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## Dissertation

### *Combined Environmental and Social Stressors in Northwest Atlanta's Proctor Creek Watershed: An Exploration of Expert Data and Community Knowledge*

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May 1, 2016

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## ABSTRACT

Environmental justice communities, those disproportionately affected by pollutants, are simultaneously exposed to multiple environmental stressors and also experience social and cultural factors that may heighten their health risks in comparison to other communities. In addition to being more susceptible to toxic exposures and being exposed to more toxins, such communities may have weakened abilities to combat or rebound from such exposures. Many communities that are overburdened by environmental exposures reject traditional risk assessment approaches that solely consider the effects of single chemicals or mixtures of like chemicals and instead have advocated for the use of place-based approaches and collaborative problem solving models that consider cumulative exposures and impacts. Cumulative risks are the combined risks from aggregate exposures to multiple agents or stressors, including chemical, biological or physical agents and psychosocial stressors. This dissertation adapts three research approaches that each use either publicly available data (“expert” data) or community-generated data about environmental and social factors in Northwest Atlanta’s Proctor Creek Watershed. Through this work, we were able to define cumulative environmental and social impacts experienced by watershed residents and to prioritize geographic areas and environmental challenges for investments in environmental monitoring and further research, community capacity-building, and policy change. A principal finding of the study is that local community knowledge is helpful to fill critical gaps about local conditions and pollution sources than a reliance on expert data alone.

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# **Chapter 1: Introduction and Statement of Purpose**

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## Introduction and Statement of Purpose

Urban communities can be negatively affected by environmental hazards and stressors contained in the urban environment. The authors of *Toxic Wastes and Race at Twenty*, reported that more than 9,000,000 people in the United States live within three kilometers of 413 commercial hazardous waste facilities (Bullard et al., 2007). The majority of these are people of color, and many live in communities in which more than one hazardous waste facility exists. Living in close proximity to environmental hazards including: hazardous waste sites, industrial sites, high traffic roadways, gas stations, and repair shops is associated with increased risk for adverse health outcomes such as adverse pregnancy outcomes, childhood cancer, cardiovascular and respiratory illnesses, and other chronic conditions (Brender et al., 2011). Exposure to unhealthy environmental conditions contributes greatly to producing and maintaining health disparities.

In the context of urban environments, health disparities can be described as partially caused by exposures to environmental hazards and differential access to resources (Payne-Sturges & Lee, 2006). Environmental justice communities, those disproportionately affected by pollutants, are simultaneously exposed to multiple environmental stressors and also experience social and cultural factors that may heighten their health risks in comparison to other communities (Zartarian et al., 2011). Such social and environmental factors have been associated with racial and ethnic disparities in health, although there is a lack of clarity with respect to how these disparities occur (Gee & Payne-Sturges, 2004). It is difficult to tease apart the impact of race and socio-economic status on environmental health disparities. Because communities in the United States are often segregated along racial and economic lines, low-income and communities of color often live in the worst conditions and subsequently exhibit the

highest levels of a wide array of health problems (Bell & Rubin, 2007). The poor environmental quality found in such neighborhoods has the most significant impact on populations whose health status is already at risk (CDC, 2010). Residential segregation has been associated with differential experiences of community stress, exposure to pollutants, and access to community resources (Gee & Payne-Sturges, 2004). Thus, the accumulation of these stressors, when not combated or counterbalanced, may result in heightened vulnerability to environmental hazards (p. 1646).

In addition to being more susceptible to toxic exposures and being exposed to more toxins, such communities may have weakened abilities to combat or rebound from such exposures. Many communities that are overburdened by environmental exposures reject traditional risk assessment approaches that solely consider the effects of single chemicals or mixtures of like chemicals and have instead advocated for the use of place-based approaches and collaborative problem solving models that consider cumulative exposures and impacts (NEJAC, 2004).

In response to concerns about limitations in the traditional risk assessment paradigm and the increased emphasis on cumulative exposures and impacts, the United States Environmental Protection Agency (U.S. EPA) first established guidance on cumulative risk assessment in 1997. The agency's most recent guidance, the *Framework for Cumulative Risk Assessment*, was published six years later. Cumulative risks are the combined risks from aggregate exposures to multiple agents or stressors, including chemical, biological or physical agents and psychosocial stressors. Cumulative risk assessment is defined as the, "...analysis, characterization, and possible quantification of the combined risks to human health or the environment from multiple agents or stressors," (U.S. EPA, 2003). In contrast to traditional risk assessment, cumulative risk

assessment is not required to be quantitative. Depending on the data needed to understand potentials exposures and risks, qualitative methods and analyses may be more appropriate (Callahan & Sexton, 2007; USEPA, 2003a, 2007b). There are also varying uses for the analyses that result from conducting cumulative risk assessments. In the *Framework for Cumulative Risk Assessment* (2003), U.S. EPA indicates that although cumulative risk assessments may be used to test hypotheses, it is more probable that such assessments be used as tools for risk management and decision making (p. 11).

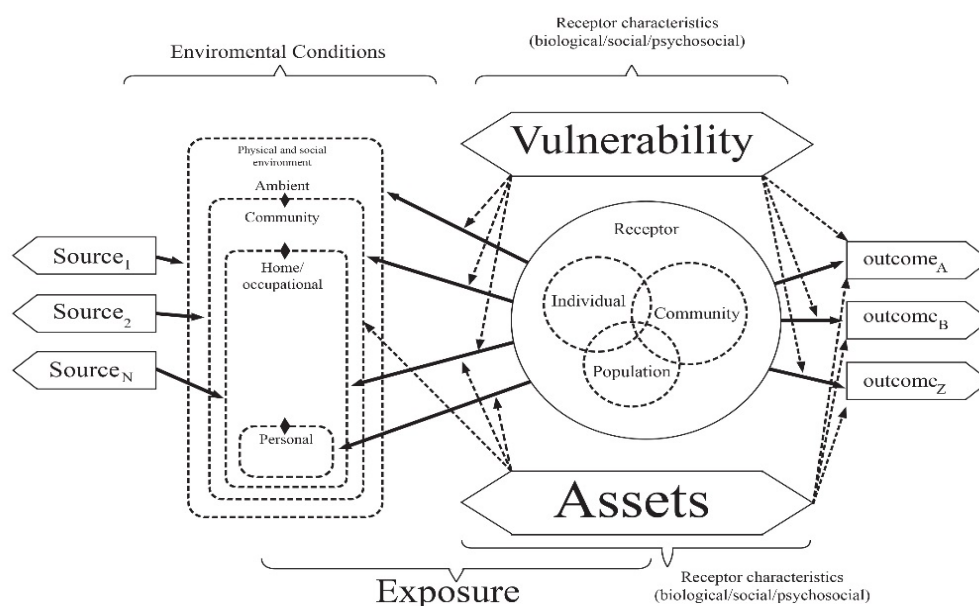
Key considerations for population-focused cumulative risk assessment include the examination of toxic mixtures, multiple exposure routes, population vulnerabilities, and sensitivities associated with population subgroups. Specific vulnerabilities include 1) susceptibility and sensitivity due to factors such as genetics, race/ethnicity, and age; 2) differential exposure that may be influenced by cultural practices; 3) differential preparedness (i.e., lack of access to health care; and 4) differential ability to recover (i.e., immune function can be compromised because factors like poor nutrition can enhance susceptibility to pollution) (Gee & Payne-Sturges, 2004; U.S. EPA, 2003).

In part, to address concerns about the limitations of the traditional risk assessment paradigm, new approaches have advanced down two tracks: 1) one that considers the combined effects of chemical mixtures resulting from similar modes of toxic action and leading to similar toxic endpoints, and 2) the other that considers the combined effects of exposure to chemicals and the interaction of non-chemical stressors such as socioeconomic status, low educational attainment, and inadequate access to health care and related psychosocial stress (Sexton, 2012). These two tracks represent two diverse approaches that characterize the majority of cumulative risk assessment scoping and problem formulation: a stressor-based approach used in assessments



of chemical mixtures and the effects-based approach that is used to examine combinations of chemical and nonchemical stressors (Sexton, 2012; U.S. EPA, 2003). While there is yet no single protocol for assessing cumulative risks using either the stressor-based or effects-based approaches, a number of published papers (Alexeeff et al., 2012; Huang & London, 2012; Sexton, 2012; Linder & Sexton, 2011; Sadd et al., 2011; Barzyk et al., 2010; Su et al., 2012; Menzie et al., 2007) offer a diverse set of methodological applications that have been used to evaluate cumulative risks and impacts.

Just as there is no consensus concerning approaches to assess cumulative risks, there is no single conceptual model to guide hypothesis testing or to inform risk management decisions to address health disparities likely resulting from the interaction of multiple stressors. A proposed conceptual model for examination of cumulative risks is found in Figure 1. This model extends the work of deFur et al. (2007) who emphasized vulnerabilities in the context of cumulative risk assessment. Social conditions such as social capital, resources, and behavior were identified as factors that contribute to vulnerability (p. 822), however these factors were not also considered for their potential protective qualities. Identified in this conceptual model as assets, their omission from the original model underscores the need for additional research on their impact on health outcomes identified in cumulative risk assessments. Specifically, these assets can buffer the manner in which stressors interact with individuals, communities, or populations (receptors) or how these receptors respond to stressors.



**Figure 1: Conceptual model of cumulative risk assessment**

The lack of consensus on approaches by which cumulative risks can be characterized and quantified poses challenges, not only for the scientific community, but for also for communities impacted by exposure to multiple chemical, biological, physical, and psychosocial stressors. Discourse with respect to cumulative risk assessment and helpful tools to facilitate its implementation have appeared in peer-reviewed scientific journals, government, and quasi-governmental organization publications (U.S. EPA, 1997; U.S. EPA, 2003; NEJAC, 2004; U.S. EPA, 2007; deFur et al., 2007; Alexeeff et al., 2012; Huang & London, 2012; Sexton, 2012; Linder & Sexton, 2011; Barzyk et al., 2010; Su et al., 2012; Menzie et al., 2007). The National Research Council (NRC) of the United States National Academies wrote in its 2009 publication, *Science & Decisions: Advancing Risk Assessment*, “EPA should focus on development of guidelines and methods for simplified analytic tools that could allow screening-level cumulative

risk assessment and could provide tools for communities and other stakeholders to use in conducting assessments,” (pp. 10, 236).

Published literature demonstrates a number of promising interventions to increase awareness of environmental hazards in disadvantaged communities to reduce exposure and enhance access to health resources (Krieger et al., 2002, Ali et al., 2008; Clark et al., 2009). Community-based participatory research (CBPR) is a collaborative approach, often between members of a community, academic researchers, and other stakeholders that engages the community as co-learners; thereby including community capacity-building strategies into the intervention design. The use of CBPR approaches links awareness gained through research and public health practice to improve community health and has the ability to create win-win partnerships between researchers and communities. In recent years, CPBR and other community-driven approaches have increasingly been used as a tool for health promotion activities (Viswanathan et al., 2004; Minkler et al., 2006; Cook, 2008). In particular, these approaches have been used to address a wide range of environmental exposures and environmental justice challenges in community settings including air pollution exposure (Gonzalez et al., 2011), the impact of the built environment on health (Downs et al., 2010), and the identification of industries that have violated emissions standards (LABB, 2011).

Although U.S. EPA published its Framework for Cumulative Risk Assessment in 2003, the development of local and state-based guidelines and methodologies to assess cumulative risks and impacts has been limited. This dissertation study contributes to a growing body of methodological approaches to integrate multiple stressors, including non-chemical ones, into the risk assessment process. The place-based study, described herein, includes three manuscripts that explore multiple environmental stressors and social factors in an environmentally degraded,

urban community, the Proctor Creek Watershed in Northwest Atlanta, Georgia using a mixed-methods approach. The study includes: quantitative, geospatial data analysis as well as participatory methods: Photovoice; identification and prioritization of street-level, neighborhood environmental health indicators; and participatory mapping. The three aforementioned manuscripts are contained in Chapters 2-4 of this document, however their purposes are also briefly described below:

- The first manuscript explores applications of screening-level cumulative impacts analyses at a small-scale watershed level using publicly available data. Adapting a cumulative impacts methodology developed by Huang & London (2012) to an analysis of the Proctor Creek Watershed, the authors' Cumulative Environmental Hazard Index was modified to address indicators of concern in Proctor Creek. Unique challenges to adapting such an approach at a small geographic scale are discussed. This study helps to illuminate opportunities for evidence-based decision-making as government agencies and other stakeholders target investments to improve environmental, social, and health conditions in the watershed.
- The second manuscript focuses on the use of a qualitative method, Photovoice to explore local community knowledge and community perceptions of environmental health risks, assets, and community strengths in the Proctor Creek Watershed. Visual data was captured through photographs taken by 10 Proctor Creek Watershed residents (Proctor Creek Watershed Researchers). This visual data has been used to influence the development of policy recommendations and strategies to mitigate risks and build upon community assets as means to decrease potential vulnerabilities in the watershed.

- The third manuscript describes the co-development, by Proctor Creek Watershed residents and Georgia State University students, of the Proctor Creek Citizen Science App. This global positioning system (GPS) enabled digital data collection tool is used to spatially and visually document meaningful yet “hidden” street-level, environmental hazards in the Proctor Creek watershed. Through a participatory approach, joint community-university teams used the App to map important attributes of the built environment that often go unaddressed in communities, yet negatively influence environmental quality, health, and quality of life. These hazards are not captured in publically available databases and therefore are typically not included in traditional risk assessment approaches despite their potential to fill data gaps for cumulative risk assessment approaches and methodologies. Spatial narratives created with community-generated data can expose “hidden hazards,” and advance environmental justice and policy change.

Results from these three manuscripts will be useful to those working in the field of cumulative risk and impacts. The methods used in these studies have the potential to be applied to other community settings, and the results will inform future public health interventions, public health practice to advance environmental justice, and methodologies for future research to advance the study of cumulative risk assessment.

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**Chapter 2: Exploring Applications of a Screening-level Cumulative Environmental Impact Analysis Model at a Small-Scale Watershed Level: Lessons Learned and Methodological Considerations**

Proposed Journal: *Environmental Justice*

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# **Exploring Applications of a Screening-level Cumulative Environmental Impact Analysis Model at a Small-Scale Watershed Level: Limitations, Lessons Learned, and Methodological Considerations**

**Key words:** cumulative risk assessment; cumulative impacts analysis; combined environmental vulnerability analysis; urban watershed

## **ABSTRACT**

Using publicly available data for environmental hazards and social stressors, we conducted a cumulative environmental vulnerability analysis for the Proctor Creek Watershed, a degraded, urban stream in Northwest Atlanta, Georgia. We generated scores for each census block group in the watershed for cumulative environmental hazards and social vulnerability and identified areas of highest cumulative impact. These areas, referred to as combined environmental vulnerability action zones (CEVAZ) reveal block groups with the highest combined environmental stressors and fewest social, economic and political resources to prevent, mitigate, or adapt to these conditions. Our analyses showed that there was little spatial overlap of areas in the Proctor Creek Watershed with respect to the highest scores for both cumulative environmental hazards and social vulnerability. Social vulnerability was also found to be more prevalent in the watershed than the distribution of environmental hazards. Despite the lack of overall correlation between the environmental hazards and social vulnerability scores, areas where these factors do overlap can be targeted for investments in environmental monitoring, pollution prevention activities, community capacity-building to engage in citizen science research, adult education and workforce development. The use of screening-level cumulative risk assessment tools provide environmental justice communities with an evidence base by which they can prioritize activities and investigation to improve the environmental and population health. Use of such tools can be

enhanced and made more relevant to communities if they are engaged to help identify data on hazards that don't exist in public databases, especially at small spatial scales.

## **Introduction**

Understanding cumulative impacts from combined environmental and social stressors is important to environmental justice communities. Exposure to these combined stressors present combined risks, also known as cumulative risks, from aggregate exposures to multiple agents or stressors, including chemical, biological or physical agents as well as psychosocial stressors like race and ethnicity, income, educational attainment, measures of social capital, and access to healthcare. When combined, such factors have the potential to negatively affect population health and quality of life. Findings from cumulative risk assessments can improve risk management and decision-making (U.S. Environmental Protection Agency, 2003), to address health disparities likely resulting from the interaction of multiple stressors, particularly at the local level.

A framework for cumulative risk assessment was recommended to the U.S. Environmental Protection Agency (U.S. EPA) in the National Environmental Justice Advisory Council's 2004 report on cumulative risk assessment, (NEJAC, 2004). The National Research Council (NRC) of the United States National Academies wrote in its 2009 publication, *Science & Decisions: Advancing Risk Assessment*, "EPA should focus on development of guidelines and methods for simplified analytic tools that could allow screening-level cumulative risk assessment and could provide tools for communities and other stakeholders to use in conducting assessments," (pp. 10, 236).

Despite the need for developing standard approaches and tools for assessing cumulative risks, there is yet no single protocol. The lack of consensus on approaches by which cumulative



risks can be characterized and quantified poses challenges, not only for the scientific community, but for also for communities impacted by exposure to multiple chemical, biological, physical, and psychosocial stressors. Environmental justice communities often want to understand their health risks and how to prevent them, but face many obstacles in accessing, integrating, and interpreting available data for risk ranking, prioritization, and decision-making (Zartarian et al., 2011). Furthermore, frameworks are needed to assist communities in prioritizing strategic action to reduce exposure to environmental hazards.

The lack of a single protocol for examining cumulative impacts is not due to a lack of interest or application of the approach. Discourse with respect to cumulative risk assessment and helpful tools to facilitate its implementation have appeared in peer-reviewed scientific journals, government documents, and quasi-governmental publications (U.S. EPA, 1997; U.S. EPA, 2003; NEJAC, 2010; U.S. EPA, 2007; deFur et al., 2007; Alexeeff et al., 2012; Huang & London, 2012; Sexton, 2012; Linder & Sexton, 2011; Barzyk et al., 2010; Su et al., 2012; Menzie et al., 2007). Furthermore, at least 23 states have either developed or adapted existing tools to analyze and evaluate cumulative risks and impacts (Gould & Cummings, 2013). Beyond state-level innovations, two online national environmental justice mapping and screening tools have recently been released by U.S. EPA, EJSCREEN and C-FERST. Both of these tools draw from national, publicly available datasets and combine environmental and demographic indicators for specific geographic areas based on user-directed input. EJSCREEN was not designed as a risk assessment tool, but it is a tool that both displays and derives environmental justice indexes from the combination of the aforementioned environmental and demographic indicators (U.S. EPA, 2015). C-FERST also allows users to gather information about and view maps of a desired community's environment; provides users with the ability to compare local, county, state, and

national estimates; explore potential solutions and community projects that reduce environmental exposures; and it contains guidance on ways that C-FERST can be used in conjunction with community assessment tools including U.S. EPA's Community Action for a Renewed Environment (CARE) Roadmap and the National Association of City and County Health Officials (NACCHO) Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) (U.S. EPA, 2015).

As national-level tools, both EJSCREEN and C-FERST provide a foundation upon which to build other cumulative risk assessment tools, however, they are both limited in their abilities to offer the full-range of environmental and social stressors that might be relevant to a specific location, and the publically available data that these tools derive their findings from are likely to be somewhat dated. Significant uncertainty also exists with respect to relevant environmental and social stressors, especially when studying small geographic areas (U.S. EPA, 2015).

The gap between what can be derived from national-level screening tools and what is locally relevant is even more evident in the state of Georgia where no local or state-level guidance for screening methodologies exist with respect to cumulative exposures or impacts. In the absence of such a guidance, however, a 2012 report published by GreenLaw, a non-profit environmental law firm, identifies environmental justice hotspots in Metro Atlanta using geographic information systems (GIS) analysis in a 14-county geographic area. Although the authors did not use the terms cumulative risks or impacts in the report, they cited research on cumulative impacts from published case studies in other states and produced a ranking of areas within the designated 14-county Metropolitan Atlanta area. While data from this report was used to help advance the development and passage of an amendment to a county zoning resolution that established distance requirements between proposed adverse environmental uses and pre-

existing pollution points in unincorporated areas (Fulton County Government, 2013; GreenLaw, 2013), the study has not been translated into policy or action that directly affects communities located in the city of Atlanta or other incorporated areas of that county.

### *Purpose of Study*

The purpose of this study was to identify the census block groups in Northwest Atlanta's Proctor Creek Watershed with the highest scores for combined cumulative environmental hazards and social vulnerability. Based on what is known about the pollution burden in the Proctor Creek Watershed and community characteristics, specifically sensitivity to socioeconomic factors, we hypothesized that the upper reaches of the Proctor Creek Watershed would exhibit greater clusters of census block groups with the combined highest concentration of cumulative environmental hazards and the fewest social resources to prevent, mitigate, or adapt to these conditions, than the lower reaches of the watershed. By conducting the study, we can help regulators and other government agencies, watershed residents, funders, non-profit and community-based organizations located in and working in the Proctor Creek Watershed to better focus efforts and resources on the areas within the watershed that are most highly impacted by environmental stressors but least able to confront and address these stressors because of high social vulnerability. This study serves to build on previously published work by Huang & London (2012) by adapting their cumulative environmental vulnerability assessment (CEVA) model to a watershed context for the first time. It also leverages the cumulative impact assessment work conducted in the Duwamish River Watershed (Gould & Cummings, 2013), a significantly larger watershed area (with cumulative impacts analyses performed at the zip code level), to employ similar cumulative risk analysis tools at a smaller spatial scale.

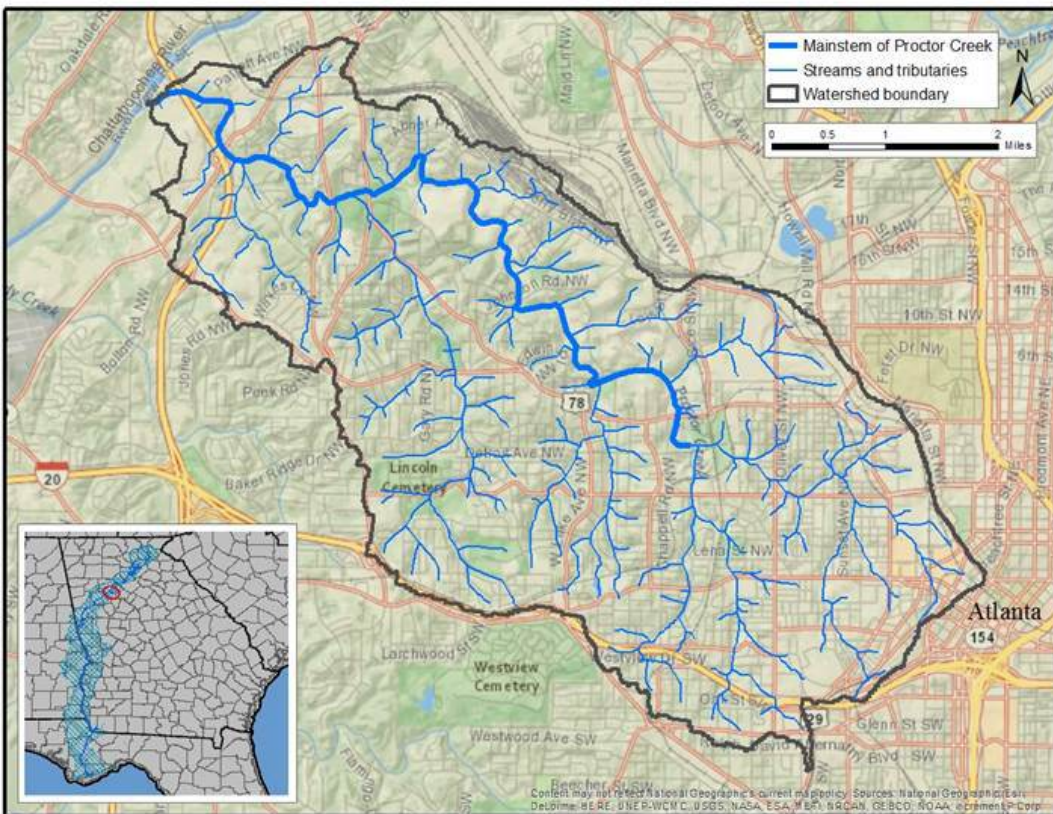
## **Methodology**

### *Study Area*

This study was conducted in the Proctor Creek Watershed located in Northwest Atlanta, (Fulton County) Georgia. Proctor Creek is a second order, urban tributary to the Chattahoochee River (DeVivo, 1995) and, comprises the only major watershed located wholly in the City of Atlanta (City of Atlanta, 2016). Proctor Creek originates in downtown Atlanta and travels for nine miles northwest to the Chattahoochee River (See Figure 1). The Chattahoochee provides drinking water for approximately four million Georgia residents including 70% of the people in the Metropolitan Atlanta Region (in the approximate amount of 450 million gallons per day) (Chattahoochee Riverkeeper, 2015) and has been listed as a threatened or endangered river on American River's Most Endangered List for seven times from 1991 to 2012 in part because of sewage pollution from the City of Atlanta, non-point source pollution, and urban development (American Rivers, 2015).

The 16 square-mile Proctor Creek Watershed is home to 38 neighborhoods, four historically black colleges and universities, an NFL football stadium, the historic homes of civil rights leaders such as Dr. Martin Luther King Jr., and more than 90,000 residents; the majority of whom are African American (United States Census Bureau, 2013; About Proctor Creek, 2015; Proctor Creek Stewardship Council, 2015; City of Atlanta, 2013). It is also home to several brownfield sites, a closed landfill, and some of the city's lowest income, highest crime, and most historically underserved neighborhoods (Zipatlas, 2016; City of Atlanta, 2015; U.S. EPA, 2015; U.S. EPA, 2014; Neighborhood Nexus, 2012; Jonsson, 2008; Williams, 2008). Because of aging infrastructure, illegal dumping, industrial activities, and the proliferation of non-point source pollution, Proctor Creek is highly impacted by environmental and other stressors and consequently does not meet its state designation as a fishable stream (GA Environmental

Protection Division, 2015; GA Environmental Protection Division, 2013; ARC, 2011). The watershed is also home to the fourth in a top five list of Metropolitan Atlanta’s environmental justice hotspots---locations where race, poverty, and pollution were most strongly correlated (GreenLaw, 2012).



**Figure 1: Map of Proctor Creek Watershed (About Proctor Creek, 2015)**

### ***Procedure***

Using ESRI ArcMAP, Version 10.1, and employing a cumulative environmental vulnerability assessment (CEVA) adapted from the work of Huang and London (2012), environmental and social vulnerability stressors impacting the watershed were analyzed. Data

from publicly available sources were examined at the census block group level and at the census tract level when block group data was unavailable. The watershed consists of 34 census tracts and 64 census block groups, with an average of 1.88 block groups per census tract (United States Census, 2014). A Cumulative Environmental Hazards Index (CEHI) similar to one previously published by Huang and London (2012) was constructed using datasets of interest to Proctor Creek Watershed residents (within the constraints of publicly available data). A Social Vulnerability Index (SVI) also based on the work of Huang and London was constructed utilizing data from the U.S. Census Bureau's American Community Survey (ACS) and point locations of healthcare facilities in the watershed. Descriptions of each index can be found below along with details on the data sets that comprise each of the indices in Tables 1 and 2 respectively. A map displaying the point-location data used in this study was shared with a group of Proctor Creek Watershed researchers (Jelks et al., 2016) to validate our approach in the context of community knowledge of environmental hazards in the watershed.

### *Cumulative Environmental Hazards*

The CEHI is a relative measure of environmental hazards calculated at the census block group level with possible scores between 0 and 1. The CEHI scores were primarily derived from the percentage of each census block group that overlaps with a one-half mile buffer around point source pollution sites as indicated in Table 1, and data from the National Air Toxics Assessment (NATA) was also used to estimate the risk of different types of cancer that result from inhaling toxics in the air. All data were normalized as the percent area of each block group within the half-mile buffer of the aforementioned point source pollution sites by dividing each value by the maximum value of the dataset. This normalization was followed by calculating the mean value

of the normalized datasets (point sources and total cancer risk) to obtain the cumulative score for the cumulative environmental hazard index.

<b>Data Type</b>	<b>Data Source</b>	<b>Timeframe</b>	<b>Description</b>
Toxic Release Inventory (TRI) Sites	U.S. Environmental Protection Agency	2013	Toxic Release Inventory Sites
Hazardous Waste Treatment, Storage, and Disposal Facilities	U.S. Environmental Protection Agency	2013	Hazardous Waste Treatment, Storage, and Disposal Facilities (RCRA Large and Small Quantity Generators)
National Pollution Discharge Elimination System (NPDES) permitted facilities	U.S. Environmental Protection Agency	2013	Sites that operate with NPDES permits
Comprehensive Environmental Response Compensation and Liability Act sites (CERCLIS)	U.S. Environmental Protection Agency	2013	CERCLIS (Superfund) site locations
Risk Management Plan Facility (RMPF) sites	U.S. Environmental Protection Agency	2013	Sites regulated under the Risk Management Plan Rule, (Section 112(r)) of the 1990 Clean Air Act
Georgia Hazardous waste inventory (HSI) sites	Georgia Department of Natural Resources, Environmental Protection Division	2013	Sites on the Georgia hazardous sites inventory list.
NATA	U.S. Environmental Protection Agency	2005	National-Scale Air Toxics Assessment (Total Cancer Risk)

**Table 1:** Data used to develop the Cumulative Environmental Hazards Index (CEHI) for the Proctor Creek Watershed

### *Social Vulnerability Index*

The data and data sources used to calculate the SVI are described in Table 2. Address geocoding in Google Earth followed by conversion to a shapefile in ESRI ArcMap 10.1 was used to create a point-location data for a spatial layer of health care facilities in the watershed. A one-half mile buffer zone was drawn around each of these facilities, and the percentage of each census block group that overlaps with the one-half mile buffer was calculated and assigned to the corresponding census block group to calculate the SVI. In our index, the presence of said facilities were considered an indicator of need. Along with the percent of each area within the one-half mile buffer around the health care facilities, percent vulnerable populations due to age (such as those under the age of five or age 60 and above), percent of families living below the federal poverty level, and percent of the population over age of 25 who have not earned a high school diploma were also used to develop the SVI. The mean value of these social stressors were calculated and then normalized to obtain the cumulative score for the social vulnerability index for each block group.

<b>Data Type</b>	<b>Data Source</b>	<b>Timeframe</b>	<b>Description</b>
Age	American Community Survey	2009-2013	Percent of people younger than five (5) or age 60 or older
Location of health care facilities	Fulton County Department of Health	2013	Location of health care facilities
Percent of families living below poverty level	American Community Survey	2009-2013	Estimates - based on a sample survey - of families who fall below the federal poverty line
Educational Attainment	American Community Survey	2009-2013	Percent of people over age 25 without a high school diploma

**Table 2:** Data used to develop the Social Vulnerability Index (SVI) for the Proctor Creek Watershed



In both indices, the data were oriented in the same direction with higher values for the CEHI corresponding to higher concentrations of cumulative environmental hazards, and higher values for the SVI corresponding to higher social vulnerability in the census block groups.

The combined CEHI and SVI scores for each block group were then ranked from largest to smallest and initially divided into thirds to yield three different categories (low, medium, and high) for both the cumulative environmental hazards and social vulnerability respectively. Due to the small scale of the study area, medium and high values were combined together into a new classification: high, and low values were retained in their initial classification.

A series of bivariate correlation analyses using IBM SPSS Statistics, Version 22 were performed to explore associations between the CEHI and SVI as well as between the individual variables that comprise each index and associations between individual components of the CEHI with components of the SVI.

## **Results**

### ***Identification of Cumulative Environmental Vulnerability Action Zones***

Bivariate analysis revealed that the overall CEHI and SVI were weakly negatively correlated, although the relationship was not statistically significant (See Table 3).

Table 3

Correlation Matrix for CEHI and SVI

---

Variable	1	2
1. CEHI	-	-.22
2. SVI		-

---

Note: \* $p < .05$ , \*\* $p < .01$

---

Individual components of the CEHI and SVI were positively correlated with each other, however. Bivariate analyses shows statistically significant positive correlations between the presence of Resource Conservation Recovery Act (RCRA) regulated large quantity generators (RLQG) and risk management plan facilities (RMPF), RCRA small quantity generators (RSQG) and Georgia Hazardous Site Inventory (HSI) facilities, RCRA small quantity generators (RSQG) and toxic release inventory (TRI) sites, Georgia HSI facilities and Comprehensive Environmental Response Compensation and Liability Act Sites (CERCLIS), and Georgia HSI and TRI facilities. Furthermore, statistically significant associations were also identified between CERCLIS and TRI sites and TRI and national pollutant discharge elimination system (NPDES)-permitted sites (See Table 4).

Table 4

*Correlation Matrix for Cumulative Environmental Hazards Index*

Variable	1	2	3	4	5	6	7	8
1. RSQG	-	.22	.29	.72**	.41**	.24	.15	-.13
2. RLQG		-	.33**	.10	-.04	-.12	-.08	.12
3. RMPF			-	.08	-.16	-.13	-.04	.17
4. HIS				-	.36**	.54**	.10	-.19
5. TRI					-	.26*	.27*	-.18
6. CERCLIS						-	-.17	-.5**
7. NPDES							-	.03
8. NATA								-

*Note: \*p<.05, \*\*p<.01*

Within the SVI, bivariate analyses shows positive statistically significant associations between percent of population living below the poverty level (Poverty) and percent vulnerable populations as well as Poverty and percent of population over the age of 25 without a high school diploma (Education). Location of health care facilities (HCF) and Education were positively correlated as were percent of vulnerable populations (VUL\_POP) and Education (See Table 5).

Table 5

*Correlation Matrix for Social Vulnerability Index*

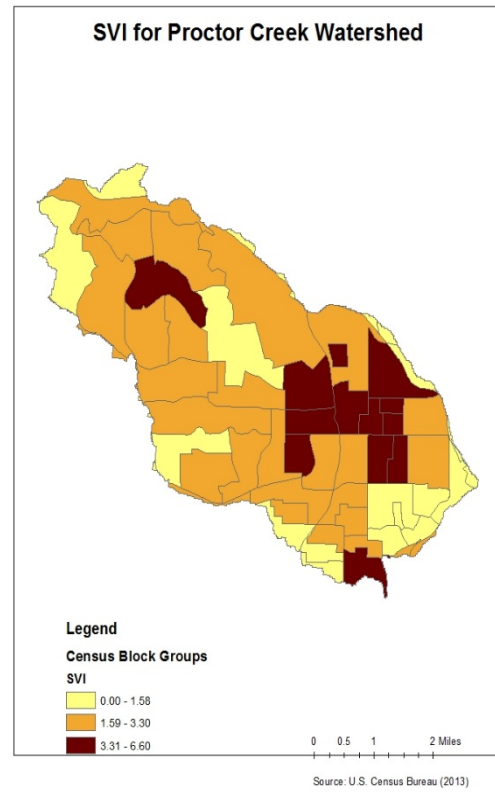
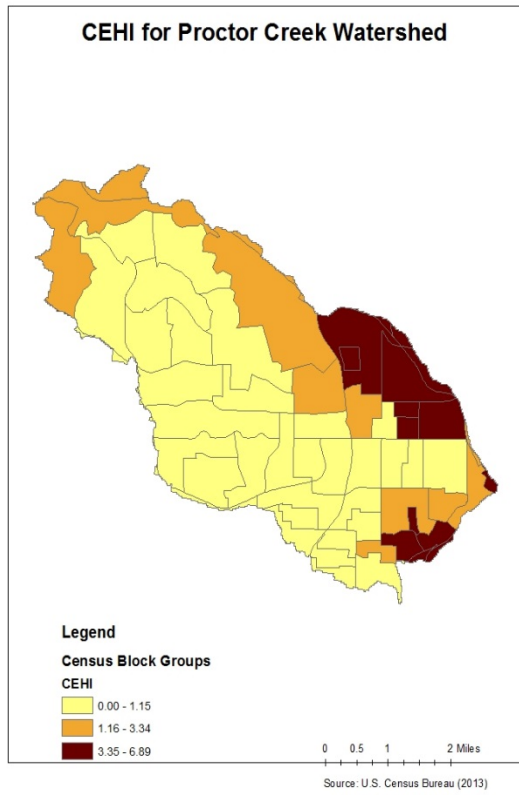
Variable	1	2	3	4
1. HCF	-	.03	.32*	.04
2. VUL_POP		-	.25*	.32**
3. EDUCATION			-	.37**
4. POVERTY				-

*Note: \* $p < .05$ , \*\* $p < .01$*

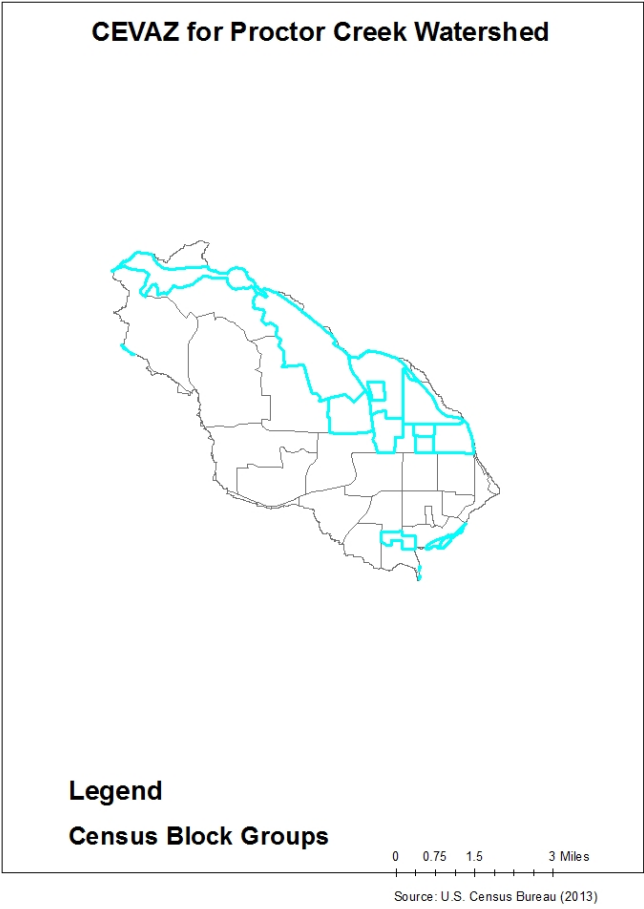
Statistically significant negative correlations exist between location of RCRA large quantity generators and Poverty and percent vulnerable populations respectively; RCRA small quantity generators and percent vulnerable populations; Georgia HSI facilities and percent vulnerable populations; and NATA total cancer risk and Poverty and RCRA large quantity generators and Education and RMPF and Education.

Spatially, cumulative environmental hazards were concentrated near the north, northwest, and northeast borders of the Proctor Creek Watershed and, to a lesser extent, near the eastern and southeastern boundaries. The majority of the watershed is characterized by social vulnerability. Priority areas where the two indices overlap were identified in the following locations: upstream and downstream near the northern, northwest, and northeastern boundaries of the watershed and near the southeast border (See Figure 4). Furthermore, social vulnerabilities are more widespread across the watershed than environmental vulnerabilities; perhaps requiring additional investments in the watershed to address social disparities.

For more meaningful analysis and comparison to the work by Huang and London, CEVAZ were identified where CEHI and SVI were either medium or high as shown in Figures 2a and 2b. Based on this categorization, more than 67% of the census block groups were classified as having high social vulnerability while 45% of the blocks groups are characterized by high cumulative environmental hazards. When examining where these two factors overlap, only 17.4% of the population in the Proctor Creek Watershed was identified as living in census block groups with both high CEHI and SVI scores. This finding did not align with community perceptions of widespread environmental pollution and degradation in the watershed. Furthermore, 38.2 % of the population lives in block groups with high CEHI and low SVI scores, 35.3% with high SVI and low CEHI scores, and 9% with both low SVI and CEHI scores. In census block groups with high social vulnerability, percent population in poverty was the factor that contributed most to the high social vulnerability scores.



**Figure 2a and b:** Cumulative Environmental Hazards (2a) and Social Vulnerability Indices for the Proctor Creek Watershed (2b)



**Figure 3:** Cumulative environmental action zones (CEVAZ) for the Proctor Creek Watershed (census block groups with combined high cumulative environmental hazards and social vulnerability)

**Table 6:** Proctor Creek Watershed Cumulative Environmental Vulnerability Action Zones

<b>Category</b>	<b>Population size (% of total population)</b>	<b># of census block groups impacted</b>	<b>% below poverty</b>	<b>% young or elderly</b>	<b>% over 25 without high school diploma</b>
<b>High SVI/High CEHI</b>	15,677 (17.4%)	15	33.8%	22.2%	24.6%
<b>Low SVI/High CEHI</b>	34,436 (38.2%)	14	11.7%	7.0%	11%
<b>High SVI/Low CEHI</b>	31,810 (35.3%)	28	38.3%	24.8%	23.2%
<b>Low SVI/Low CEHI</b>	8,127 (9.0%)	7	18.1%	24.5%	14.4%

## **Discussion**

Although the hypothesis that census block groups in the upper reaches of the watershed would have the largest clusters of high CEHI and SVI scores was proven, these block groups exist somewhat independently of each other, and the extent of spatial overlap of the indices is minimal. There was a weak negative correlation between the CEHI and SVI for the Proctor Creek Watershed although it was not statistically significant. Pollution generating facilities were primarily concentrated in census block groups along the northern borders of the watershed, and social vulnerability was fairly widespread with only a small portion of the watershed characterized as having low social vulnerability. These areas of low social vulnerability overlap, in part, with the portion of the watershed that is in central Atlanta business district where income levels tend to be higher as well as near the confluence of the Chattahoochee River where poverty is also not as severe as communities in the headwaters of the watershed. The difference in social



vulnerability near the confluence is likely influenced by the dismantling of public housing in these areas (Brown, 2009).

Although there was little direct, overall overlap of areas with the highest scores for the CEHI and SVI, the CEVAZ identified in this analysis will be used to help inform environmental justice policy recommendations as well as recommendations related to investments in community capacity-building, environmental monitoring, and corrective action to address environmental stressors in the Proctor Creek Watershed. Neighborhood Planning units, community-based organizations, and non-profit organizations that are active in these geographic areas can prioritize and target their advocacy and outreach efforts to encourage future studies, ongoing environmental monitoring, pollution prevention activities, and greater transparency with respect to actions taken by neighboring industrial facilities in the context of right-to-know and emergency planning laws (Fischer, 2005). The prevalence of social vulnerability in the watershed suggests opportunities for investment in adult education, workforce development initiatives, and other efforts that lead to greater levels of employment; thereby reducing income gaps and the influence of social stressors on risk vulnerabilities (CDC, 2011).

There are several limitations to this analysis that should be noted including limitations of the publicly available data used in the approach, inadequate capture of land-use activity, the gap between existence of a hazard and exposure, and equal weighting of hazards. The lack of availability of publicly accessible, local data especially with respect to the location of and occurrence of non-chemical, environmental hazards in the watershed can greatly impact the results of cumulative risk analyses. As noted about other screening tools, land-use activity cannot be captured in the analysis (Sadd et al, 2011). To that end, only chemical hazards are included in the model, however some physical and biological hazards are also of concern to community

residents. When data from this analysis was shared with residents of the Proctor Creek Watershed, concern was expressed about the lack of inclusion of important stressors that have potential to impact health and quality of life (Jelks, 2016). Data about other environmentally adverse uses, especially at the street or neighborhood level, are not as readily available as the data sources used in the index. They are therefore not captured in the model and might result in the exclusion of potentially important sources of risk.

Also, the presence of hazard sites is not equivalent to potential for or actual human exposure to the sites. For example, the presence of sites such as combined sewer overflow facilities are included in the model, however the total number of combined sewer and or sanitary sewer overflows impacting Proctor Creek and the neighborhoods through which it flows is not. Depending on the dataset, presence of a site also does not necessarily signify whether the site is active or closed. Because the model does not address the type of waste generated, processed, or stored in the facilities, there is no determination of whether the activities at the facility will lead to broader exposure. The CEVA model represents a measure of vulnerability and risk. Because risk is a prospective measure, we don't know the true impact until an exposure happens and is identified. Conducting a cumulative environmental vulnerability analysis is helpful in supporting risk management decisions, however it does not reveal current sources or extent of exposure (Lentz et al., 2015; Sexton & Linder, 2010; Corburn, 2002).

In our approach environmental hazards are added together and averaged to help calculate CEHI scores for each census block group; therefore no weighting of the significance or severity of the hazards are considered. To avoid making value judgements on what the affected community considers important, all hazards were weighted equally. The actual greatest sources of risk might not correspond to greatest perceived sources of risk as identified by residents and

other watershed stakeholders. Because this model represents a screening-level methodology and not risk assessment in a regulatory context, it was deemed inappropriate to establish thresholds based on value judgements.

### *Lessons Learned and Methodological Considerations*

Because environmental justice communities are generally concerned about cumulative impacts in relatively small geographic scales (i.e. neighborhood level, watershed scale, etc.), the resultant information from analyses performed at larger scales (i.e., the census tract, zip code, or county levels) can only provide generalized knowledge and therefore might not adequately meet the needs and interests of impacted communities. This limitation can greatly impact the ability of a community to carry out risk ranking activities. Furthermore, exploring spatial and statistical associations between variables at larger units of analysis might disguise relationships within and between those units that might not exist or may be represented differently when conducting analysis at smaller units (i.e., census block groups).

In conducting spatial analyses, buffers drawn around the point locations of environmental stressors and pollution generating facilities should be considered at spatial scales that are representative of the area being studied, and choosing varying distances should be explored to determine the optimal distance that will prevent masking of variations in the data. In this study, buffers were chosen at a distance of 0.5 miles around the aforementioned hazard sites and healthcare facility point locations although previously published studies used larger values (Huang & London, 2012). Because of the relatively small scale of the watershed, drawing buffers at larger areas might have artificially inflated the census block groups potentially impacted by environmental hazards.

At small spatial scales, data gaps can be enhanced through the use of fine-grained, locally collected data, including data collected by trained citizen science researchers. While data at smaller spatial scales is more desirable and might enhance relevance of cumulative impact analyses for a specific local area, it may be less reliable in its statistical significance or stability as cumulative risk indicators (Gould & Cummings, 2013). The cumulative risk assessment process can then be refined through employing an iterative process and should be coupled with tools such as the 8-Step CARE Roadmap, PACE-EH, or where appropriate, the steps for conducting health impact assessments (HIAs). These processes integrate community in meaningful dialogue and sharing of local knowledge that can illuminate the presence of environmental hazards that would otherwise be missed and not included in cumulative risk analyses.

### **Recommendations and Directions for Future Research**

Recommendations from this study include the need for investment in further research and locally-driven data collection efforts, including citizen science initiatives, to ensure that otherwise hidden hazards are integrated into cumulative risk analyses (CRA); thereby increasing accuracy and robustness of CRA models. Integrating publicly available data with locally-collected data that present a more fine-grained picture of potential risk at the neighborhood or street levels, would greatly improve this analysis. When conducting cumulative risk analyses, it is also important to engage community residents--- those with historical knowledge, lived experience, daily interactions within, and a vested interest in the future of a particular place. In examining community concerns about environmental issues and health hazards, those impacted

by such issues and hazards can help inform risk management decisions, interventions, and further research (Corburn, 2002).

At a watershed scale, in particular, other factors for analyses can also improve predictions from the model. If integrated into the model in a meaningful way, data such as percent of impervious surfaces as well as percent vegetative cover, existence of and acreage of parks and greenspace as well as green infrastructure can help identify additional hazard risk and potential factors to mitigate said risks. Other meaningful factors for analyses include built environment stressors such as age and condition of occupied housing stock, risk of West Nile Virus, and water quality data. Tracking these indicators as they change over time might be useful in helping local communities understand the implications of policy and practice recommendations that are implemented as a result of cumulative risk analyses.

## **Conclusion**

This study applied a cumulative impacts screening method to a small-scale watershed area in Atlanta, Georgia. We demonstrated that screening-level cumulative risk assessment tools are useful in helping environmental justice communities to identify priority areas to target for a wide range of activities to improve environmental quality and reduce social disparities that impact health. Only publically available data was used in the study, however the use of cumulative risk analysis tools can be enhanced by the inclusion of local data at small spatial scales, particularly the neighborhood and street levels. Often having localized data can present opportunities for the finer-grained analysis needed to influence relevant decision-making and strategic action (London et al, 2011) in the most vulnerable communities. Citizen science initiatives can play a key role in advancing the collection of such data and engaging communities

in meaningful ways in the process of cumulative risk assessment. The results of exploring cumulative risks and impacts in a community also amplifies the need for public policies and risk management activities to address environmental and social hazards through coordinated, comprehensive approaches instead of the segmented, approaches that characterize current regulatory and risk management paradigms.

## References

- About Proctor Creek. (2014). Retrieved from: <http://aboutproctorcreek.info/>.
- American Rivers. (2015). Most Endangered Rivers. Retrieved from: <http://www.americanrivers.org/endangered-rivers/about/>
- Alexeeff, G.V., Faust, J.B., August, L.M., Milanese, C., Randles, K., Zeise, L. & Denton, J. (2012). A method for assessing cumulative impacts. *International Journal of Environmental Research and Public Health*, 9, 648-659; doi:10.3390/ijerph9020648.
- Ali, R., Oden, K., & Xu, S. (2008). Community-based participatory research: a vehicle to promote public engagement for environmental health in China. *Environmental Health Perspectives*. 116(10): doi:10.1289/ehp.11399
- Atlanta Regional Commission (ARC). (2011). Proctor Creek – *Headwaters to the Chattahoochee: Watershed Improvement Plan*. Atlanta, Georgia.
- August, L.M., Faust, J.B., Cushing, L., Zeise, L. & Alexeeff, G.V. (2012). Methodological considerations in screening for cumulative environmental health impacts: Lessons learned from a pilot study in California. *International Journal of Environmental Research and Public Health*, 9, 3069-3084; doi:10.3390/ijerph9093069.
- Baron, S., Sinclair, R., Payne-Sturges, D., Phelps, J., Zenick, H., Collman, G.W., O'Fallon, L.R. (2009). Partnerships for environmental and occupational justice: contributions to research, capacity and public health. *American Journal of Public Health*, (99)3,S517-25.
- Barzyk, T.M., Wilson, S. & Wilson, A. (2015). Community, state, and federal approaches to cumulative risk assessment: Challenges and opportunities for integration. *International Journal of Environmental Research and Public Health*, 12, 4546-4571; doi:10.3390/ijerph120504546.
- Barzyk, T.M., Conlon, K.C., Chahine, T., Hammond, D.M., Zartarian, V.G., & Schultz, B.D. (2010). Tools available to communities for conducting cumulative exposure and risk assessments. *Journal of Exposure Science and Environmental Epidemiology*, 20, 371-384.
- Braithwaite, R. L., Taylor, S.E., & Austin, J.N. (2000). Communities of color respond to environmental threats to health. *Building health coalitions in the black community* (pp.81-99). Thousand Oaks, California: Sage Publications.
- Brender, J.D., Maantay, J.A. & Chakraborty, J. (2011). Residential proximity to environmental hazards and adverse health outcomes. *American Journal of Public Health*, 101, S37-S52.

- Brown, R. (2009, June 20). Atlanta is making way for new public housing. *The New York Times*. Retrieved from: [http://www.nytimes.com/2009/06/21/us/21atlanta.html?\\_r=0](http://www.nytimes.com/2009/06/21/us/21atlanta.html?_r=0).
- Bullard, R.D., Mohai, P., Saha, R. & Beverly Wright. (March 2007). *Toxic wastes and race at twenty 1987-2007: Grassroots struggles to dismantle environmental racism in the United States*. Cleveland, Ohio: United Church of Christ Justice and Witness Ministries.
- Centers for Disease Control and Prevention (CDC). (2011). CDC Health Disparities and Inequalities Report – United States, 2011. Retrieved from: <http://www.cdc.gov/mmwr/pdf/other/su6001.pdf>.
- Chattahoochee Riverkeeper. (2015). River Uses. Retrieved from: <https://chattahoochee.org/river-uses/>
- Clark, N.M., Mitchell, H.E. & Rand, C.S. (2009). Effectiveness of educational and behavioral asthma interventions. *Pediatrics*, 3, 185-192.
- City of Atlanta (2015). City of Atlanta brownfield program. Retrieved from: <http://www.atlantaga.gov/index.aspx?page=382#BKAssessment>
- City of Atlanta (2016). The Proctor Creek Watershed. Retrieved from: <http://www.atlantawatershed.org/inside-dwm/offices/watershed-protection/atlantas-watersheds/the-proctor-creek-watershed/>
- Cook, W.K. (2008). Integrating research and action: a systematic review of community-based participatory research to address health disparities in environmental and occupational health in the USA. *Journal of Epidemiology and Community Health*, 62(8):668-76.
- Corburn, J. (2002). Combining community-based research and local knowledge to confront asthma and subsistence-fishing hazards in Greenpoint/Williamsburg, Brooklyn, New York. *Environmental Health Perspectives*, 110(2): 241-248.
- Corburn, J. (2002). Environmental justice, local knowledge, and risk: The discourse of a community-based cumulative exposure assessment. *Environmental Management*, 29(4), 451-466.
- Corburn, J. (2005). *Street Science: Community Awareness and Environmental Health Justice*, chap. 3 (Cambridge, MA: MIT Press, 2005).
- deFur, P.L., Evans, G.W., Hubal, E.A.C., Kyle, A.D., Morello-Frosch, R., & Williams, D.R. (2007). Vulnerability as a function of individual and group resources in cumulative risk assessment. *Environmental Health Perspectives*, 115(5): 817-824.
- DeVivo, J.C. (1995). Impact of introduced red shiners, *Cyprinella Lutrensis*, on stream fishes



- near Atlanta, Georgia. In K.J. Hatcher (Ed.), Proceedings of the 1995 Georgia Water Resources Conference (pp. 95-98). Athens, GA: The University of Georgia, Carl Vinson Institute of Government.
- Downs, T.J., Ross, L., Mucciarone, D., Calvache, M-C., Taylor, O., & Goble, R. (2010). Participatory testing and reporting in an environmental-justice community of Worcester, Massachusetts: a pilot project. *Environmental Health*, 9,34.
- Dunn, A.J. & Alexeeff, G.V. (2010). Beyond risk assessment: Principles for assessing community impacts. *International Journal of Toxicology*, 29(1), 78-87.
- Elmwood, S. (2009). Multiple representations, significations and epistemologies in community-based GIS. *Qualitative GIS: A Mixed Methods Approach* (SAGE Publications, Inc.).
- Environmental Justice Advisory Council (NEJAC). (2004). *Ensuring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts*. Retrieved from: <http://www.epa.gov/environmentaljustice/resources/publications/nejac/nejac-cum-risk-rpt-122104.pdf>
- Faust, J.B. (2010). Perspectives on cumulative risks and impacts. *International Journal of Toxicology*, 29(1). 58-64.
- Fischer, F. (2005). *Citizens, Experts, and the Environment: The Politics of Local Knowledge* (Duke University Press, Duram, NC), 143-192.
- Fitzpatrick, K. and LaGory, M. (2011). *Unhealthy cities: poverty, race, and place in America*, 6.
- Freudenberg, N., Pastor, M., & Israel, B. (2011). Strengthening Community Capacity to Participate in Making Decisions to Reduce Disproportionate Environmental Exposures. *American Journal of Public Health*, 101, 123-129.
- Fulton County Government (2013). Fulton Board adopts innovative environmental justice policy. Retrieved from: <http://fultoncountyga.gov/latest-news/6229-fulton-board-adopts-innovative-environmental-justice-policy>
- Gee, G.C. & Payne-Sturges, D.C. (2004). Environmental health disparities: A framework Integrating psychosocial and environmental concepts. *Environmental Health Perspectives*, 112(17) 1645-1653.
- Georgia Environmental Protection Division (GA EPD). (2015). Georgia's Water Quality Standards. Retrieved from: <http://epd.georgia.gov/georgia-water-quality-standards>.
- Georgia Environmental Protection Division (GA EPD). (2013). Georgia's 2012 305(b)/303(d) List of Waters. Retrieved from: <http://www.gaepd.org/Documents/305b.html>.

- Gonzalez, P.A., Minkler, M., Garcia, A.P., Gordon, M., Garzon, C., Palaniappan, M., Prakash, S. & Beveridge, B. (2011). Community-based participatory Research and Policy Advocacy to Reduce diesel exposure in West Oakland, California. *American Journal of Public Health*, 101, 166-175.
- Gould, L. & Cummings, B.J. (2013). Duwamish Valley Cumulative Health Impacts Analysis: Seattle, Wasngington, Just Health Action and Duwamsih River Cleanup Coalition/Technical Advisory Group.
- GreenLaw. (2012). *The Patterns of Pollution: A Report on Demographics and Pollution in Metro Atlanta*. Retrieved from: <http://greenlaw.org/Files/GreenLaw/2012/PatternsofPollution,FINAL,GreenLaw3-26-2012.pdf>.
- GreenLaw (2013). Environmental justice prevails in Atlanta zoning: Atlanta-area zoning amendment adds environmental justice reviews. Retrieved from: Retrieved from: <http://greenlaw.org/news/press-releases/environmental-justice-prevails-in-atlanta-zoning.html>
- Huang, G. & London, J.K. (2012). Cumulative environmental vulnerability and environmental justice in California's San Joaquin Valley. *International Journal of Environmental Research and Public Health*, 9, 1593-1608; doi:10.3390/ijerph9051593.
- Jelks, N.O., Smith, D.O., Hawthorne, T., Fuller, C.H., Dai, D. & Stauber, C.E. (2016) *Participatory research in Northwest Atlanta's Proctor Creek Watershed: Using Photovoice as a tool to explore environmental health risks at the water's edge*. Unpublished manuscript.
- Jelks, N.O., Stauber, C.E., Dai, D., Fuller, C.H. & Hawthorne, T. (2016). Mapping the hidden hazards: Spatial data collection of street-level environmental stressors in a degraded, urban watershed.
- Jonsson, P. (2008). New life for Atlanta's English Avenue. *The Christian Science Monitor*. Retrieved from: <http://www.csmonitor.com/USA/2008/1211/p02s01-usgn.html>
- Krieger, J.K., Takaro, T.K., Allen, C., Song, L., Weaver, M., Chai, S. & Dickey, P. (2002). The Seattle-King County healthy homes project: implementation of a comprehensive approach to improving indoor environmental quality for low-income children with asthma. *Environmental Health Perspectives*, 2,322-22.
- Lentz, T. J., Dotson, G. S., Williams, P. R. D., Maier, A., Gadagbui, B., Pandalai, S. P., Lamba, A., Hearl, F., & Mumtaz, M. (2015). Aggregate Exposure and Cumulative Risk Assessment—Integrating Occupational and Non-occupational Risk Factors. *Journal of Occupational and Environmental Hygiene*, 12(sup1), S112–S126. <http://doi.org/10.1080/15459624.2015.1060326>.

- London, J., Huang, G., & Zagofsky, T. (2011). *Land of Risk/ Land of Opportunity*. UC Davis Center for Regional Change (Davis, CA). Retrieved from: [http://www.crla.org/sites/all/files/content/uploads/Resources/Report\\_Land\\_of\\_Risk\\_Land\\_of\\_Opportunity.pdf](http://www.crla.org/sites/all/files/content/uploads/Resources/Report_Land_of_Risk_Land_of_Opportunity.pdf)
- Louisiana Bucket Brigade. (2011). Environmental Health Monitoring Tools. Retrieved from: <http://www.labucketbrigade.org/article.php?list=type&type=4>.
- MacDonnell, M.M., Haroun, L.A., Teuschler, L.K., Rice, G.E., Hertzberg, R.C., Butler, J.P., Chang, Y., Clark, S.L., Johns, A.P., Perry, C.S., Garcia, S.S., Jacobi, J.H. & Scofield, M.A. (2013). Cumulative risk assessment toolbox: Methods and approaches for the practitioner. *Journal of Toxicology*, 1-36.
- Menzie, C.A., MacDonell, M.M. & Mumtaz, M. (2007). A phased approach for assessing combined effects from multiple stressors. *Environmental Health Perspectives*, 115(5) 807-816.
- Minkler, M., Vasquez, V.B., Warner, J.R., Steussey, H. & Facente, S. (2006). Sowing the seeds for sustainable change: a community-based participatory research partnership for health promotion in Indiana, USA and its aftermath. *Health Promotion International*, 2,293-300.
- National Association of County and City Health Officials (NACCHO).(2000). *Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) Guidebook*, 50-56.
- National Environmental Justice Advisory Council (NEJAC). (2004). *Ensuring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts*. Retrieved from: <http://www.epa.gov/environmentaljustice/resources/publications/nejac/nejac-cum-risk-rpt-122104.pdf>
- National Research Council of the National Academies. (2009). *Science and Decisions: Advancing Risk Assessment*. National Academies Press. Washington, DC. Retrieved from: [http://www.nap.edu/openbook.php?record\\_id=12209&page=R1](http://www.nap.edu/openbook.php?record_id=12209&page=R1)
- National-Scale Toxics Assessment (NATA). (2012). Retrieved from: <http://www.epa.gov/nata2005/>
- Neighborhood Nexus. (2012). Conditions in NPU-L: English Avenue and Vine City. Retrieved from: <http://www.neighborhoodnexus.org/content/conditions-npu-l-english-avenue-and-vine-city>
- Olden, K. & White, S.L. (2005). Health-related disparities: Influence of environmental factors. *The Medical Clinics of North America*, 89(4), 721-738.

- Ottinger, G. (2011). Community-based science: a strategy for achieving environmental justice And improving environmental awareness. *Studies in Sustainability*. White Paper Series.
- Park Pride (2011). *Proctor Creek North Avenue Watershed Basin: A Green Infrastructure Vision*.
- Paustenbach, D.J., Jernigan, J.D., Finley, B.L., Ripple, S.R. & Keenan, R.E. (1990). The current practice of health risk assessment: Potential impact on standards for toxic air contaminants. *Journal of the Air and Waste Management Association*, 40(12), 1620-1630.
- Proctor Creek Stewardship Council (PCSC). (2015). Water Quality and Neighborhood Data. Retrieved from: <http://www.proctorcreek.org/creek-data.html>.
- Sadd, J.L., Pastor, M., Morello-Frosch, R., Scroggins, J., & Jesdale, B. (2011). Playing it safe: Assessing cumulative impact and social vulnerability through an environmental justice screening method in the south coast air basin, California. *International Journal of Environmental Research and Public Health*, 8, 1441-1459; doi:103390/ijerph8051441.
- Salinas, J.J., Shah, M., Abdelbary, B., Gay, J.L. & Sexton, K. (2012). Application of a novel method for assessing cumulative risk burden by county. *International Journal of Environmental Research and Public Health*, 9, 1820-1835; doi:10.3390/ijerph9051820.
- Salmon, A.G. (2010). Do standard risk assessment procedures adequately account for cumulative risks? An exploration of the possibilities using California's Air Toxics Hot spots guidelines. *International Journal of Toxicology*, 29(1) 65-70.
- Sexton, K. (2012). Cumulative risk assessment: An overview of methodological approaches for evaluating combined health effects from exposure to multiple environmental stressors. *International Journal of Environmental Research and Public Health*, 9, 370-390; doi:10.3390/ijerph9020370.
- Sexton, K. & Linder, S.H. (2010). The role of cumulative risk assessment in decisions about environmental justice. *International Journal of Environmental Research and Public Health*, 7(11), 4037-4049.
- Su, J.G., Jerrett, M., Morello-Frosch, R., Jesdale, B.M., Kyle, A.D. (2012). Inequalities in cumulative environmental burdens among three urbanized counties in California. *Environment International*, 40, 79-87.
- United States Census Bureau/American FactFinder. "B01001: Sex by Age," 2009-2013 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2013. Web. 11 November 2015. Retrieved from: <http://factfinder2.census.gov>.
- United States Census Bureau/American FactFinder. "B01003: Total Population," 2009-

- 2013 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2013. Web. 11 November 2015. Retrieved from: <http://factfinder2.census.gov>.
- United States Census Bureau/American FactFinder. "B15003: Educational Attainment for the Population 25 Years and Over," 2009-2013 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2013. Web. 11 November 2015. Retrieved from: <http://factfinder2.census.gov>.
- United States Census Bureau/American FactFinder. "B17010: Poverty Status in the Past 12 Months of Families by Family Type by Presence of Related Children under 18 years By Age of Related Children," 2009-2013 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2013. Web. 11 November 2015. Retrieved from: <http://factfinder2.census.gov>.
- United States Environmental Protection Agency (U.S. EPA). (1997). Guidance on Cumulative Risks Assessment, Part 1. Planning and Scoping. Washington, DC. Retrieved from: <http://www.epa.gov/OSA/spc/2cumrisk.htm>.
- United States Environmental Protection Agency (U.S. EPA). (2000). Cumulative Exposure Project. Retrieved from: <http://www.greenlink.org/assess/pdfs/cumulativeexposure.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2003). Framework for Cumulative Risk Assessment. Washington, DC. EPA/600/P-02/001F. Retrieved from: <http://www.epa.gov/raf/publications/framework-cra.htm>
- United States Environmental Protection Agency (U.S. EPA). (2007). Concepts, Methods and Data Sources for Health Risk Assessment of Multiple Chemicals, Exposures and Effects. Cincinnati, OH. Retrieved from: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=190187>
- United States Environmental Protection Agency (U.S. EPA). (2008). Combined Sewer Overflows Demographics. National Pollutant Discharge Elimination System (NPDES). Retrieved from: [http://cfpub.epa.gov/npdes/cso/demo.cfm?program\\_id=5](http://cfpub.epa.gov/npdes/cso/demo.cfm?program_id=5).
- United States Environmental Protection Agency (U.S. EPA). (2012). Urban Waters. Retrieved from: <http://www2.epa.gov/urbanwaters>.
- United States Environmental Protection Agency (U.S. EPA). (2013). Partners for progress in Proctor Creek: Recreating a sustainable creekside community in the city. Retrieved from: <http://www.urbanwaters.gov/pdf/ProctorCreekBackgrounder.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2014). West Atlanta Watershed Alliance engages communities to protect three creeks. Retrieved from: <http://www.epa.gov/sites/production/files/2014-05/documents/uw-factsheet-westatlanta2014.pdf>
- United States Environmental Protection Agency (U.S. EPA) Office of Research and

- Development, National Exposure Research Library. (2015). Community-focused exposure and risk screening tool (C-FERST) quickstart guide. Retrieved from: <http://www.epa.gov/c-ferst/c-ferst-quickstart-guide>
- United States Environmental Protection Agency (U.S. EPA). (2015). EJSCREEN: Environmental Justice Screening and Mapping Tool. Retrieved from: <http://www2.epa.gov/ejscreen/what-ejscreen>.
- United States Environmental Protection Agency (U.S. EPA). (2015). Proctor Creek Watershed/Atlanta (Georgia). Retrieved from: <http://www.epa.gov/urbanwaterspartners/proctor-creek-watershedatlanta-georgia>
- Vazquez-Prokopec, GM., Eng, JLV., Kelly, R., Mead, DG., Kolhe, P., Howgate, J., Kitron, U., & Burkot, TR. (2010). The risk of West Nile Virus infection is associated with combined sewer overflow streams in Urban Atlanta, Georgia, USA. *Environmental Health Perspectives*, 118, 1382-1388.
- Viswanathan, M., Ammerman, A., Eng, E., Gartlehner, G., Lohr, KN., Griffith, D., Rhodes, S., Samuel-Hodge, C., Maty, S., Lux, L., Webb, L., Sutton, SF., Swinson, T., Jackman, A., & Whitener, L. (2004). *Community-Based Participatory Research: Assessing the Evidence*. Evidence Report/Technology Assessment No. 99 (Prepared by RTI—University of North Carolina Evidence-based Practice Center under Contract No. 290-02-0016). AHRQ Publication 04-E022-2. Rockville, MD: Agency for Healthcare Research and Quality.
- Williams, P. (2008). 30318 from Poverty by the numbers. *Atlanta Magazine*, April 2008.
- Zartarian, V.G., Schultz, B.D., Barzyk, T., Smuts, M., Hammond, D.M., Medina-Vera, M. & Geller, A.M. (2011). The Environmental Protection Agency's Community-Focused Exposure and Risk Screening Tool (C-FERST) and its potential use for environmental justice efforts. *American Journal of Public Health*, S286-S294.
- Zipatlas. (2016). Unemployment rate in Atlanta, GA by zip code. Retrieved from: <http://zipatlas.com/us/ga/atlanta/zip-code-comparison/unemployment-rate.htm>.



**Chapter 3: Participatory Research in  
Northwest Atlanta’s Proctor Creek  
Watershed: Using Photovoice to Explore  
Environmental Health Risks at the Water’s  
Edge**

Proposed Journal: *Health & Place*



## **Participatory Research in Northwest Atlanta's Proctor Creek Watershed: Using Photovoice to Explore Environmental Health Risks at the Water's Edge**

**Key words:** community-based participatory research; environmental health; photovoice; community engagement; local community knowledge; urban watersheds

### **ABSTRACT**

In this study we used a participatory research method, photovoice, to better understand community perceptions about environmental health risks and community assets and strengths in and around an urban, degraded watershed in Northwest Atlanta, Georgia. This watershed, formed by Proctor Creek, will be a focal point for redevelopment and infrastructure investments over the next 25 years. Participants engaged in data collection, participatory data analysis, internal discussions of findings, development of policy and remedial action recommendations, and presentations to watershed residents and decision makers. Data analysis involved identifying key themes from photos, participants' written commentary about their photos, and transcriptions of photo discussions. We present a conceptual model informed by participants' understanding of the urban policies and practices that influence health and impact quality of life in their watershed. Participants identified the following primary themes: 1) threats to the natural environment, 2) built environment stressors that influence health, 3) blight and divestment of public resources, and 4) hope for the future. Residents' vision for the future of the watershed --- a restored creek, revitalized neighborhoods, and restored people is fueled by a strong connection to history, memory, and sense of place. A CBPR approach was used to disseminate results to watershed residents and stakeholders and to translate research findings into watershed restoration, community revitalization, and policy solutions. By engaging community members in defining their own concerns about community challenges, the value of local knowledge was realized in identifying environmental health challenges as well as their potential solutions.



## **Introduction**

Proctor Creek used to be a source of pride for Northwest Atlanta communities---a place where children played, where people fished, and were baptized. Today, however, the creek is highly impacted by pollution and other stressors and does not meet its state-established designated use for fishing (Atlanta Regional Commission, 2011; Georgia Environmental Protection Division, 2013). In 2013, the United States Environmental Protection Agency ( U.S. EPA) designated Proctor Creek as a partnership site for the Urban Waters Federal Partnership, a program that brings together federal government agencies to stimulate regional and local economies, create local jobs, improve quality of life, and protect health by revitalizing urban waterways in underserved communities (U.S. EPA, 2012; 2013; 2015).What was once a seemingly forgotten area of the City of Atlanta is now the subject of intense focus from multiple stakeholders including government agencies, academic institutions, local and national non-profits, and private developers in addition to residents and community organizations that have invested decades of sweat equity and activism to revitalize the watershed (About Proctor Creek, 2015).

As a result of this renewed interest, residents of the watershed want to ensure that solutions sought by government and private organizations are driven by community needs and include authentic engagement and principles of collaborative problem-solving (West Atlanta Watershed Alliance, 2013). Instead of waiting on such entities to design and implement inclusive community engagement processes, residents are collaborating with community-based organizations, academic institutions, and technical assistance providers to structure alternative methods to document and elevate resident input, local knowledge, and community-identified needs in parallel planning and development schemes.

## *Environmental Justice and participatory research approaches*

The 17 Principles of Environmental Justice affirm the rights of communities to, “... participate as equal partners at every level of decision-making, including needs assessment, planning, implementation, enforcement and evaluation,” (First National People of Color Environmental Leadership Summit, 1991). Meaningful community involvement is important not only for planning and public health practice, but also for research. Community-based participatory research (CBPR) is a collaborative approach, often between members of a community, academic researchers, and other stakeholders that engages the community as co-learners, designers, and implementers of the research (Viswanathan et al., 2004; W.K. Kellogg Foundation, 2001; Israel et al, 1998). Although participatory approaches such as CBPR have been effective in addressing a number of environmental health hazards (Gonzalez et al., 2011; Israel et al, 2010; Ali et al., 2008; Cook, 2008; Minkler et al., 2006; O’Fallon & Dearry, 2002; Shephard et al., 2002), the literature with respect to their use with watershed-based challenges is limited. Work by Wilson, Heaney, and colleagues (Wilson et al., 2007; Heaney et al., 2007) has focused on the use of a similar approach to CBPR, Community Owned and Managed Research (COMR), in rural watershed settings. The literature, however, is relatively silent with respect to the application of such approaches in urban watershed contexts.

In this study, we used a CBPR approach paired with photovoice to explore community perceptions of environmental health, assets, and strengths in the Proctor Creek Watershed. Photovoice, a specific, participatory, research methodology, has three distinct goals: 1) to help people to document both strengths and concerns about their communities through photos; 2) to raise awareness and encourage critical dialogue about both personal and communities’

challenges through discussing said photos in small and large group settings; and 3) to influence decision makers (Wang & Burris, 1997). This methodology has been used to explore environmental health issues such as food insecurity (Hieldelberger & Smith, 2015), agricultural issues (Postma et al, 2014), built environment stressors (Kreuter et al., 2012; Redwood et al., 2010), and to a lesser extent, environmental health disparities (Kovaic et al., 2014). Few, if any publications document the use of photovoice to explore environmental health in the context of urban watersheds.

The research described herein evolved from a series of 15 watershed-focused community meetings and listening sessions conducted from February 2012 to August 2013 and engaging a total of 177 Proctor Creek Watershed residents. These community meetings and listening sessions were convened by three organizations with a history of collaboration to improve health and environmental conditions in the Proctor Creek Watershed: the West Atlanta Watershed Alliance (WAWA), the Community Improvement Association, and Environmental Community Action (ECO-Action). They worked in partnership with members of the newly established Proctor Creek Stewardship Council (PCSC) and with support from faculty and student researchers at Georgia State University in Atlanta, Georgia.

### *Purpose of the study*

The purpose of this study was to assist in hearing, understanding, valuing, and elevating local, community knowledge and perceptions about environmental health risks and assets and strengths that might be useful in mitigating risks in the Proctor Creek Watershed. Furthermore the study was designed to help watershed residents advocate for environmental justice by

increasing support for community-driven redevelopment, clean-up, and restoration of the watershed.

## **Methods**

### *Study area and participant recruitment*

Proctor Creek is an urban tributary to the Chattahoochee River and the only major watershed located wholly in the City of Atlanta (City of Atlanta, 2013). The nine (9) mile-long watershed covers a 16 square mile area, has a population greater than 90,000 people in more than 38 neighborhoods, and primarily traverses six City of Atlanta neighborhood planning units (NPU)<sup>1</sup> (About Proctor Creek, 2015; United States Census Bureau; 2014). Many watershed residents, who are primarily African American, experience social and economic disparities (City of Atlanta, 2013).

Study participants were identified, from September to October 2014, through recruitment flyers posted in community parks, recreation centers, and health clinics as well as through face-to-face contact at community association and Neighborhood Planning Unit (NPU)<sup>1</sup> meetings and communities of faith within the Proctor Creek Watershed. Additionally, early recruits were engaged to help identify other participants through snowball sampling to meet the desired sample size and to ensure representation from the majority of the six primary NPUs that comprise the watershed. Participants were required to be at least 18 years of age and reside in the Proctor

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<sup>1</sup> In Atlanta, the city is divided into 25 Neighborhood Planning Units or NPUs. Each NPU has a citizen advisory council responsible for making recommendations to the Mayor and City Council on matters of zoning, land use, and a range of other social and economic determinants that influence health and quality of life.

Creek Watershed. Minors and those who do not live in the study area were excluded.

Demographic information was collected from the participants at the start of the project.

### *Ethical Considerations and Training*

The community partners helped develop and approve the participant recruitment strategy and all research protocols. Human subjects' research approval was granted by the Georgia State University Institutional Review Board (Study # **H14531**). Each participant was consented to participate in the study by the student investigator after the benefits, risks, and their rights as research participants were explained.

Prior to data collection, each participant was provided with an overview of research ethics and training in photovoice ethics (Wang & Redwood-Jones, 2001), basic techniques of documentary photography, and use of their specific camera equipment (if using a loaned camera). They were required to participate in role plays in which they practiced conducting the informed consent process for potential photo subjects and were given physical copies of a training reference document that outlined the procedure. Safety protocols and possible risks of participating in the project, such as loss of property and physical harm, were also addressed (Wang, 2003).

Participants selected the photographs that they desired to include in the research dissemination efforts and granted written consent for their public use and display. All of the participants chose to disclose their identities, by name, in association with their photographs and the narratives that accompany them.

### *Procedures*

We implemented photovoice from October 2014 to January 2015 in 11 sessions. Each session, lasted three hours, included lunch, and took place at one of two central sites: a community center located in a public school and the community room of a local health clinic. Researchers who owned their own digital cameras or camera phones used them, and those who did not have access to a suitable camera were loaned a digital camera by the university partner. Watershed researchers were compensated at a rate of \$20/hour for each session and received a maximum of \$660.00 for their participation and contribution to the research.

### *Data collection*

The participants took photographs that reflect their experiences living in the Proctor Creek Watershed. Participants were instructed to take photographs, in between sessions, of things that represented environmental health concerns and challenges (things to be improved) and assets and strengths (things to be celebrated and built upon) in the watershed. The researchers also produced data through writing photograph captions and descriptions and telling stories about their images. Large group discussions were video recorded and transcribed verbatim.

### *Data analysis and interpretation*

Following each session, the student investigator input transcripts into MaxQDA, Version 11 (Verbi Software GmbH, Berlin, Germany), a qualitative and mixed methods data analysis software; used memos to develop initial concepts and broad themes; and conducted line-by-line coding as recommended in the grounded theory approach to assist in the conceptualization of

initial themes about the research. Themes and codes were not determined a priori. As code saturation was reached, focused coding was applied to draw upon on the most significant and or frequently repeated codes (Charmaz, 2006); requiring the investigator to make determinations about the appropriate, initial codes to be used to develop comprehensive categories to describe the data. In tandem with this process, memos were also developed to summarize key linkages and possible connections between ideas and codes emerging from the data. The constant comparative method (Glaser & Strauss, 1967) was also used to compare codes for similarities and differences and to facilitate development of broad themes and categories followed by sub-themes and categories.

At the beginning of each session, the student investigator presented verbal summaries of the previous session, queried researchers about their perspectives on the key themes that emerged from those sessions, and presented initial codes for assessment of alignment with participant-identified themes and validation by the watershed researchers.

Participatory data analysis of photographs and narratives written by participants was conducted using a three-stage process: 1) selection, 2) contextualization, and 3) codification (Wang & Burris, 1997). Watershed researchers selected 20 photographs that they felt most accurately reflected the community's concerns and assets, told stories about them in small and large group discussions; and identified themes that emerged from both individual and collective data. Researchers categorized these themes as either 1) watershed challenges and concerns or 2) watershed assets and strengths. Next, each researcher narrowed his or her 20 photos to a group of 10 for more detailed analysis and public dissemination.

Each researcher's top 10 photographs were printed, individually analyzed, and discussed in small group sessions. A worksheet with semi-structured, open-ended, questions using a

modified version of the SHOWeD framework (Wang, 1999) was used to guide the analysis of each photo. Through use of this modified SHOWeD questioning technique, watershed researchers were challenged to think critically about what their photographs depict, the root causes of the problems the photographs represent, and potential solutions to address the challenges represented in the photographs. The researchers developed written responses for each question on the SHOWeD worksheet and used these as the basis for discussions about their photos. The watershed researchers jointly identified and wrote themes to describe the issues that emerged from the photos and from discussions about the photographs (Wang & Burris, 1997). Participants wrote captions and brief narratives for each photo that helped to illuminate their perspectives. Researchers categorized their themes in the aforementioned two broad categories. Participants' narratives and written responses to the SHOWeD questions were typed by the investigator, entered into MaxQDA 11, and coded based on previously agreed upon codes. Themes and sub-themes were identified. At the final session, specific themes were finalized from the previously identified categories and prioritized by the research participants for dissemination.

## **Results**

### *Study Participants*

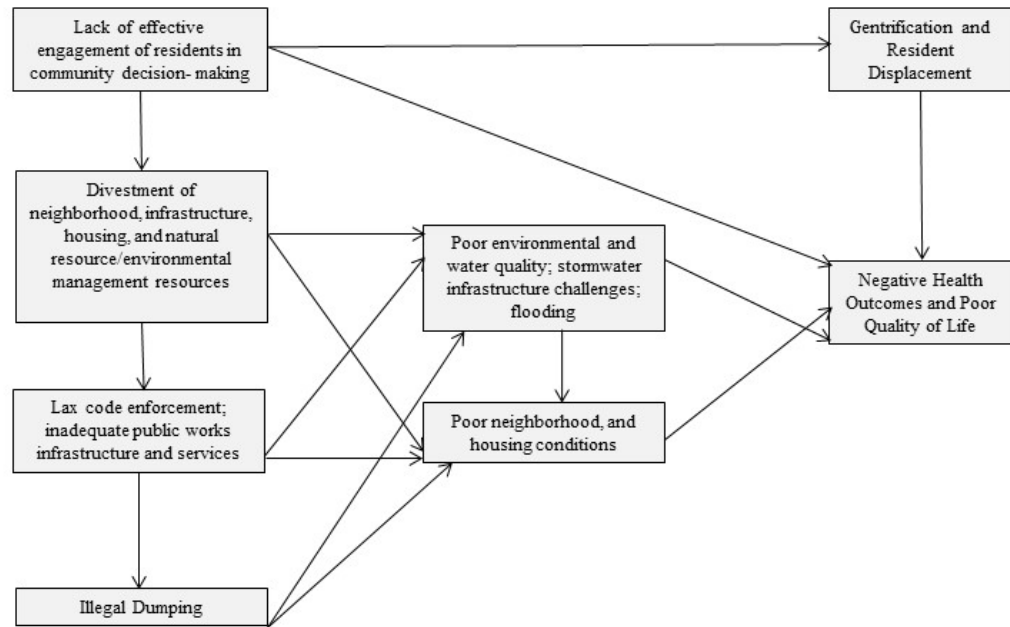
Ten Proctor Creek Watershed residents ranging from age 29 to age 65 were recruited to participate in the study as watershed researchers. Each participant was retained throughout the six months of the study. Eighty percent of the watershed researchers were African American, and 70% were female. The researchers lived in seven of the 38 neighborhoods and represented five of the six NPUs in the watershed. Collectively, the researchers brought a total of 325 years of



lived experiences in the watershed to the study; with individual participants ranging from eight (8) to 66 years of residency. They had varying previous interaction with Proctor Creek and different levels of prior experience using cameras, however none of them were familiar with photovoice.

Strengths and assets identified by the researchers included the creek itself, the rich historical and cultural legacy associated with Northwest Atlanta communities through which the creek flows, and the association of Proctor Creek communities with the Civil Rights Movement through leaders like the Rev. Dr. Martin Luther King, Jr. and Mrs. Coretta Scott King who lived in the watershed. Engaged community members and community activism to improve health and quality of life in the watershed, in various forms, also resounded as strengths for the watershed.

The Proctor Creek Watershed researchers took variable numbers of photographs (ranging from 89 to 483 per researcher). With more than 1,500 photos taken and 11 group sessions held, our analysis revealed four (4) general themes that posit Proctor Creek as both a polluted eyesore, nuisance, and toxic liability for those who live in the watershed and as a community asset and natural resource to be valued, protected, and restored. These themes are: 1) threats to the natural environment (water and land), 2) built environment stressors that influence health, 3) neglect and divestment of public resources; and 4) hope for the future. The first three themes are linked conceptually as shown in Figure 1 and describe the ways that the watershed researchers believe urban policies and practice negatively impact health and quality of life in the watershed. To describe these and the fourth theme, a positive vision for the future, we share the words and photographs of the watershed researchers to provide context and illuminate meaning.



**Figure 1:** Conceptual model linking urban policies and practice in the Proctor Creek Watershed to poor environmental, neighborhood, and housing conditions and negative health outcomes and poor quality of life.

*Threats to the Natural Environment*

There was a strong connection to sense of place (Woods, 2009) and value placed on Proctor Creek. Many discussions about the visual data collected as a part of this research were steeped in remembrance of when this now degraded, urban stream was a community asset--- clean, vibrant, and full of life--- not a liability. Proctor Creek is seen as a place of both former and current beauty as well as resilience despite the numerous challenges facing it. A hope and

vision for the future was articulated by the researchers that includes a playable, fishable, swimmable Proctor Creek, and restored people and community from a holistic perspective (health, economics, and quality of life).

Because of the proximate location of the creek and its tributaries to homes and other areas of community access, the aesthetics of the creek, pollution, and water quality in the creek emerged as sub-themes and primary concerns of watershed researchers. These concerns included sewage pollution from aging infrastructure; chemicals; and illegal dumping of tires, construction debris, and trash. Researchers photographed what they called, “toxic film” floating atop the waters of Proctor Creek and discussed seeing dead fish, turtles with fungi on their backs, and “murky waters” that they considered both threats to resident quality of life as well as to wildlife and their habitats. Concerns about water quality and pollution were evident in many photo descriptions and commentary shared by watershed researchers such as the following:

*“...contamination and bacteria [are] sitting on top of our creek water...,”* and *“The rainbow colors of an oil slick may be pretty, but this water quality degradation is nothing to celebrate. Oil contamination comes from illegal dumping, junkyards, and street runoff.”*

Sewage contamination was cited as a primary contributor to poor water quality in Proctor Creek as described by one researcher who wrote: *“[Our community] is being made the toilet of Atlanta...”*

Another researcher took the following photograph and wrote the commentary below it:



**Figure 2.** *WARNING!!!: “I saw this sign, read this, and could not believe that Proctor Creek was so unsafe...[The sign] tells a new story about Proctor Creek. Not the story that the elders tell about playing and swimming in the creek... not the story about Proctor Creek being the habitat for all kinds of animals and children learning about nature just from observing their environment. People were actually baptized in Proctor Creek! It’s hard to believe these stories when we see the warning signs.”*

Illegal dumping was identified as a threat to the health and aesthetics of Proctor Creek as well as to residents and the land around the creek. Watershed researchers suggested that two levels of illegal dumping impact the watershed: 1) dumping done by those who don’t live in the watershed and 2) dumping done by those who likely live in and travel through the watershed regularly. Lack of city services to facilitate proper disposal of trash was also identified as a community concern. These perceptions are supported with excerpts and images such as the following:

*“People [are] passing through communities [and] relieving trash in places they don’t live in...,”* and *“Humans are using the creek for a trash dumpster. With trash inside, fish, birds, and*

*other wildlife has disappeared. It tells us that some in our community don't take the time to properly dispose of trash. [There are] not enough trash cans along the street....some don't care. Not enough trash cans are provided by the City. ”*



**Figure 3. Illegal Dumping:** *“I actually saw the truck that was dumping this debris. I stopped and asked the driver what was going on and did he have the authority to dump this mess there. He said he was told to dump it there. I snapped the picture and called the number on the side of the truck. The owner of the truck said he didn't know what I was talking about but that he would make sure the mess would be cleaned up. It never was...”*

Another researcher commented about a different photo: *“This photo shows me what little respect people that don't live here have for our community. [Our community] does have its problems but most of them come from outsiders that feel that they can just dump their trash here and drive away. From tires, bagged trash, old furniture to dead bodies (yes bodies have been found on overgrown lots) people feel that because this community looks abandoned it doesn't really matter what they do.”*

In association with photos of illegally dumped scrap tires in and around Proctor Creek, one researcher associated the large number of car repair and maintenance shops, in parts of the watershed, with dumping activities. The researcher wrote, “...*[There are] irresponsible businesses...very little [is] being done about tires that can be used for more than dumping in the creek...the people who work around this area don’t care.*”

The photo below (Figure 4) and its caption refer to the belief that local businesses sometimes hire people to properly dispose of scrap tires who, in turn, illegally dump the tires in the Proctor Creek Watershed and other communities.



**Figure 4.** *Tires...Really???: “Simple minded people has taken it upon themselves to dispose old tires in Proctor Creek instead of paying money to properly dispose of the tires.”*  
A health concern about tires was expressed this way: “*Tires [are] being thrown on street near the creek...this is where mosquitoes set up habitats for breeding...*”

Researchers also indicated that they had concerns with community conditions and inadequate city services that help to enable illegal dumping: “*[There are] not enough lights in*

*the community and not enough patrolling by code enforcement, and [‘no dumping’] signs being placed in certain areas.”*

#### *Built environment stressors that influence health*

In addition to concerns about pollution, illegal dumping, aesthetics and water quality, watershed researchers identified built environment stressors that influence health in the Proctor Creek Watershed. These built environment stressors are influenced, in part, by the natural environment. They reflect challenges of living at the water’s edge and downstream of impervious surfaces associated with dense development in the headwaters of the watershed. These stressors include flooding and the mold and mildew associated with it in housing located near Proctor Creek. Researchers linked those occurrences and conditions to potential health problems in the community as well as damage to and loss of property in the following words:

*“We need to address the flooding. When the water sits longer than 36 hours, that’s a problem.”*

*“The houses are molded...children live here...senior citizens live here.”*

*“We’re in the creek area, and there is mold and mildew.”*

*“Mold and mildew have adverse effects [on people] in housing.”*



**Figure 5.** *What’s Going On?: “Dangerous living arrangement...mold and mildew...It floods here often as seen by the mold/mildew on [the] yellow house. [This] photo could educate people about the dangers of living near waterways.”*

With flooding can come displacement as well as damage and loss to property from soil erosion. Particularly in downstream neighborhoods, watershed researchers shared frustration from homeowners who have lost inches of their residential property because of flooding and feel that their cries for help have fallen on deaf ears in city government. Watershed researchers captured photos and discussed the efforts that some residents have instituted to develop their own structural barriers on their properties to prevent flooding, erosion, loss of property, and contact with the waters of Proctor Creek.



## *Neglect and Divestment of Public Resources*

Watershed researchers linked their perceived lack of investment in infrastructure improvements and government actions to restore Proctor Creek to perceptions that city government officials do not care about their neighborhoods and have in turn neglected this part of the city. A lack of meaningful community engagement opportunities by which residents can help influence planning decisions was also voiced as a key concern.



**Figure 6.** *Ugly and Forgotten: "...This was once a family residence [near]by Proctor Creek. Now it's a dilapidated house in disrepair. Signs posted behind it say hazards and disease lie in the creek...mold, mildew, bacteria...Structures like this can remain for years and years in our community. Even if laws or ordinances exist, no one will take action. Ugly and abandoned is not enough. The city lacks funds. The maintenance codes cannot be followed. [The] community has no voice. Because of the hazardous and unhealthy creek, this caused the house to be vacant."*

When explaining what select photos tell us about life in the Proctor Creek Watershed, researchers wrote statements such as, “*Having to watch things deteriorating before your very eyes;*” “*We are unimportant;*” “*No one cares;*” “*[The] community and its resources have been neglected;*” “*Our community is not a priority to the city;*” and, “*The neighborhood seems forgotten...as if without any hope.*”

Despite the sentiment that government officials neglect neighborhoods in the Proctor Creek Watershed, watershed researchers are aware of renewed interest in the watershed (About Proctor Creek, 2014). The looming threat of gentrification in the wake of increasing development pressures in the watershed was discussed. While there was acknowledgement that “*...change is going to happen,*” and the admission that, “*we need new residents in the community...*” because of high vacancy rates in parts of the watershed (Neighborhood Nexus, 2010), the watershed researchers were concerned that, “*...environmental clean-up and restoration of Proctor Creek will happen only after in place residents are pushed out for newcomers.*”



**Figure 7.** *Site for Sore Eyes: “They don’t really care about us! Our community’s historical houses that sits on Proctor Creek [are] deteriorating from mold, mildew, and asbestos. They are not trying to save the historical value, rather they want to tear down and gentrify.”*

When responding to why conditions of blight and environmental degradation exist in the community, researchers provided commentary such as, “*Bureaucracy,*” and “*No one is noticing that [our] neighborhoods are suffering...*”

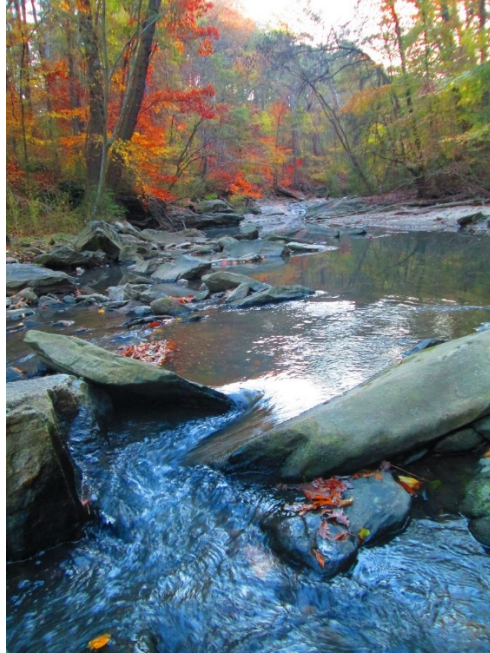
There was a consistent refrain represented in commentary about visual images that relate to the need for government accountability and urgent action to address the challenges in the Proctor Creek Watershed:

*“People in higher places are not held accountable for the positions they’re in and [are] not being responsible once they get your vote.”*

*“Get local officials to take our community more seriously about our creek... Things are this way because someone failed to follow through. There should be more accountability to what happens in our community.”*

### *Hope for the future of the Proctor Creek Watershed*

In the eyes, hearts, and minds of community residents, there is value, life and beauty in Proctor Creek and the neighborhoods through which it flows, despite the pollution and other stressors. Proctor Creek as a natural resource with potential to improve quality of life in the watershed also emerged as a strong sub-theme in the research. The creek as wildlife habitat and a natural asset for the community resounded in both written commentary and critical conversations about visual data alike. One researcher referred to Proctor Creek as, “*a hidden treasure,*” while another researcher referred to it as: “*Natural beauty...wildlife habitat.*” The photo below captures a challenges like erosion along the banks of Proctor Creek while also celebrating its beauty.



**Figure 8.** *Granite Falls (Proctor Creek): “Scenic beauty, bare tree roots from erosion, fall colors, steamy water in frosty sunrise...gorgeous nature in our backyard..”*

When recounting childhood memories about Proctor Creek, one researcher lamented over the visual evidence that she and other researchers collected that affirmed its transition from a valuable natural resource to a dumping ground:

*“As a child I enjoyed the environment of the neighborhood, about a block from my house. I used to walk down to the creek because I enjoyed the scenery. It taught me how to experience nature for myself, and I learned about different birds just from their colors, shape and sizes. I watched the different insects that flew around the environment of the creek. As I listened to the water, crickets and frogs sang in my ears. Most of all, I loved catching craw-fish and fish as they swam through the stream of the creek...[Now] I see a place where kids can’t play anymore...The importance of this water is being overlooked... [You] can’t play in the natural habitat. [It is]*

*used as a dumping spot... Back then, I wasn't even afraid to drink the water. Now, I'm afraid to touch it..."*

Other researchers had similar memories expressed in these ways:

*"I remember the habitat that used to be around the creek and how alive it was. Over the years, it has changed tremendously. It's toxic. The water is toxic..."*

*"I see a place where I used to play in the water and watch fish swim in the creek and catch crawfish. Because of the leaves and trash impacting [the creek] all the beauty of the creek has disappeared."*

Critical conversations about community concerns led to dialogue about community-driven solutions and policy change to address or mitigate said concerns. Solutions proposed by watershed researchers to improve health and quality of life in the Proctor Creek Watershed included increasing opportunities for meaningful community engagement so that residents most impacted by proposed changes in the Proctor Creek Watershed are a part of the planning efforts, increasing acreage of parks and greenspace in the Proctor Creek Watershed (particularly in the headwaters communities), implementing green infrastructure projects to help alleviate flooding, creating a comprehensive stormwater management plan for the watershed, and advancing a stormwater utility. Finally, investments in sewer and other infrastructure, more vigilant enforcement of illegal dumping laws, more effective code enforcement, and the creation of jobs to employ community members to perform critical services that are not being addressed by government were primary sub-themes.

One photo depicted a vacant property overgrown with kudzu. The researcher wrote the following: *“This area has been vacant for years. [It] would make a great park or walking trail for a healthy community. The land in our community has great potential. It could be used for a new and improved neighborhood and would increase community value.”*

Not all solutions were externally focused on decision makers. Some were focused on residents, themselves: *“The residents need to take control of their neighborhood. If we continue to allow this level of disrespect, it will continue to happen. Also, we need to be role models for everyone. This is where we live and we should help maintain it, clean it, and teach the youth to respect the land. Give back more than you take out.”*

Researchers expressed their desire for Proctor Creek to, once again, be fishable, swimmable, and playable. Proctor Creek is a legacy that residents want to leave for younger generations. The hope for the future is anchored in remembrance of the past---what Proctor Creek used to be like----the ways that Proctor Creek was a usable asset and resource for the community. These desires were expressed through statements like the following:

*“...[I want to] return the creek to its [former] glory.”*

*“[I’d like to] restore the creek back to its original status to give [the] community its vibrant luster.”*

*“I’m overwhelmed, but if I can share with my grandkids the beauty that once was, and if I can help beautify it and bring it back, I will...”*

*“My interest right now is revitalizing the creek and trying to do whatever I can...I would just like to drink it again. Because when we was kids, we drunk from that creek. Everything connected to that creek, we were a part of. [My goal] is beautifying it and seeing it revamped. It was told to me that they used to baptize in the creek. Now, I’m scared to put my foot in it, to go near it because of the toxics in it...”*

*“I learned to swim in that creek. I played in that creek, fished in that creek. I just want it like it was...”*

## **Discussion**

Photos taken by the watershed researchers illustrated commonalities and shared concerns about a wide selection of natural and built environment stressors and social, political, and environmental conditions that can influence health and quality of life in urban settings. These concerns, about the city of Atlanta as well as other urban settings, have been documented elsewhere in other published literature (Mariano, 2014; Kreuter et al., 2012; Redwood et al., 2010; Runfola & Hankins, 2009). These concerns link urban policies and practice to negative health outcomes and poor quality of life as represented in the conceptual model depicted in Figure 1. Proctor Creek is seen by the watershed researchers in its duality----a community hazard and an asset to be celebrated, valued, and restored to its former glory as a focal place for community activity. The perspectives of the researchers demonstrate concern for numerous environmental challenges impacting the creek itself, the neighborhoods through which it flows, and the people who inhabit the watershed.



Some community concerns voiced here have been well documented beyond this photovoice project. Derelict properties dot the watershed landscape, while investors buy properties and some intentionally allow them to fall in disrepair (Mariano, 2014; Runfolo & Hankins, 2009)---a practice that residents consider a precursor to gentrification. In addition to citing blight and disinvestment in the watershed, watershed researchers concurrently described how neglect by government and lack of effective engagement of the impacted community in planning decisions are also culprits of the negative transformation of the community thus far. Other concerns identified by the watershed researchers, such as inadequate parks and greenspace, housing-related hazards such as mold, and neighborhoods that are vulnerable to flooding, have also been identified as community challenges that deserve further research and attention from researchers and decision makers in environmental justice literature (Faber & Krieg, 2005).

### *Strengths and Limitations of the Study*

A strength of this study is the use of a CBPR approach. The collaborative nature of such an approach calls for the equitable involvement of all partners in the research process while valuing the unique strengths, perspectives, and knowledge that all partners bring. By beginning the research with a topic of importance to the community, the typical top down approach to research was replaced with a bottom-up effort that accepts and understand the importance and viability of community knowledge and local and cultural context when trying to promote social action, improve community health, and eliminate health disparities (W.W. Kellogg Foundation, 2001; Israel et al., 1998).

The collaborative nature of photovoice allows participants to share and teach their truths to each other, other community members, and decision makers in an effort to initiate critical conversations about issues impacting health and quality of life and to advance social change. Participants also develop valuable skills that can increase agency to advocate for solutions to issues of concern for community residents. These skills include reflecting on their truths and realities of life in their communities (Wang, 1999), and reflecting on and understanding the interactions between community realities and municipal policies and practice.

While the methods were made intentionally broad so that the researchers had maximum flexibility to select the themes that they wanted to represent through their photographs, the majority of the photographs taken for this project did not include people in them. Because the study was physically situated in the Proctor Creek Watershed and participants were required to live within the watershed boundaries, researchers might have depicted the creek in the majority of their photos because they thought that the academic partner was looking primarily for such photos. At least one researcher felt the need to justify taking photos that did not include the creek; explaining that the images represented other challenges that impacted her quality of life (i.e. blight and inadequate code enforcement). Also, the results are not generalizable to all residents living in degraded, urban watersheds, however these data provide valuable insight into the perceptions of a portion of the population and can be used as preliminary data for future research.

### **Dissemination and next steps**

The watershed researchers shared their photographs and commentaries at two “sneak preview” community exhibitions; displaying 20% of the photovoice collection and attended by

mixed crowds of Proctor Creek Watershed residents; policy makers; and representatives from non-governmental organizations who are currently working in the watershed on issues related to water quality monitoring, food security, parks and greenspace acquisition, and development of affordable housing. Dissemination of the research results is regarded as an ongoing need that cannot be accomplished in a single outreach event. As a result, a larger exhibition followed by a watershed-wide traveling tour are being planned to display photographs from the photovoice collection at libraries, community and recreation centers, and other large gathering spaces and centers for civic activity in the watershed.

Just as the research dissemination will be an ongoing process the advocacy efforts, that have been initiated through sharing photographs and commentary from the project, will also be pursued over time. Systemic change takes time. The environmental health challenges witnessed and experienced by Proctor Creek Watershed residents and the economic, social, and political conditions that created them did not happen overnight. The advocacy needed to produce social action and the changes needed to address community challenges are also expected to happen over time and only through the success of long-term organizing strategies.

## **Conclusion**

In summary, residents of Atlanta's Proctor Creek Watershed, who served as watershed researchers, identified specific urban policies and practices that influence negative health outcomes and poor quality of life in their urban, environmentally degraded community. Their comprehension of the links between built and natural environment stressors, blight and divestment of public resources, and lack of effective and meaningful engagement of the affected community in planning and decision-making is informed by their lived experience as residents of

the watershed. Residents' articulation of these key challenges in the context of historical memory and connections to sense of place led to a positive vision and hope for the future: a fishable, swimmable, playable Proctor Creek and environmental, economic, and social equity benefits for the community. This study is one of few that has engaged urban watershed residents in defining environmental health risks, community challenges, and assets and strengths to mitigate said risks through a systematic and participatory methodology of taking photos to encourage critical analyses of community issues and to advance policy and social change. The value of local knowledge was realized in identifying environmental health challenges as well as their potential solutions. The importance of communities giving voice to their challenges and identifying community assets and strengths that might aid in addressing and overcoming such challenges is consistent with key tenants of environmental justice and is too often overlooked in traditional stakeholder approaches.

## **Acknowledgements**

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## References

- About Proctor Creek (2015). Groups working in Proctor Creek. Retrieved from: <http://aboutproctorcreek.com/groups-working-in-proctor-creek/>.
- Ali, R., Olden, K. & Xu, S. (2008). Community-based participatory research: A vehicle to promote public engagement for environmental health in China. *Environmental Health Perspectives*, (116): 10, 1281-1284.
- Atlanta Regional Commission (ARC). (2011). Proctor Creek – *Headwaters to the Chattahoochee: Watershed Improvement Plan*. Atlanta, Georgia.
- Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*, London, England: Sage Publications, 2006.
- City of Atlanta. (2015). Neighborhood Planning Unit. Retrieved from: <http://www.atlantaga.gov/index.aspx?page=739>
- City of Atlanta. (2013). Department of Watershed Management: The Proctor Creek Watershed. Retrieved from: <https://www.atlantawatershed.org/inside-dwm/offices/watershed-protection/atlantas-watersheds/the-proctor-creek-watershed/>
- Cook, W.K. (2008). Integrating research and action: a systematic review of community-based participatory research to address health disparities in environmental and occupational health in the USA. *Journal of Epidemiology and Community Health*, 62(8):668-76.
- Faber, D.J. & Krieg, E.J. (2005). *Unequal Exposure to Ecological Hazards 2005: Environmental Injustices in the Commonwealth of Massachusetts*, p. 59. Retrieved from: <http://www.northeastern.edu/nejrc/wp-content/uploads/Final-Unequal-Exposure-Report-2005-10-12-05.pdf>
- First National People of Color Leadership Summit. (October 1991). Principles of Environmental Justice. Retrieved from: <http://www.ejnet.org/ej/principles.html>.
- Georgia Environmental Protection Division of the Georgia Department of Natural Resources. (2013). Georgia's 2012 Integrated 305(b)/303(d) Report. Retrieved from: <http://www.gaepd.org/Documents/305b.html>.
- Glaser, B.G. & Strauss, A.L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. New York, NY: Aldine De Gruyter.
- Gonzalez, P.A., Minkler, M., Garcia, A.P., Gordon, M., Garzon, C., Palaniappan, M., Prakash, S. & Beveridge, B. (2011). Community-based participatory Research and Policy Advocacy to Reduce diesel exposure in West Oakland, California. *American Journal of Public Health*, 101, 166-175.

- Heaney, C. D., S. M. Wilson, and O. R. Wilson. 2007. The West End Revitalization Association's community-owned and managed research model: Development, implementation, and action. *Progress in Community Health Partnerships* 1 (4): 339–50.
- Heidelberger, L. & Smith, C. (2015). The food environment through the Camera Lenses of 9- to 13-year-olds living in urban, low-income, Midwestern households: A photovoice project. *Journal of Nutrition Education and Behavior*, (47):5, 437-445.e1
- Israel, B.A., Coombe, C.M., Cheezum, R.R., Schulz, A.J., McGranaghan, R.J., Lichtenstein, R., Reyes, A.G., Clement, J. & Burris, A. (2010). Community-based participatory research: A capacity-building approach for policy advocacy aimed at eliminating health disparities. *American Journal of Public Health*, (100):11, 2094-2102.
- Israel, B.A., Schulz, A.J., Parker, E., & Becker, A.B. (1998). Review of community-based research: Assessing partnership approaches to improve public health. *The Annual Review of Public Health*, 19: 173-302.
- W.K. Kellogg Foundation. (2001). Community Scholar's Program. Retrieved from: <http://depts.washington.edu/ccph/commbas.html>.
- Kovacic, M. B., Stigler, S., Smith, A., Kidd, A., & Vaughn, L.M. (2014). Beginning a partnership with photovoice to explore environmental health and health equities in minority communities. *International Journal of Environmental Research and Public Health*, 11, 11132-11151.
- Kreuter, M., Kegler, M.C., Joseph, K.T., Redwood, Y.A. & Hooker, M. (2012). The impact of implementing selected CBPR strategies to address disparities in urban Atlanta: A retrospective case study. *Health Education Research*, (27): 4, 729–741.
- Mariano, W. (November 1, 2014). Betting on 'The Bluff': As a Buckhead investor buys up a neighborhood, his derelict properties draw crime, fuel blight. *The Atlanta Journal Constitution*.
- Minkler, M., Vasquez, V.B., Warner, J.R., Steussey, H. & Facente, S. (2006). Sowing the seeds for sustainable change: a community-based participatory research partnership for health promotion in Indiana, USA and its aftermath. *Health Promotion International*, 2,293-300.
- Neighborhood Nexus. (2010). Explore the region. Retrieved from: <http://www.neighborhoodnexus.org/>.
- O'Fallon, L.R. & Deary, A. (2002). Community-based participatory research as a tool to advance environmental health sciences. *Environmental Health Perspectives*, 110 (Suppl. 2): 155–159.

- Postma, J., Peterson, J., Vega, MJY., Ramon, C., Cortes, G. (2014). Latina youths' perceptions of children's environmental health risks in an agricultural community. *Public Health Nursing*, 31(6), 508-516.
- Redwood, Y., Schulz, A.J., Israel, B.A., Yoshihama, M, Wang, C.C. & Kreuter, M. (2010). Social, economic, and political processes that create built environment inequities. *Community Health*, 33(1), 53-67.
- Runfola, D.M. & Hankins, K. B. (209). Urban dereliction as environmental injustice. *ACME: An International E-Journal for Critical Geographies*, 9 (3), 345-367.
- Shepard, P.M., Northridge, M.E., Prakash, S. & Stover, G. (2002). Preface: Advancing environmental justice through community-based participatory research. *Environmental Health Perspectives*, 110(Suppl.2): 139–140.
- United States Census Bureau. American FactFinder. “B01003: Total Population,” 2009-2013 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2013. Web. 11 November 2015. Retrieved from: <http://factfinder2.census.gov>.
- United States Environmental Protection Agency (U.S. EPA). (2013). Urban waters voices: Darryl Haddock. Retrieved from: [https://www.youtube.com/watch?feature=player\\_embedded&v=pHjVdHeLqKU](https://www.youtube.com/watch?feature=player_embedded&v=pHjVdHeLqKU)
- United States Environmental Protection Agency (U.S. EPA). (2013). Federal Agencies Expand Urban Waterway Revitalization Effort to Proctor Creek in Atlanta. Retrieved from: <http://yosemite.epa.gov/opa/admpress.nsf/0/F14EBAB9801D086985257B6E0062E55C>
- United States Environmental Protection Agency (U.S. EPA). 2015. 19 Designated Urban Waters Locations. Retrieved from: <http://www.urbanwaters.gov/projects.html>.
- United States Environmental Protection Agency (U.S. EPA). 2013. Partners for progress in Proctor Creek: Recreating a sustainable creekside community in the city. Retrieved from: <http://www.urbanwaters.gov/pdf/ProctorCreekBackgrounder.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2012). Urban Waters. Retrieved from: <http://www2.epa.gov/urbanwaters>.
- Viswanathan, M., Ammerman, A., Eng, E., Gartlehner, G., Lohr, KN., Griffith, D., Rhodes, S., Samuel-Hodge, C., Maty, S., Lux, L., Webb, L., Sutton, SF., Swinson, T., Jackman, A., & Whitener, L. (2004). *Community-Based Participatory Research: Assessing the Evidence*. Evidence Report/Technology Assessment No. 99 (Prepared by RTI—University of North Carolina Evidence-based Practice Center under Contract No. 290-02-0016). AHRQ Publication 04-E022-2. Rockville, MD: Agency for Healthcare Research and Quality.
- Wang, C. (2003). Using Photovoice as a participatory assessment and issue selection tool: A



- case study with the homeless in Ann Arbor. In Minkler, M & Wallerstein, N. Eds. *Community-based Participatory Action Research for Health*, 179-196. San Francisco: Wiley, John & Sons, Inc.
- Wang, C. (1999). Photovoice: A participatory action research strategy applied to women's health. *Journal of Women's Health*, 8(2): 185-192.
- Wang, C. & Burris, M. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Education and Behavior*, 24(3), 369-387.
- Wang, C. & Redwood-Jones, Y. (2001). Photovoice ethics: Perspectives from Flint Photovoice. *Health Education and Behavior*, 28(5): 560-572.
- West Atlanta Watershed Alliance (WAWA). (2013). Urban waters federal partnership comes to Proctor Creek. Retrieved from:  
<http://wawa-online.org/urban-waters-federal-partnership-comes-to-proctor-creek/>
- Wilson, S. M., O. R. Wilson, C. D. Heaney, & Cooper, C. (2007). Use of EPA collaborative problem-solving model to obtain environmental justice in North Carolina. *Progress in Community Health Partnerships: Research, Education and Action* 1 (4): 327-38.
- Woods, T.A. (2009). What is sense of place? Importance of Place. Retrieved from:  
<http://www.importanceofplace.com/2009/04/what-is-sense-of-place.html>



**Chapter 4: Mapping the Hidden Hazards:  
Spatial Data Collection of Street-Level  
Environmental Stressors in a Degraded, Urban  
Watershed**

Proposed Journal: *International Journal of  
Environmental Research and Public Health*



## **Mapping the Hidden Hazards: Spatial Data Collection of Street-Level Environmental Stressors in a Degraded, Urban Watershed**

**Key words:** participatory mapping; community GIS; participatory GIS; Community-based participatory research (CBPR)

### **ABSTRACT**

We utilized a participatory mapping approach to collect point locations, photographs, and select attributes of built environment stressors identified and prioritized by community residents living in a degraded, urban watershed in Northwest Atlanta, GA. Proctor Creek Watershed residents used an indicator identification framework to select three watershed stressors that influence urban livability: standing water, illegal dumping on land and in surface water, and faulty stormwater infrastructure. Through a community-university partnership and using Geographic Information Systems and digital mapping tools, watershed researchers collected data associated with these stressors to create a spatial narrative that offers visual documentation and representation of community conditions that negatively influence both the environment and quality of life in urban areas. We demonstrate that community-based knowledge can contribute to and extend scientific inquiry while also helping communities to advance environmental justice and leverage opportunities for remediation and policy change.

### **Introduction**

Both natural and built environments contain environmental hazards and stressors that negatively impact urban communities, and the existence of these hazards and stressors is often coupled with inequitable distribution of exposures, risk, and vulnerabilities (Kjellstrom et al., 2007; Satterthwaite, 1993; Srinivasan et al., 2003). Urban settings, therefore, pose special

challenges to addressing population health and health disparities (Barnett et al., 2011; CIHI, 2010; Gee & Payne-Sturges, 2004; Northridge et al., 2003).

The Framework for Urban Health posits that the health of urban populations is a function of urban living conditions and municipal-level determinants as well as national and global social, economic, and political trends (Galea et al, 2006). Because of the direct influence that urban living conditions have on the health of urban populations, this conceptual model suggests that urban living conditions are the most feasible determinant to modify and that seeking to make, "specific and targeted changes," in these conditions should be prioritized to improve the health of urban populations (p. 12).

The built environment is inextricably linked to urban living conditions. Exploring the influence that aspects of the built environment have on the health of urban populations helps to broaden understanding of the environmental health challenges in cities, as well as identify opportunities to make tangible built environment modifications to promote health and improve quality of life (Vlahov et al, 2007; Srinivasan et al., 2003). Studies that examine the existence and quality of municipal services such as sanitation, drainage, infrastructure maintenance, garbage collection, and access to safe drinking water, through a regulation and enforcement lens, tend to support policy-level changes (Vlahov et al, 2007; Galea & Vlahov, 2005; Bell & Rubin, 2007; Cook, 2008; Corburn, 2004; Freudenberg, et al., 2011; Gonzalez et al., 2011).

While widely used to engage lay citizens in making biological observations about the natural world (Dickinson et al., 2010; Silvertown, 2009; Sullivan et al., 2009), in recent years, citizen science in air and water quality monitoring and other community-based approaches have been used to address a wide range of health and environmental justice challenges in community

settings (Downs et al, 2008). Few published studies, however, focus on built environment stressors; thereby presenting challenges with identifying evidence-based practice aimed at improving urban living conditions to promote health. As noted by Northridge et al., (2003), “While the theory that connects the built environment to health and well-being is intuitively plausible, we still have a long way to go in collecting sufficient empirical data to make convincing appeals for planning and policy changes by the weight of the evidence,” (p. 557).

Participatory mapping approaches apply citizen science principles and draw upon the fields of community mapping and Public Participatory Geographic Information Systems (PPGIS). While community mapping doesn’t require professional mapping expertise and is led by members of a community who use local knowledge to inform dialogue about particular spaces and the environmental, political, economic, and social conditions that shape them (Parker, 2006; Perkins, 2007), PPGIS is an approach through which GIS practitioners attempt to make GIS more accessible to members of the public and provide vehicles through which citizens are empowered to influence spatial decision making (Abbot et al. 1998; Craig et al.,2002; Mukherjee 2015). Through community based participatory research and other community-academic partnerships, community knowledge can be joined with technical mapping expertise to create alternative community narratives that can influence investment of resources and urban policy and practice to improve environmental quality and promote health.

According to Pavloskaya, GIS can be powerful because of, “...its ability to create visual images of the world based on scientific information, to unveil previously hidden natural and social landscapes with an authority of science,” (2009). The use of GIS allows for not only map-making and visualization of data, but also complex spatial analysis (Abbot et al., 1998). Participatory approaches such as photovoice use photographs to raise awareness about critical community issues and advance policy change (Jelks et al., 2016; Cannuscio et al., 2009; Carlson

et al., 2006). Pairing visual evidence with traditional analytical research methods such as the use of GIS makes research processes more accessible to and useful for citizens in crafting compelling community narratives that can be presented to fellow residents and decision makers and used as the basis for remedial action and better environmental management. Documenting community conditions both spatially and visually can assist community residents in influencing spatial decision making.

The purpose of this article is to describe the process and findings of a collaborative community-university partnership forged to elevate Proctor Creek Watershed residents' knowledge of street-level environmental hazards, through collection and analysis of spatial and visual data, and to leverage this knowledge to advance meaningful engagement in community decision making that achieves environmental justice and policy change.

## **Methodology**

### *Study Area*

The Proctor Creek Watershed is located in Northwest Atlanta, Georgia. After decades of public disinvestment and neglect, watershed residents are faced with multiple environmental challenges that may pose health risks including: illegal dumping, impaired water quality, aging and polluting sewer infrastructure (combined sewer overflow system), brownfields, pervasive flooding, and elevated risk for West Nile Virus infection (Jelks et al., 2016; U.S. EPA, 2008; Vazquez-Prokopec et al., 2010; ARC, 2011; City of Atlanta, 2013). The stream and its tributaries flow through residential neighborhoods (including residential lots), public parks, and school grounds. Community meetings with watershed residents have also revealed anecdotal accounts

of fishing in the stream for the purpose of consumption. Recently, Proctor Creek's was designated a priority area for investment through Urban Waters Federal Partnership, and this has resulted in increased interest in the area (Jelks et al., 2016; U.S. EPA, 2013; Wheatley, 2013)

### ***Community-Driven Research Agenda***

This research was conducted over a five-month period and commenced with the identification of indicators representing street-level environmental hazards by Proctor Creek Watershed Researchers. These researchers (described in Jelks et al., 2016) developed the indicators in response to the following questions: 1) What contamination and pollution is in the Proctor Creek Watershed?; 2) What potential human health impacts are there from this contamination and pollution?; and 3) What actions can be taken and/or proposed to address these environmental and human health hazards? The watershed researchers triangulated existing data by using both publicly available "expert" data obtained from U.S. Environmental Protection Agency databases and community generated data, obtained from a photovoice project (Jelks et al., 2016).

### **Inclusion Criteria for Indicators**

The watershed researchers adapted and agreed upon an indicator identification framework and inclusion criteria from the work of Badland et al., (2014). Once identified, indicators were divided into three categories, based on said inclusion criteria: 1) The indicator is promising because it meets at least 50% of the criteria; 2) The indicator may be useful but requires further development to meet the criteria; or; 3) The indicator is not useful for our

research purpose, either because it fails to meet the criteria of interest, or is redundant because of similar, but more promising measures. Through a ranking process, the watershed researchers prioritized three locally relevant indicators: 1) locations where there is often standing water or where water commonly pools or collects, 2) locations where there is illegal dumping (in Proctor Creek or its tributaries or on land surfaces in the Proctor Creek Watershed), and 3) locations where there is faulty stormwater infrastructure (clogged or collapsed storm drains, sinkholes or depressions caused by inadequate drainage).

#### *Co-Development of Digital Data Collection Tools*

Through a collaborative process, the Proctor Creek Watershed Researchers worked with faculty and students from the Georgia State University School of Public Health and Department of Geosciences to develop a digital data collection tool using the Environmental Systems Research Institute (ESRI) ArcGIS Online program. The Proctor Creek Citizen Science Application (App) is downloadable to smart phones and tablets and is connected to a database server that allows for real-time data collection, storage, and sharing.

The app also allows for the collection of photos and/or videos, and prompts the user to record global positioning system (GPS) coordinates of the location being mapped. Data can be recorded by multiple app users simultaneously and updated on the server in real time; allowing teams of data recorders to physically see where other data collection is happening and to prevent duplication of efforts in the field. Use of the App is currently restricted to study participants, and the App is compatible with Apple and Android mobile phones and tablets.



### *Data Collection*

A total of 10 watershed researchers were paired with faculty and students from GSU in five field teams of four persons each to collect data within the Proctor Creek Watershed boundaries using the Proctor Creek Citizen Science App. Two watershed researchers were assigned to each team. The researchers determined the routes to travel for data collection based on their knowledge of areas that were heavily impacted by standing water, illegal dumping, and stormwater infrastructure challenges. While the watershed begins in downtown Atlanta, the researchers began their mapping in two heavily impacted neighborhoods, English Avenue and Vine City and moved further west into the lower reaches of the watershed. The routes selected corresponded with heavily travelled (by both car and foot traffic) arteries and the corresponding side streets. In the upper reaches of the watershed the researchers travelled by foot from south to north on Northside Drive and Joseph E. Lowery Blvd. and from east to west on Dr. Martin Luther King Jr. Drive, Joseph E. Boone Blvd, and Donald L. Hollowell Parkway. As they transitioned downstream, the researchers continued moving in a westward direction on Joseph E. Boone, Dr. Martin Luther King Jr. Drive, and Donald L. Hollowell Parkway.

Each team had a minimum of one device that was connected to the ArcGIS online application. Phase one of the data collection occurred during two separate two-hour field sessions in March and April 2015. Phase two of the data collection occurred during three subsequent sessions in May, June, and July 2015 and included only community researchers and the lead author. A community-generated Proctor Creek map of environmental hazards was developed with the data collected by the research teams.



**Figure 1:** Proctor Creek Watershed Researcher mapping a vacant lot with illegal dumping beside a vacant and abandoned house

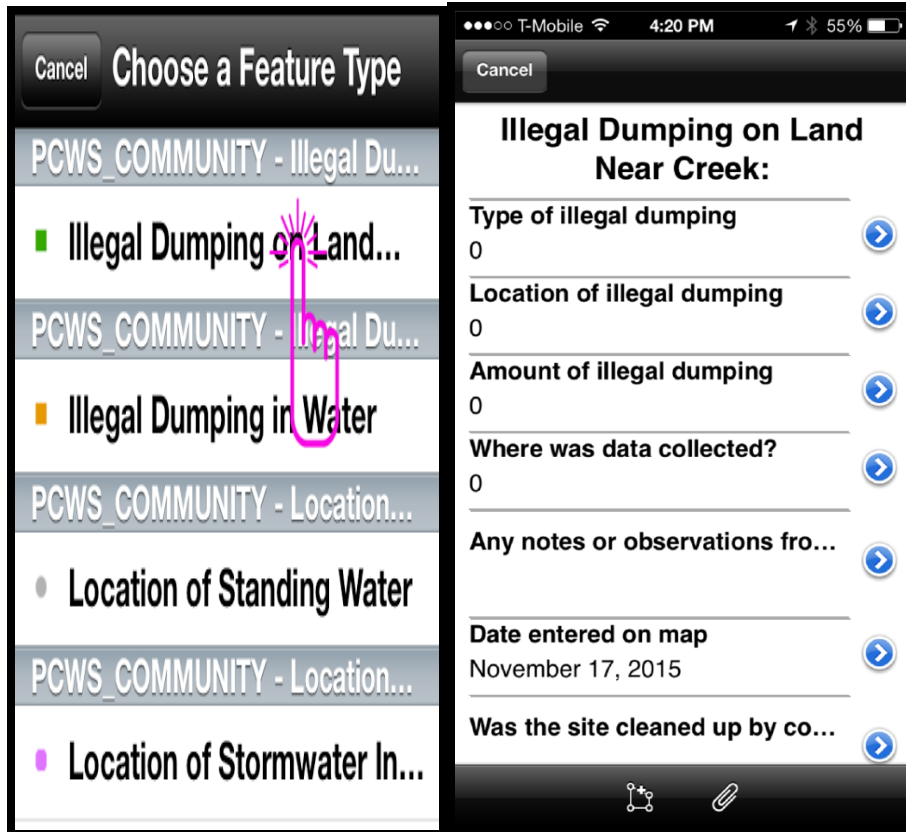
### *Data analysis*

The lead author and watershed researchers used ArcGIS Online functions (query and analysis tools) to aggregate and analyze the data contained in the community-generated Proctor Creek map. A series of maps were generated to visually display the data collected by the research teams. Heat map analyses were conducted to visually explore density, and hot spot analyses were performed to map statistically significant patterns of clustering within the data. Select results from this statistical analysis are included in the Results section. Each stressor was explored individually using the hot spot analysis tool, and a merged layer of related stressors exhibiting statistical significance were analyzed to produce a heat map. The queries conducted were determined by the watershed researchers.

## **RESULTS**

### *App Development*

Domains with subtypes were created in each feature class, representing Proctor Creek watershed stressors, to minimize data entry challenges for the end users entering data into the Proctor Creek Citizen Science App. A series of data entry prompts were developed into an easy-to-use, drop-down, multiple choice menu of data fields that corresponds to each hazard identified and mapped (see Figure 2). Data fields include type of hazard, location, amount, and other hazard-specific data as detailed in Table 1. Optional field notes from the user can also be entered into the database.



**Figure 2:** Examples of entry fields for data entry in the Proctor Creek Citizen Science App

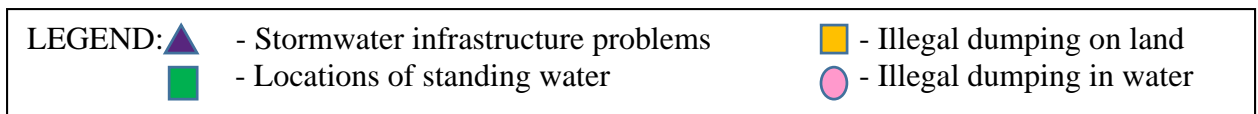
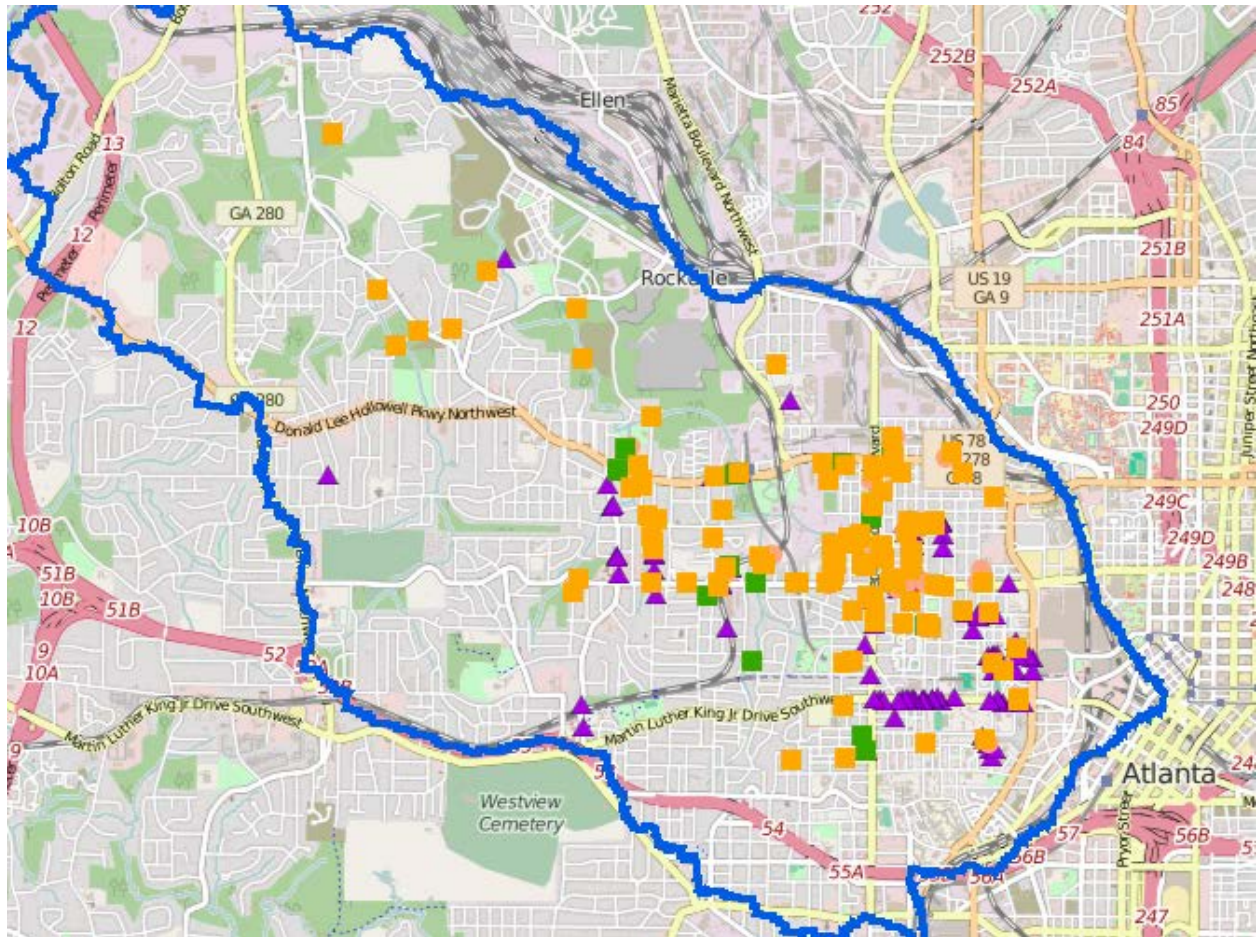
Type of Hazard Recorded in App	Hazard Specific Information Recorded in App
<b>Standing Water/Pooling Water</b>	<ul style="list-style-type: none"> <li>-Raining right now</li> <li>-Not raining right now</li> <li>-Not raining now, but rained in last 48 hours</li> <li>-Visible evidence of mold on buildings nearby</li> <li>-Presence of damp, moldy smell in the area</li> </ul>
<b>Type of Illegal Dumping in Water</b>	<ul style="list-style-type: none"> <li>-Sewage/floatable solid</li> <li>-Non-point source pollution (bottles, cans, potato chip bags, etc.)</li> <li>-Heavy Debris (tires, heavy items that someone most likely had to put directly into the creek)</li> <li>-Other</li> </ul>
<b>Type of Illegal dumping on Land</b>	<ul style="list-style-type: none"> <li>-Construction or other building materials</li> <li>-Scrap tires</li> <li>- Housing debris (couches, mattresses, furniture, etc.)</li> <li>- Assorted debris (mixture of household trash, litter: cans, bottles, plastic bags, etc.)</li> <li>-Other</li> </ul>
<b>Type of Stormwater Infrastructure Problems</b>	<ul style="list-style-type: none"> <li>-Clogged storm drains</li> <li>-Clogged stormwater pipes</li> <li>-Collapsed storm drains</li> <li>-Sinkholes/Depressions</li> </ul>

**Table 1:** Hazard-specific data choices from drop-down menus collected in the Proctor Creek Watershed Citizen Science App

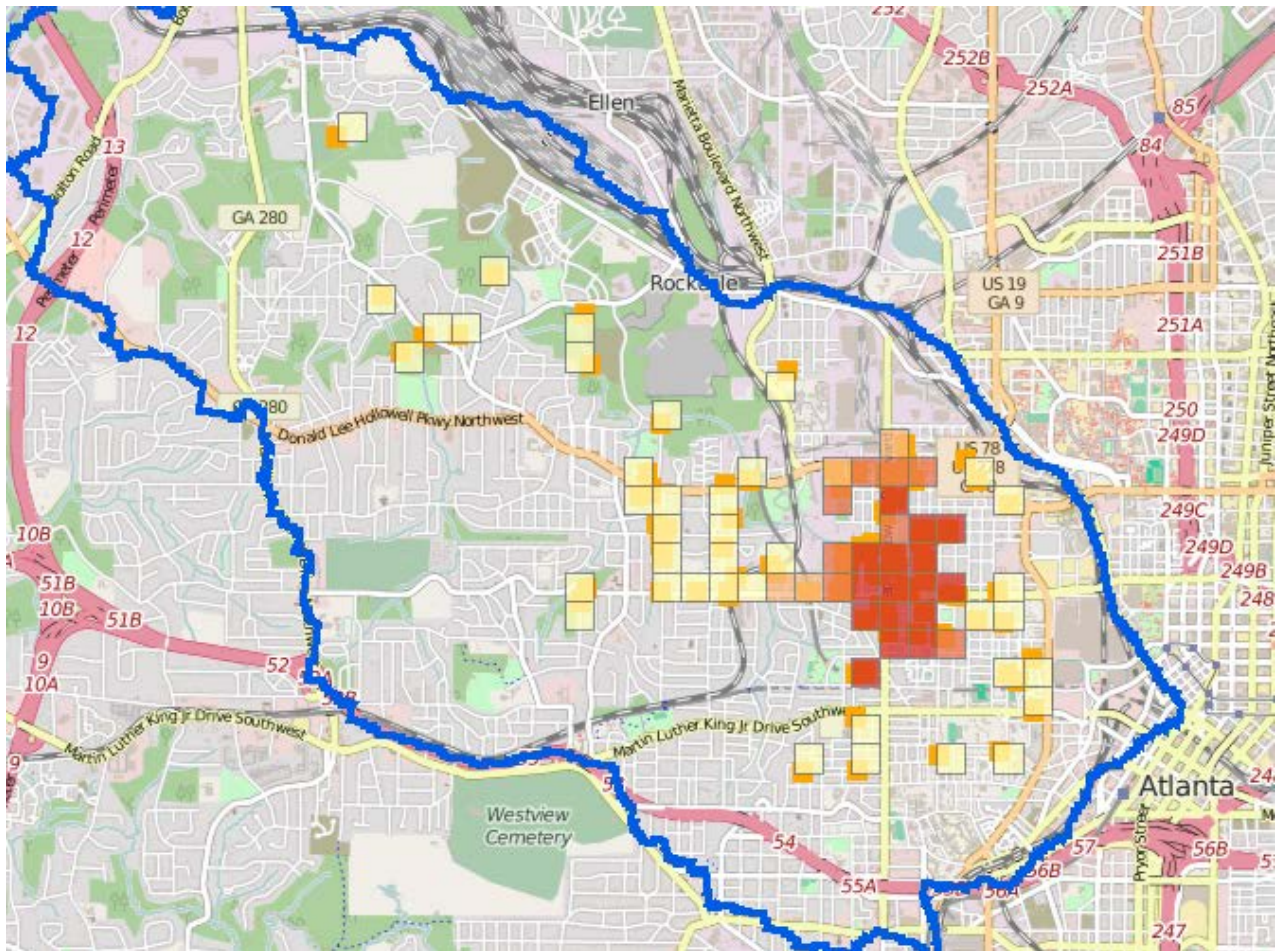
Over a period of five (5) days (total 10 hours), the community-university and community field teams mapped 50% of the watershed. We produced a community-generated map that accompanied by its database, pinpoints exact locations of and photographs depicting environmental hazards in the watershed. A total of 275 data points were generated across all indicators. Illegal dumping on land made up 44% (121 of 275) of the total data points followed by locations of stormwater infrastructure problems at 42% (116 of 275), locations with standing water at 9% (25 of 275), and illegal dumping in the creek at 4.7% (13 of 275). Point locations representing these hazards are displayed on the community-generated map (Figure 3).

The data were analyzed using the ArcGIS Online hot spot spatial analysis tool to detect statistically significant hazard clusters using the Getis-Ord GI\* statistic. The p-values and z-scores that result from this analysis help identify areas where high or low values cluster spatially (ESRI, 2013). In these maps, the orange and red colored blocks represent hot spots or a

statistically significant clustering of high values. The darker the color, the higher the confidence levels (ranging from the 90% to the 99% levels). Yellow blocks are not statistically significant. No cold spots (blue colored blocks representing statistically significant clusters of low values) were identified in any of our analyses, however there were both hot spots and areas in which the patterns are random (depicted by yellow blocks). Individual analyses of the illegal dumping on land and stormwater infrastructure challenges data revealed 28 and 23 statistically significant features respectively, based on application of a false discovery rate (FDR) correction for multiple testing and spatial dependence (ESRI, 2016). These clusters are shown in figures 4 and 5. In figure 6, we display a heat map that allowed the study participants to see visually where the highest density of both illegal dumping on land and location of stormwater infrastructure problems exist. The map visually represent the largest areas where most of the points are concentrated and symbolized with colors to represent these areas. Because heat maps only account for the geographic location of point features on a map, statistical significance cannot be assumed. (ESRI, 2015). Examples of photographs taken to visually document hazards mapped by the watershed researchers are found in Figure 7.



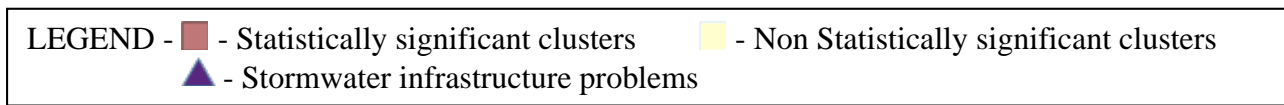
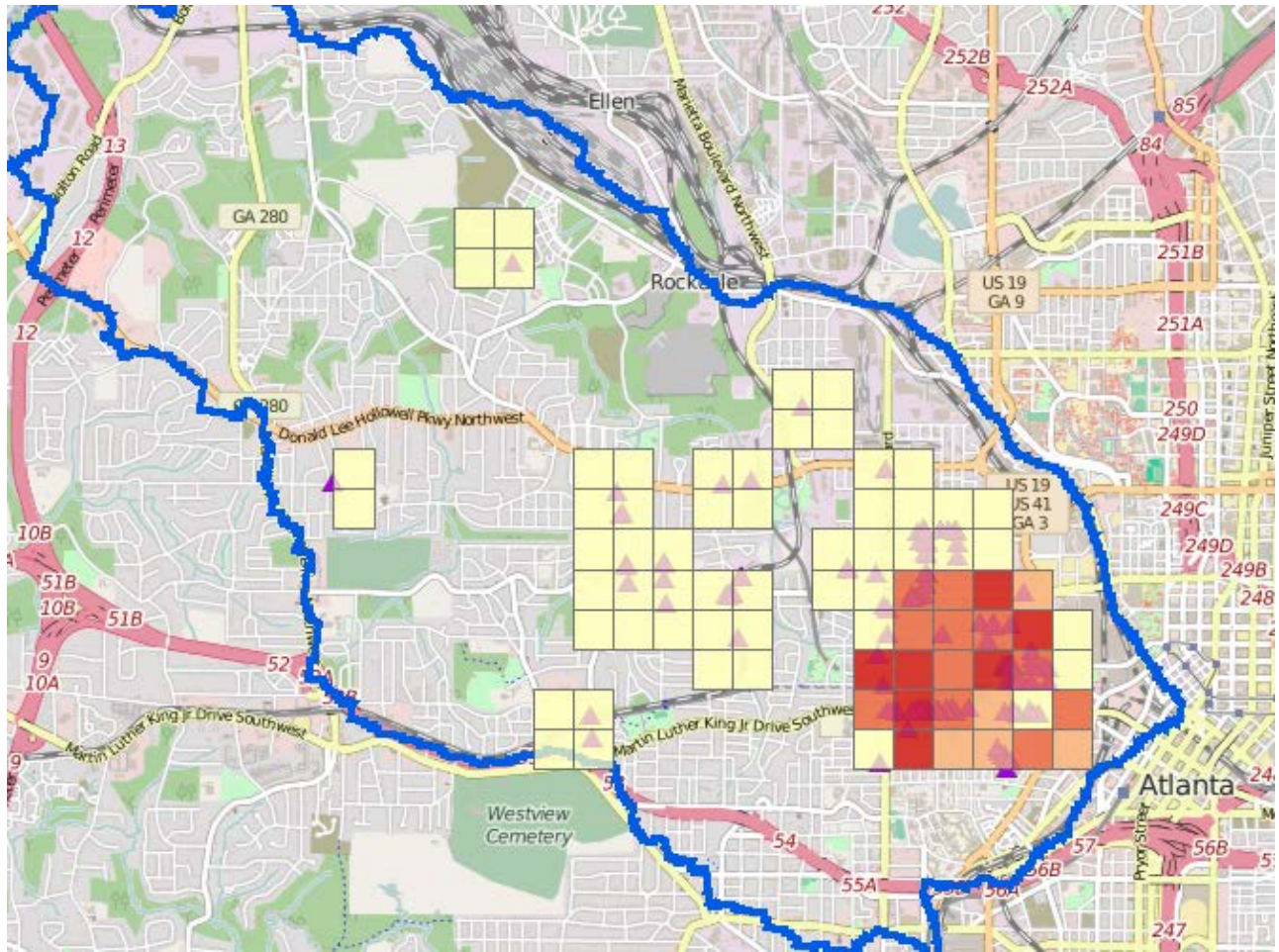
**Figure 3:** Community Generated Map of Proctor Creek Hidden Hazards



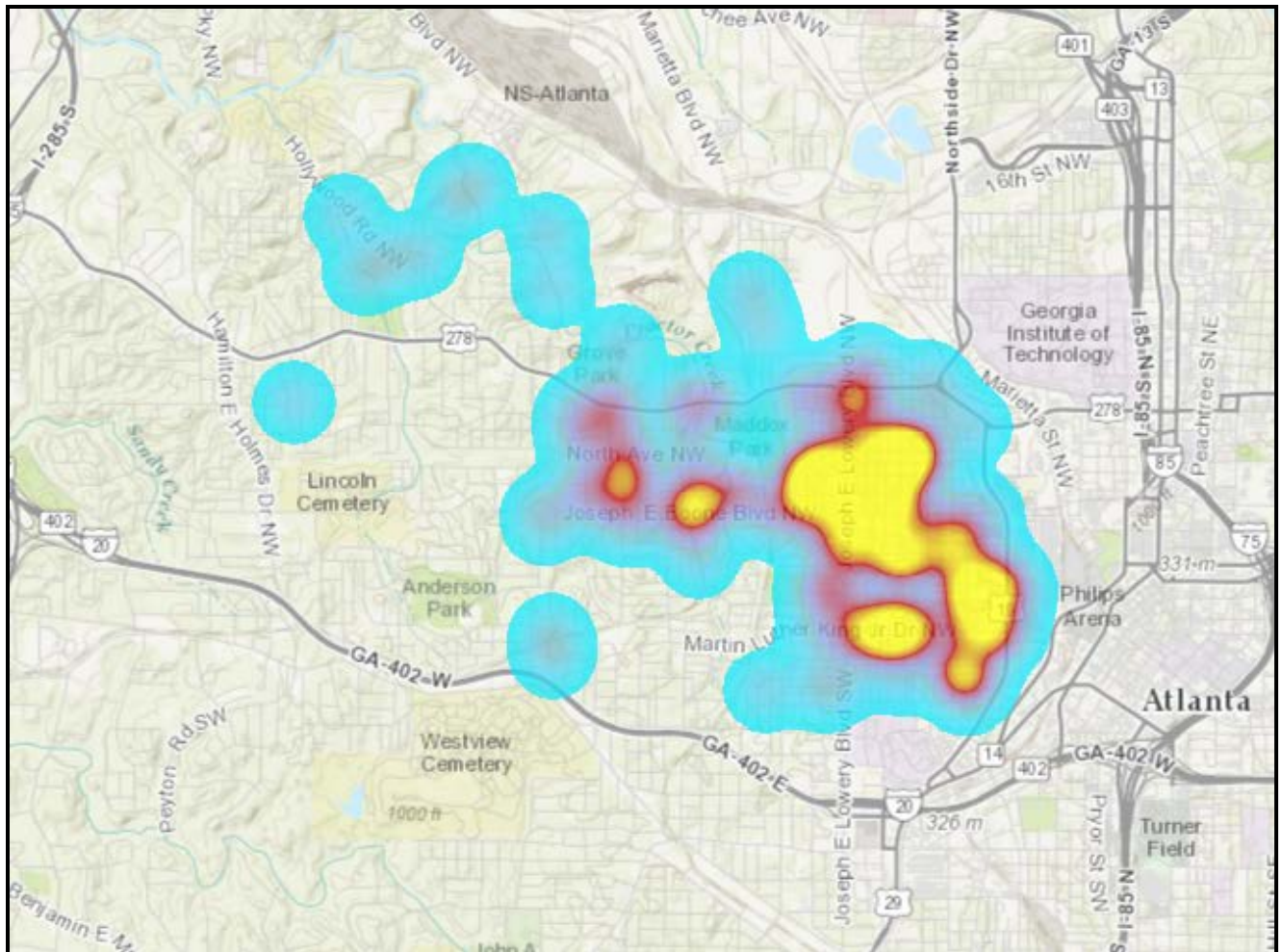
**LEGEND** - ■ - Statistically significant clusters      ■ - Non Statistically significant clusters  
 ■ - Illegal dumping on land

**Figure 4:** Statistically significant clustering of areas with illegal dumping mapped by community researchers in the Proctor Creek Watershed





**Figure 5:** Statistically significant clustering of locations with stormwater infrastructure problems mapped by community researchers in the Proctor Creek Watershed



**Figure 6:** Areas of highest density (depicted by the colors yellow and red) of illegal dumping on land and locations of stormwater infrastructure problems in the Proctor Creek Watershed (does not denote statistical significance)



**Figure 7:** Examples of photographs documenting Proctor Creek Watershed hazards

## **Discussion**

This study was designed to explore and document community knowledge of neighborhood-level environmental hazards. Unlike many GIS projects, the database design was controlled by the research participants. Local knowledge and technical mapping expertise came together to enact a community plan that included both collaborative design of the app and data collection. The collaborative effort between community and university partners enabled a tech-savvy phenomena to be put in the hands of and effectively used by a non tech-savvy audience. This participatory mapping approach connected maps to visual stories of hazards that were “hidden in plain sight,”--- abundant and widely distributed across parts of the Proctor Creek Watershed landscape yet seemingly invisible to decision makers and others who are positioned to help improve urban living conditions in Atlanta neighborhoods.

Although mapping has only been conducted in roughly 50% of the watershed, the field research teams identified a host of statistically significant areas in the Proctor Creek Watershed that warrant improvements with respect to illegally dumped trash and debris on land and in terms of the condition and maintenance of stormwater infrastructure (i.e. clogged and sometimes collapsed storm drains). The heat map generated after conducting spatial analysis on the merged layers representing these two data sets illuminates the need to pay attention to these areas. While heat maps are tools for data visualization, and the color gradients indicate areas of increasingly higher density (from blue to, purple, red, orange, and yellow respectively), these maps do not necessarily depict statistically significant data as the maps displaying hot spots do. Watershed researchers, however, found such maps useful to communicate to decision makers which areas in the watershed they deem necessary to prioritize for remedial action (areas characterized by red and yellow).

The data collected by community residents, even in the initial stages proves “community truths” and validates local, spatial knowledge with respect to the existence of, often overlooked, environmental hazards. Proctor Creek Watershed residents are optimistic that having valid maps and spatial data accompanied with photographic images can move city officials from inaction to action and motivate fellow watershed residents to increase advocacy efforts designed to improve deleterious environmental conditions.

### *Study Strengths and Limitations*

Maps speak the language of the decision makers, and in this case, the community-generated map gives the community voice that is supported by location-specific visual evidence.

It conveys context about built environment stressors in the watershed and can ignite discourse about underlying root causes associated with community challenges. The participatory mapping approach empowers community residents with a vehicle through which they can contribute their spatial knowledge to inform local planning and environmental management decisions and practices. It demonstrates action instead of reaction; helping community residents to create a place for themselves at planning, code enforcement, and watershed management decision-making tables. In addition to increasing community agency to press for remedial action and policy change, identification of hazard locations can also be used to plan community responses such as clean-ups and community education efforts to raise awareness about the causes, consequences of, and solutions to illegal dumping and other challenges experienced in the Proctor Creek Watershed.

Despite its utility in helping to elevate and prioritize areas for greater public investment in community action, city services, and remedial measures, the methodological approach has several limitations. First, because the ArcGIS Online platform is internet-based, there are occasional problems with accessing the platform for field data collection. It is also possible that some data points show up in the wrong place; requiring data to be validated. Use of the app requires internet-enabled computers and/or mobile devices and leaves out those without access to them. Although recent literature suggests that smart phones are beginning to bridge the digital divide because of wider accessibility, even in developing countries (Dogbey et al, 2014), smartphone users tend to be younger in age than general cell phone users (Boulos et al., 2011; Lane & Manner, 2011); thereby adding a new dimension to the divide between those with and without access to contemporary communications devices. These younger users, when coming from low-income households, are more burdened by costs associated with accessing the internet

from mobile devices than from traditional computing platforms (Brown et al., 2011). Using apps like the one described herein may then prove costly if mobile users have a limited data plan. Furthermore, while access to the ArcGIS Online platform, on which the app operates, is free, a subscription is required to perform data analysis.

Our study-specific data collection was limited and might be biased by where the research teams went. Our data does not represent findings from across the entire watershed. Meaningful data analysis was subsequently limited due to its dependence on a minimum number of points to identify statistically significant spatial clustering within specific hazard types. The content that we designed the Proctor Creek Citizen Science app to collect was also not streamlined to allow for greatest utility in advanced data analyses. While the app prompts users to quantify the amount of illegal dumping identified, it does not do so for the amount of standing water or prompt users to distinguish highly clogged storm drains from those that are minimally clogged. Being able to identify the data points with the highest impacts through data analysis queries will enhance the ability of this approach to help planners and other municipal officials determine where the most immediate remedial measures should be applied.

User subjectivity can also influence what is deemed significant and consequently, what should be documented. Our app allows users to document visual evidence to substantiate the data points collected, however the decision to map or not to map lies in the hands of individual researchers. Although there was agreement on the environmental stressors to document in the study area, there were differing perspectives with respect to mapping specific sites. Because of the seemingly ubiquitous nature of illegal dumping in the Proctor Creek Watershed, this hazard was underrepresented in the community-generated data. In some cases, watershed researchers felt that occurrences of illegal dumping, were so commonplace that every pile did not rise to the

level of needing to be documented. What was not documented may be just as important as that which was documented and is likely to have a great impact on the effectiveness of the approach.

### **Directions for Action and future research**

There is consensus among the watershed researchers that maps, photographic documentation, and GPS coordinates are vital to having productive interaction with government officials that is capable of advancing corrective action. Proctor Creek Watershed residents have a mechanism for which they can use to hold government officials accountable. If repeated in the designated study area over time, such an approach can also be used to track remedial action and spatio-temporal changes in urban living conditions. Highlighting otherwise hidden hazards is the first step in ensuring that they receive the attention they deserve. At minimum, the utility of this approach for local planning, watershed management, and code enforcement practices can be enhanced as additional data is collected and analyzed. It will also be important to determine if the results of this participatory mapping approach can lead to production of a comprehensive, fine grained data layer that is appropriate to integrate with publicly available data for the purposes of cumulative risk assessment and impact analyses. In contrast to the environmental hazards in the Proctor Creek Watershed identified in other studies (Jelks et al., 2016), none of the relevant environmental hazards identified by the watershed researchers were chemical hazards. Uncovering these hidden hazards for integration with publicly available hazard data is consistent with other community-engaged research to explore non-chemical stressors in the context of approaches like cumulative risk assessment. The integration of publicly available data with data obtained through participatory mapping will lead to more accurate maps of watershed residents' proximity to hazard sources than can be generated with publically available data alone.

Conducting training refresher sessions to help study participants retain app user “know how” and providing training to expand use of the app to new participants will help to sustain ongoing engagement. Presentation of preliminary data collected with the app has already led to discussions with city government officials about identification of scrap tires for which funds can be obtained for clean-up from a state government program. The aforementioned group of researchers have now also been trained to identify illicit discharges (pollution from pipes and drains) into Proctor Creek; a data attribute that can be added to enhance the pre-existing app. A relationship with city watershed protection officials is being forged that is expected to yield faster responses to watershed-based problems than prior to these community residents’ engagement in this process. As new users and user groups are trained in the use of the app, however, there will be a need to verify and perhaps edit new data entries. Particularly, if any data points are added via computer and not in the field, location of the hazards will need to be verified prior to presentation of the data to decision makers or for advocacy purposes.

## **Conclusion**

This study contributes to ongoing discourse with respect to meaningful citizen engagement in urban planning and health promotion strategies to improve built environment outcomes that is consistent environmental justice principles and best practices for public participation in environmental and other public health decision making. The case demonstrates the benefits derived from using community-generated spatial data to examine community concerns. This approach can help democratize decision making and can alter power relations by putting powerful data in the hands of community residents to help prioritize and leverage action when issues go unseen or are consistently unaddressed.



Because ArcGIS Online is an open source platform, it can be adapted to meet specialized needs and concerns in a wide range of locales. Because of the resources needed, however, such an approach should be pursued on a case-by-case basis and should not be considered a universal solution. It is, however, a viable option for activities that expand meaningful community engagement alternatives for those desiring to influence local, urban governance. When community-based organizations partner in meaningful ways with academic institutions, resource limitations can be overcome; both in terms of access to devices needed to conduct field activities as well as the technical expertise required to design digital data collection tools based on needs expressed by community stakeholders.

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## References

- Abbot, J., Chambers, R., Dunn, C., Harris, T. de Merode, E., Porter, G., Townsend, J., Weiner, D. (1998). Participatory GIS: opportunity or oxymoron? *Participatory Learning and Action Notes*, 33, 27-33.
- Atlanta Regional Commission (ARC). (2011). Proctor Creek – Headwaters to the Chattahoochee: Watershed Improvement Plan. Atlanta, Georgia.
- Badland, H., Whitzman, C., Lowe, M., Davern, M., Aye, L., Butterworth, I., Hes, D. & Giles-Corti, B. (2014). Urban liveability: Emerging lessons from Australia for exploring the potential for indicators to measure the social determinants of health. *Social Science & Medicine*, 111, 64-73.
- Barnett, A.G., Plonka, K., Seow, W.K., Wilson, L-A., & Hansen, C. (2011). Increased traffic exposure and negative birth outcomes: A prospective cohort in Australia. *Environmental Health*, 10:26. Retrieved from: <http://www.ehjournal.net/content/10/1/26>.
- Barzyk, T.M., Conlon, K.C., Chahine, T., Hammond, D.M., Zartarian, V.G., & Schultz, B.D. (2010). Tools available to communities for conducting cumulative exposure and risk assessments. *Journal of Exposure Science and Environmental Epidemiology*, 20, 371-384.
- Bell, J. & Rubin, V. (2007). *Why place matters: Building a movement for healthy communities*. Policylink. Retrieved from: [http://www.policylink.org/sites/default/files/WHYPLACEMATTERS\\_FINAL.PDF](http://www.policylink.org/sites/default/files/WHYPLACEMATTERS_FINAL.PDF)
- Boulos, M.N.K., Wheeler, S., Tavares, C. & Jones, R. (2011). How smartphones are changing the face of mobile and participatory healthcare: An overview with example from eCAALYX. *BioMedical Engineering OnLine*, 10:24.
- Brown, K., Campbell, S.W. & Ling, R. (2011). Mobile phones bridging the digital divide for teens in the US? *Future Internet*, 3, 144-158.
- Burris, S., Hancock, T., Lin, V & Herzog, A. (2007). Emerging strategies for healthy urban governance. *Journal of Urban Health*, 84(Suppl 1): 154–163.
- Canadian Institute for Health Information (CIHI). (2010). Urban physical environments and health inequalities: Factors influencing health. Ottawa, Ontario. Retrieved from: [http://www.healthequity.umd.edu/documents/cphi\\_urban\\_physical\\_environments\\_en.pdf](http://www.healthequity.umd.edu/documents/cphi_urban_physical_environments_en.pdf).
- Cannuscio, C.C., Weiss, E.E., Fruchtman, H., Schroeder, J. Weiner, J. & Asch, D.A. (2009).

- Visual epidemiology: Photographs as tools for probing street-level etiologies. *Social Science & Medicine*, 69: 553-564.
- Carlson, E., Engebretson, J. & Chamberlain, R. (2006). Photovoice as a social process of critical consciousness. *Qualitative Health Research*, 16, 836-852.
- Centers for Disease Control and Prevention (CDC). (2010). Environmental Health. Healthy People 2020. Retrieved from: <http://www.healthypeople.gov/subtopics-sdoh/environmentalhealth>.
- Chattahoochee Riverkeeper (CRK). (2015). Neighborhood water watch monitoring data. Retrieved from: <http://www.chattahoochee.org/nww/>.
- City of Atlanta Department of Watershed Management (2013). The Proctor Creek Watershed. <http://www.atlantawatershed.org/inside-dwm/offices/watershed-protection/atlantae28099s-watersheds/the-proctor-creek-watershed/>
- Community Toolbox (2008). Assessing community needs and resources. *Community Assessment*. Retrieved from: <http://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources/collect-information/main>
- Cook, W.K. (2008). Integrating research and action: a systematic review of community-based participatory research to address health disparities in environmental and occupational health in the USA. *Journal of Epidemiology and Community Health*, 62(8):668-76.
- Corburn, J. (2004). Confronting the challenges in reconnecting urban planning and public health. *American Journal of Public Health*, 94(4): 541-545.
- Craig, W. J., Harris, T.M. & Weiner, D. (2002). *Community Participation and Geographic Information Systems*. London; New York: Taylor & Francis.
- Curtis, A., Blackburn, J.K., Widmer, J.M. & Morris, J.G., Jr. (2013). A ubiquitous method for street scale spatial data collection and analysis in challenging urban environments: Mapping health risks using spatial video in Haiti. *International Journal of Health Geographics*, 12(21): 1-14.
- Cutrona, C.E., Wallace, G. & Wesner, K.A. (2006). Neighborhood characteristics and depression: An examination of Stress Processes. *New Directions in Psychological Science*, 15(4):188-192.
- Dickinson, J.L., Zuckerburg, B. & Bonter, D.N. (2010). Citizen science as an ecological research tool: Challenges and benefits. *Ecology, Evolution and Systematics*, Vol. 41: 149-172.

- Dogbey, J., Qigley, C., Che, M. & Hallo, J. (2014). Using smartphone technology in environmental sustainability education: The case of the Maasai Mara Region in Kenya. *International Journal of Mobile and Blended Learning*, 6(1): 1-16.
- Downs, T.J., Ross, L., Mucciarone, D., Calvache, M-C., Taylor, O., & Goble, R. (2010). Participatory testing and reporting in an environmental-justice community of Worcester, Massachusetts: a pilot project. *Environmental Health*, 9,34.
- Environmental Systems Research Institute, Inc. (ESRI) (2016). FDR correction. Retrieved from: [http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-statistics-toolbox/what-is-a-z-score-what-is-a-p-value.htm#ESRI\\_SECTION1\\_2C5DFC8106F84F988982CABAEDBF1440](http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-statistics-toolbox/what-is-a-z-score-what-is-a-p-value.htm#ESRI_SECTION1_2C5DFC8106F84F988982CABAEDBF1440)
- Environmental Systems Research Institute, Inc. (ESRI) (2015). Heat maps. Retrieved from: <http://doc.arcgis.com/en/maps-for-sharepoint/arcgis-map-web-part/heat-maps.htm>
- Environmental Systems Research Institute, Inc. (ESRI) (2013). How hot spot analysis (Getis Ord Gi\*) works. Retrieved from: [http://resources.arcgis.com/en/help/main/10.1/index.html#/How\\_Hot\\_Spot\\_Analysis\\_Get\\_is\\_Ord\\_Gi\\_works/005p00000011000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/How_Hot_Spot_Analysis_Get_is_Ord_Gi_works/005p00000011000000/)
- Elwood, S. (2009). Multiple representations, significations, and epistemologies in community-based GIS. In M. Cope & S. Elwood (Eds). *Qualitative GIS: A Mixed Methods Approach*, (pp. 57-74). Thousand Oaks, CA: Sage Publications, Inc.
- Federal Emergency Management Agency (FEMA). (2005). Localized flooding. Reducing Damage from Localized Flooding: A Guide for Communities, p. 2-1 – 2-10. Retrieved from: <http://www.fema.gov/pdf/fima/FEMA511-03-Chapter2.pdf>.
- Freudenberg, N., Pastor, M., & Israel, B. (2011). Strengthening Community Capacity to Participate in Making Decisions to Reduce Disproportionate Environmental Exposures. *American Journal of Public Health*, 101, 123-129.
- Freudenberg, N. (2006). Interventions to improve urban health. In N. Freudenberg, S. Galea & D. Vlahov (Eds). *Cities and Health of the Public*, (pp. 294-326). Nashville, TN: Vanderbilt University Press.
- Galea, S., Freudenberg, N. & Vlahov, D. (2005). Cities and population health. *Social Science & Medicine* 60, 1017–1033.
- Galea, S. & Vlahov, D. (2005). Urban health: Evidence, challenges, and directions. *Annual Review of Public Health*, 26:341–65
- Gaventa, J. (2004). Towards participatory governance: Assessing the transformative possibilities. In S. Hickey & G. Mohan (Eds). *Participation – From Tyranny to Transformation? Exploring New Approaches to Participation in Development*, (pp. 25-41). New York,

NY: Zed Books, Ltd.

Gee, G.C. & Payne-Sturges, D.C. (2004). Environmental health disparities: A framework integrating psychosocial and environmental concepts. *Environmental Health Perspectives*, 112(17) 1645-1653.

Georgia Environmental Protection Division (GA EPD) of the Georgia Department of Natural Resources. (2013). Georgia's 2012 Integrated 305(b)/303(d) Report. Retrieved from: <http://www.gaepd.org/Documents/305b.html>.

Geronimus, A.T. (2000). To mitigate, resist, or undo: Addressing structural influences on the health of urban populations. *American Journal of Public Health*, 90(6): 867-872.

Gonzalez, P.A., Minkler, M., Garcia, A.P., Gordon, M., Garzon, C., Palaniappan, M., Prakash, S. & Beveridge, B. (2011). Community-based participatory Research and Policy Advocacy to Reduce diesel exposure in West Oakland, California. *American Journal of Public Health*, 101, 166-175.

GreenLaw. (2012). *The Patterns of Pollution: A Report on Demographics and Pollution in Metro Atlanta*. Retrieved from: <http://greenlaw.org/Files/GreenLaw/2012/PatternsofPollution,FINAL,GreenLaw3-26-2012.pdf>.

Harper, D. (1994). On the authority of the image: Visual methods at the crossroads. In N.K. Denzin & Y.S. Lincoln (Eds). *The Sage Handbook of Qualitative Research*, First Edition, (pp.408-417). London, England: Sage.

Israel, B.A., Coombe, C.M., Cheezum, R.R., Schulz, A.J., McGranaghan, R.J., Lichtensetin, R., Reyes, A.G., Clemente, J. & Burris, A. (2010). Community-based participatory research: A capacity-building approach for policy advocacy aimed at eliminating health disparities. *American Journal of Public Health*, 100(1): 2094-2102.

Jelks, N.O., Dai, D., Fuller, C.H. Hawthorne, T. & Stauber, C.E. (2016). *Exploring applications of a screening-level cumulative environmental impact analysis model at a small-scale watershed level: Limitations, lessons learned, and methodological considerations*. Unpublished manuscript.

Jelks, N.O., Smith, D.O. Hawthorne, T. Fuller, C.H., Dai, D. & Stauber, C.E. (2016) *Participatory research in Northwest Atlanta's Proctor Creek Watershed: Using Photovoice as a tool to explore environmental health risks at the water's edge*. Unpublished manuscript.

Kjellstrom, T., Friel, S., Dixon, J., Corvalan, C., Rehfuess, E., Campbell-Lendrum, D., Gore, F. & Bartram, J. (2007). Urban Environmental Health Hazards and Health Equity. *Journal of Urban Health*, 84(Suppl 1): 86-97.

- Lane, W. & Manner, C. (2011). The impact of personality traits on smartphone ownership and use. *International Journal of Business and Social Science*, 2(17): 22-28.
- LaDeau, S.L., Leisnham, P.T., Biehler, D. & Bodner, D. (2013). Higher Mosquito Production in Low-Income Neighborhoods of Baltimore and Washington, DC: Understanding Ecological Drivers and Mosquito-Borne Disease Risk in Temperate Cities. *International Journal of Environ Research and Public Health*. 10(4): 1505–1526.
- Lee, S. & Guhathakurt, S. (2013). Bridging environmental sustainability and quality of life in Metropolitan Atlanta’s urban communities. *Community Quality-of-Life Indicators: Best Cases VI*, pp. 207-231.
- Minkler, M. (2010). Linking science and policy through community-based participatory research to study and address health disparities. *American Journal of Public Health*, 100(Suppl. 1): S81-S87.
- Minkler, M., Vasquez, V.B., Warner, J.R., Steussey, H., & Facente, S. (2006). Sowing the seeds for sustainable change: A community based participatory research partnership for health promotion in Indiana, USA and its aftermath. *Health Promotion International*, 21(4): 293-300.
- Mukherjee, F. (2015). Public participatory GIS: History, literature review and sustainability of PPGIS. *Geography Compass* 9(7), 384–94.
- Northridge, M.E., Sclar, E.D. & Biswas, P. (2003). Sorting out the connections between the built environment and health: A conceptual framework for navigating pathways and planning healthy cities. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 80(4), 556-568.
- O’Fallon, L.R. & Dearry, A. (2002). Community-based participatory research as a tool to advance environmental health sciences. *Environmental Health Perspectives*, 110(Suppl. 2): 155–159.
- Ompad, D., Galea, S., Caiaffa, W. & Vlahov, D. (2007). Social determinants of the health of urban populations: Methodologic considerations. *Journal of Urban Health*, 84(Suppl 1): 42–53.
- Parker, B. (2006). Constructing community through maps? Power and praxis in community mapping. *Professional Geographer*, 58(4), 470–84.
- Park Pride (2011). Proctor Creek North Avenue Watershed Basin: A Green Infrastructure Vision. Retrieved from: [http://www.parkpride.org/get-involved/community-programs/park-visioning/content/more-info/2010\\_pna\\_overview.pdf](http://www.parkpride.org/get-involved/community-programs/park-visioning/content/more-info/2010_pna_overview.pdf)
- Pavloskaya, M (2009). Non-quantitative GIS. In M. Cope & S. Elwood (Eds). *Qualitative GIS: A Mixed Methods Approach*, (pp. 13-37). Thousand Oaks, CA: Sage Publications, Inc.

- Payne-Sturges, D. & Lee, G.C. (2006). National environmental health measures for minority and low-income populations: Tracking social disparities in environmental health. *Environmental Research*, 102, 154-171.
- Perera, B; Ostbye, T. & Jayawardana, C. (2009). Neighborhood environment and self-rated health among adults in southern Sri Lanka. *International Journal of Environmental Research and Public Health*, 6, 2102-2112.
- Perkins, C. (2007). Community mapping. *The Cartographic Journal*, 44(2), 127–37.
- Popay, J. & Williams, G., (1996). Public health research and lay knowledge. *Social Science & Medicine*, 42(5), 759–768.
- Pridmore, P., Thomas, L., Haveman, K., Sapag, J., Wood, L. (2007). Social capital and healthy urbanization in a globalized world. *Journal of Urban Health*, 84(Suppl 1): 130–143.
- Rambaldi, G., Cooperation, C., Kyem, P.A.K., McCall, M. & Weiner, D. (2006). Participatory spatial information management and communication in developing countries. *The Electronic Journal of Information Systems in Developing Countries (Ejisd)*, 25(1), 1-9.
- Runfola, D.M. & Hakins, K.M. (2009). Urban dereliction as environmental injustice. *ACME: An International E-Journal for Critical Geographies*, 9 (3), 345-367.
- Satterthwaite, D. (1993). The impact on health of urban environments. *Environment and Urbanization*, 5(2):87-111.
- Shepard, P.M., Northridge, M.E., Prakash, S. & Stover, G. (2002). Preface: Advancing environmental justice through community-based participatory research. *Environmental Health Perspectives*, 110(Suppl.2): 139–140.
- Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology and Evolution*, 24(9) 467–471.
- Snedker, K.A. & Hooven, C. (2012). Neighborhood perceptions and emotional well-being in young adulthood. *Journal of Child and Adolescent Psychiatric Nursing*, 26 (2013) 62–73.
- Srinivasan, S., O’Fallon, L.R., & Deary, O. A. (2003). Creating healthy communities, healthy homes, healthy people: Initiating a research agenda on the built environment and public health. *American Journal of Public Health*. 93(9):1446-1450.
- Sullivan, B.L., Wood, C.L., Liff, M.J., Bonney, R.E., Fink, D. & Kelling, S. (2009). eBird: A citizen-based observation network in the biological sciences. *Biological Conservation*, 142 (1): 2282-2292.

- Teedon, P., Gillespie, M., Lindsay, K. & Baker, K. (2014). Parental perceptions of the impacts the built environment has on young children's health: A qualitative examination and lay assessment amongst residents in four Scottish communities. *Health & Place*, 28: 50-57.
- United States Environmental Protection Agency (U.S. EPA). 2015. My Right to Know Application. Toxics Release Inventory (TRI) Program. Retrieved from: <http://www2.epa.gov/toxics-release-inventory-tri-program/my-right-know-application>
- United States Environmental Protection Agency (U.S. EPA). 2015. Risk Management Plan (RMP) Rule. Retrieved from: <http://www2.epa.gov/rmp>.
- United States Environmental Protection Agency (U.S. EPA). 2008. Combined sewer overflows demographics. National Pollutant Discharge Elimination System (NPDES). Retrieved from: [http://cfpub.epa.gov/npdes/cso/demo.cfm?program\\_id=5](http://cfpub.epa.gov/npdes/cso/demo.cfm?program_id=5).
- United States Environmental Protection Agency (U.S. EPA). 2013. Partners for progress in Proctor Creek: Recreating a sustainable creekside community in the city. Retrieved from: <http://www.urbanwaters.gov/pdf/ProctorCreekBackgrounder.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2012). EPA scientists develop tools to help communities identify and prioritize environmental health issues. Retrieved from: <http://www2.epa.gov/sites/production/files/2015-05/documents/c-ferst-fact-sheet.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2012). Urban Waters. Retrieved from: <http://www2.epa.gov.gov/urbanwaters>.
- Vlahov, D., Freudenberg, N., Proietti, F., Ompad, D., Quinn, A., Nandi, V. & Galea, S. (2007). Urban as a determinant of health. *Journal of Urban Health*, 84(1): i16-i26.
- Vlahov, D. & Galea, S. (2002). Urbanization, urbanicity, and health. *Journal of Urban Health*, 79 (4 Suppl 1): S1-S12.
- Vazquez-Prokopec, GM., Eng, JLV., Kelly, R., Mead, DG., Kolhe, P., Howgate, J., Kitron, U., & Burkot, TR. (2010). The risk of West Nile Virus infection is associated with combined sewer overflow streams in Urban Atlanta, Georgia, USA. *Environmental Health Perspectives*, 118, 1382-1388.
- Wang, C. & Burris, M. (1997). Photovoice: Concept, methodology, and use for participatory needs assessment. *Health Education and Behavior*, 24(3), 369-387.



- Wheatley, T. (2013). Could Proctor Creek - and northwest Atlanta - be revitalized by a greenway project? Creative Loafing. Retrieved from:  
<http://clatl.com/freshloaf/archives/2013/05/14/could-proctor-creek-and-northwest-atlanta-be-revitalized-by-a-greenway-project>.
- Yee, D.A. (2008). Tires as mosquito habitat: A review of studies within the Eastern United States. *Journal of Medical Entomology*, 45(4), 581-593.
- Zartarian, V.G., Schultz, B.D., Barzyk, T., Smuts, M., Hammond, D.M., Medina-Vera, M. & Geller, A.M. (2011). The Environmental Protection Agency's Community-Focused Exposure and Risk Screening Tool (C-FERST) and its potential use for environmental justice efforts. *American Journal of Public Health*, S286-S294.

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**Chapter 5: Directions for Future Research**

**& Conclusion**

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## **Directions for Future Research**

The field of cumulative risk assessment continues to evolve as different methodological approaches are used and different spatial scales are included in cumulative impact analyses. Screening level tools are useful to help determine rudimentary ranking schemes of negatively impacted areas at various units of analysis (i.e., zip code level, county, census tract, census block group). They are limited, in their utility, however because of the data from which they derive their analyses. Publicly available data is typically used for transparency and to facilitate consistent approaches and comparisons across different locales. The availability and type of data used in cumulative risk analyses can limit the ability of these analyses to provide relevant data for ranking and decision making at neighborhood or street scales, where most environmental justice communities tend to be concerned.

Through examining both primary and secondary data used in this three-part study, environmental hazards were not as prevalent as members of the Proctor Creek community thought that they were, due in part, to the limitations of the publicly available data. Expanding this current body of research in a manner that would be meaningful to the affected community would require integration of key, yet disparate data sources such as the age and condition of occupied housing stock, risk of West Nile Virus, percent impervious surface, percent vegetative cover, capacity of green infrastructure to prevent flooding events, and water quality data. The analyses conducted and described herein can also be expanded by the integration of local data with existing publicly available data to create a more robust understanding of both chemical and nonchemical hazards impacting the Proctor Creek community. Filling information gaps with respect to potential exposures that affect vulnerable populations within communities can be targeted through

developing effective community partnerships. Building on previously identified community assets, residents can engage in citizen science efforts to help collect meaningful data through which cumulative impacts analyses can be extended.

Exploration of the integration of locally collected environmental hazards data, particularly non chemical environmental hazards would greatly advance cumulative impact analyses approaches. Both this dissertation and previously published results from cumulative risk assessments and cumulative impacts analyses have cited the need to integrate local data, however some have fallen short of bringing together publicly available data with local, citizen science data to measure the extent to which cumulative impacts analyses are improved by the inclusion of local knowledge and citizen science data.

## **Conclusion**

In a local context, this research helps to provide guidance for mitigating environmental risks and vulnerabilities and for making investments in community capacity-building, environmental monitoring, and community interventions in the Proctor Creek Watershed. It is also providing watershed residents with tools to influence local policy decisions. The study's impact is yet to be fully realized as data is becoming translated into action to inform and shape restoration and revitalization efforts in the watershed and to hinder siting of additional locally unwanted land uses.

This study demonstrated and has helped an impacted community to identify and prioritize key environmental hazards that impair environmental quality and threaten human health in their

watershed. Engaging in this research has helped to support efforts to create an action plan to address environmental and public health hazards in the Proctor Creek Watershed. It also adds to the limited knowledge of methods that can enhance community-based cumulative risk assessment (CBCRA) research in urban, environmental justice communities.

When collectively considering the participant-generated data in this study with the secondary, publicly available (expert) data, it is apparent that publicly available data alone is not adequate to define community challenges or solutions to those challenges. The publicly available data used in the cumulative impacts analysis reported herein failed to include community-identified street-level “hidden hazards” in the Proctor Creek Watershed such as illegal dumping sites, places where water pools and flooding occurs, and areas with stormwater infrastructure challenges that lead to localized flooding events. These data are not captured in publicly available data sets used by regulatory agencies.

Collectively, the studies in this dissertation describe three distinct methodologies, using diverse types of data that can all be used as pathways to positive change and action for environmental justice communities. The use of participatory, citizen science offers opportunities for novel experiences that can shape grassroots engagement in environmental activism, urban planning, health promotion, and policy development and implementation. Not only does it democratize the process of scientific inquiry, but such efforts also have the potential to provide scientists and other experts with greater access to fine-grained data sets that fill in contextual gaps and improve scientific analysis and non-regulatory decision-making.

## References

- Alexeeff, G.V., Faust, J.B., August, L.M., Milanese, C., Randles, K., Zeise, L. & Denton, J. (2012). A method for assessing cumulative impacts. *International Journal of Environmental Research and Public Health*, 9, 648-659; doi:10.3390/ijerph9020648.
- Atlanta Regional Commission (ARC). (2011). Proctor Creek – *Headwaters to the Chattahoochee: Watershed Improvement Plan*. Atlanta, Georgia.
- August, L.M., Faust, J.B., Cushing, L., Zeise, L. & Alexeeff, G.V. (2012). Methodological considerations in screening for cumulative environmental health impacts: Lessons learned from a pilot study in California. *International Journal of Environmental Research and Public Health*, 9, 3069-3084; doi:10.3390/ijerph9093069.
- Barzyk, T.M., Wilson, S. & Wilson, A. (2015). Community, state, and federal approaches to cumulative risk assessment: Challenges and opportunities for integration. *International Journal of Environmental Research and Public Health*, 12, 4546-4571; doi:10.3390/ijerph120504546.
- Barzyk, T.M., Conlon, K.C., Chahine, T., Hammond, D.M., Zartarian, V.G., & Schultz, B.D. (2010). Tools available to communities for conducting cumulative exposure and risk assessments. *Journal of Exposure Science and Environmental Epidemiology*, 20, 371-384.
- Bell, J. & Rubin, V. (2007). *Why place matters: Building a movement for healthy communities*. Policylink.
- Brender, J.D., Maantay, J.A. & Chakraborty, J. (2011). Residential proximity to environmental hazards and adverse health outcomes. *American Journal of Public Health*, 101, S37-S52.
- California Environmental Protection Agency (CAL EPA). (2011). Diesel and Health Research. Retrieved from: <http://www.arb.ca.gov/research/diesel/diesel-health.htm>.
- Centers for Disease Control and Prevention (CDC). (2010). Environmental Health. Healthy People 2020.
- Centers for Disease Control and Prevention (CDC). (2012). Blood Lead Levels in Children. Retrieved from: <http://www.cdc.gov/nceh/lead/ACCLPP/Lead Levels in Children Fact Sheet.pdf>
- Chattahoochee Riverkeeper (CRK). (2013). Neighborhood water watch monitoring data. Retrieved from: <http://www.chattahoochee.org/nww/>.
- City of Atlanta Department of Watershed Management (2013). The Proctor Creek Watershed.

<http://www.atlantawatershed.org/inside-dwm/offices/watershed-protection/atlantae28099s-watersheds/the-proctor-creek-watershed/>

- deFur, P.L., Evans, G.W., Hubal, E.A.C., Kyle, A.D., Morello-Frosch, R., & Williams, D.R. (2007). Vulnerability as a function of individual and group resources in cumulative risk assessment. *Environmental Health Perspectives*, 115(5):817-824.
- Down, T.J., Ross, L., Mucciarone, D., Calvache, M-C., Taylor, O., & Goble, R. (2010). Participatory testing and reporting in an environmental-justice community of Worcester, Massachusetts: a pilot project. *Environmental Health*, 9,34.
- Dunn, A.J. & Alexeeff, G.V. (2010). Beyond risk assessment: Principles for assessing community impacts. *International Journal of Toxicology*, 29(1), 78-87.
- Environmental Justice Advisory Council (NEJAC). (2004). *Ensuring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts*. Retrieved from: <http://www.epa.gov/environmentaljustice/resources/publications/nejac/nejac-cum-risk-rpt-122104.pdf>
- Faust, J.B. (2010). Perspectives on cumulative risks and impacts. *International Journal of Toxicology*, 29(1): 58-64.
- Gee, G.C. & Payne-Sturges, D.C. (2004). Environmental health disparities: A framework integrating psychosocial and environmental concepts. *Environmental Health Perspectives*, 112(17) 1645-1653.
- Georgia Environmental Protection Division (GA EPD) of the Georgia Department of Natural Resources. (2013). Georgia's 2012 Integrated 305(b)/303(d) Report. Retrieved from: <http://www.gaepd.org/Documents/305b.html>.
- GreenLaw. (2012). *The Patterns of Pollution: A Report on Demographics and Pollution in Metro Atlanta*. Retrieved from: <http://greenlaw.org/Files/GreenLaw/2012/PatternsofPollution,FINAL,GreenLaw3-26-2012.pdf>.
- Huang, G. & London, J.K. (2012). Cumulative environmental vulnerability and environmental justice in California's San Joaquin Valley. *International Journal of Environmental Research and Public Health*, 9, 1593-1608; doi:10.3390/ijerph9051593.
- Linder, S.H. & Sexton, K. (2011). Conceptual models for cumulative risk assessment. *American Journal of Public Health*, 101(S1): S75-S81.
- MacDonnell, M.M., Haroun, L.A., Teuschler, L.K., Rice, G.E., Hertzberg, R.C., Butler, J.P.,

- Chang, Y., Clark, S.L., Johns, A.P., Perry, C.S., Garcia, S.S., Jacobi, J.H. & Scofield, M.A. (2013). Cumulative risk assessment toolbox: Methods and approaches for the practitioner. *Journal of Toxicology*, 1-36.
- Menzie, C.A., MacDonell, M.M., & Mumtaz, M. (2007). A phased approach for assessing combined effects from multiple stressors. *Environmental Health Perspectives*, 115(5) pp: 807-816.
- National Association of County and City Health Officials (NACCHO).(2000). *Protocol for Assessing Community Excellence in Environmental Health (PACE-EH) Guidebook*, 50-56.
- National Environmental Justice Advisory Council. (NEJAC). (2004). *Ensuring Risk Reduction in Communities with Multiple Stressors: Environmental Justice and Cumulative Risks/Impacts*. Retrieved from:  
<http://www.epa.gov/environmentaljustice/resources/publications/nejac/nejac-cum-risk-rpt-122104.pdf>
- National Research Council of the National Academies. (2009). *Science and Decisions: Advancing Risk Assessment*. National Academies Press. Washington, DC.  
Retrieved from: [http://www.nap.edu/openbook.php?record\\_id=12209&page=R1](http://www.nap.edu/openbook.php?record_id=12209&page=R1)
- National-Scale Toxics Assessment (NATA). (2012). Retrieved from:  
<http://www.epa.gov/nata2005/>
- Park Pride (2011). *Proctor Creek North Avenue Watershed Basin: A Green Infrastructure Vision*.
- Paustenbach, D.J., Jernigan, J.D., Finley, B.L., Ripple, S.R. & Keenan, R.E. (1990). The current practice of health risk assessment: Potential impact on standards for toxic air contaminants. *Journal of the Air and Waste Management Association*, 40(12), 1620-1630.
- Payne-Sturges, D. & Lee, G.C. (2006). National environmental health measures for minority and low-income populations: Tracking social disparities in environmental health. *Environmental Research*, 102, 154-171.
- Salmon, A.G. (2010). Do standard risk assessment procedures adequately account for cumulative risks? An exploration of the possibilities using California's Air Toxics Hot spots guidelines. *International Journal of Toxicology*, 29(1) 65-70.
- Sexton, K. (2012). Cumulative risk assessment: An overview of methodological approaches for evaluating combined health effects from exposure to multiple environmental stressors. *International Journal of Environmental Research and Public Health*, 9, 370-390; doi:10.3390/ijerph9020370.



- Su, J.G., Jerrett, M., Morello-Frosch, R., Jesdale, B.M., Kyle, A.D. (2012). Inequalities in cumulative environmental burdens among three urbanized counties in California. *Environment International*, 40, 79-87.
- Texas Commission on Environmental Quality (Texas CEQ). 2013. Sources of Air Emissions. Retrieved from: [http://www.tceq.texas.gov/airquality/areasource/Sources\\_of\\_Air\\_Pollution.html/#Point](http://www.tceq.texas.gov/airquality/areasource/Sources_of_Air_Pollution.html/#Point)
- United States Environmental Protection Agency (U.S. EPA). 2008. Combined sewer overflows demographics. National Pollutant Discharge Elimination System (NPDES). Retrieved from: [http://cfpub.epa.gov/npdes/cso/demo.cfm?program\\_id=5](http://cfpub.epa.gov/npdes/cso/demo.cfm?program_id=5).
- United States Environmental Protection Agency (U.S. EPA). (2007). Concepts, Methods and Data Sources for Health Risk Assessment of Multiple Chemicals, Exposures and Effects. Cincinnati, OH. Retrieved from: <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=190187>
- United States Environmental Protection Agency (U.S. EPA). (2000). Cumulative Exposure Project. Retrieved from: <http://www.greenlink.org/assess/pdfs/cumulativeexposure.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2003). Diesel Exhaust in the United States. Retrieved from: <http://www.epa.gov/cleandiesel/documents/420f03022.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2013). Diesel Particle Matter. <http://www.epa.gov/region1/eco/airtox/diesel.html>.
- United States Environmental Protection Agency (U.S. EPA). (2003). Framework for Cumulative Risk Assessment. Washington, DC. EPA/600/P-02/001F. Retrieved from: <http://www.epa.gov/raf/publications/framework-cra.htm>.
- United States Environmental Protection Agency (U.S. EPA). (1997). Guidance on Cumulative Risks Assessment, Part 1. Planning and Scoping. Washington, DC. Retrieved from: <http://www.epa.gov/OSA/spc/2cumrisk.htm>.
- United States Environmental protection Agency (U.S. EPA). 2012. National Ambient Air Quality Standards (NAAQS). Retrieved from: <http://www.epa.gov/air/criteria.html>.
- United States Environmental Protection Agency (U.S. EPA). 2013. Partners for progress in Proctor Creek: Recreating a sustainable creekside community in the city. Retrieved from: <http://www.urbanwaters.gov/pdf/ProctorCreekBackgrounder.pdf>.
- United States Environmental Protection Agency (U.S. EPA). (2008). *The CARE Roadmap: 10 Step Plan to Improve Community Environment and Health*. Retrieved from: <http://www.epa.gov/care/library/20080620roadmap.pdf>.

United States Environmental Protection Agency (U.S. EPA). (2012). Urban Waters. Retrieved from: <http://www2.epa.gov/urbanwaters>.

Vazquez-Prokopec, GM., Eng, JLV., Kelly, R., Mead, DG., Kolhe, P., Howgate, J., Kitron, U., & Burkot, TR. (2010). The risk of West Nile Virus infection is associated with combined sewer overflow streams in Urban Atlanta, Georgia, USA. *Environmental Health Perspectives*, 118, 1382-1388.

Zartarian, V.G., Schultz, B.D., Barzyk, T., Smuts, M., Hammond, D.M., Medina-Vera, M. & Geller, A.M. (2011). The Environmental Protection Agency's Community-Focused Exposure and Risk Screening Tool (C-FERST) and its potential use for environmental justice efforts. *American Journal of Public Health*, S286-S294.