in the ACS are housing, employment, family, and demographic characteristics. Data is collected from housing units and group quarters.

a. Sample

We used a complete case sample of 72,103 census tracts and includes continental United States as well as Hawaii and Alaska. A simple check of our complete case sample showed that none of the census tracts had a population of zero. The complete case sample drops to 71,374 with the inclusion of the control variables because the control variables have more missing data. In Table 4.1 are the descriptive statistics of all the variables.

Table 4.1 Descriptive Statistics of Variables

	mean	sd	min	max	median
total cancer risk	31.59	12.98	6.17	1505.12	30.93
White, not latinx (%)	63.46	30.14	0	100.00	73.13
Latinx (%)	15.54	21.14	0	100.00	6.50
Black, not Latinx (%)	13.34	21.97	0	100.00	3.66
female-headed household (%)	13.64	8.60	0	84.76	11.55
some college and up (%)	56.98	17.71	4.74	100.00	56.08
median household income	57232.14	28282.58	2499.00	250001.00	50982.00
renter (%)	35.78	21.94	0	99.10	30.97
unemployment (%)	9.76	5.93	0	60.28	8.45
housing units built in 1970s-present (%)	55.26	28.61	0	100.00	56.94
median housing value	218507.10	173743.70	9999.00	1000001.00	162000.00
workers in manufacturing (%)	10.53	6.91	0	71.77	9.19
median age	38.86	7.50	11.50	83.20	38.90

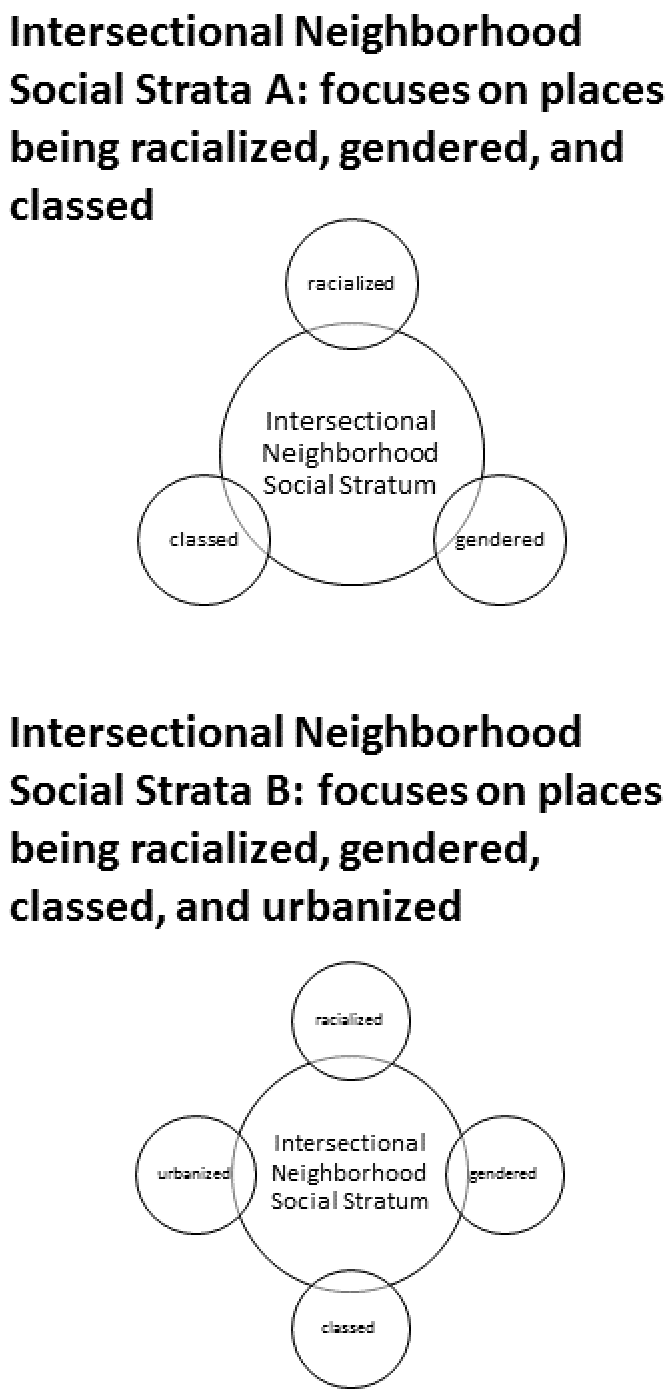
b. Dependent Variable: Estimated Cancer Risk from Air Toxics

The dependent variable is the EPA's NATA 2014 estimated cancer risk from air toxics in a lifetime (70 years) per million persons. The total estimated cancer risk from air toxics in a lifetime from all sources of air emissions including point, nonpoint, road, nonroad, biogenics, fires, secondary, and background. Estimated cancer risk from air toxics is an optimal choice for methodological and theoretical reasons. First, given the novel methodological approach, it is best to use linear models with a dependent variable as a continuous outcome with a normal distribution (Evans et al. 2018). Second, estimated cancer risk from air toxics is an important environmental health indicator because it represents the mechanisms of inequality in health impacts from air emissions. Toxic air emissions come from a variety of sources including point (e.g. large industrial facilities, electric power plants, dry cleaners, airport, railroads, etc...), nonpoint (e.g. this include smaller or too many to individualize inventory such as residential heating, consumer and commercial product usage, commercial cooking, oil and gas production, and industrial, commercial and institutional fuel combustion, etc...), on road (e.g. mobile sources such as cars, trucks, etc...), nonroad (e.g. lawn and garden equipment, agricultural, construction, industrial and commercial equipment and recreational equipment), fires (e.g. does not include recent wild fires), biogenics (e.g. air toxics from vegetation such as formaldehyde, acetaldehyde and methanol), secondary (e.g. air toxics that form in the atmosphere due to photochemical reactions), and background (e.g. air toxics concentrations that are average in ubiquitous nature). Exposure to toxic air emissions can have a range of detriment health effects for people including respiratory, cardiovascular, and reproductive (Curtis et al. 2006). Researchers have shown the influence of social inequalities and privileges contributing to air pollution disparities with poor, non-white neighborhoods at most risk (Bell and Ebisu. 2012; Clark, Millet, and Marshall 2014; Ard 2016). Research has yet to explore gender dynamics on air pollution. Air pollution and it's adverse health outcomes is an optimal choice for methodological and theoretical reasons.

V. Axes of Marginalization and Inequality

We constructed two census tract-level stratum groups and they are visually depicted in Figure 4.2. The first one is represents neighborhood structural dynamics— racialized, gendered, and classed (Neighborhood Social Stratum A in Figure 4.2). The second one represents neighborhood structural dynamics—racialized, gendered, classed, and urbanized (Neighborhood Social Stratum B in Figure 4.2). Neighborhood Social Stratum A represents the next step of intersectionality from the social identity to the neighborhood level. Neighborhood Social Stratum B is the next step to developing neighborhood social starta indicating neighborhood characteristics beyond the social identity such as whether the census tract is within a metro or nonmetro.

Figure 4.2 Visual Depiction of Neighborhood Social Stratum



All variables are at the census tract-level and are from the American Community Survey, 5-year wave, 2010-2014. We used percentages for all the variables except for median household income and metro. In order to construct the tract-level stratum groups, we used percentiles by first calculating the 2-tiles or tertiles (3-tiles) of each variable. 2-tiles is two percentiles groups with the median as the middle and half of the observations in each tile. Tertiles is three percentiles with one third of the observations in each tile. To gauge the racialized dimension of place, we calculated the 2-tiles based on the median (a lower tile representing units below the median and an upper tile representing units above the median). To capture the gendered and classed dimensions of place, we calculated tertiles consisting of 3-tile groups: a lower tile includes the units in the lower tile or the units with the lowest percentages within the sample, a middle tile includes the units in the middle tile or the units closest to the median percentages within the sample, and an upper tile includes the units in the upper tile or the units with the highest percentages within the sample. For the urbanized dimension of place, it was included as a dummy code (e.g. 1=metro and 0=nonmetro). Each census tract is assigned a tile group based on the tract's tile placement. Then based on the tile group combination, we made the tract-level stratum groups. Below, we discuss in detail how we gauge the racialized, gendered, classed, and urbanized dimensions of place[4]. Figure 4.3 summarizes the details.

[4] Before moving on to the specific calculations, we would like to briefly discuss reification. While we made calculations to capture the racialized, gendered, classed, and urbanized dimensions of place, these numbers and categories do not entirely capture the complicated, overlapping systems of racism, classism, and sexism. Furthermore, there are multiple forms of racism, classism, and sexism. We acknowledge our limitations. We use these categories as a tool to bring critical awareness of the indispensability communities face while at their expense other communities have privilege (see Cho, Crenshaw, and McCall 2015)

Figure 4.3 Neighborhood Social Stratum Summaries

Intersectional Neighborhood Social Stratum A

Racialized (4 categories)	Gendered	Classed
• Category 1: Lower quantile % Black & lower quantile % Latinx • Category 2: Upper quantile % Black & lower quantile % Latinx • Category 3: Lower quantile % Black & Upper quantile % Latinx • Category 1: Upper quantile % Black & upper quantile % Latinx	• Lower tertile of % single female-headed household • Middle tertile of % single female-headed household • Upper tertile of % single female-headed household	• Educational Attainment • Lower tertile of % some college and up • Middle tertile of % some college and up • Upper tertile of % some college and up • Income • Lower tertile of median household income • Middle tertile of median household income • Upper tertile of median household income

Intersectional Neighborhood Social Stratum B

Racialized (4 categories)	Gendered	Classed	Urbanized
• Category 1: Lower quantile % Black & lower quantile % Latinx • Category 2: Upper quantile % Black & lower quantile % Latinx • Category 3: Lower quantile % Black & Upper quantile % Latinx • Category 1: Upper quantile % Black & upper quantile % Latinx	• Lower tertile of % single female-headed household • Middle tertile of % single female-headed household • Upper tertile of % single female-headed household	• Educational Attainment • Lower tertile of % some college and up • Middle tertile of % some college and up • Upper tertile of % some college and up • Income • Lower tertile of median household income • Middle tertile of median household income • Upper tertile of median household income	• Metro • Non-Metro

a. Racialized

The ACS reports tract-level racial and ethnicity statistics. To construct racialized dimension in our stratum groups, we used variable Hispanic or Latino Origin by Race. Specifically, we used percentage of Black, not Latinx and percentage of Latinx. We calculated the 2-tile based on the median for percentage of Black, not Latinx and percentage Latinx separately. We then constructed four category based on the 2-tiles: Category 1 is the census tracts that have below the median of percent Black, not Latinx and below the median of percent Latinx, Category 2 is the census tracts that have above the median of percent Black, not Latinx and below the median of percent Latinx. Category 3 is the census tracts that have below the median of percent Black, not Latinx and above the median of percent Latinx. Category 4 is the census tract with above the median of percent Black, not Latinx and above the median of percent Latinx.

b. Gendered

The ACS reports tract-level household type. To construct the gendered dimension of the stratum groups, we used the category female-headed household of the household type variable. Based on percentage of female-headed households of census tracts, we calculated tertiles. Based on the tertiles, we made three groups: Category 1 are the census tracts in lower tile of the tertiles in other words have the lowest percentages of female-headed households within the sample. Category 2 are the census tracts within the middle tile of the tertiles thereby have the middle percentages of female-headed household within the sample. Category 3 are the census tracts that have upper tile of the tertiles which are the census tracts with the highest percentages of female-headed household. We used female headed household to capture the gendered family structure.

c. Classed – Educational attainment

The classed dimension of the intersectional neighborhood social strata contains two parts of educational attainment and income. The ACS reports education levels at the census tract level. We used the educational attainment for the population 25 years and over variable to calculate the percentage of "some college and up" (includes "some college, less than 1 year; some college, 1 or more years, no degree, associate's degree, bachelor's degree, master's degree, professional school degree, doctorate degree) of the census tract. Based on the tertiles of percentage of "some college and up," we made three groups: Category 1 are the census tracts in lower tile of the tertiles. Category 2 are the census tracts within the middle tile of the tertiles. Category 3 are the census tracts that have upper tile of the tertiles.

d. Classed - Income

The second part to the classed dimension is income. The ACS reports median household income at the census tract level. We used the median household income variable. We calculated the tertiles of median household income to construct three groups: Group 1 are the census tracts within the lower tile. Group 2 are the census tracts within the middle tile. Group 3 are the census tracts in the upper tile.

e. Urbanized

In order to capture the urbanized dimension, we used the metro variable came from rural-urban continuum code from United States Department of Agriculture's Economic Research Services. We converted the nine categories variable into a metro variable with categories 1-3 being metro (coded as 1) and 4-9 being non metro (coded as 0).

f. Control variables

The analyses include two control models. The first (Model C) includes median age of the census tract. The second control model (Model D) includes variables previous environmental justice research has examine to test whether the effects are still valid. The sample coverage between Model C and Model D is varies because the inclusion of all the control variables is limited to complete data. All control variables are centered to their mean.

Median age

This is the median age of total population. This variable was taken from the median age by sex variable. It is important to control from median age because age is related to health. A census tract with a higher older population may be differ in health from a census tract with a lower older population.

Unemployment

Percent of unemployment is the number of civilian labor force, unemployed divided by the total population 16 years and over in labor force. This variable is calculated with the employment status for the population 16 years and over.

Median year structure built

Median year structure built of housing units. This is calculated by the median year structure built.

Median housing value

Median housing value of owner-occupied housing units. This is calculated by the median value (dollars).

Manufacturing

Percent of workers in manufacturing is the number of civilian employed population 16 years and over in manufacturing divided by the total civilian employed population 16 years and over. This variable is calculated by Industry by Occupation for the Civilian Employed Population 16 years and over.

Renters

The ACS reports numbers of occupied housing units at the census tracts. We used the tenure variable to calculate the percentage of renters.

VI. Analyses

Multilevel models are widely used within the social sciences due to their applicability to control and analyze nested data. The multilevel approach accounts for clustering by partitioning total residual variation into the levels of within-group and between-group variation. The most common examples of multilevel models are with administrative or geographic groups such as students nested in schools, census counties within states, or timely-estimates within units (i.e. panel data). Recently, scholars (Evans et al. 2018; Evans 2019; Evans and Erickson 2019) have expanded the applicability of multilevel modeling to account for theoretical clustering instead of solely administrated or geographical clustering with the development of multilevel analysis of individual heterogeneity and discriminatory accuracy (MAIHDA). The structure of MAIHDA is to nest individuals (level 1) within social strata (level 2) based on intersectional group combinations of race, class, and gender. Evans et al (2018) argues "[c]lustering occurs when individuals share something that creates similarity between them and ignoring this clustering would violate the regression assumption of independence" (4). The power of

MAIHDA is to use multilevel modeling to account for expected theoretical clustering among individuals' social statuses with advanced statistical models.

MAIHDA fills the gap for a more critical analytic approach to intersectionality in quantitative research. Black feminists argue social inequalities are intersectional in that privileges and oppressions happen through a complicated, array of combinations of social inequalities rather than singular components of inequality. Statistically, examining the vast array of combinations of social groups based on axes of inequalities can expand quickly and consume the number of degrees of freedom. Traditionally, statistics have used interaction terms, however interaction terms need a reference group thereby only allowing comparison between two groups. MAIHDA addresses these concerns by using the hierarchical structure of multilevel modeling to analyze the array of combinations of axes of inequalities. MAIHDA is also parsimonious in that it examines the overlapping social inequalities without using degrees of freedom as compared with fixed effects model. In this analysis, we extrapolate the MAIHDA approach to use geographical unit of analysis (e.g. census tracts) in order to focus on intersectionality working at higher ecological levels such as the neighborhood or community level.

Given the spatial importance of environmental inequality research, here we extend the MAIHDA from the individual-level to the geographic-level. By moving from the individual to geographic level, the models evaluate intersectionality at higher ecological levels such as the structural or aggregate level. Our approach nests census tracts (level 1) within intersectional neighborhood social stratum (level 2) to account for the structural theoretical clustering to examine environmental hazards. Previous research demonstrates neighborhoods with higher proportions of non-whites and poor have higher exposure to environmental risk (Taylor 2014). We assume that census tracts with similar racialized, gendered, and classed compositions share similarities in their risk exposure. To account for the similarities between these census tracts, we use multilevel modeling.

Our analysis uses a two-level random intercept model with census tracts (level 1) clustered within intersectional neighborhood social stratum (level 2). We constructed intersectional neighborhood social stratum based on the combination of axes of inequalities as discussed above across social spatial dimensions of racialized, gendered, classes, and urbanized. Each geographic social strata is assigned a unique number representing the strata's unique combination. The geographical intersectional components are within the geographical social stratum or level 2. To control for the additive effects of axes of inequalities or the singular components, we added main effects predictors as fixed effects (e.g. percentage of Latinx) (see Model 2 in the tables below). We also examined models with additional control variables important in the previous literature mentioned above (see Model 4 in the table below).

$$y_{ij} = \beta_{0_j} + \beta_1 + \cdots + \beta_k + \mu_{0j} + e_{0ij}$$

$$\text{Level 2: } [\mu_{0j}] \sim N(0, \sigma^2_{strata})$$

$$\text{Level 1: } [e_{0ij}] \sim N(0, \sigma^2_{e0})$$

The outcome is y_{ij} for census tract i in stratum j. Where β_{0j} is the vector of the intercept for each stratum j. The full saturated model has k number of main effects (β) that may consist of additive and control effects. There are two random effects within the model including the within-group (level 1) and between-group (level 2) residuals. At level 2, the residual or difference between the level 2 average value of the outcome and the expected value of y is the level 2 residual μ_{0j}. In other words, μ_{0j} is the residual variation between the geographical social stratum and represents the variation among the intersectional neighborhood social stratum groups. The between group random effect is are normally distributed and has a variance of σ^2_{strata}. At level 2, the residual or difference between the level 1 average value of the outcome and the expected value of y is the level 1 residual e_{0ij}.The within group random effect is normally distributed and has a variance of σ^2_{e0}. Since the random effects represent the difference between types of averages and expected value of specific units, after controlling for the main additive effects and assuming there is no omitted variables bias, the stratum-level residual represents the interaction effect for each stratum j. The omitted variable is an important condition because it can also be attributed to variables not included in the model. We account for that with the inclusion of control variables.

Intraclass coefficient also referred as the ICC is the percent of variance explained at intersectional neighborhood social stratum (level 2) out of the total variation. As explained above, the interaction effects within the models is captured in intersectional neighborhood social stratum. Thus the ICC encapsulates the amount of variance explained by interaction effect.

$$ICC = \frac{\sigma^2_{strata}}{\sigma^2_{strata} + \sigma^2_{e0}} * 100$$

In our analyses, we include two sets of models, the first is a direct extension of MAIHDA to the geographic-level. Model A includes census tracts nested within intersectional neighborhood social stratum dimensions that are racialized, gendered, and classed. Specifically, model A includes four dimensions of geographical neighborhood social stratum with the following number of categories: racialized (4 categories), gendered (3 categories), classed - educational attainment (3 categories), and classed - median household income (3 categories). We constructed categories based on 2-tiles or tertiles of the percentages of demographics of a census tract. An example of a intersectional neighborhood social strata would be the unique combination of 2123 representing: upper tile of % Black & lower tile of % Latinx (2), lower tile of female headed-household (1), middle tile of some college and up (2), and upper tile of median household income (3). There is a total of 108 neighborhood social stratum and ninety-six percent had 30 or more census tracts. There were no empty neighborhood social stratum.

Building on Model A, we analyze a second set of models. Model B includes urbanized as part of its intersectional neighborhood social stratum to capture an unique spatial level characteristic essential to understanding environmental health risk with intersectionality. At the geographic and community level, it is important to consider urbanization to examine spatial power among residents in the neighborhood. Spatial inequality researchers argue urbanization as a social dimension to demonstrate power (Lobao Hooks, and Tickamyer 2007). To gauge an axe of inequality exclusivity at the neighborhood level, in model B we included a fifth dimension of urbanization. Thus, model B is census tracts (level 1) within intersectional neighborhood social stratum (level 2) of five dimensions of geographical social stratum with the following number of categories: racialized (4), gendered (3), classed - educational attainment (3), classed - median household income (3), and urbanized (2). An example of a neighborhood social strata would be the unique combination of 21231 representing: upper tile of % Black & lower tile of % Latinx (2), lower tile of female headed-household (1), middle tile of some college and up (2), upper tile of median household income (3), and metro (1).

VII. Results

We will first discuss the results from the neighborhood social stratum A and is referred to as Model A. Table 4.2 has the results for Models A1-A4. Traditionally, multilevel analysis begins with the null model without any fixed effects. Model A1 is the null model and its intercept (β_1) is about 32 indicating the national tract-level average of estimated cancer risk is about 32 per million persons. The random effect at the intersectional neighborhood social strata ($\sigma_{\mu 0}^2$) is 21.79 and the random effect at the census tract level (σ_{e0}^2) is 149.58. The intraclass coefficient (ICC) which is the amount of variance explained by the intersectional neighborhood social stratum is a about 12.67%. Common ICCs range between 5-6%. Thus, a large amount of variation in environmental health risk at the census tract level is explained by the intersectional neighborhood level. Thereby highlighting the importance of using multilevel modeling to examine the intersectional neighborhood social stratum among census tracts.

Table 4.2 EIM Bayesian Models with Four Dimensions of Neighborhood Social Stratum

	Model A1: Null			
	coefficient	lower CI	higher CI	p-values
β_1	31.666	30.710	32.485	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx				
Lower quantile % Black & upper quantile % Latinx				
Upper quantile % Black & upper quantile % Latinx				
female household tertile (ref=lower quantile)				
middle quantile				
upper quantile				
some college & up tertile (ref=lower quantile)				
middle quantile				
upper quantile				
median household income tertile (ref=lower quantile)				
middle quantile				
upper quantile				
other control variables				
metro				
median age, centered				
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-present (%), centered				
unemployment (%), centered				
renters (%), centered				
$\sigma^2_{\mu 0}$	21.789	16.140	29.203	
σ^2_{e0}	149.585	148.124	151.207	
ICC	12.673	9.730	16.345	
N	72103			

Table 4.2 EIM Bayesian Models with Four Dimensions of Neighborhood Social Stratum (continued)

	Model A2: Main Effects			
	coefficient	**lower CI**	**higher CI**	**p-values**
β_1	25.051	23.843	26.262	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	8.541	7.426	9.684	0.000
Lower quantile % Black & upper quantile % Latinx	5.327	4.198	6.470	0.000
Upper quantile % Black & upper quantile % Latinx	8.128	7.012	9.183	0.000
female household tertile (ref=lower quantile)				
middle quantile	1.114	0.149	2.067	0.008
upper quantile	3.280	2.340	4.170	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-1.687	-2.643	-0.698	0.001
upper quantile	-0.549	-1.425	0.397	0.127
median household income tertile (ref=lower quantile)				
middle quantile	0.199	-0.705	1.109	0.329
upper quantile	0.907	-0.048	1.829	0.033
other control variables				
metro				
median age, centered				
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-present (%), centered				
unemployment (%), centered				
renters (%), centered				
$\sigma^2_{\mu 0}$	3.400	2.155	5.217	
σ^2_{e0}	149.676	148.037	151.267	
ICC	2.242	1.423	3.373	
N	72103			

Table 4.2 EIM Bayesian Models with Four Dimensions of Neighborhood Social Stratum (continued)

	Model A3: Metro & Age Controls			
	coefficient	**lower CI**	**higher CI**	**p-values**
β_1	22.721	21.621	23.911	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	7.386	6.455	8.316	0.000
Lower quantile % Black & upper quantile % Latinx	4.280	3.257	5.271	0.000
Upper quantile % Black & upper quantile % Latinx	6.519	5.551	7.566	0.000
female household tertile (ref=lower quantile)				
middle quantile	0.822	0.007	1.629	0.024
upper quantile	2.395	1.558	3.244	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-2.027	-2.864	-1.101	0.000
upper quantile	-1.550	-2.429	-0.691	0.001
median household income tertile (ref=lower quantile)				
middle quantile	-0.188	-1.020	0.583	0.329
upper quantile	-0.155	-0.988	0.713	0.378
other control variables				
metro	5.553	5.293	5.854	0.000
median age, centered	-0.045	-0.060	-0.031	0.000
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-present (%), centered				
unemployment (%), centered				
renters (%), centered				
$\sigma^2_{\mu 0}$	2.719	1.599	4.270	
σ^2_{e0}	146.364	144.783	147.927	
ICC	1.823	1.082	2.818	
N	72103			

Table 4.2 EIM Bayesian Models with Four Dimensions of Neighborhood Social Stratum (continued)

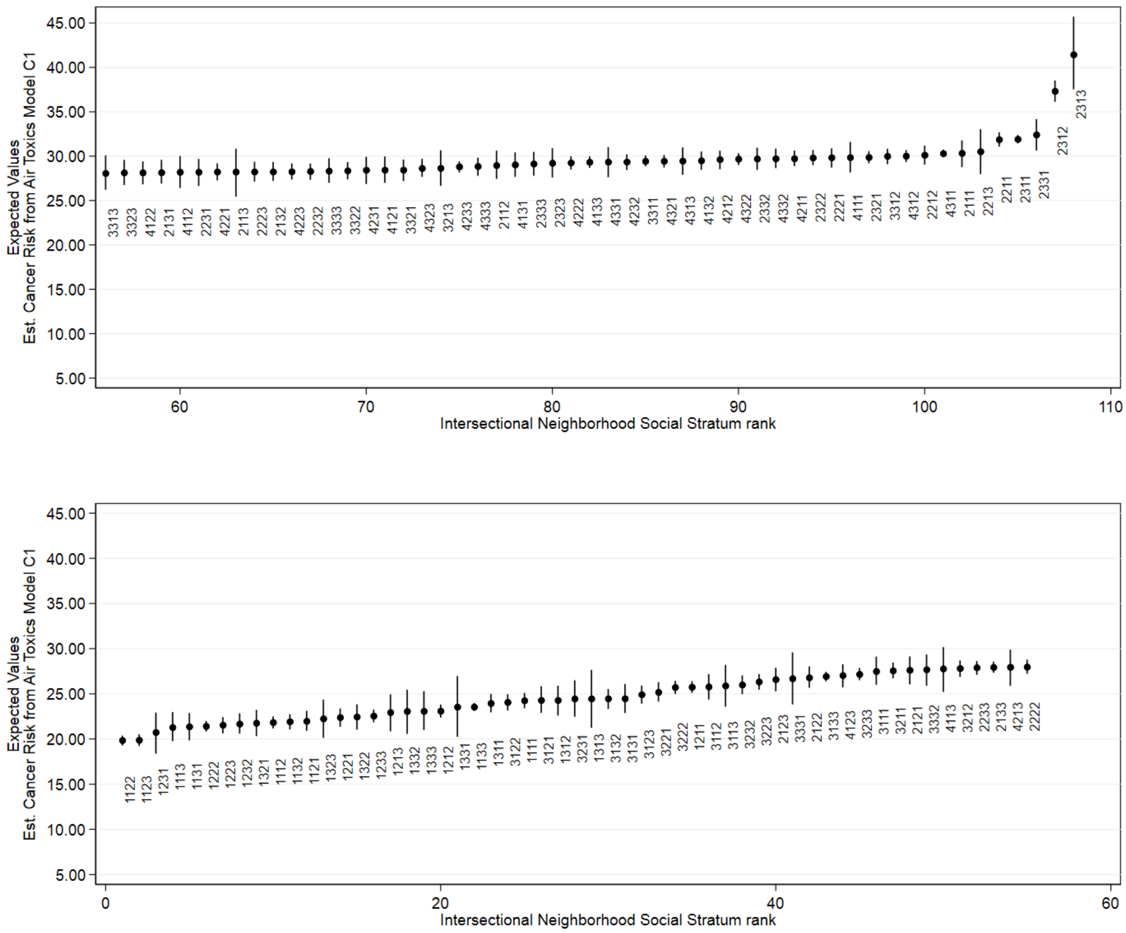
	Model A4: All Control			
	coefficient	**lower CI**	**higher CI**	**p-values**
β_1	23.929	22.898	24.915	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	7.223	6.237	8.188	0.000
Lower quantile % Black & upper quantile % Latinx	3.464	2.515	4.417	0.000
Upper quantile % Black & upper quantile % Latinx	5.706	4.807	6.640	0.000
female household tertile (ref=lower quantile)				
middle quantile	1.016	0.216	1.761	0.007
upper quantile	2.547	1.712	3.395	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-2.476	-3.312	-1.649	0.000
upper quantile	-2.845	-3.703	-2.057	0.000
median household income tertile (ref=lower quantile)				
middle quantile	0.045	-0.711	0.803	0.459
upper quantile	-0.245	-1.080	0.644	0.285
other control variables				
metro	5.161	4.877	5.431	0.000
median age, centered	-0.030	-0.046	-0.015	0.000
manufacturing (%), centered	-0.036	-0.050	-0.022	0.000
median housing value, centered	0.000	0.000	0.000	0.000
housing units built in 1970s-present (%), centered	0.029	0.026	0.032	0.000
unemployment (%), centered	-0.001	-0.020	0.018	0.463
renters (%), centered	0.034	0.028	0.040	0.000
$\sigma^2_{\mu 0}$	2.332	1.306	3.980	
σ^2_{e0}	145.412	143.924	147.018	
ICC	1.591	0.892	2.667	
N	71374			

The main effects model (Model B1) includes the additive main effects within the model to examine the magnitude of the intersectional neighborhood social stratum when controlling for the additive category effects. The intercept lowers to about 25 estimated cancer risk from air toxics per million persons because the additive effect coefficients explain away the main average of the outcome variable. All the additive effects are categorical variables and to interpret the categorical coefficient are compared to the reference category. For the race and ethnicity variable, in general, census tracts with higher percent Black and Latinx are more at risk than census tracts with lower percent Black and Latinx. Census tracts with higher proportion of Blacks and lower proportions of Latinx (race category 2) are at the highest risk as compared to other racial categories. Gendered family structure follows a gradient pattern in that census tracts with higher proportions of female-headed household have higher environmental health risk. The proportion of higher educational attainment does not follow a gradient, instead census tracts with the middle tertile of proportion of some college or more has the lowest environmental health risk compared to the lower terile of educational attainment. The upper tertile of educational attainment has a smaller coefficient value than middle tertile but is not found to be significant. Finally, as the census tract's median household income increases there is a slight increase in health risk. The difference between middle tertile is not found to be significant however the upper tertile is. The lower additive effect income has is contrary to what previous research has found and we will explore this in late models. Additionally, out of the additive effects the race and ethnicity coefficients are the highest followed by gendered family structure.

The ICC between Model A1 and Model B1 decrease from roughly 12.67% to 2.24% because the additive main effects soaked up the variation of between the intersectional neighborhood social stratum (from 21.79 to 3.40). To examine the how much is variation explained by the additive effects, we calculate the percent of the difference of the between-stratum variation of Model A1 and Model B1 divided by the between variation of Model A1. The additive effects of race/ethnicity, gendered family structure, educational attainment, and median household income breakdown of census tracts explain about 82.32% of the variation of estimated cancer risk from air toxics. Thus, about 18% of the variation of environmental risk is left unexplained and could be intersectional neighborhood effects.

Model C1 is a main effects model with two control variables of median age and metro. The directions of the coefficients for race and ethnicity, gender, and educational attainment remain although their coefficient strength decreases slightly. However, median household income coefficients are negative instead of positive as they were in Model B1. The median age of a census tract is census tracts with older median age have lower cancer risk. More importantly, census tracts that are within a metro have significantly higher estimated cancer risk. Metro is the second highest coefficient to the race and ethnicity breakdown of census tracts. The significance of metro motivates our set of Model B to incorporate metro into the neighborhood social stratum. The ICC of Model C1 decreases slightly to 1.82%. The additive effects and control variables explain about 87.45% of estimated cancer risk from air toxics meaning about 13% of the variation is explained by intersectional neighborhood effects. Figure 4.4 demonstrates the expected values of environmental health risk across the intersectional neighborhood social stratum. The tails of the dots represent the credible intervals. The figure demonstrates the range of environmental health risk across neighborhoods and their intersectional structural position across racialized, gendered, and classed dimensions.

Figure 4.4 Estimated Cancer Risk from Air Toxics across Intersectional Neighborhood Social Stratum A



Each intersectional neighborhood social strata A consist of a 4-digit code (_ _ _ _).
1st digit: Category 1-Lower quantile % Black & lower quantile % Latinx; Category 2-Upper quantile % Black & lower quantile % Latinx; Category 3-Lower quantile % Black & Upper quantile % Latinx; Category 4-Upper quantile % Black & upper quantile % Latinx
2nd digit: Category 1-Lower tertile of % single female-headed household; Category 2-Middle tertile of % single female-headed household; Category 3-Upper tertile of % single female-headed household
3rd digit: Category 1-Lower tertile of % some college and up; Category 2-Middle tertile of % some college and up; Category 3-Upper tertile of % some college and up
4th digit: Category 1- Lower tertile of median household income; Category 2-Middle tertile of median household income; Category 3-Upper tertile of median household income

Model D1 incorporates additional controls of unemployment, number of workers in manufacturing, median housing value, housing units built after 1970s, and renters. All coefficients direction and magnitude stay consistent with the exception of educational attainment and median household income. Educational attainment changes to be a gradient in that as proportion of some college and up increases there is a corresponding decrease in environmental health risk. Median household income changes to a gradient with higher median household income have a lower environmental health risk, however, the coefficients are not statistically significant. The addition of the control variables is related to the educational attainment and income. The ICC of model D1 decreases from Model C1 to 1.59%.

Table 4.3 includes Models B1-B4. Given the magnitude of metro within the model (Model C1 & D1), we decided to add urbanization to neighborhood social stratum in a second set of models (Model B). Model A2 is the null model and has about 29 national average of estimated cancer risk per million persons. The random effect between the neighborhood social stratum is 32.61 and the random effect between the census tracts is 145.25 making the ICC 18.24%. The ICC Model B with the neighborhood social stratum including metro is much higher than the previous set of models. This is important because metro is strictly place-variable involved with our theoretical contributions.

Table 4.3 EIM Bayesian Models with Five Dimensions of Neighborhood Social Stratum

	Model B1: Null			
	coefficient	lower CI	higher CI	p-values
β_1	29.703	28.860	30.505	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx				
Lower quantile % Black & upper quantile % Latinx				
Upper quantile % Black & upper quantile % Latinx				
female household tertile (ref=lower quantile)				
middle quantile				
upper quantile				
some college & up tertile (ref=lower quantile)				
middle quantile				
upper quantile				
median household income tertile (ref=lower quantile)				
middle quantile				
upper quantile				
metro (ref=non-metro)				
other control variables				
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-2010 (%), centered				
unemployment (%), centered				
renters (%), centered				
median age, centered				
$\sigma^2_{\mu 0}$	32.610	26.364	39.921	
σ^2_{e0}	145.254	143.737	146.739	
ICC	18.237	15.353	21.500	
N	72103			

Table 4.3 EIM Bayesian Models with Five Dimensions of Neighborhood Social Stratum (continued)

	Model B2: Main Effects			
	coefficient	**lower CI**	**higher CI**	**p-values**
β_1	21.988	20.883	23.041	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	8.292	7.338	9.245	0.000
Lower quantile % Black & upper quantile % Latinx	3.298	2.328	4.218	0.000
Upper quantile % Black & upper quantile % Latinx	6.854	5.869	7.888	0.000
female household tertile (ref=lower quantile)				
middle quantile	1.021	0.096	1.849	0.014
upper quantile	2.726	1.917	3.597	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-1.949	-2.786	-1.090	0.000
upper quantile	-1.667	-2.593	-0.772	0.002
median household income tertile (ref=lower quantile)				
middle quantile	-0.462	-1.256	0.412	0.145
upper quantile	-0.739	-1.602	0.164	0.069
metro (ref=non-metro)	6.446	5.718	7.159	0.000
other control variables				
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-2010 (%), centered				
unemployment (%), centered				
renters (%), centered				
median age, centered				
$\sigma^2_{\mu 0}$	4.757	3.481	6.414	
σ^2_{e0}	145.301	143.838	146.811	
ICC	3.147	2.343	4.221	
N	72103			

Table 4.3 EIM Bayesian Models with Five Dimensions of Neighborhood Social Stratum (continued)

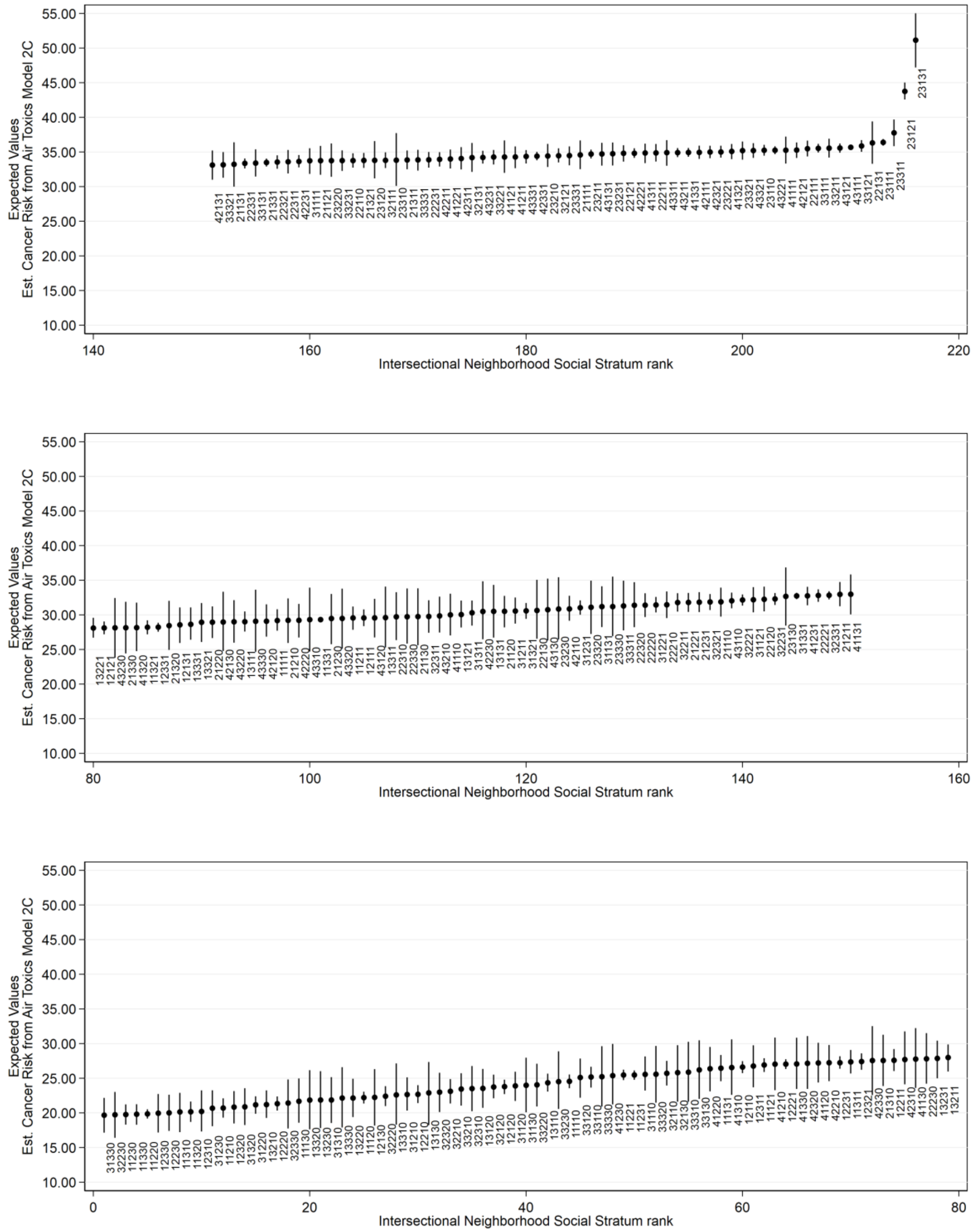
	Model B3: Age Control			
	coefficient	**lower CI**	**higher CI**	**p-values**
β_1	22.195	21.004	23.251	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	8.203	7.160	9.184	0.000
Lower quantile % Black & upper quantile % Latinx	3.161	2.083	4.102	0.000
Upper quantile % Black & upper quantile % Latinx	6.592	5.546	7.551	0.000
female household tertile (ref=lower quantile)				
middle quantile	0.927	0.100	1.744	0.016
upper quantile	2.474	1.593	3.395	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-1.943	-2.782	-1.085	0.000
upper quantile	-1.783	-2.646	-0.881	0.001
median household income tertile (ref=lower quantile)				
middle quantile	-0.381	-1.236	0.475	0.208
upper quantile	-0.626	-1.583	0.338	0.102
metro (ref=non-metro)	6.417	5.672	7.195	0.000
other control variables				
manufacturing (%), centered				
median housing value, centered				
housing units built in 1970s-2010 (%), centered				
unemployment (%), centered				
renters (%), centered				
median age, centered	-0.048	-0.060	-0.035	0.000
$\sigma^2_{\mu 0}$	4.865	3.529	6.428	
σ^2_{e0}	145.209	143.872	146.687	
ICC	3.227	2.377	4.259	
N	72103			

Table 4.3 EIM Bayesian Models with Five Dimensions of Neighborhood Social Stratum (continued)

	Model B4: All Control			
	coefficient	lower CI	higher CI	p-values
β_1	23.373	22.246	24.489	0.000
race (ref=lower quantile % Black & lower quantile % Latinx)				
Upper quantile % Black & lower quantile % Latinx	7.954	6.882	9.004	0.000
Lower quantile % Black & upper quantile % Latinx	2.405	1.368	3.383	0.000
Upper quantile % Black & upper quantile % Latinx	5.763	4.754	6.844	0.000
female household tertile (ref=lower quantile)				
middle quantile	1.131	0.254	2.035	0.006
upper quantile	2.659	1.754	3.611	0.000
some college & up tertile (ref=lower quantile)				
middle quantile	-2.387	-3.205	-1.581	0.000
upper quantile	-3.214	-4.115	-2.274	0.000
median household income tertile (ref=lower quantile)				
middle quantile	-0.104	-0.875	0.772	0.399
upper quantile	-0.641	-1.568	0.312	0.095
metro (ref=non-metro)	6.035	5.257	6.756	0.000
<u>other control variables</u>				
manufacturing (%), centered	-0.047	-0.061	-0.033	0.000
median housing value, centered	0.000	0.000	0.000	0.000
housing units built in 1970s-2010 (%), centered	0.027	0.023	0.030	0.000
unemployment (%), centered	0.008	-0.009	0.027	0.187
renters (%), centered	0.036	0.030	0.042	0.000
median age, centered	-0.031	-0.047	-0.016	0.000
$\sigma^2_{\mu 0}$	4.612	3.285	6.298	
σ^2_{e0}	144.311	142.768	145.813	
ICC	3.072	2.235	4.196	
N	71374			

Model B2 is the main effects model with only the additive effects. For most of the coefficients, their directions remain the same as before except income. Census tracts with higher median household income have lower health risk however middle tertile is not found to be significant. Interestingly, the additive metro effect has an even higher coefficient as it did in the previous set of models. The ICC is 3.15% slightly higher than Model B1. Model C2 is the main effect model with the median age for the census tract control. Median age of the census tract is found to that census tracts with more older residents have lower health risk. Figure 4.5 shows the expected values of estimated cancer risk from air toxics across intersectional neighborhood social strata B. The range of environmental health risk in Figure 4.5 is wider than Figure 4.4 showing that urbanization is an important factor to explaining variation in environmental health risk. In the figure 4.5, intersectional privileged communities have lower environmental health risk while intersectional marginalized communities have higher environmental health risk. The power the EIM is to connect the story of inequality with oppression and privilege instead of seeing focusing exclusively on the oppression. Finally, Model D2 finds similar results as previous model. Interestingly, percent of some college and up has slightly higher coefficients as previous models. The ICC is about 3.07%.

Figure 4.5 Expected Values of Estimated Cancer Risk from Air Toxics across Intersectional Neighborhood Social Stratum B



Each intersectional neighborhood social strata B consist of a 5-digit code (_ _ _ _ _).

1st digit: Category 1-Lower quantile % Black & lower quantile % Latinx; Category 2-Upper quantile % Black & lower quantile % Latinx; Category 3-Lower quantile % Black & Upper quantile % Latinx; Category 4-Upper quantile % Black & upper quantile % Latinx

2nd digit: Category 1-Lower tertile of % single female-headed household; Category 2-Middle tertile of % single female-headed household; Category 3-Upper tertile of % single female-headed household
3rd digit: Category 1-Lower tertile of % some college and up; Category 2-Middle tertile of % some college and up; Category 3-Upper tertile of % some college and up
4th digit: Category 1- Lower tertile of median household income; Category 2-Middle tertile of median household income; Category 3-Upper tertile of median household income
5th digits: Category 1-tract is within metro; Category 2-tract is not within metro

a. A note on Robustness…

There are outlier census tracts with extremely high estimated cancer risk. We tested models with the outliers removed and results remain the same. While the magnitude of stratum-specific effects changes when extreme outlier cases are removed from the analysis, the rank ordering of risk remains remarkably similar. This suggests that while outlier cases contribute substantially to the observed overall effects, they by no means are responsible for explaining all of the elevated risk faced by certain types of communities. Rather, they may simply be extreme cases that reflect larger and fairly ubiquitous patterns of marginalization and risk. We argue, therefore, that while robustness checks such as this are useful, it is more appropriate to include these cases in the presentation of final results.

VIII. Discussion

Given the magnitude of previous research documenting the unequal environmental health threats among communities of color, poor, and women, it is essential for scholars to incorporate an explicitly theoretical framework and methodology that is intersectional at the community level. Most work in past takes an additive methodological approach even though theoretical frameworks suggest inequality happens intersectionally meaning through a complex array of social dimensions including race, class, and gender. The three theoretical traditions of environmental justice, population health, and intersectionality are converging on a critical perspective that emphasizes the structural level to evaluate disparities outcomes beyond the individual-level. Each theoretical approach has something unique to offer to other to move forward in including intersectionality theory further into their research. We presented the eco-intersectional multilevel (EIM) perspective to address the gap of evaluating disparities outcomes intersectionally at the higher ecological levels by using multilevel modeling to account for theoretical clustering. While researchers have expanded intersectional perspective into quantitative environmental inequality work by incorporating spatial clustering techniques (Liévanos 2015) and spatial regression models (Grineski et al. 2013), these approaches are limited to evaluate the vast spectrum of intersectional social dimensions. Methodological intersectional approaches require the ability to compare groups to each other to examine how the same environment creates dimensions of advantages and disadvantages (McCall 2005). Multi-level modeling approaches allows for the comparison among groups (Evans et al. 2018).

The EIM perspective demonstrates national intersectional patterns of environmental health threats of the census tracts with higher proportions of Black, Latinx, single-female household, lower educational attainment, lower income, and residing in metro area. The results reflect previous case studies while weaving them together into a national pattern. EIM emphasizes intersectionality working at higher ecological levels like neighborhoods and incorporates that perspective theoretically and methodologically. These findings likely surprise no one who has a passing familiarity with issues of environmental racism, struggles for environmental justice, and/or environmental health. Yet the literatures these areas of scholarship are based on have historically relied heavily on case studies to document the relationship between poor and minority communities and likelihood to be exposed to health-harming environmental hazards. What EIM perspective adds is a novel method for quantifying, in explicitly intersectional terms, the geographies of environmental health inequalities.

Numerous compelling accounts detail the sources of these environmental hazards, the choices that were made about whose health would be sacrificed, and the ultimate impact on community residents. Along those same lines, intersectional privileged communities have lower environmental health risk at the expense of the indispensability of communities having higher environmental health risk. What has been missing is a way to satisfactorily quantify the intersectional nature of these inequalities overall, the extent of them, and the diversity both of the origins of these hazards and the impacts they have on population health. It is our hope that this new tool will be used in pursuit of social and environmental justice. This mechanism can help to explain inequalities between populations observed when individuals are surveyed, as well as geographic variation and inequalities. The power of EIM is to emphasize the intersectional dimensions to environmental health threats.

Limitations to this research include the absence of the decision making processes that are both historical and contemporary that examine more nuance understanding of the location of environmental hazards. The environmental health outcome was estimated cancer risk from air toxics, cancer risk can develop due to a number of other polluters such as water and land contamination. Future directions of EIM could use various outcomes outside environmental health threats such as educational or economic outcomes. Finally, the neighborhood social strata in future research could incorporate immigration, eviction rates, suburban, and regional. Using what we learned but always bring it back to critical perspectives of environmental justice, population health, and intersectionality.

CHAPTER V

CONCLUSION

I. Introduction

In chapter 1, I began by highlighting classical quantitative environmental justice research and elaborated on ways the quantitative research can move forward with a critical environmental justice lens. This dissertation had two main goals of presenting ways to move research from classical quantitative environmental justice to critical quantitative environmental justice. The first was to address theoretical gaps that focused on singular systems of oppressions (e.g. racism or capitalism), and instead, focus on frameworks that examine the interlinking systems of oppressions, such as racial capitalism as presented in chapter 2 and intersectionality theory as presented in chapter 4. Furthermore, classical quantitative environmental justice research has taken for granted the racial formations of various non-white groups by assuming the Black/white binary and homogeneous mechanisms among non-white groups. In Chapter 3, I presented Latinx destinations as a framework to dive deeper into Latinx racial projects. The second goal of the dissertation was to present novel methodological approaches of evaluating intersectionality, race, and space. Previous research acknowledges the importance of examining overlapping systems of power, however previous research has been limited to singular-dimensional independent variables or the use of interaction terms. Chapter 4 presented the novel method of eco-intersectional multilevel modeling to evaluate intersectional environmental health risk at the neighborhood level. Furthermore, in chapter 3, the methodological approach to use Latinx destinations to examine spatial and temporal dimensions was useful to explain disparate environmental outcomes. Finally, chapter 2 uses a measurement of proximity to military base to examine militarization of place and environmental health disparities. Chapters 2, 3, and 4 presented a critical quantitative environmental justice research by using the racial state, incorporating Latinx destinations, and emphasizing intersectionality.

This dissertation presented ways to move theoretically and methodologically forward into critical quantitative environmental justice research. Critical environmental justice has four pillars to examine environmental justice issues: 1) center on the intersectional dimensions of race, class, gender, sexuality, ability, and species; 2) apply a multitude of scales; 3) highlight the role of state power; and 4) emphasize racial and socioeconomic indispensability (Pellow 2018). This dissertation fulfills the four pillars of critical environmental justice in the following ways: 1) this dissertation acknowledges overlapping systems of oppression with racial capitalism and intersectionality theory; 2) this dissertation takes a multiscalar approach by focusing on a case study of Las Vegas and national studies; 3) this dissertation includes frameworks incorporating the racial state with racial capitalism and the treadmill of destruction; and 4) this dissertation centers on racial and social justice.

II. What we learned

This dissertation consists of three empirical studies to address theoretical and methodological gaps within classical quantitative environmental justice. The chapters may seem separate, but they are interrelated in many ways. I will briefly recap and synthesize them below.

Chapter 2 presented the case study of environmental health risk from air toxics in Las Vegas to evaluate the relationship between militarism and the environmental inequalities. Las Vegas presents an important case study of hazard risk, militarism, race, and place because it is located near a prominent air force base and the city has large racial and ethnic minority populations. By synthesizing the theoretical frameworks of racial capitalism and the treadmill of destruction, chapter 2 argues the military is an integral part of the racial state and produces environmental health risk for historically marginalized communities. The racial state "is composed of institutions, the policies they carry out, the conditions and rules which support and justify them, and the social relations in which they are embedded" (Omi and Winant 1994: 83). The military is part of the racial state enforcing racial inequalities. I employed a measurement of proximity to nearest military base to operationalize militarism of a census tract. Using spatial regression, the results demonstrate neighborhoods in closer proximity to military base have higher health risk than areas further away. Neighborhoods with higher percentage of Latinx and low-income residents also experience higher health risk. The findings suggest militarism is a barrier to social equity and sustainability of environmental justice. Furthermore, given the current rise of militarism within right-wing governments, such as United States and Brazil, the results suggest troubling concerns for environmental justice because the rise of the military-state is likely to cause more environmental inequalities.

The case study of Las Vegas and other southwestern cities demonstrate Latinx vulnerability, however, a national analysis of Latinx vulnerability to environmental health risk has yet to be evaluated. Previous research on environmental disparities assume homogeneous racial formations for non-white groups, in other words, they assume a Black/white binary. There are variety of frameworks within the sociology of race and ethnicity that dive deeper into understanding racial/ethnic relations beyond the

Black/white binary. Previous research at the national level has not focused exclusively on Latinx communities and environmental inequalities. The subsequent chapter aimed to address these concerns by focusing on the socio-political and economic dimensions of Latinx communities in the United States.

Chapter 3 presented a national-level study to evaluate whether there are differences in environmental health vulnerabilities across spatial and temporal difference among Latinx destinations. The chapter put the theoretical frameworks of environmental inequality—the increase of environmental hazards across historically marginalized communities—and spatial assimilation—over time historically marginalized communities will accumulate economic and cultural capital to move from areas with more hazards to areas with less hazards—in conversation with each other (Massey 1995; Taylor 2014). Using the methodological approach of Latinx destinations which defines areas based on their temporal Latinx growth, we had four categories: traditional Latinx destinations (counties that had at least the national average of Latinx population in 1990), early new Latinx destination (counties that did not have at least the national average of Latinx population in 1990 and had at least 150% Latinx growth between 1990-2000), recent new Latinx destination (counties that did not have at least the national average of Latinx population in 1990 and had at least 150% Latinx growth between 1990-2010), and non Latinx destinations (counties that did not fit any of the previous categories) (Monnat 2017). Using spatial regression, the results support the environmental inequality hypothesis that Latinx destinations have higher environmental health risk than non Latinx destination. However, when examining the differences in environmental health risk among Latinx destinations, the results show early new and recent new Latinx destinations have higher risk than traditional Latinx destinations. The findings do not support the spatial assimilation hypothesis and add a nuance to the environmental inequality hypothesis in that spatial and temporal differences in Latinx communities have different environmental health risk. The findings suggest the push and pull factors of the economic industries and racial state institutionalization are constructing disparate Latinx vulnerability for environmental health risk.

The results from chapter 2 and 3 painted a complicated picture of political, social, and economic systems working together to create hazard vulnerability throughout the nation. However, current methods in quantitative research are limited to singular independent variables or interaction terms which are not truly intersectional (Green et al. 2017). Previous research, such as the chapters 2 and 3, take a singular dimensional approach to examining these systems independently while acknowledging intersectional environmental effects. The following chapter presents a novel methodological approach to examine intersectional hazard risks by putting environmental justice, population health, and intersectionality theory in conversation with each other.

Chapter 4 centered on conceptualizing and evaluating intersectionality at the neighborhood level in relation to environmental health threats. Intersectionality theory emphasizes the overlapping systems of power that form unique oppressions and privileges including environmental risks and privileges. This chapter re-focuses on intersectionality working in higher ecological levels, such as the neighborhood level where previous research demonstrates the importance of housing and zoning to environmental hazards (Pulido 2000; Ducre 2012). Previous research argues environmental health risk is intersectional, however, quantitative research has been limited. We presented an eco-intersectional multilevel (EIM) approach to evaluate environmental health risks by extrapolating recent statistical innovation in population health of multilevel modeling to evaluate social cluster patterns. The results painted a national level picture of environmental inequalities happening through multiple intersectional systems of racialized, gendered, classed, and urbanized power where intersectional privileged neighborhoods have lower environmental health risk at the expense of intersectional marginalized communities having higher environmental risk. The findings suggest the importance of intersectionality working at multiple levels from the social identity to the structural level.

Chapters 2, 3, and 4 used a critical environmental justice perspective to address concerns from classical quantitative environmental justice research, but it is by no means exhaustive. This dissertation raises important questions for future research.

III. Unanswered Questions

While this dissertation provides insights into important aspects of critical quantitative environmental justice, it also raises a number of further questions. Below, I discuss unanswered questions raised from this dissertation and suggestions for future research.

Chapter 2 presents an important case study of militarism in relation to environmental inequalities and raises further additional questions. First, in chapter 2, the military is presented as a homogeneous, singular institution, when in reality, there is a gradation of militarism and various forms of militarism, from policing communities, military bases, to border patrol. Similarly, the United States military consist of various branches (i.e. air force, army, marines, and navy) and there may be different corresponding organizational effects on environmental inequalities. Since Las Vegas only has air force military bases, chapter 2 focused on the air force. The inner mechanisms and organizational effects of these various militaries have something to add to environmental justice issues. Future research can theoretically unpack the nuances between these organizational structures and what their roles and corresponding impacts. Especially, given that different military branches focus on specific ecological dimensions. Second, are the results from chapter 2 location specific? Chapter 2 focused on a specific metropolitan space and a follow-up question is how does the urbanization of space interact with the military? Future research could do a national analysis or a comparative study to unpack these questions. Also, given the importance of urbanization to the capitalist system, it would be interesting to unpack the relation of urbanization to racial capitalism and the treadmill of destruction. Future research could discuss the interaction between the military-industrial complex with the urban growth machine.

Chapter 3 unpacked nuances within assumptions the Black/white binary by focusing on Latinx destinations and environmental health disparities. This important research brings up a number of questions. First, the role of gendered migration within Latinx destinations framework. To this point, all previous research on Latinx destinations has ignored the gendered dimension of Latinx migration, however, recent work from Golash-Boza (2015) and Ribas (2016) emphasizes the role gender within migration, capitalism, and Latinx communities. In particular, chapter 3 found many new Latinx destinations in North and South Carolina and Ribas (2016) research focused on a meat processing plant in the Carolinas and found a relationship between gender, labor, and the environment. Future research should incorporate gendered migration to dive deeper into the overlapping racialized and gendered systems. Second, follow-up question is the relationship between rural gentrification and Latinx destinations. Rural gentrification is the process of rural places experiencing changing demographics and economies, for example, white retired residents moving into the rural countryside and raises the need for service and health industries that have racialized, gendered, and classed divisions of labor. Future research should unpack more theoretical richness between Latinx destinations and rural gentrification into racial capitalism to discuss how the racial state takes part in the push and pull factors.

Chapter 4 presented a novel approach to evaluate neighborhood level intersectional environmental health risks. First, the chapter re-emphasizes the importance of neighborhood-level intersectionality and presented a way to quantify it. This brings up important questions about understanding the relationship between positionality of social identity and aggregate structural levels. Future research should unpack this dynamic and inner mechanisms. Second, Chapter 4 focuses heavily on environmental inequality and not enough on environmental privilege. It is important to recognize the interconnection between environmental inequality and privilege (Pulido 2000). By focusing on the environmental privilege, the national story connects communities with multiply (intersectional) oppressions have higher environmental health risk because multiply (intersectional) privileged communities have lower environmental health risk. Third, the EIM models used were evaluating estimated cancer risk from air toxics, a natural follow-up question is, would the results remain the same for other neighborhood level outcomes (e.g. water pollution or hazardous facility sites)? Future research should expand to various neighborhood level outcomes to other environmental hazards. Along those same lines, future research should evaluate other measurements to capture racialized, classed, gendered, and urbanized dimensions. For example, future research could expand to include the operationalization of intersectionality at the neighborhood level with residential segregation indexes or eviction rates.

Chapters 2, 3, and 4 presented ways to move forward into a critical quantitative environmental justice, but no study is perfect. This dissertation presents several ways of moving forward with future research.

IV. Conclusion

This dissertation addressed theoretical and methodological gaps within classical quantitative environmental justice research. While it may seem Chapters 2, 3, and 4 are mutually exclusive, they are connected in number of different ways. Chapter 2 was a case study of Las Vegas and demonstrated militarism has a role in environmental health impacts. Additionally, Las Vegas has high degree of Latinx vulnerability similar to previous case study research of cities in the southwest, including El Paso, Phoenix, and southern California. Latinx destinations framework is a way to conceptualize and evaluate Latinx vulnerability. Chapter 3 was a national study to examine Latinx vulnerability through Latinx destinations. The results showed a complicated story of risks disparities happening across political and economic dimensions and suggested for approaches that emphasize interlinking systems of power. Chapter 4 was a national study to examine neighborhood-level intersectional environmental health risks. Chapters 2, 3, and 4 are in conversation with each other to address the theoretical and methodological gaps within classical quantitative environmental justice research.

This dissertation presented first steps into a critical quantitative environmental justice. Future research focusing on racial state, expanding Black/white binary, and employing intersectional statistical methods is needed to continue understanding and fighting environmental injustice issues.

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