PARTICIPATORY SCIENCE FOR DATA FEMINISM: APPLICATION OF AN ORIGINAL FEMINIST FRAMEWORK FOR ASSESSING PARTICIPATORY DATASETS IN URBAN PLANNING DECISION-MAKING

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PARTICIPATORY SCIENCE FOR DATA FEMINISM: APPLICATION OF AN ORIGINAL FEMINIST FRAMEWORK FOR ASSESSING PARTICIPATORY DATASETS IN URBAN PLANNING DECISION-MAKING

Approved by:

Dr. Elora Lee Raymond, Advisor
School of City and Regional Planning
Georgia Institute of Technology

Dr. Clio Andris
School of City and Regional Planning, School of Interactive Computing
Georgia Institute of Technology

Dr. Carl DiSalvo
School of Literature, Media, and Communication, School of Interactive Computing
Georgia Institute of Technology

Date Approved: April 24, 2023

To Dr. Mary Frank Fox, for believing in me from day one.

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LIST OF ABBREVIATIONS

EPA	U.S. Environmental Protection Agency
HBCU	Historically Black Colleges and Universities
HOLC	Home Owner's Loan Corporation
IoT	Internet of Things
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
PAB	Planning Accreditation Board
PSDF	Participatory Science for Data Feminism
PSE	Partnership for Southern Equity
UHI	Urban Heat Island
WAWA	West Atlanta Watershed Alliance

SUMMARY

The purpose of this study is to characterize participatory data science as an effective feminist framework for urban planning decision-making and assess its efficacy in achieving planning outcomes through a climate-oriented case study (UrbanHeatATL) in the Atlanta context. Cities are trending towards rapid digitization, and scholarship on Big and small data suggests that emerging methods of data collection and implementation are inherently biased because they disassemble individual identities into single-dimensional data points (Leurs, 2017; D'Ignazio & Klein, 2020). Feminist epistemology suggests that meeting communities where they are when making policy decisions through practices such as participatory data collection and governance is an effective way to reduce bias against marginalized individuals and their communities (Maguire, 1987; DiSalvo et al., 2012; Campbell & Wasco, 2000; Ortiz & Guiterrez, 2015). The UrbanHeatATL case is assessed against an original feminist framework for assessment of participatory science, the Participatory Science for Data Feminism (PSDF) framework. The PSDF framework has three dimensions: 1) *participatory metadata*, which addresses question of who is participating in data collection, how data are being collected, and who these data will represent; 2) *data for power/data for liberation* seeks to characterize why data are being collected and what stories are being told by the data; and 3) *efficacy in planning outcomes* is to assess whether these data are being collected as a means for implementation of plans and policy to lead to more equitable outcomes for marginalized communities. The project followed data feminism principles of data collection and told a compelling narrative about heat-vulnerable communities, but gaps remain in translating datasets into equitable

planning and policy outcomes. Steps need to be taken by planning decision-makers and researchers to better integrate community participation into data collection by making technology more accessible. Researchers must also work directly with planning decision-makers before, during, and after the data collection process to determine a path forward for policy and planning outcomes.

CHAPTER 1. INTRODUCTION

I present this thesis primarily to address existing knowledge gaps across the fields of feminist epistemology, data science, climate change planning, and urban planning decision-making. Effective data management is necessary for twenty-first century urban planners, as data collection and utilization become ubiquitous to the smart city of the future (Batty et al., 2012). Smart cities literature emphasizes the importance of Big Data integration into city planning (Floridi, 2012; Batty, 2013; Batty, 2012), and some cities are actively working to ensure transparency and accessibility of such datasets (Adler, 2017). Despite the pervasiveness of Big Data in a smart city future, current data priorities in Atlanta are at a much smaller scale. Planning decisions in Atlanta are often made by leveraging small data or no data at all (Boehner & DiSalvo, 2016), so algorithmic auditing processes to reduce biases in large datasets (Corple & Linabary, 2020; Leurs, 2017; Raji et al., 2020) are not an effective tool for equitable data-driven outcomes in the city. Therefore, turning to feminist methods of data collection, analysis, and implementation may provide a solution to more equitable planning outcomes in Atlanta.

Feminist data science scholarship (data feminism) suggests that large datasets - which do not, necessarily, imply Big Data - are inherently biased, as they disassemble complex individuals into single data points (Leurs, 2017; D'Ignazio & Klein, 2020). Biases in datasets of all sizes are further exacerbated when there is not an effective mechanism in place to translate data from positive, empirical sources to value-based decision-making (Intemann, 2012). Judgements made by planners and policymakers based on empirical evidence and mainstream theories alone may lead to outcomes that betray preferences of a local community (MacCrae & Whittington, 1988). Feminist epistemology suggests that meeting communities where they are when making policy decisions through practices such as participatory data collection and governance is an effective way to reduce bias against marginalized individuals and their communities (Maguire, 1987; DiSalvo et al., 2012; Campbell & Wasco, 2000; Ortiz & Guiterrez, 2015).

Feminist issues in planning have become a more central focus of the literature in the past 30 years. Calls to action in the 1990s (Beall, 1996; Spain, 1993) and early 2000s (Leavitt, 2003; Fenster, 2005; Doan, 2010) exemplify the urgent need to better integrate feminist frameworks in urban planning since the modernization of the field for the twenty-first century. Furthermore, there is a lack of consideration for integrating feminist frameworks into planning as the field continues to evolve and require rigorous data mobilization. Because of the intersectional nature of feminist issues (Crenshaw, 1989), employing an effective data feminism framework in a planning context could lead to more equitable planning outcomes beyond gender, such as race, class, and educational status. The purpose of this study is to characterize participatory data science as an effective feminist framework for urban planning decision-making and assess its efficacy in achieving planning outcomes through a climate-oriented case study in the Atlanta context. I am not just assessing whether the case was effective in achieving its goals, but also whether the participatory design process and organizational power structures which exist in the case facilitated outcomes in urban planning decision-making.

Utilizing an original framework rooted in principals of data feminism (the Participatory Science for Data Feminism framework), I find that the case (UrbanHeatATL) excelled along dimensions of *participatory metadata* and *data for power/data for* *liberation* but lacked clarity on *efficacy in planning outcomes*. The project followed data feminism principles of data collection and told a compelling narrative about heat-vulnerable communities, but gaps remain in translating datasets into equitable planning and policy outcomes.

CHAPTER 2. LITERATURE REVIEW

2.1 The Nexus Between Cities, Data, and Feminism

The advent of the Internet in the late 20th century has led to rapid digitization of information for collection, maintenance, processing, analysis, and distribution of data. Data are measurements or observations that display information in an organized manner (Herzog, 2016). Datasets are bigger, more descriptive, more invasive, and more readily available than ever before, leading to issues which are epistemological, or what to do with big data, and ethical, or how big data are used. Because of this, datasets require technological solutions (Floridi, 2012). A general definition of big data is data which is too expansive to be handled by Microsoft Excel. This definition is not comprehensive, nor is it illustrative to the characteristics that may be inherent in the field. Kitchin (2013) defines Big data as having the following characteristics: volume, velocity, variety, exhaustiveness, resolution, indexicality, relationality, flexibility. In other words, big "B" Big data are dynamic and multi-dimensional compared to small "b" big data sets. Big Data is collected through directed digital surveillance of human activity, automatic capture from digital devices, or volunteered data from users of social media or crowdsourced data sets.

Organizational decision-makers rely on data to enhance capacities to reduce uncertainty through pattern recognition and predictive analytics (Kowalczyk & Buxmann, 2014). Private firms utilize data analytics for decision-making processes. Big data analytics allows private firms to make high quality decisions that can lead to positive outcomes (Li et al., 2022). Data offers insights into firms' market, competitors, customer and user bases, potential opportunities for growth, and potential challenges that firms may face.

Like firms, cities are becoming digitized and reliant on data. As early as 1999, the concept of “network cities” characterized urban areas reliant on Internet and data for urban governance and global communication (Townsend). In the years since, cities have become more inter- and intra-connected through digital globalization and localized Internet of Things (IoT). Internet of Things includes the network between people, technology, data, and the environment and the decisions and advancements able to be made by the data generated from this nexus (Ashton, 2009; Li et al., 2009; Rose et al., 2015). The digitization of cities has led to a new paradigm of smart cities. Smart cities IoT is governed by “intelligence functions that are able to integrate and synthesize [IoT] data to some purpose, ways of improving the efficiency, equity, sustainability and quality of life in cities” (Batty et al., 2013, pp. 482). According to Batty, smart cities function because of effective implementation of data into actionable items.

Counter to Batty’s claim of data improving efficiency, equity, and sustainability in smart cities are well documented cases of inherent biases in the methodologies, technologies, and practices used in data collection, analysis, and implementation. Buolamwini and Gebru (2018) found that big data machine-learning algorithms used in facial recognition software have a bias against darker-skinned women, and organizations utilizing such technologies have failed to take steps to correct these biases. Nuaimi et al. (2015) find that the sensitive nature of IoT data for smart cities could create a threat to citizens’ wellbeing, safety, and privacy, and suggest citizen participation and increased government moderation as potential solutions. D’Ignazio and Klein (2020), on their seminal work on data feminism, establish that “it’s almost always the bodies of those who have been disempowered by forces they cannot control, such as sexism, racism, or classism

–or, more likely, some combination of all three –who experience the most severe consequences of [the choices we make in our practices of data collection, analysis, and communication]" (pp. 19). Data analysis practices utilized by firms and cities often reduce communities and people to individual points devoid of personal information. To combat this reduction of self, data-centered research must be approached through a lens which minimizes harm to individuals and communities. One such method is to approach research through a feminist framework.

At its core, feminism is a movement for the advancement of rights of underserved identities. Feminist epistemology suggests that meeting communities where they are when making policy decisions through practices such as participatory data collection and governance is an effective way to reduce bias against marginalized individuals and their communities (Maguire, 1987; DiSalvo et al., 2012; Campbell & Wasco, 2000; Ortiz & Guiterrez, 2015). For the greater part of the twentieth century, feminist movements were focused on a single dimension: advancement of women's rights (Mansbridge, 1995). In 1989, Kimberle Crenshaw introduced the concept of intersectionality to the feminist canon. Intersectionality challenges the notion that a single feminism focused on advancing the rights of women is an appropriate fit for all women or marginalized individuals. Intersectional feminism considers that women have other identities that may exacerbate the discrimination they face. Therefore, in this paper, I adopt an intersectional approach in my analysis, and will use both feminism and intersectional feminism interchangeably.

Building upon the intersectional feminism framework of the late twentieth century, data feminism is the modern paradigm for equity-oriented data stewardship. A principal tenet of data feminism is that "data feminism isn't only about gender" (D'Ignazio & Klein, 2020, pp. 15), and an effective feminist framework in a planning context could lead to more equitable planning outcomes beyond a gender dimension, such as race, class, and educational status.

Central to data feminism is the concept of power. Classically, power can be viewed as a relational exchange between those who have power and those who do not. Max Weber defines power as "the probability that one actor within a social relationship will be in a position to carry out his own will despite resistance…" (1978, pp. 53). Individuals with marginalized identities, such as women and people of color, are allowed to engage in certain activities only if individuals and institutions in positions of power grant them permission to do so. Different factions of feminist scholarship view power as either a resource or a means of domination (Young, 1990). Data feminism frames power through both perspectives. According to D'Ignazio and Klein, high-fidelity data collection is a resource intensive operation that can only be done by institutions that have access to these resources, such as governments, universities, and corporations. Often, such institutions are managed and governed by individuals who wield societal power because of privileges inherent in their identities. These institutions also utilize power to maintain dominance over marginalized identities they choose to represent (or not represent) in the data they collect. Wielding such power allows these institutions to determine the narratives that data tell, and what decisions should be made around these issues. D'Ignazio and Klein assert that "if data is not collected on a particular group, or on a particular issue, then institutions in power can pretend that the issue doesn't exist" (2020, pp. 143). It is through power which data collection is translated into outcomes, and it is those who wield the power that determine outcomes *for whom*.

2.2 Gaps in Planning Decision-Making

In order to approach data-driven decision-making in a feminist way, planners must bridge gaps and overcome barriers in pedagogy, equity and efficiency, wicked problems, and community mobilization.

Urban planning education does not adequately train planners to be data literate. The Planning Accreditation Board (PAB) is an organization which accredits universities in North America that offer bachelor's and master's in urban planning. In 2017, the PAB released a set of accreditation standards which included the following language on data curriculum: "Quantitative and Qualitative Methods: data collection, analysis and modeling tools for forecasting, policy analysis, and design of projects and plans." A new set of standards, published in 2022, includes updated language on data literacy, including a reframing of the skillset from qualitative and quantitative methods (which emphasizes research design) to analytical skills and tools. The updated text reads as follows: "Analytical Skills and Tools: Research and critical analysis skills for preparing and conducting research; quantitative and qualitative methods of data collection, analysis, and forecasting; methods of geo-spatial analysis, mapping and data visualization; data analytics and urban technology." The 2022 text categorizes analytical skills as critical for research and data collection, geo-spatial analysis, and data analytics and urban technology. Inclusion of data analytics and urban technology in North American planning accreditation standard signifies a paradigm shift in urban planning: cities, and the methods that we use to design and govern them, are becoming reliant on digital data.

Decision-makers' concerns for the welfare of the public are often at odds with the desire to maximize efficiency in political and economic decision-making (Stone, 1997). This equity-efficiency trade-off creates friction in planning decision-making, as planners must often choose between implementing policies and plans that better social welfare at the cost of scientific or economic innovation, and vice versa. Le Grand (1990) suggests, however, that the equity-efficiency trade-off may not actually exist depending on how one defines efficiency. If the goal of efficiency is for society to operate at its most optimal state, then maximizing public welfare through equity would be implicit in societal efficiency.

Another barrier to effective urban planning decision-making is the nature of the problems that urban planners seek to solve. Urban planning problems are wicked and have no definitive problem definition or solution (Rittel & Webber, 1973). There is no one approach to addressing planning problems, and implementing a process that is effective in one urban context may not work in others. MacRae and Whittington (1988) found that "several, perhaps many, objectives must be considered in the decision-making process" (pp. 258). Judgements made by planning decision-makers based on empirical evidence and mainstream theories alone may lead to outcomes that betray preferences of a local community (MacCrae & Whittington, 1988). Feminist epistemology suggests that meeting communities where they are when making policy decisions through practices such as participatory data collection and governance is an effective way to reduce bias against marginalized individuals and their communities (Maguire, 1987; DiSalvo et al., 2012; Campbell & Wasco, 2000; Ortiz & Guiterrez, 2015). One such practice is citizen science.

Citizen science is a participatory practice in which community members or laymen volunteer to collect data or engage in research as part of a scientific inquiry (Silvertown, 2009). Effective citizen science campaigns invest in making sure that citizen scientists have access to the technology and training they need to engage in the research process. These programs offer data collection tools at little or no cost to project participants and will often offer training. Projects that seek to collect many data points over a large geographic area are well suited for a citizen science research methodology. The United States government tracks federally funded citizen science projects on a publicly available online platform, *citizenscience.gov.* Citizen science projects are sponsored by several federal agencies such as NASA, the EPA, and the NSF. Like any methodological approach, citizen science has its shortcomings. Citizen scientists need to be trained to collect data properly so as to maintain data integrity. Citizen scientists are recruited on a volunteer basis, and it is difficult to mobilize participants who do not already have a vested interest in science or research (Cohn, 2008).

2.3 Urban Heat Islands and Extreme Heat Vulnerability

The urban heat island (UHI) effect makes densely populated urban centers 1-7 degrees (Fahrenheit) warmer than outlying areas (Environmental Protection Agency [US EPA], 2022). This difference is graphically represented in Figure 1. Temperatures are higher in urban areas because of the reduced tree canopy, concrete infrastructure and low-albedo materials that absorb and retain heat, and urban geometry which reduces air flow between buildings. Increased anthropomorphic activity in urban areas such as vehicle traffic, air conditioners, and industrial activities increase air temperatures as well. Interventions to urban heat include planting trees to increase a city's green canopy, painting roadways, buildings, and rooftops with high-albedo materials that absorb less heat, and using energy efficient appliances and air conditioners.

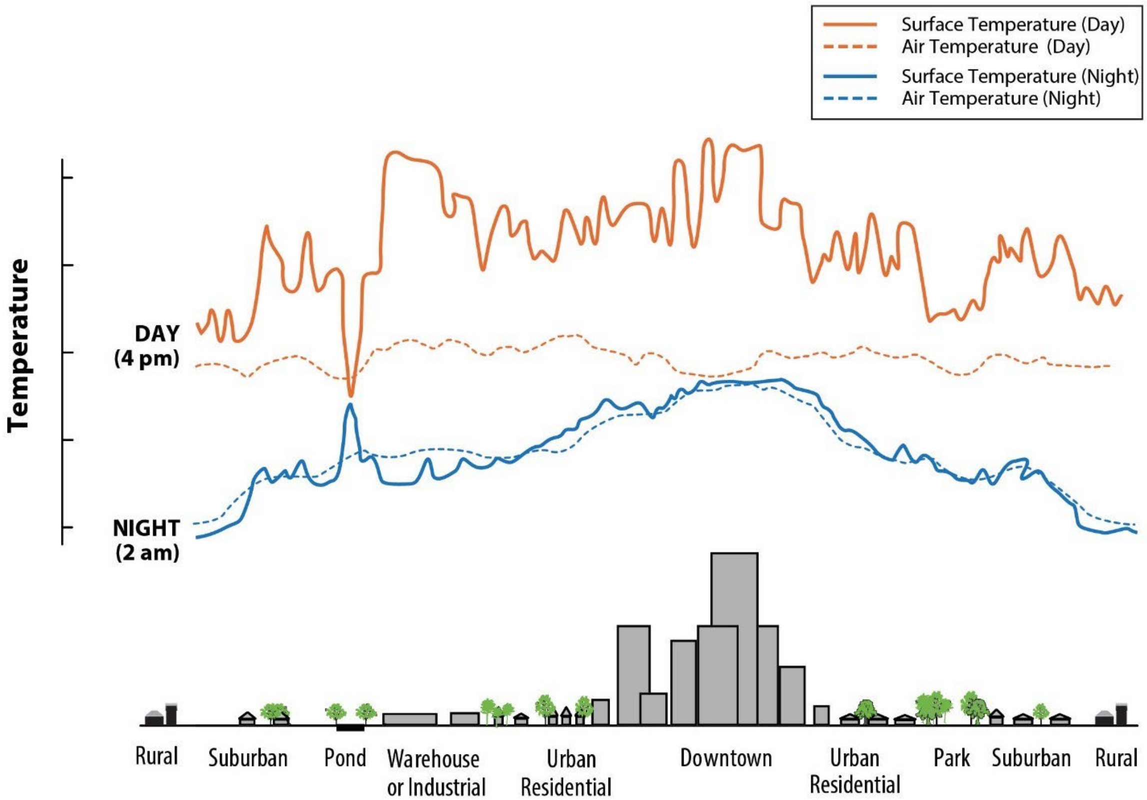

Figure 1. Heat Island Effect Diagram (Environmental Protection Agency [U.S. EPA], 2014)

There are several barriers to measuring the prevalence and impacts of urban heat island effect. The National Weather Service has stationary air temperature sensors at major airports across the country that assess and report temperatures in major cities (NOAA, 2022). These sensors give an average temperature reading of an entire urban area, so they fail to differentiate microclimates at the neighborhood or street levels. Other methods of measuring urban heat include using remote sensing data, which gives a highly granular measurement of heat (LANDSAT imagery has a resolution of 30 meters). Satellite imagery, however, presents land surface temperatures and does not measure ambient air temperatures. Other urban heat models, such as meso- and micro-scale simulations may be able to offer insights on ambient air temperature in urban micro-climates, but these are computer generated assessments which require making assumptions about the urban environment that may not accurately reflect existing conditions (Mirzaei & Haghighat, 2010).

Existing forms of empirically measuring urban heat are often coupled with demographic data and social narratives on heat to build a complete picture of *heat vulnerability* in communities of interest. There are several definitions for extreme heat vulnerability, which is a measure of how resilient a population is to extreme heat across environmental, demographic, and socioeconomic dimensions (Conlon et al., 2020). A common framework for determining the heat vulnerability of a community is to consider the exposure (quantitative environmental measures), sensitivity (qualitative demographic and health data), and adaptive capacity (qualitative and quantitative interview data) of a community (Wilhemini & Hayden, 2010). Socially vulnerable communities face potential negative effects caused by external stressors on human health, such as human-caused disasters or disease outbreaks (Centers for Disease Control, 2022).

2.4 Environmental Decision-Making, Historical Exclusion, and Marginalized Communities

It is well documented that communities of color, ethnic minorities, indigenous peoples, and low-income communities face a greater number of environmental stressors than their whiter and more affluent counterparts (Mohai et al., 2009). These communities (henceforth marginalized communities) face systematic institutional and geographic barriers predicated on historical practices of exclusion, which in turn increase exposure to high-risk environments (Holifield, 2001; Bullard, 1999; Bullard, 1993). Urban heat, because of its magnifying effect on the Earth's ozone layer, may be considered a significant air pollutant (Stone, 2005) which, on average, affects marginalized communities at greater rates than white and affluent counterparts (Hsu et al., 2021). According to Bullard (1994), marginalized communities face unequal environmental protections across procedural, geographic, and social dimensions, creating a need for *environmental justice* for affected populations.

One such historical exclusion policy that continues to impact marginalized communities is *redlining*. Redlining was a practice of systematically discriminating against certain neighborhoods based on race and income and denying services such as mortgages, loans, and credit to those communities (Legal Information Institute, 2022). In the 1930s, the Home Owners' Loan Corporation (HOLC), a federal agency of the United States government, issued "Residential Security" maps of cities that graded neighborhoods based on lending desirability. Neighborhoods deemed "unsuitable" or "undesirable" for investment were colored red. Redlined communities experienced "worse housing market outcomes with respect to home ownership, house values, rents, and vacancy rates over subsequent decades" (Aaronson et al., 2021, pp. 357). Divestment of redlined neighborhoods encouraged white residents, who could afford to get loans elsewhere, to leave these neighborhoods (white flight). Thus, historically redlined neighborhoods became black and remain majority-minority in the present day. Figure 2 (below) is a colorized HOLC Residential Security map of Atlanta from 1938. Redlined communities were concentrated in the South and West quadrants of the city, clustered around Downtown.

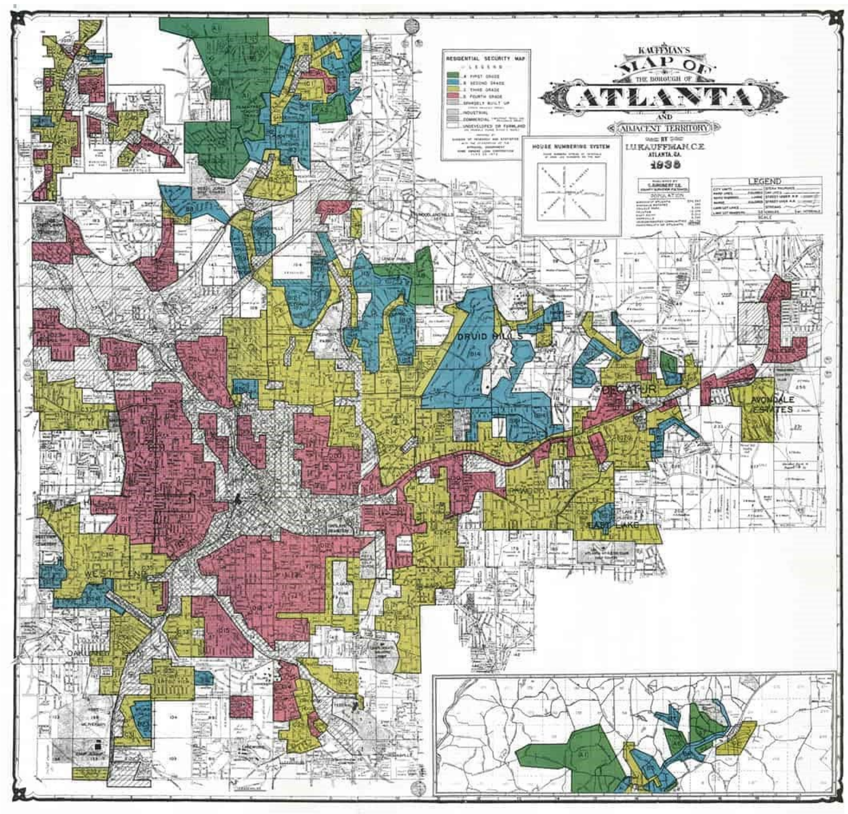

Figure 2. HOLC Redlining Map of Atlanta, 1938 (University of Richmond, n.d.)

Unsurprisingly, historically redlined neighborhoods have been found to be highly vulnerable to urban heat. Li et al (2022) found that across eleven Texas cities, neighborhoods with higher proportions of redlining had significantly elevated heat-related outpatient visit rates and inpatient admission rates compared to non-redlined neighborhoods. Across the Southeast, the temperature disparity between redlined neighborhoods and non-redlined neighborhoods in the same urban area may reach 7 degrees Celsius, or approximately 13 degrees Fahrenheit (Hoffman et al., 2020). Redlined neighborhoods also have built environments less resilient to urban heat. These neighborhoods have sparser tree canopies and more impervious surfaces that absorb and radiate heat (Nowak et al., 2021). While research connecting urban heat and redlined communities is prolific, it is uncertain if planning interventions to reduce urban heat have been made with the wishes of the affected communities in mind. D'Ignazio and Klein (2020) find that "It is more frequently the case that communities of color are mapped by institutions in power, whose worldviews and value systems may differ vastly from those of the community" (pp.132). Thus, there is a pressing need to ensure that data on urban heat is being collected, utilized, and implemented in a manner which is representative of the of the needs of marginalized communities, which are most vulnerable to this crisis.

2.5 Key Questions

Based on this review, I present two key questions to guide this study.

1. How are citizen scientists in Atlanta collecting, utilizing, and implementing participatory data towards urban planning outcomes?
2. How can planning decision-makers leverage intersectional and marginalized identities from a feminist perspective (such as the Participatory Science for Data Framework) to lead to more equitable planning outcomes?

The goal of this inquiry is to connect participatory data collection to outcomes. Chapters 3 and 4 present a data feminism framework and a research methodology rooted in principles of feminist epistemology, respectively, towards answering these questions.

CHAPTER 3. METHODOLOGY

3.1 Case Studies and Case Selection

This thesis is a case study of a participatory data collection project (UrbanHeatATL) in an urban planning context. According to Yin (2014), a case study is an empirical inquiry which "investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident". Case studies include a subject of inquiry – the case – and an object of assessment – the framework used to investigate the case (Thomas, 2011). I describe the case in detail in Section 4.1 of this thesis, and theoretically assess the case for the rest of Chapter 4. In this study, I am not interested in the findings/data from the UrbanHeatATL case, but rather the organizational processes that are part of a participatory data collection effort such as UrbanHeatATL. I consider how UrbanHeatATL was structured organizationally, how decisions made by researchers may have affected participatory outcomes, and how the project fits into the broader context of planning for climate resilience against issues such as urban heat.

I chose the UrbanHeatATL case for this study for a number of reasons. The scale and prominence of UrbanHeatATL made information on the project easily accessible online. The project was completed in phases each summer, so there was a well-defined time period for the case (May 2021-August 2021). Urban heat is a salient issue in many disciplines such as public policy, urban planning, design, environmental studies, and climate science; as global temperatures continue to rise, urban thermal comfort is a growing concern for urban planners (Keith & Meerow, 2022). I chose a case specific to Atlanta because of the city's legacy of inequality in the built environment, efforts towards climate-conscious governance, and limited use of data science in civic decision-making. Atlanta's legacy of redlining has made certain neighborhoods significantly hotter (up to 7 degrees Celsius, 13 degrees Fahrenheit) than others (Hoffman et al., 2020). Residents of Atlanta's redlined neighborhoods also face greater rates of urban heat morbidities such as asthma and diabetes (Nardone et al., 2020). The city of Atlanta has a governmental unit, the Office of Resilience, dedicated to climate-based decision-making in areas such as clean energy. Despite efforts to address the detrimental legacy of redlining and reduce the effects of climate change in the built environment, urban planning and public policy decision-makers in the City of Atlanta have notably failed to utilized data and technology in the decision-making process (Boehner & DiSalvo, 2016). The UrbanHeatATL project is an excellent case through which to consider how decision-makers may connect participatory planning practices and data feminism principles towards equitable outcomes in climate-oriented planning decision-making.

3.2 Positionality Statement

This inquiry considers the UrbanHeatATL project as a case of participatory data collection and citizen science for assessment against my original PSDF framework. From May 2021 to August 2021, I was a paid graduate intern on the UrbanHeatATL research team. My job was to act as a liaison between Georgia Tech and the project's partners, particularly the City of Atlanta. While working on the project, I was never actively involved in data collection, but I did engage directly with community members and members of the media about the project. I recognize that I am approaching this case as an outsider to heat vulnerable and marginalized communities that UrbanHeatATL sought to engage. I am also reflecting on the case as a graduate student at Georgia Tech, with direct access to project researchers and urban heat experts affiliated with the Institute. In building the case, I draw from my own recollection of the project as well as information available publicly online. I choose to include names of public figures associated with the project, either as researchers or project partners, to demonstrate the wealth of knowledge wielded by the multidisciplinary project team as well as the connections the project had to policy initiatives around urban heat. I do not explicitly name any of the other students involved in the project unless their names are published online. At the time of writing this thesis, I was no longer affiliated with the UrbanHeatATL project.

3.3 Data

A qualitative, code-based case analysis of the UrbanHeatATL project was performed following an original framework. I describe my framework, the Participatory Science for Data Feminism framework, in Section 3.4. Twenty-six artifacts were retrieved from primary, secondary, and tertiary sources available publicly online. Google search engine was the primary retrieval tool for artifacts. Search terms (with and without quotation marks) included: urbanheatatl, Urban Heat Atl, and Urban Heat Atlanta. No artifacts were available from academic search engines Google Scholar, Scopus, and Web of Science. Artifacts included news and magazine articles and blog posts about UrbanHeatATL and affiliated projects, digital newsletters produced by the UrbanHeatATL team, and other written or audio-visual materials that reference the project. Private communications, such as email or archived videos of weekly project all-hands meetings were not included as artifacts. Social media posts were also excluded from the study, as social media studies is a separate field of study beyond the scope of this inquiry.

3.4 The Participatory Science for Data Feminism Framework

Based on the literature on data science, participatory planning, data feminism, environmental justice, and local government decision-making, I present here an original framework, the Participatory Science for Data Feminism (PSDF) framework to code and analyze the UrbanHeatATL case. I follow the principles of data feminism to derive this framework and its respective codes, which I present as a series of questions grouped across three dimensions for case analysis: *participatory metadata*, *data for power/data for liberation*, and *efficacy in planning outcomes*. Sections 3.4.1 -3.4.4 explain the PSDF framework for qualitative coding in greater detail.

3.4.1 Participatory Metadata

In data science, metadata is "the information we create, store, and share to describe things, [which] allows us to interact with [entities and organizations] to obtain the knowledge we need" (Riley, 2017, pp. 1). Effective and equitable analysis of data requires a foundational understanding of how such data are produced. According to Loukissas (2019), "All data are entangled with places, institutions, processes, and people that fundamentally shape their significance and use" (pp. 189). Effective participatory research presents a standard of metadata that is replicable, minimizing heterogeneity and misuse (Yarmey & Baker, 2013). Access to adequate metadata reduces the opportunities for misinformation, misinterpretation, and misuse of data (Jagadish et al., 2022). Accessible metadata is a "value-added language that serves as an integrated layer in an information system," allowing for a structured relationship between data and its intended use or activity (Greenberg, 2017, pp. 22).

I use metadata as a more concise term for "descriptive details about [data]." *Participatory metadata* redefines metadata as a process of participation that positions researchers and those affected by research as integral to the data collection process. Rather than consider descriptive details about individual data points or the whole data set, participatory metadata repositions the concept of metadata into an inquiry on the process of participatory data production by asking the following questions:

1. Where are these data being collected?
2. Who is engaging in data collection?
3. What participatory methods (citizen science, charette, survey, etc.) are being utilized?
4. What populations are being represented by the data?

Understanding who is involved in a participatory science endeavor, where that endeavor occurs, and who will be served by the resulting dataset is fundamental to approaching citizen science through a data feminist perspective. Ideally, *participatory metadata* reveals that the case in question leveraged citizen scientists from marginalized communities that will be directly affected by the data collect process and outcomes.

3.4.2 Data for Power/Data for Liberation

Beyond the process of data production is considering what is inherent in the data itself. Data has become a ubiquitous tool utilized in organizational decision-making, and "forward-thinking" organizations rely on a data-driven culture to respond more quickly and effectively to opportunities (Dykes, 2019). D'Ignazio and Klein (2020) find that "imbalance of power… is when those institutions in power obscure their political agendas behind a veil of objectivity and technology" (pp. 132). The goal of *data for power/data for liberation* is to determine what story the data are telling, beyond considering how the data were collected and what facts and figures may be visualized through the data. That is, comparing the data with existing studies, prevailing ideas in the field, and the opinions and experiences of community members to build a complete narrative of the planning problem. *Data for power/data for liberation* asks the following questions:

1. Why are these data being collected?
2. What patterns prevail in the data?
3. What story do these data tell?
4. What is missing from the data?

Floridi (2012) suggests that the major epistemological problem with data, particularly big data, is that "there is too much of them" (pp. 436). Analysis of data does not rely on the scale of what can be processed, but rather what small patterns are inherent or hidden below the surface in a large dataset. Data feminism also looks at the story of how an evidence-based discovery or case came to be, revealed through reflection and self-discourse. Data storytelling reveals different narratives in the data which achieve a variety of outcomes such as revealing information of personal interest, revealing anomalies and deficiencies in systems, and enabling a deeper understanding of a phenomenon (Ojo & Heravi, 2018). *Data for power/data for liberation* shows that an effective participatory project mobilizes and empowers members of marginalized communities to succeed beyond narratives of oppression.

3.4.3 Efficacy in Planning Outcomes

The final dimension of the PSDF framework is efficacy in planning outcomes. An overarching goal of this study is to better leverage data science for equitable planning outcomes. It is not enough to be able to collect and analyze data; data must then be translated into outcomes. Tran Thi Hoang et al. (2019), found that participatory decision-making in a smart city context often excluded participants from the actual decision-making process. The goal of participatory planning practices and data feminism is to combat structures of hierarchy, power, and oppression facing marginalized communities (Smith, 1973; Maguire, 1987; D'Ignazio & Klein, 2020). Efficacy in planning outcomes seeks to determine what policies or planning decisions are made with or because of the respective dataset, and what their effects are by asking the following questions:

1. What policy or planning decisions have been made as a consequence of data collection?
2. Are planning decision-makers using the data towards equitable outcomes?
3. What about the project should be changed or improved to better incentivize equity in planning and data utilization?
4. How are these data connected to existing initiatives that also address the problem at hand?

3.4.4 General Notes on the PSDF Framework

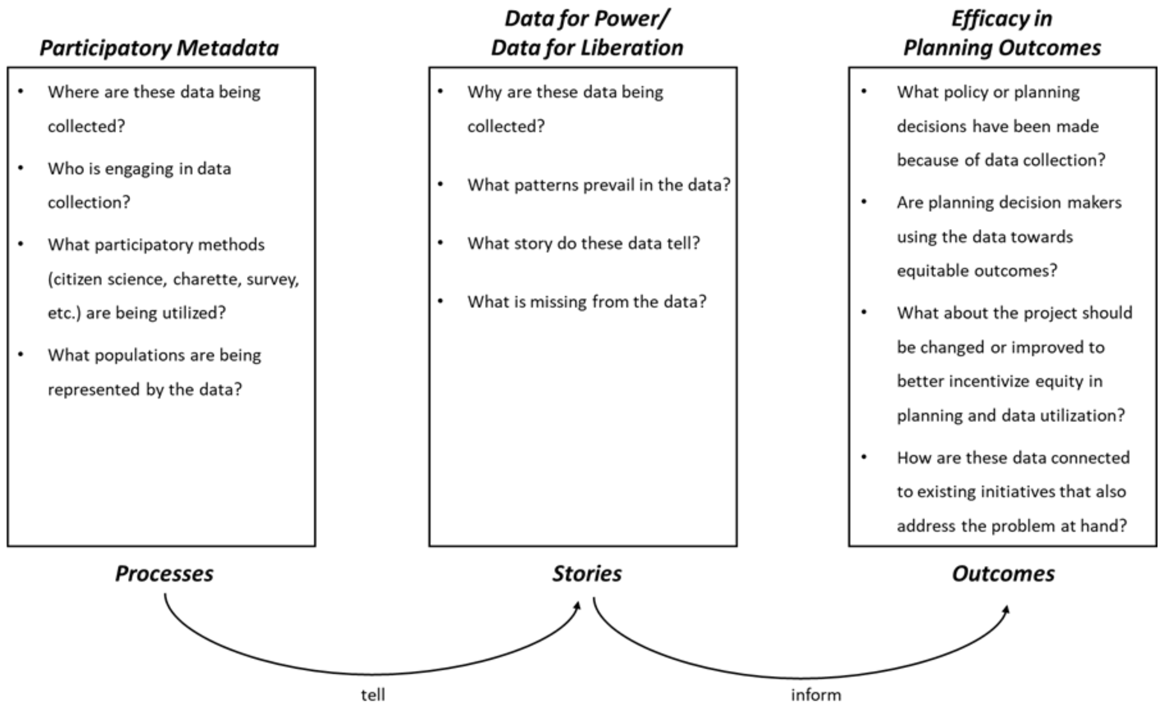

Figure 3. The Participatory Science for Data Feminism Framework

The PSDF framework is designed for general applications to a variety of participatory data collection efforts. This, of course, includes citizen science efforts, as well as data which are collected through public canvassing, survey administration, public comment, or public observation. The questions provided within the framework mean to set a general baseline for assessment. When assessing a case, one may choose to ask all questions, forego some, or generate new questions for deeper inquiry. Effective application of the PSDF framework, like much of feminist epistemology, is fluid and designed for application to many cases. While the framework seeks to connect process to outcomes, applying a single dimension to a case in detail may reveal substantial insights across areas of interest such as process design, data storytelling, or planning outcomes. The goal of the framework is to *describe the processes which tell stories that inform outcomes in planning decision-making.*

3.5 Qualitative Coding Methods

I coded the artifacts in two cycles, beginning with a round of structural coding following protocol outlined by Saldana (2016, Chapter 3). First, I did an initial read-through of each artifact to determine which dimensions of the PSDF framework could be coded in the artifact (participatory metadata, data for power/data for liberation, and efficacy in planning outcomes). On my second read-through of each artifact, I identified excerpts which could be coded with one of the guiding questions tied to the PSDF framework (e.g., participatory metadata > "Who is engaging in data collection?"). Coded excerpts from all artifacts were compiled in an Excel spreadsheet with descriptive notes and comments. Based on coded excerpts, a descriptive narrative was written about the case. An example of this structural coding process is as follows, using a passage from an artifact from Atlanta Magazine (Worley, 2021). Coded excerpts are underlined, and codes are numbered and included below the passage.

> Both Stone and the Urban Heat ATL researchers hope to provide useful information to planners and policymakers. (The City of Atlanta is a partner in Urban Heat ATL.) Atlanta's climate, like that in other cities, is facing another kind of compounding event: a development boom that threatens to reshape the physical landscape as it displaces longtime residents in hot (so to speak) neighborhoods. <u>Jelks noted that Southwest Atlanta already contains a fair amount of forest—if it can be shown that those trees are helping keep temperatures down, maybe that fact will confer some protection</u>.[1] <u>"Is that, then, an extra bit of ammunition to help bolster the on-the-ground advocacy that is happening to make sure that people are not displaced from these areas as more development comes, as gentrification comes?[2,3]</u>" <u>Jelks said. The</u>

hope is that the data can give members of targeted communities the knowledge and resources to advocate for themselves.[4]

Darryl Haddock, of the West Atlanta Watershed Alliance, says there's value in being able to quantify something that, in certain respects, resists quantification: trees, forest, greenspace—these centerpieces of Atlanta's civic identity.[5] "When developers come, and they talk about tax-revenue generation, we can say that there's ecological value that could offset that,"[6] he said, looking out at the centuries-old forest in Oakland City. There are plenty of reasons to leave the trees standing: the educational aspect of a wooded preserve, the mysterious beauty of the forest, the way that access to nature anchors communities and connects the generations.[7] All that ineffable stuff. But there are more prosaic reasons, too. "We don't want to give away free air conditioning," Haddock said.[8]

1. Efficacy in planning outcomes – "Are local government decision-makers using the data towards equitable outcomes?"
2. Data for power/data for liberation – "What story do these data tell?"
3. Efficacy in planning outcomes – "What policy or planning decisions have been made as a consequence of data collection?"
4. Data for power/data for liberation – "Why are these data being collected?"
5. Data for power/data for liberation – "What patterns prevail in the data?"
6. Efficacy in planning outcomes – "What policy or planning decisions have been made as a consequence of data collection?"
7. Data for power/data for liberation – "What story do these data tell?"
8. Data for power/data for liberation – "What is missing from the data?"

In my second cycle, I further coded the artifacts categorized as *data for power/data for liberation* following a thematic coding process (Saldana, 2016, Chapter 4). I identified themes of vulnerability, greenspace, and technology, and explained how these themes were present in the UrbanHeatATL project and how they affected the design, process, and decision-making outcomes of participatory data collection.

This inquiry is a meta-analysis of the process and outcomes of another research project, UrbanHeatATL. To avoid confusion about whether I am referring to this thesis or the UrbanHeatATL project, I must make a note about how the two will be differentiated in the text of this document. When referencing my original inquiry (outlined in this chapter) which I conducted towards writing this document, I refer to such as *this inquiry, this study,* or *this thesis*. When referencing the UrbanHeatATL project, I refer to such as *the case*, *the project,* or by name. There is also a point of distinguishing my dataset of artifacts from UrbanHeatATL's dataset. When referencing the qualitative artifact data I used to write this thesis, I refer to such as *the artifacts* or *my data*. General references to *the dataset* imply the data collected by UrbanHeatATL. When discussing the case, to distinguish between university affiliated project researchers (and interns) and participatory data collectors, I use the terms *researchers* or *investigators* to refer to the former, and *participants, data collectors*, or *citizen scientists* to refer to the latter.

This thesis follows principles of feminist epistemology to build a qualitative narrative about a particular case. Towards that end, I seek to make my research as accessible and replicable as possible despite my personal connection to the project. Before conducting this study, I received written permission via email from Dr. Kim Cobb (former project Co-PI) and a representative from the Georgia Tech Global Change Program to use UrbanHeatATL as the evaluative case study for this thesis. The findings I present in the following chapter reflect only what I was able to assess from publicly available digital artifacts about UrbanHeatATL. After consulting with the Institutional Review Board via email, it was determined that this thesis analyzes processes, organizations, and institutions;

as such, it is not human subjects research and does not require further approval from the Institutional Review Board.

The goal of this study is not to evaluate the quality of data collected by the UrbanHeatATL team, but rather the process of data collection, project management, and data dissemination utilized by a public-facing participatory science initiative such as UrbanHeatATL. According to the UrbanHeatATL website, the project has amassed over 1 million data points since its inception. There is no question that the dataset is robust based on sheer magnitude. I chose to undertake this study to demonstrate that the operationalization of even robust, politically salient datasets into planning outcomes must be predicated on practices of equity, justice, and community inclusion. Examining the case of UrbanHeatATL through the PSDF framework, I ask how citizen scientists in Atlanta are collecting, utilizing, and implementing participatory data towards urban planning outcomes, and how planning decision-makers can leverage intersectional and marginalized identities from a feminist perspective, such as the Participatory Science for Data Framework, to lead to more equitable planning outcomes.

CHAPTER 4. FINDINGS

4.1 The UrbanHeatATL Case

UrbanHeatATL was launched in March 2021 as part of the Atlanta Science Festival's Environmental and Climate Science Events programming. The project is a self-described "cross-disciplinary collaboration empowering students and the Atlanta community through mapping extreme heat in underserved communities… [which] aims to use this data, collected by community members, to further environmental and climate justice in Atlanta" (UrbanHeatATL, 2023). At the Atlanta Science Festival, a virtual panel titled "It's Getting Hot in Here: Urban Heat Islands" was the first public advertisement of this project. The panel, moderated by Partnership for Southern Equity's former Just Energy Director Chandra Farley, included a dialogue between experts on climate, urban heat, and environmental justice. It should be noted that none of the panel presenters were Principal Investigators of the UrbanHeatATL project, but some were involved in the project through organizational partnerships. The virtual panel, while it marked the inception of the UrbanHeatATL project, falls outside of the timeframe of my study. I choose to consider the inaugural summer (May 2021 – August 2021) of the project in this thesis. Figure 4 below illustrates the project timeline through April 2023, just over two years after project launch.

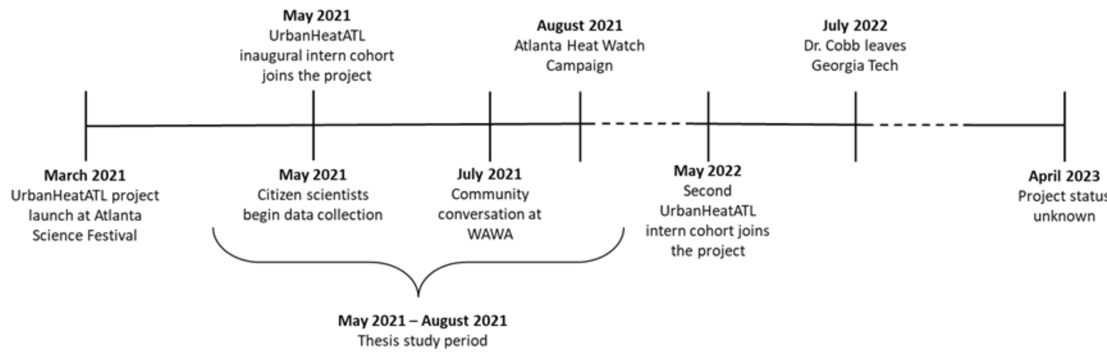

Figure 4. UrbanHeatATL Project Timeline, March 2021-April 2023

The UrbanHeatATL project was led by researchers out of two universities in Atlanta: the Georgia Institute of Technology (Georgia Tech) and Spelman College. Co-Principal Investigators on the UrbanHeatATL project include Dr. Kim Cobb and Dr. Na'Taki Osborne-Jelks. At the time of the project's launch, Dr. Cobb was an ADVANCE Professor at the School of Earth and Atmospheric Sciences at Georgia Tech and director of the university's Global Change Program. In July 2022, Dr. Cobb left Georgia Tech and is no longer affiliated with the UrbanHeatATL project. Dr. Jelks is an Assistant Professor of Environmental and Health Sciences at Spelman College, and the Director of the West Atlanta Watershed Alliance (WAWA). She remains the Principal Investigator of the project as of March 2023. The project had several organizational partners, including the City of Atlanta's Mayor's Office of Resilience, WAWA, Partnership for Southern Equity (PSE), and Harambe House Charities. Partner organizations such as WAWA and PSE have organizational missions centered around issues of environmental justice and climate equity for marginalized communities in Atlanta. The Global Change Program at Georgia Tech was the primary data steward for UrbanHeatATL, and thus responsible for project design, data collection, analysis, dissemination, and visualization. Global Change Program staff and researchers, alongside co-PIs, managed citizen scientists affiliated with the project.

Two cohorts of summer interns from Georgia Tech and Spelman College were involved with the project. Seven full-time interns were involved in the project from May 2021 August 2021. I participated in the program as an intern in summer of 2021, where my role was to be a liaison between the project and the Mayor's Office of Resilience. Figure 4 displays the organizational relationships of all the actors in the UrbanHeatATL project. White boxes represent the actors involved in the project, which may be organizations, groups, or individuals. Straight lines denote a direct connection between actors, with blue boxes along lines explaining the relationship between actors. UrbanHeatATL had a hierarchical organization, with citizen scientists and community members at the bottom of the hierarchy, reporting to Georgia Tech's Global Change Program and WAWA, respectively.

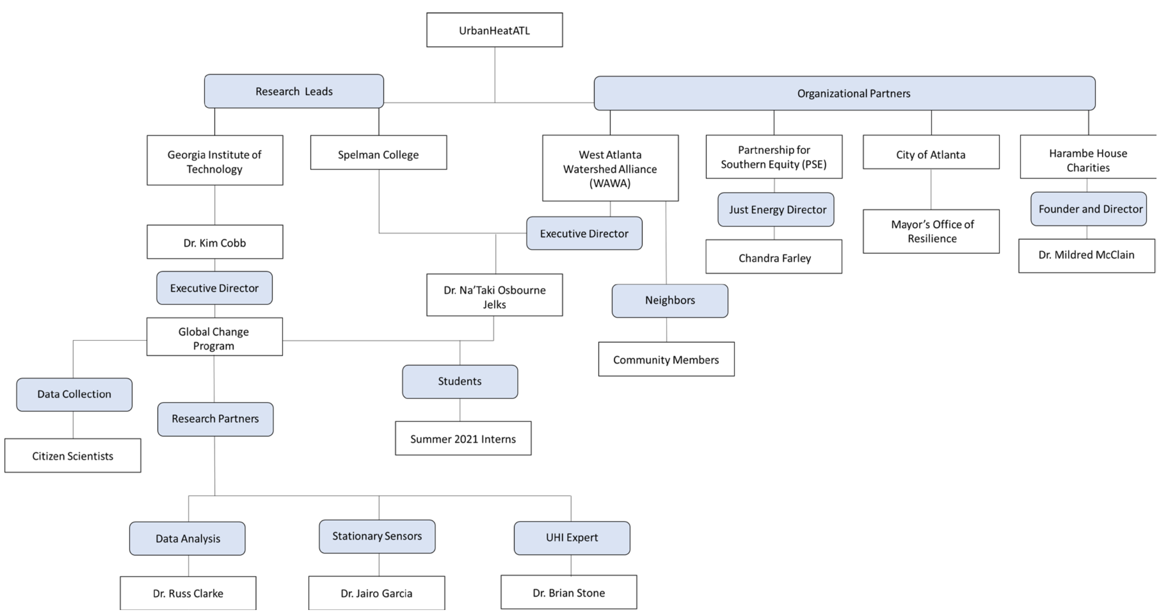

Figure 5. UrbanHeatATL Organizational Chart

It is necessary here to discuss the differences in perspective and power that Georgia Tech affiliated researchers had compared to Spelman affiliated researchers. The power that these two institutions utilize in their decision-making processes is defined by their histories, demographic makeup of faculty and students, and geographic location. The Georgia Institute of Technology was founded as a public research institution in 1885 by white men for white men. Women were not allowed to attend the Institute until 1952, and people of color were not allowed to enroll until 1961 (Georgia Tech, n.d.). Spelman College, a historically black college/university (HBCU), was founded as a seminary school for black women in 1881 and became a liberal arts college in 1924 (Spelman College, n.d). Based on reporting from Fall 2022, the undergraduate student body at Georgia Tech remains a plurality white (37%) and male (60%) with white men making up the largest proportion (22%) of the students (Georgia Tech, 2023a). Sixty-eight percent of faculty at Georgia Tech are male and 63% of faculty are white (Georgia Tech, 2023b). Ninety-seven percent of Spelman students are black women, and 67% of the faculty are female (Spelman College, 2022). Geographically, Georgia Tech's campus is integrated more closely with the Midtown, West Midtown, and Home Park neighborhoods, with campus housing in Home Park and the Tech Square development in Midtown. Spelman College is part of the Atlanta University Center, which includes fellow HBCUs Morehouse College and Clark Atlanta University. The Atlanta University Center is surrounded by the Vine City, Ashview Heights, Castleberry Hill, West End, and Downtown neighborhoods. It is apparent based on history, demographics, and geography alone that Georgia Tech and researchers affiliated with the Institute may approach problems of equity and representation through a perspective ignorant of the needs and wants of marginalized communities. Spelman affiliated project researchers, moreover, were both more aware of the needs and wants of marginalized communities because of demographic similarity and geographic proximity.

Citizen scientist volunteers utilized their phones and mobile air temperature sensors from PocketLab to collect geographically coded temperature data while walking or biking around the City of Atlanta. PocketLab is a company that offers software, technology, training resources, and support for educators looking to use citizen science methods in their classrooms. Global Change Program staff and program interns trained citizen scientists on data collection best practices, including producing and disseminating mobile sensor training videos that were shared through social media and email. The data was managed and cleaned outside of the PocketLab environment using Python and ArcGIS Online for visualization. Citizen scientists did not engage in data cleaning or visualization, as this job was handled by researchers affiliated with Georgia Tech. Maps were published on the UrbanHeatATL website (*urbanheatatl.org*). Interactive maps that show changes in the dataset over time were published using ArcGIS Online. As of April 2023, trying to utilize this application to view the maps, however, generates an error message and does not display the data. The complete UrbanHeatATL dataset is available upon request via email.

Figure 6. Mobile Sensor Carrying Tips from "Sampling Tips" Flyer (included with permission from creator)

Figure 7 (below) illustrates the data collection, analysis, and visualization process. Citizen scientists would voluntarily join the project through recruitment at community events, by word-of-mouth, or in response to UrbanHeatATL promotional materials. Before data collection, citizen scientists were trained either directly by a project researcher or virtually using materials produced by UrbanHeatATL. Citizen scientists collected data during daylight hours. Participants emailed data points to UrbanHeatATL researchers using their smartphones. Promotional flyers reveal that community scientists were also invited to join the UrbanHeatATL Slack channel to connect and communicate about the project process in real-time. Participants were encouraged to collect data passively as they went about their day to simulate activity patterns where community members would be exposed to urban heat.

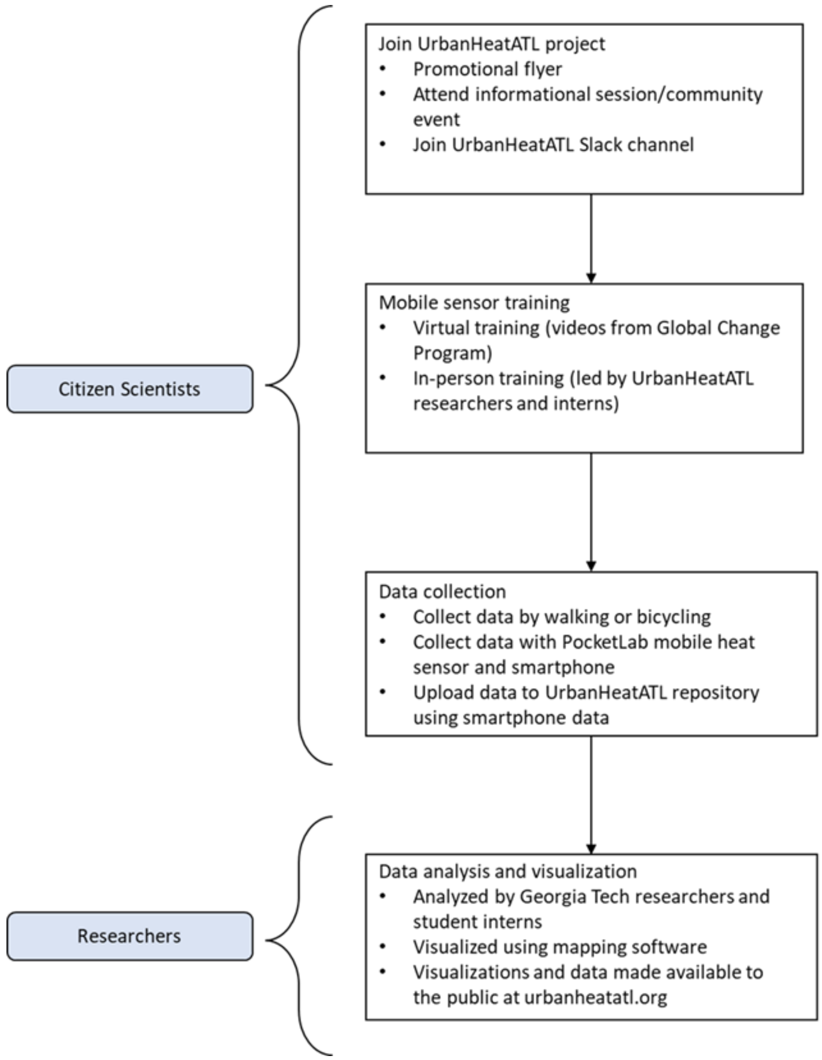

Figure 7. UrbanHeatATL Data Collection and Analysis Process

At the time of writing this thesis, the status of the UrbanHeatATL project remains unknown. A cohort of interns has not been announced for summer 2023. The website does not appear up to date, as links to pages such as the project Mission Statement seem to be broken or empty. There is no inclination that the project is officially over, but UrbanHeatATL social media profiles have not been active since June 2022.

4.2 Case Assessment Against the Participatory Science for Data Feminism Framework

4.2.1 Participatory Metadata

Participatory metadata was a dimension present across all artifact types except for official UrbanHeatATL Newsletters. This may be because newsletters were produced specifically for an audience of readers already involved with the UrbanHeatATL project. Newsletters were primary sources produced by project staff and published through the official UrbanHeatATL mailing list from July 2021- October 2021. Other primary sources were promotional and instructional flyers produced to encourage volunteers to join the project or inform volunteers about data collection best practices. Flyers, along with news and magazine articles, reveal descriptive details which characterize the project and its participatory nature.

Project boundaries were defined in a flyer published in project newsletters as "areas inside the Atlanta perimeter, as defined by Interstate-285;" this study area extends beyond the official geographic boundaries for the City of Atlanta. A student data scientist even took temperature readings in Sandy Springs, a suburb north of Atlanta which extends beyond the perimeter. While the study area for UrbanHeatATL was within the Perimeter, data collection focused on neighborhoods close to Georgia Tech and the Atlanta University Campus, such as Vine City, West End, Oakland City, and English Avenue. Figure 5 was published in the UrbanHeatATL Newsletter dated September 3, 2021. The darker purple on the figure shows areas where the most data had been collected up to that date, while blank spaces on the map signify no data collected in that area.

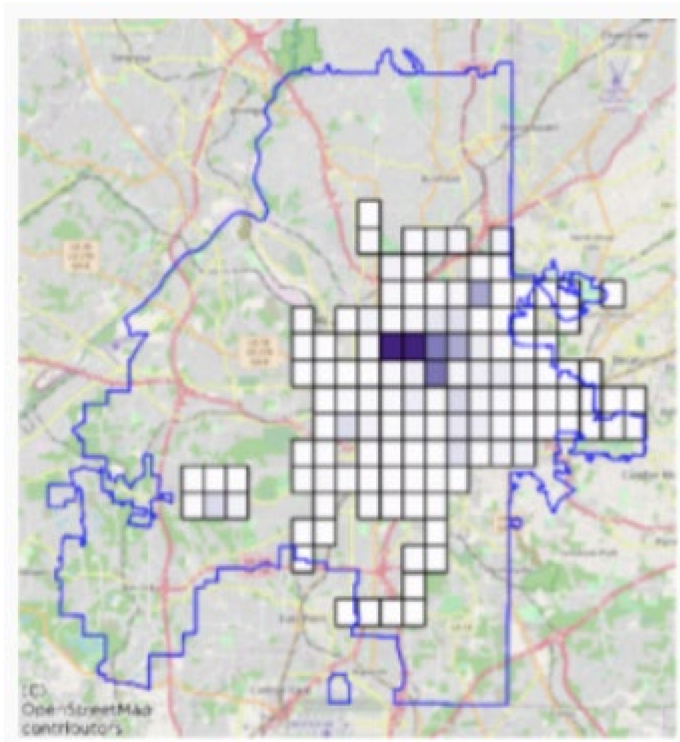

Figure 8. Spatial Density of UrbanHeatATL Data Points Collected as of September 2021

The population that UrbanHeatATL sought to serve through this study was communities vulnerable to urban heat. Characterizing extreme heat vulnerable communities in Atlanta requires an understanding of 1) what demographic characteristics make an individual vulnerable to urban heat, and 2) what geographic areas are most vulnerable to urban heat, either because of the built environment, lack of tree canopy, urban geometry, or increased anthropogenic activity. Researchers already understood *who* these vulnerable communities were, as that is well documented in the literature on urban heat and climate vulnerability. Mobilizing these communities to engage in citizen science was a different story.

Artifacts published by UrbanHeatATL, such as promotional flyers and newsletters, demonstrate the project's attempts to recruit community members as citizen scientists. The exact number of community participants involved in the project was not disclosed in any primary documents, but an excerpt from Experience Magazine stated that 80 college students and 10 community members were included in the project (Solomon, 2022). Because university students tend to live on or around their college campuses, an overlap may exist between community members and college students. It is uncertain whether 10 community members is a discrete value or if an overlap exists.

Figure 9. UrbanHeatATL Interns Lead a Community Conversation in the West End Neighborhood, July 2021 (original photograph)

Community engagement was a key element of the project beyond recruiting community members to collect mobile sensor data. On July 21, 2021, UrbanHeatATL interns led a community conversation in the West End neighborhood at WAWA's outdoor activity center. Turnout was moderate, with four community members joining in person and eight joining virtually. WAWA was instrumental in the recruitment of community members for the community conversation (and in mobile sensor data collection) as the organization is headquartered in the West End neighborhood, and Dr. Jelks is a Spelman alumna and West Atlanta resident herself.

4.2.2 Data for Power/Data for Liberation

Systematic analysis of excerpts tied to data for power/data for liberation revealed three major themes in the UrbanHeatATL case: misconceptions about vulnerability, accessibility in data collection, and discrepancy in values about greenspace/trees.

Vulnerability, a theme present across many artifacts, was a central theme for determining if the UrbanHeatATL project was well equipped to develop a data narrative towards dismantling structures of oppressive data storytelling that marginalized communities are subject to in "traditional" data collection and evaluation efforts. Asking *Why are [UrbanHeatATL] data being collected?* and *what story do [UrbanHeatATL] data tell?* revealed that the purpose of the project was to identify which neighborhoods were most vulnerable to urban heat and get a more detailed understanding of what interventions these areas needed. To connect a broader understanding of who heat vulnerable communities are to planning decision-making, UrbanHeatATL mapped hotspots in Atlanta to confirm if those hotspots that were geographically vulnerable to urban heat were also where people who were socially vulnerable to urban heat lived. According to Dr. Jelks, data from the project "'really aligns with this narrative of what we have seen in other cities,' …Those formerly redlined neighborhoods 'lack the critical natural infrastructure that serves as this buffer to extreme heat'" (Samuel, 2021). Researchers also understood that some neighborhoods thought to be home to heat vulnerable populations, such as those in Southwest Atlanta, have well-built environments with dense tree canopies that assist in reducing the impacts of urban heat. Areas such as Downtown Atlanta and neighborhoods immediately adjacent to the Atlanta University Center (Vine City, English Avenue, West End, and Oakland City) had less trees and more concrete, despite being demographically similar to neighborhoods in Southwest Atlanta. In an interview with WABE, Dr. Jelks revealed that UrbanHeatATL data collection was focused on neighborhoods adjacent to the Atlanta University Center to produce evidence for a case in investing time, resources, and policies towards reducing urban heat in these neighborhoods (Samuel, 2021).

Data collection accessibility was a second theme prevalent across this dimension. A major barrier to community involvement in data collection and other project practices was UrbanHeatATL's heavy reliance on digital technology. Mobile data sensors required access to a smartphone with cellular internet capabilities and the ability to send emails to an online data repository. Heat vulnerable communities may not have access to the technology and the knowledge needed to participate. Mobilizing certain heat vulnerable individuals, such as the elderly, to participate in the project was also limited, as these communities did not have access to or did not engage regularly with the project's primary means of communication: email newsletters, posts to social media (such as Facebook, Twitter, and Instagram), the UrbanHeatATL website, and the UrbanHeatATL Slack channel.

Access to technology in participatory data collection extended beyond the scope of the UrbanHeatATL project. Researchers and students not otherwise affiliated with the project, such as high schoolers, were also interested in contributing data, but they did not have access to PocketLab sensors. In one artifact – a virtual seminar on citizen science that featured UrbanHeatATL as a featured project – a participant asked "…can you advise on apps that can be used to gather heat and ground cover data easily? the most accessible tech my students have is their smartphones…" (Cobb et al., 2021). As the primary data steward for the project, the Georgia Tech Global Change Program was responsible for decisions about participatory data collection. Georgia Tech's position as a research organization suggests that data integrity and fidelity was prioritized over accessibility in data collection. While Georgia Tech had the capacity to train citizen scientists and provide mobile sensors, heat vulnerable community members may have not had the capacity to volunteer their time or resources to participate in the study.

Another theme relevant to *data for power/data for liberation* was differing attitudes that urban heat experts or researchers had about increased greenspace/tree canopy as a UHI intervention compared to the attitudes of heat vulnerable communities identified by UrbanHeatATL. It is widely recognized that urban areas with robust tree canopies have much cooler daytime and nighttime temperatures than urban areas with less robust tree canopies and more impervious surfaces (Aram et al., 2021; Bowler et al., 2010; Doick et al., 2014; Sun & Chen, 2017; Xu et al., 2022). The EPA suggests increasing tree vegetation cover to lower surface air temperatures in urban areas (US EPA, 2014), and cities across the country (including Atlanta) have pledged to increase urban greenspace to combat urban heat (Cusick, 2021). Project researchers' general attitudes about Atlanta's tree canopy was that "there's value in being able to quantify something that, in certain respects, resists quantification: trees, forest, greenspace—these centerpieces of Atlanta's civic identity…"

(Worley, 2021). Communities of interest in the UrbanHeatATL project have a geographic profile (less trees, more concrete) which make them appropriate candidates for these traditional interventions against urban heat.

During the Community Conversation in the West End neighborhood in July 2021, however, heat vulnerable community members expressed to UrbanHeatATL researchers that they were opposed to certain interventions against urban heat, such as planting trees and weatherizing homes. Seniors and individuals living in low-income households felt that they do not have the resources or ability to maintain any significant changes to their communities or homes. In a blog post reflecting on this meeting, Khorashahi (2021) writes that "For a long time, conversations about community development, particularly in predominantly Black neighborhoods in Atlanta, have not sought input from community members. Community members felt as though interventions that outside stakeholders found useful (such as planting more trees or installing speed bumps in a residential street) were made without the consent or input of community members. Community members discussed that their personal experiences with urban heat mitigation strategies, such as increasing or preserving tree canopy, often contradicted what "experts" claimed…". While the community conversation offered a space for a few West End neighbors to voice their opinions and concerns about the project, it is unclear whether community members' feedback was effectively integrated.

In addition to feeling as though decisions were being made without their consent, community members considered the long-term effects of UHI intervention from a different perspective, specifically tree planting and home retrofitting. Researchers focused on the climate and public health effects of UHI intervention – planting trees to cool off neighborhoods and retrofitting buildings to cool off homes has a direct effect on mortality rates in heat vulnerable communities (Stone et al., 2019; Gabbe et al., 2022). Community members, however, focused on the economic effects that these interventions would have on their neighborhoods. Planting more trees and retrofitting buildings would, in the long run, increase property values, making homes less affordable for low-income and elderly residents that were heat-vulnerable (Donovan et al., 2021; Merse et al., 2009). In community members' minds, UHI mitigation strategies went beyond cooling their homes and neighborhoods and exacerbated concerns of neighborhood change and gentrification.

4.2.3 Efficacy in Planning Outcomes

Efficacy in planning outcomes seeks to understand how policy and planning decision-makers bridge the data collection process into policy and planning decision-making. Many of the excerpts revealed that this connection was missing, and that the UrbanHeatATL project was designed as a prescriptive effort to collect data that could then be used by decision-makers to implement environmental justice policies. There were no programs that target heat island intervention made as a direct a consequence of UrbanHeatATL data collection. Some urban heat policies, such as opening cooling centers and retrofitting old properties through WeatheRISE ATL, were initiated during the project study period and advertised concurrently. Rather than immediately translating to policy, data collection was preventative, with the intent to address issues like gentrification and loss of tree canopy. Dr. Jelks, in remarks to Atlanta Magazine, characterized the project as "an extra bit of ammunition to help bolster the on-the-ground advocacy that is happening to make sure that people are not displaced from these areas as more development comes, as gentrification comes" (Solomon, 2021). Researchers and project participants were hopeful that data collection could raise awareness of the issues of urban heat and be utilized in future data-based decision-making.

UrbanHeatATL researchers intended data to be utilized by local governments and planning decision-makers to implement policies to promote equitable outcomes. During the study period, the City of Atlanta's Mayor's Office of Resilience launched the #HeatSeasonATL campaign on social media, where informational posts were shared on platforms such as LinkedIn, Instagram, Twitter, and Facebook. The campaign was intended to increase awareness of urban heat island effect, share resources and interventions that City of Atlanta residents could utilize to combat extreme heat, and raise awareness for UrbanHeatATL. Researchers from across Atlanta, led by Spelman University, also participated in the Atlanta Heat Watch Campaign sponsored by NOAA and the National Integrated Heat Health Information System (NIHHIS). Like UrbanHeatATL, the Atlanta Heat Watch Campaign utilized mobile temperature sensors to capture high-fidelity georeferenced air temperature data. The Atlanta Heat Watch Campaign, however, only captured data on a single day. Other heat-mapping projects such as the Bucket Brigade initiative in Louisiana and the Philadelphia Urban Heat Mapping Campaign out of Drexel University followed similar methodologies but were not related to UrbanHeatATL.

It is apparent that UrbanHeatATL and the city's related efforts to address the urban heat island effect were successful advocacy campaigns, but the project was not designed in a manner which linked participatory data collection efforts with urban planning outcomes. There were few urban planners affiliated with the project (Dr. Brian Stone was the only planner publicly named as project partner), and the city's Department of City Planning, which facilitates all planning, zoning, and building decisions in the city, was notably absent as a project partner. While a self-identified goal of the UrbanHeatATL project was to “further environmental and climate justice in Atlanta” (UrbanHeatATL, 2023), project researchers never clearly defined how the citizen science data would contribute towards this goal through plans or policies.

In the final chapter of this thesis, I present recommendations that UrbanHeatATL and other participatory science projects may implement to effectively bridge the participatory data collection process into planning decision-making to achieve efficacy in planning outcomes.

CHAPTER 5. DISCUSSION AND CONCLUSION

This study revealed that UrbanHeatATL succeeded as a data collection effort but fell flat as a *participatory* data collection effort. The project was designed with equity in mind and efforts were made by researchers throughout the study period to engage with communities of interest as citizen scientists and for feedback about the project. Agency over the project, however, remained in the hands of project researchers and UHI experts, with community members engaging and contributing to the project in modes pre-determined by researchers. The project also achieved some of its data collection goals. Historically redlined communities, such as those adjacent to the Atlanta University Center, were found to be hotter than other neighborhoods in the city because of a diminishing tree canopy and increased impervious surfaces in these neighborhoods. Residents of redlined communities were also determined to be most vulnerable to the effects of urban heat, redlined communities were home to seniors, low-income households, and communities of color. Data were collected with the intent to be leveraged by policymakers and planners into policies that lead to more equitable outcomes in heat vulnerable communities. Gaps remain, however, in translating data collection to policy outcomes due to research barriers as a result of the Covid-19 pandemic and shortcomings in community mobilization and stakeholder relationships.

5.1 Impact of Covid-19 on Participatory Research

UrbanHeatATL was launched in March 2021 and the inaugural round of data collection was conducted that summer. Covid-19 was declared a global pandemic in March 2020, and uncertainty about the effects and severity of the disease persisted well over a year later (NIH Medline Plus Magazine, 2021). Concerns over proliferation of the illness changed the nature of participatory research conducted during the pandemic (Johanna et al., 2021; Sattler et al., 2022). In-person interaction was limited, so digital and remote methods of data collection and engagement, such as virtual webinars, were utilized. Populations most vulnerable to Covid-19, such as low-income individuals, the elderly, and communities of color, reduced their interactions with others before and during the study period (Lewis et al., 2022). Unfortunately, these communities are also most vulnerable to urban heat and populations of interest for the study. It is uncertain if UrbanHeatATL may have had more success mobilizing members of vulnerable target communities to engage in data collection if not for the pandemic, but Covid-19 still presented a barrier to community engagement and mobilization.

5.2 Where Do We Go from Here?

Reflecting two years later, it is evident that UrbanHeatATL was an effective advocacy campaign that encouraged policy decision-makers to think more critically about urban heat interventions. In 2023, the City of Atlanta re-launched the Clean Energy Advisory Board to better position clean energy transition policies to serve marginalized communities (City of Atlanta Mayor's Office of Communications, 2023). The city also commissioned its first comprehensive urban heat and flood risk assessment in 2022, led by Dr. Brian Stone and Dr. Evan Mallen. Dr. Stone is a co-Investigator of the UrbanHeatATL project. The project is set to be completed sometime in 2023. It is difficult to determine if these initiatives were a direct result of the UrbanHeatATL project, but many of the actors involved in these policies – such as Brian Stone and Chandra Farley (the City of Atlanta's Chief Resilience Officer as of September 2022) – were also involved with UrbanHeatATL.

There remains room for improvement in the study, both in the design of the participatory process and the translation of community input into planning decision-making. I present here three recommendations towards addressing these shortcomings.

5.2.1 Policy Recommendation: Accessibility in Participatory Data Collection

Although UrbanHeatATL was a project designed specifically to mobilize members of marginalized communities as participatory researchers in a project aimed at understanding and ultimately reducing heat-related vulnerability, participatory methods utilized in the project were inaccessible to many heat-vulnerable households. My inquiry revealed that the PocketLab mobile heat sensors were an effective data collection tool but an ineffective *participatory* data collection tool. The sensors required that citizen scientists have access to a smartphone that could run the PocketLab app during data collection and stable internet access to email collected data to Global Change Program researchers for analysis and visualization. According to a study from the Pew Research Center (Vogels, 2021), roughly a quarter of adults (24%) in low-income households (<$30,000 a year) do not have access to a smartphone, and 43% of adults in low-income households do not have stable Internet in their homes. Low-income neighborhoods are at a significantly greater risk for urban heat exposure because they face increased impervious surfaces, less vegetation, and higher population density (Benz & Burney, 2021). Lack of access to critical technology meant that some low-income community members, who are known to be highly heat vulnerable, were disqualified from participatory data collection.

This shortcoming in participatory project design comes because of Georgia Tech's Global Change Program being the project's primary data steward. In seeking to engage in a participatory data collection process, the UrbanHeatATL project fell into the trap of *user-centered design*. User-centered design focuses on the end user of some product or technology, and decisions about process and technology design are determined based on the needs of the end user (Abras et al., 2021). Researchers and organizations managing a design process often choose to center the needs of assumed "potential users" over other users. Often, these potential users are assumed to be members of a hegemonic "unmarked" group – which "…in the United States, this means (cis)male, white, heterosexual, 'able-bodied,' literate, college educated, not a young child and not elderly, with broadband internet access, with a smartphone…" (Constanza-Chock, 2020, pp. 77) – or assumed to be similar in nature or identity to the researchers/designers (The Vozmob Project, 2011). In the case of UrbanHeatATL, researchers assumed that citizen scientists would have access to a smartphone and Internet, because nearly all Georgia Tech students have access to a smartphone and Internet.

One intervention to avoid issues of technology accessibility in future participatory data collection efforts is to involve citizen scientists in the research design process. Here I suggest utilizing the data feminist principle of *pluralism,* which is valuing many voices and perspectives throughout the data science process, including process design, data collection, and data analysis. Through pluralism, the process of determining how to structure a participatory data collection effort becomes, in and of itself, participatory. To engage community members in designing the participatory data collection process, a low barrier-to-entry methodology, such as mailed surveys or door-to-door canvassing may be employed. Including community members in the design process gives community members agency over their own participation in data collection by transferring some of the power that project researchers have over project administration to community members.

5.2.2 Policy Recommendation: Strengthening the Community/Researcher/Decision-Maker Nexus

An issue that arose in the participatory data collection process beyond access to technology was researchers' access to heat vulnerable community members. While some of the lack of community participation in UrbanHeatATL's inaugural summer may be explained by fears and uncertainty surrounding Covid-19, eighty Georgia Tech and Spelman students still participated as citizen scientists, while only 10 community members joined the project. The Community Conversation event hosted in the West End neighborhood – a heat vulnerable community of interest – at the West Atlanta Watershed's Outdoor Activity Center – an organization with deep ties to many communities in west Atlanta – still only attracted eight community members to attend. This discrepancy in community versus student participation suggests that students' relationships with the UrbanHeatATL project are stronger than that of heat vulnerable community members. A key issue in participatory research design is establishing trust between the researchers and the participants. If project participants trust that the researchers are acting in the participants' best interest, they will more willingly share information with researchers in an open and authentic manner (Grayson et al., 2020). Likewise, a stronger connection between researchers and the community they seek to serve could encourage community members to trust that data are being collected in the community's best interest, and further encourage community members to volunteer in ongoing or future participatory data collection efforts. This nexus between community members, researchers, and policy decision-makers is key in realizing project outcomes.

An example of practices that diminish trust between community and researchers was revealed in discrepancies between the two groups relating to UHI mitigation strategies. The differing attitudes about greenspace between heat vulnerable communities and researchers/UHI experts are a symptom of the differences in power wielded by researchers/experts and communities. Without consulting the community, the power to make decisions to plant trees or weatherize homes as a UHI intervention belongs solely to the researchers/experts/planning decision-makers. It is not uncommon for members of marginalized communities to be excluded from the decision-making process because their wishes counteract that of planning decision-makers and institutions in positions of power; a case of tree planting in a marginalized community in Detroit was met with pushback from community members, as those planting trees did not consult with the impacted community before taking action (Johnson, 2019). UrbanHeatATL researchers structured the project to receive and integrate feedback from the community into design of project outcomes, yet increasing urban greenspace remains the primary policy intervention that decision-makers in the city rely on to mitigate urban heat.

Of course, expecting members of marginalized communities to engage with a project that has not been proven to offer some direct benefit or support to the community is an unreasonable expectation. Many individuals with marginalized identities are not afforded the same privileges and luxuries that students at prestigious research institutions and nationally renowned colleges are implicitly afforded, such as access to resources and technology, financial stability, time, and social capital. My recommendation, then, is for researchers and policy decision-makers to themselves become more familiarized with and build social capital within the communities they seek to serve. Researchers should take it upon themselves to position their work and perspectives within the community, to ensure that the data they are collecting and working with represents the communities they seek to serve. D'Ignazio and Klein suggest that “the people that have access to data and to the technical skills to work with it are those that have the most stake in reproducing the status quo” (2020, pp.134). Therefore, decision-makers seeking to operationalize data into planning outcomes should also make sure that they are aware of and engaged in the needs of marginalized communities.

Another step that researchers can take to strengthen the connection between themselves, community members, and planning decision-makers is to find means of returning project agency to project participants. Data feminism recognizes that much of the work in data science, such as data cleaning and collaboration with peers, goes unrecognized. A simple way that researchers may return project agency to the community is by publicly acknowledging participatory scientists (with explicit consent) in an accessible manner. This recognition could be through the award of a certification of participation, monetary reward, or a similar token to project participants. Additionally, UrbanHeatATL recognizes project Principal Investigators, affiliated researchers, organizational partners, and student interns on its website and public facing social media. Noticeably absent from this ensemble are citizen scientists, who have arguably the most important role in the project: collecting the data! Including names of citizen scientists (again, with explicit consent) in UrbanHeatATL’s public facing online pages is a simple way to recognize project participants for their time and efforts.

5.2.3 Policy Recommendation: Equitable Data Collection for Effective Planning Policy

A major shortcoming of the UrbanHeatATL project was the missing link between participatory data collection and urban planning decision-making. Citizen scientists collected a detailed and robust dataset with over 1 million data points, heat vulnerable community members were engaged and polled about their feelings on urban heat, and the government and community organizations made the public aware about the urban heat island effect. Public involvement and awareness about urban heat is on the rise, yet there continues to be a dearth of plans or policies to address the issue in Atlanta. UrbanHeatATL researchers made it explicitly clear that they knew which neighborhoods were historically redlined and which kind of built environments (more concrete/impervious surfaces, less trees) were most susceptible to urban heat. Despite this knowledge, there were no clearly defined policies or plans to address these issues, and there are still none today.

Towards designing for justice, D'Ignazio and Klein state that "Equity is both an outcome and a process" (2020, pp. 191). I have already suggested a set of recommendations towards designing a more equitable participatory data collection process, but these recommendations are for naught if such projects do not create equitable outcomes. In addition to building community trust and stronger relationships with heat vulnerable communities, decision-makers need to make sure their policy goals are explicitly clear and align with that of researchers. For example, the City's Office of Resilience could have set a goal to finance the weatherization of 100 households in Atlanta that were in heat vulnerable communities. The UrbanHeatATL project would then map where these homes were and engage residents on whether they would like to participate in the initiative. Then, the city or another appropriate project partner would weatherize the identified homes as appropriate. Engaging the correct community partners or including decision-makers in the project design process could lead to operationalization of data collection into actionable policy and planning outcomes.

5.3 Conclusion

In this thesis, I used UrbanHeatATL as a case study for the integration of data feminism principals in participatory data collection towards urban planning decision-making, but I hope that the findings from this study and the included recommendations may be applied to many more participatory data collection efforts. Assessed against the Participatory Science for Data Feminism framework, UrbanHeatATL succeeded in utilizing participation as metadata and leveraging data for power/data for liberation through a citizen science methodology that sought to engage marginalized individuals in redlined neighborhoods that were most vulnerable to urban heat. While some efforts have been made by the city to implement policies and plans to mitigate urban heat, the relationship between these efforts and UrbanHeatATL is unclear, and the impact of these policies has not been recorded yet. Future study should consider what steps decision-makers should take to operationalize the data into policies with measurable community impact. I recommended that 1) researchers work to better mobilize community members in participatory data collection through accessible project design, 2) efforts be made to strengthen the nexus between community members, researchers, and planning decision-makers and, 3) data collection and community mobilization efforts are bridged into equitable planning outcomes through setting well-defined policy goals. The data is there and it’s good; we just have to figure out how to use it.

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