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Air Quality Citizen Scientists: A Case Study of the Hudson Valley Air Quality Coalition

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by

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To my Dad, Todd Aichele.

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Introduction

In this research, I seek to understand the process by which people become involved in citizen science projects. Over the course of my experience at Bard College as an Environmental and Urban Studies student, I have had the opportunity to begin to immerse myself in the local culture of environmental activism. This is largely due to my enrollment in a class called EUS 223: Air Quality Research Lab. It was during this course that I was introduced to the topic of air quality, beyond just colloquial knowledge about smog from growing up in Los Angeles. We started to explore issues of indoor and outdoor air quality, mostly in the veins of particulate matter and mold spores. From this experience, I was given the opportunity to work for a semester in the Bard Community Sciences Lab as the intern for air quality research. While I was doing this work, I was able to meet community leaders who worked in collaboration with the lab to not only do research, but to do research for the benefit of the community.

This work was incredibly engaging, and I developed a huge appreciation for the community leaders who had fostered this relationship between the institution of Bard College and the community that the institution is situated in, the Hudson Valley. I was able to learn about the different activist groups in our area, and began to attend meetings. I believe that my position in relationship to this community gives me a unique opportunity as a researcher. My familiarity with the participants, the Hudson Valley Air Quality Coalition, and the lab gives me access to a robust point of view. Each of these has informed my perspective and has hopefully led to a strong analysis that treats the subjects with accuracy. My research question is as follows: What is the citizen science process for air quality advocates in the Hudson Valley? Using the work of the Hudson Valley Air Quality Coalition as a case study.

Citizen science as a recognized phenomena finds its origin in the 1990s. One definition comes from a British school of thought, and another from an American. The British definition, described by sociologist Alan Irwin, states that science should be responsive to citizens, and also that citizens should be capable of producing reliable scientific data and knowledge (Irwin, 1995). The American-origin definition of citizen science is much more specific and therefore far less applicable, determined by ornithologist Rick Bonney. Bonney's use of the term refers to the submission of data to professionals by amateurs in a voluntary manner (UCL, 2023). The term also appears in the Oxford English Dictionary as "Scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (OED, 2023). This definition seems to draw on Irwin, but over-emphasizes the role of the institution and under-appreciates the organization that can occur in the 'general public'. The definition of citizen science most relevant to this work is the definition provided by Irwin.

My hypothesis was that the Hudson Valley Air Quality Coalition is an example of true collaborative citizen science, and that a focus on issues of air quality makes the objectives of this group unique from other forms of environmental advocacy. My research confirmed my hypothesis, and elaborated on those concepts. I observed that participants with individual interest in the topic of air quality, typically formed in an educational setting, were connected by their interpersonal relationships with an institutional figure. This was able to result in a citizen science relationship because the nature of the institution was flexible. Individuals who were founding members had common goals and views, policy being a goal and the belief that human health improvements are a priority being a view. My research suggests that air as a resource requires a

deviation from typical environmental conservation strategies and policies, which inspires a centering of human impact, and an expanded view of pollution impact.

Context

The modern imaginary of "the scientist" conjures a picture of someone hunched over a machine in a long white lab coat, in a bright white sterile room, surrounded by multicolor potions in beakers and Bunsen burners. While that might describe some labs, it certainly is not representative of the entire practice of science. Science, as described by the Oxford English Dictionary, is "A branch of study that deals with a connected body of demonstrated truths or with observed facts systematically classified and more or less comprehended by general laws, and incorporating trustworthy methods (now esp. those involving the scientific method and which incorporate falsifiable hypotheses) for the discovery of new truth in its own domain" (OED, 2023). In essence, this is the process of the pursuit of knowledge, including data collection, trial, error, and discovery. The practice of citizen science gives anyone the opportunity to be part of the scientific process. This accessibility is crucial for many reasons. Processes in the natural world, such as the depletion or pollution of natural resources, happen and affect people on a global scale. Climate change is happening on a global scale. In parts of the world where formal education resources and research funding resources are scarce, citizen science has the potential to create equity. Even in the parts of the world where residents enjoy those luxuries, citizen science can be a tool of fostering community. Especially in research concerning the environment, a mobilized citizen science group can generate immense amounts of data (Schaefer, 2020).

Alan Irwin's definition of citizen science comes from his groundbreaking book, *Citizen Science: A Study of People, Expertise, and Sustainable Development* (1995). Irwin's training is in sociology, and this book is one of the key links between the study of citizen science, environmental science, and scientific practice as sociological phenomena. In Irwin's definition of citizen science, he posits that a certain social and political climate must exist in order to create the citizen scientist. Irwin rejects the idea of scientific determinism, or the idea that scientific enquiry and progress are the result of an inevitable human process. Instead, he believes that science, or scientific institutions can be "*flexible* in the face of expressed social needs or wishes" (Irwin, 1995, p. 51). This flexibility can occur once the traditional scientist is able to let go of the idea of total objectivity within their study. Because science is a socially constructed process from the assumptions made in a hypothesis, to the institution a scientist is employed by, to the chosen method of study, and to the way meaning is derived from a result, scientists would do best to acknowledge these factors as bearing on the research than to claim objectivity (Irwin, 1995). Another important observation from Irwin is the fact that environmental science bears a certain "real-world complexity" that cannot ever be fully represented by the limited scope of the scientific method; The nature of the problems cannot be separated into neat variables that abide by laws, and therefore do not compute as equations or scale from the ecosystem to the lab (Irwin, 1995). When traditional, formal methods of science can only explain the phenomena of cause and effect through introduced variables within a controlled setting, interpreted in contrast to a control test, the applicability of those findings is extremely limited in the reality of the environment (Irwin, 1995). This is not to suggest that we should do away with that form of science, because it is tried and true and useful for gaining certain insights. But it is true that

environmental science is rarely neat, and despite that, we should do it anyway. This area of study is inherently interdisciplinary, which has led to a limited literature, but also speaks to the depth of the existing literature. One of the first journals to collect and publish literature about citizen science was founded in 2014 by the Citizen Science Association and Ubiquity Press Ltd. (Citizen Science: Theory and Practice, n.d.). Ten years later, this journal has filled out this "young" genre and helped establish the field of research, documenting the evolution over time.

The other field of study I will be discussing in this paper is the study of air quality. Mentions of air quality have been made since the time of Hippocrates, but because understandings of disease were also rudimentary, the connection between human health or environmental wellbeing and air quality would not be made until much later (Fowler, 2020). One of the first dedicated texts about the issue was published in 1661, titled *The Inconvenience of Aer and Smoak in London* by John Evelyn (Fowler, 2020). This text is the first to make the claim that industrial emissions in cities were having negative impacts upon human health (Fowler, 2020). London has been a place of particular concern, as one of the first cities to rapidly industrialize. The Clean Air Act of 1956 passed by the British Parliament was a landmark for government intervention in industry to improve urban conditions (Fowler, 2020). Not only does this intervention link issues of air quality to human behaviors, but it attests to the intensification of this problem in tandem with the intensification of production in the modern era. The United States Congress passed the Clean Air Act in 1970, and the document has been amended many times since then. The EPA lists air quality milestones as beginning in 1975, which gives us an idea of the beginning of the policy story regarding air quality in the United States (EPA, 2023). Unfortunately, air quality policy is nowhere near where it needs to be to ensure clean air access

for all, as outdoor air pollution currently accounts for somewhere between five to ten percent of premature deaths in the contiguous United States (Dedoussi, 2020). The EPA reports as of 2011 that the Clean Air Act Amendment of 1990 has been successful to an extent in emissions reduction, preventing 160,000 premature adult deaths as a result of PM 2.5 in 2010 and 230,00 in 2020 (U.S. EPA, 2011). While this prevention is significant, it still leaves a bulk of issues to be addressed, especially in urban areas. Pollution and exposure to pollution have to be at advanced levels to lead to premature death, which demonstrates that there is a long way to go to achieve clean air access for all. Because the case study I am focusing on is located in the United States, the scope of this paper is mostly concerned with the policy choices made by the United States at the federal, state, and municipal levels. However, to provide an example of effective policy as a result of community action, we can once again look to London.

London, England has recently enacted a set of policies to make the city the world's first LEZ, or Low Emissions Zone. This story starts in 2013 with the tragic death of a nine year old girl named Ella Adoo-Kissi-Debrah, who was the first person in the world to have 'air pollution' listed as a cause of death (Arts Council England, 2024). This recognition of the deadly capabilities of London's air quality problem created a movement in the community called #BreatheForElla, which inspired public artworks and community groups who brought further attention to the issue, and supported the creation of "Ella's Law" (Arts Council England, 2024). This is also known as the Clean Air Bill, which requires local authorities to bring air quality under their domain up to minimum standards set by the World Health Organization within five years (Arts Council England, 2024). So, on April 8th, 2019, the Mayor of London launched the first version of the Ultra Low Emissions Zone which sets the city on track to comply with the

goals put forth by the bill (London City Hall, 2023). This zone has expanded to 18 times the size of the original zone, and works in tandem with the larger Low Emissions Zone to cover the majority of the London metro area (London City Hall, 2023). The policies mostly target modes of transportation, attaching a toll to older vehicles and incentivizing the use of new vehicles with reduced emissions that are not subject to the toll (London City Hall, 2023). The Mayor's Office has also created a fund which subsidizes the purchase of compliant vehicles, making this transition less cost prohibitive for residents of lower economic status (London City Hall, 2023). The results thus far have been overwhelmingly successful, with a 41% reduction in average harmful particulate matter (PM 2.5) concentrations since 2017, as well as reductions in carbon and nitrous oxide emissions (London City Hall, 2023). While the exact human health impact has not yet been identified, it would be within reason to correlate these reductions as having a positive impact on the health of London metro residents, especially those who fall within the inner city Ultra Low Emissions Zone. This example provides a template of one policy strategy, to target vehicle emissions, which has had a quantifiable impact. This also demonstrates the efficacy of place-based, municipal level policy which can target specific emission sources based on local context. While official government documents do not cite Ella's life as the impetus for policy, it is important to recognize that the efforts of community advocacy played a large part in mobilizing the government to act on behalf of citizen health.

Issues of air quality are typically split into two categories: issues of indoor air quality and issues of outdoor air quality. Each sphere has unique pollutant sources, but they are not exactly separate. Because of the transient nature of air, and depending on the structure, what is indoor is outdoor and what is outdoor is indoor too. That being said, outdoor air quality concerns are

typically things such as: ground level ozone, fine particulate matter, carbon monoxide, lead, sulfur dioxide, nitrogen dioxide, and more (State of R.I., 2022). These emissions are usually a result of industrial activity, wood burning or forest fires, and in a lesser part, transportation (State of R.I., 2022). Indoor air quality pollutants come in a whole other category. These pollutants can include: allergens, asbestos, carbon monoxide, formaldehyde, lead, mold, pesticides, radon, smoke, and more (NIEHS, 2021). These pollutants are usually a byproduct of building materials, deferred maintenance, human activities, and off-gassing (NIEHS, 2021). Air quality concerns are often comorbid with other environmental concerns because of the way that microscopic particles of pollutants become suspended in the air (U.S. EPA, 2011). Gasses, spores, and particles that become suspended in the air become a danger to human health because of the ease at which they spread (Smith, 2023). Air pollutants have a number of effects ranging from detriment to human health, detriment to the layers of the atmosphere, escalation of global warming, degradation of water or soil quality, and more (U.S. EPA, 2011). Common understandings of air quality issues are typically limited to topics such as greenhouse gasses or smog. Actually, both of those are blanket terms that could describe any number of contaminants. Greenhouse gasses, while damaging, actually pose minimal direct threats to human health. Greenhouse gasses are things such as: carbon dioxide, water vapor, methane, nitrous oxide, and fluorinated gasses (MIT, 2021). Smog is more of a concern for human health as it refers to the collection of particulate matter. Smog is made up of three main components: ground level ozone, which is made of volatile organic compounds (often condensed to VOCs) and nitrous oxide, as well as particulate matter (CalTech, n.d.). Particulate matter is a byproduct of combustion, in the form of microscopic pieces of matter that become suspended by other particles in the atmosphere

(CalTech, n.d.). The size of these particles matters too, especially when it comes to interactions with the body through the respiratory and vascular systems (Smith, 2023). This matter is categorized by size in microns, sorted into three categories: Microns measuring 0.1 or below are ultrafine, 2.5 or below are fine, and 10 or below are considered coarse (Smith, 2023). The smaller the particle, the more dangerous, and prolonged exposure to air quality concerns, indoor or outdoor, can lead to a number of health complications in all living things (Smith, 2023). While both greenhouse gasses and smog are serious air quality concerns, it is important to differentiate between the impacts and sources of these pollutants.

The foremost government agency in the United States of America taking on the issue of air quality is the National Institute of Environmental Health Services (NIEHS). This institution was founded in 1966, preceding the federal Clean Air Act (NIEHS, 2021). Founding director Paul Kiotin was a leader in the field of "environmentally caused lung diseases", specializing in the health challenges caused by asbestos and beryllium (NIEHS, 2021). From this, we can glean that issues of human health and air quality have long been intertwined in this country, with a history of governmental awareness before action. The NIEHS website boasts many informative articles, podcasts, and recommendations. On the indoor air quality page, there is a section dedicated to the data generated by citizen science initiatives, in addition to a section dedicated to the air quality concerns and initiatives acknowledged by tribal nations (NIEHS, n.d.). The effort to include these voices is significant in creating equity in the scientific community. Without diminishing the strides made by this institution for bringing awareness to and collecting data on the issue, it would also be fair to say that much of this information has not been translated into policy.

Environmental regulations in the United States happen on several levels. Like most policies, this starts at the federal level, and gains specificity as the scale decreases into state, district, and municipal levels. The largest federal branch dealing with environmental protections is the Environmental Protection Agency. Under the Air Enforcement page on the EPA website, federal enforcement is reported to be concerned with three main sources: stationary sources, mobile sources, and hydrofluorocarbon sources (EPA, 2023). Most of this text has to do with the impact of industrial emissions, fuel types, and the dangers of imported devices that were manufactured according to different air quality standards (EPA, 2023). This is largely focused on outdoor air quality, and specifically emissions caused by human activity. There is no mention to the fact that the United States was the top carbon dioxide emitter over the span of time from 1751 to 2017, creating 400 billion tons, and accounting for 25% of historical emissions (Ritchie, 2024). If any government in the world had a responsibility to improve practices around air quality, that burden would fall to the United States.

This project is specific to the Hudson Valley. The Hudson Valley, known for its scenic views and artistic history, lies in upstate New York. The agency responsible for maintaining air quality standards set by the federal and state governments is the New York State's Department of Environmental Conservation, or NYSDEC. The NYSDEC website has a tab within the environmental protection section of the website about issues of air quality (NYSDEC, n.d.). This website advertises general information about air quality sources and current burn bans. It also links to a page on “community air quality”, which boasts an odor hotline and an archive of community projects that the department has supported (NYSDEC, n.d.). The agency appears to

be generally geared towards keeping industrial activity in check according to existing standards and suggesting that residents should follow what they deem to be best practices.

The boundaries of what is considered to be the Hudson Valley are disputed, but state agencies use this term to describe the watershed area of the Hudson River from Albany to Manhattan. This is by no means the entire stretch of the river; The term is more commonly used to describe this place with some cultural unity. The counties that are included in this stretch of the river are: Albany, Rensselaer, Greene, Columbia, Ulster, Dutchess, Orange, Putnam, Rockland, and Westchester (and perhaps Bronx and New York City counties in expanded definitions) (Hudson Valley Tourism, 2024). Not only do these communities share some cultural unity, but the specific geography of being in a valley means that these areas share air quality concerns in large part. When particulate matter and some denser gasses become suspended in the atmosphere, they collect and settle with gravity (CalTech, n.d.). This means that valley regions are particularly susceptible to issues of air quality because of the low elevation and containment of air inherent to the geography (EPA, 2023). The county where Bard College is located is Dutchess County, and just across the river banks from where we sit is Ulster County. Many Hudson Valley Air Quality Coalition members are local to this area, but not all. Kingston is the largest city in the immediate area, and is one of 12 cities in New York State to maintain a Conservation Advisory Council (City of Kingston, n.d.). This council was formed in 2008 and their mission statement reads as follows: “Ensure the conservation of the City of Kingston's natural resources and the enhancement and protection of its environment while fostering unified action on environmental matters.” (City of Kingston, 2021). Because this is an advisory council, suggestion and proximity to local lawmakers is the most powerful thing it has to offer. I was told

that when residents voice concerns about the environment, it is typically recommended that they speak with this council. While it has the potential to be a good resource, it has not been effective in addressing the needs of the community considering that it has not been able to sponsor policy.

Something I would like to address is the connotation that comes with the word citizen. While this is a word that does have a legal definition in the United States, as well as a cultural association, I am not using it to invoke these meanings. For clarification, the legal definition is: "All persons born or naturalized in the United States, and subject to the jurisdiction thereof, are citizens of the United States and of the State wherein they reside" (Library of Congress, n.d.). I use the words citizen, resident, community member, and constituent, all to describe people that live in an area and engage with culture in that area. When I describe the citizen scientist, I do not mean in the literal sense that this person interested in collecting data holds citizenship. When I use the term citizen, I am defining every human being as a citizen of the planet, connected to every person globally and especially to their community of neighbors. I hope that with this definition, this language does not exclude anyone.

Literature Review

The literature around citizen science as it relates to air quality is surprisingly rich considering its relative newness. While I was not able to find an example of the sociological research I am conducting on this niche, I was able to come up with some essential texts on the topic of citizens as data collectors and the role of the institution in the research to policy process. The first article relevant to this work was published in the Humanities and Social Sciences Communication journal in 2022, titled "Translating Citizen-Generated Air Quality Data into Evidence for Shaping Policy" (Mahajan, 2022). This research yielded many important findings,

one of which being the insight that citizen science is particularly helpful in the collection of air quality data because of potential scale. This process has the externality of "strengthening the science-policy-society interface." (Mahajan, 2022, p. 5). This research suggests that citizen councils around air quality policy are meaningful to the policy-advisory process, although not many exist (Mahajan, 2022). Citizen science has the possibility to expand methods, forming the opportunity to communicate through "data stories", which integrate sensor data and local knowledge (Mahajan, 2022). This research is important because it acknowledges the necessity for policy and posits a four part framework for achieving policy as a goal. They call this the Evidence Co-Creation Framework, which can be used as a tool to legitimize and/or standardize the citizen science to policy process in the eyes of lawmakers (Mahajan, 2022). These steps are: mapping, sensing, analysis, and sharing (Mahajan, 2022). Mapping is defined as identifying problems and stakeholders, sensing refers to the process of data collection, which exists in an expanded definition here, and analysis is the process of data interpretation and contextualization (Mahajan, 2022). Finally, sharing is defined as the creation of accessible data sharing resources which also includes a feedback mechanism (Mahajan, 2022). These steps are not intended to simply be followed from beginning to end; In the article they present them as being steps within a cycle that can inform the next investigation. This is a helpful tool to consider when thinking about the intentions behind the process of doing citizen science.

Another important text in the literature is a synthesis looking at 33 case studies of citizen science air quality activism. This research was published by the World Resources Institute in 2022, and is titled "Clean Air Action: Applications of Citizen Science to Identify and Address Air Pollution Emission Sources" (Moses, 2022). The goal of this research was to determine the

efficiency of citizen science groups in correctly identifying “relevant” sources of emissions (Moses, 2022). This research had many findings, but I believe that two pieces of the research are useful to the scope of my paper. The first of these is the determination that the collection and public sharing of data was not sufficient to produce political action (Moses, 2022). They found that community groups had to take further steps to transform said data into action, done through six pathways according to their analysis (Moses, 2022). Another thing they found was that when academic or government researchers fostered trust with community groups to co-lead these initiatives, the outcomes were tied to specific sources of emission and were largely successful in creating policy (Moses, 2022). A relationship that centers both reputable data and citizen concern as a united front was key to gaining political attention (Moses, 2022). This data builds on the previous study because it specifies the mechanisms that garner political attention. Citizen scientists, when partnered with an institution, have more capability to be productive. The nature of that relationship is also important. The second piece of this research, which is important to this project, is the identification of challenges commonly faced by citizen science groups. They were able to identify two main challenges: The former being the difficulty in understanding the complexity of the issue and identifying actionable data, and the latter being frustrations when little to no action was taken as a result of the data (Moses, 2022). Identifying these challenges is important because the recognition of these issues can result in a conversation about solutions. These findings in particular point to the inherently complex nature of the type of science one interacts with when delving into issues of air quality, and again, recognizes that policy is a priority.

The following study inspired both the design and the content of my research. Published in 2020 in the Citizen Science: Theory and Practice journal, this article is titled “Citizen-Based Air Quality Monitoring: The Impact on Individual Citizen Scientists and How to Leverage the Benefits to Affect Whole Regions” (Schaefer, 2020). The goal of this research was to determine the sentiment of individuals about their experience collecting air quality data as part of a citizen science project, and the research team conducted interviews with 36 participants over the course of a year (Schaefer, 2020). The primary finding of this research was the knowledge-leak effect of participation in air quality data collection into the larger community (Schaefer, 2020). A majority of participants reported having positive experiences that led them to share information with their local network (Schaefer, 2020). In the conclusion, they report, “All volunteers in the three testbeds wanted to continue their participation and offered to take on more responsibilities and actions, given the necessary support structures. These included broad support in building, calibrating, and maintaining the devices; In communicating the topic to the broader public and to political decision-makers; And to building alliances with other organizations to fight against the origins of pollutants.” (Schaefer, 2020, p. 10). This research suggests that the experience of practicing citizen science develops a deeper interest in research and data collection (Schaefer, 2020). It also suggests that the existence of a citizen science group within a community has positive externalities such as increased awareness, education, and interest in activism for all residents (Schaefer, 2020). This research also touches on the role that positive associations and enjoyment play in maintaining a citizen science project (Schaefer, 2020). The findings of this research are important to this project because they center the human experience when practicing science, which is something I hope to build upon in this research.

In order to attach this literature to upstate New York, I would like to discuss a case study published by the United States Government under the CitizenScience.Gov initiative. This case study was published under the title, “The Air Sensor Toolbox | Citizen Scientists Measure Air Quality” (Clements, 2014). This case study centers the residents of Tonawanda, NY. When residents noticed recurrent health issues in 2004, they organized into the Clean Air Coalition of Western New York (Clements, 2014). Members started collecting data individually, and discovered elevated levels of benzene emitted by the local Coca-Cola plant (Clements, 2014). Because benzene is a known carcinogen, the New York Department of Environmental Conservation and the Environmental Protection Agency held this company accountable and reduced benzene levels by 86% (Clements, 2014). In turn, the EPA developed the Air Sensor Toolbox to kickstart more participatory science (Clements, 2014). The part of this case study that is relevant to this project is the result of this community’s organization. This is a great illustration of the types of results citizen science can generate. Not only was the site of pollution addressed, but this event caused the EPA to develop an Air Sensor Toolbox, and disseminate air sensors through the Air Sensor Loan program (EPA, 2024). Additionally, it adds to the literature (and tradition) of citizen science air quality activism in upstate New York, which situates this project in this context.

Another study important to this research, which provides insight into the nature of air transience and pollution science, is titled “Premature mortality related to United States cross-state air pollution” by Dedoussi et al., published in the journal *Nature* (2020). This study is illustrative of the movement of air pollutants in the contiguous United States, from their source based on data from the Nation Emissions Inventory to their impact quantified as premature

deaths which is estimated using peer-reviewed exposure limits (Dedoussi, 2020). This research suggests “that 41 to 53 percent of air-quality-related premature mortality resulting from a state’s emissions occurs outside that state” (Dedoussi, 2020). This assertion is important for two reasons. Firstly, it strengthens the argument that poor air quality has serious and quantifiable impacts on human health (Dedoussi, 2020). Secondly, it shows the disjointed nature of emission and impact, which implies that while individual states may legislate proactively, it may not solve the air quality issue and will be difficult to correlate impact (Dedoussi, 2020). In my own interpretation, this study is a call to action for large-scale policy development that is cooperative across all types of borders. The human health costs associated with PM 2.5 emissions are too high and too wide-reaching to continue business-as-normal.

Finally, to give definition to the project that is environmental advocacy, it is important to have an understanding of what environmental justice is. There are two documents that best describe the goals and methods of groups seeking environmental justice: The Principles of Environmental Justice, and the Jemez Principles for Democratic Organizing (EJN 1991; 1996). The Principles of Environmental Justice include seventeen principles which were created and adopted by delegates at the first National People of Color Environmental Leadership Summit (EJN, 1991). These principles range from demands to the government, to affirmations of practices in the community, each one important. I would like to highlight principles 1, 4, 7, and 12 (EJN, 1991). Principle 1 is an affirmation of “the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be free from ecological destruction”; This principle reminds us that ecological destruction has impacts far beyond the place in which the destruction occurs, and calls for a recognition of the interdependence of Earth’s systems (EJN

1991, p. 1). Principle 4 calls for protections against nuclear testing and waste, in particular when the disposals of this waste "threaten the fundamental right to clean air, land, water, and food"; This principle calls attention to the irreversible effects of nuclear technologies upon our landscape, and reminds us of the basic human right for the access to natural resources which sustain life (EJN, 1991, p. 1). Principle 7 makes a demand for "the right to participate as equal partners at every level of decision making, including needs assessment, planning, implementation, enforcement, and evaluation"; This principle outlines the necessity to be inclusionary at every step of creating environmental justice, and to create space for those communities which have been historically marginalized (EJN, 1991, p. 1). Lastly, principle 12 "affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature, honoring the cultural integrity of all our communities, and provided fair access for all to the full range of resources"; Principle 12 acknowledges the need for infrastructure and remediation that takes climate into account, as well as the importance of accessibility for all community members in this process (EJN, 1991, p. 1). These principles provide a framework that environmental advocates can strive towards and use to inform their methods.

The Jemez Principles for Democratic Organizing speak more to the internal functions of organizations seeking justice, so that these movements can avoid replicating structures of oppression and be effective (EJN, 1996). This document is based around six core principles. The first principle is to be inclusive: This principle states that the leadership and membership of the movement should reflect the diversity of the world, and that "this requires more than tokenism" (EJN, 1996, p. 1). This definition reminds us that despite the way that identity and representation

have been weaponized, inclusion and diversity remain important to advocacy work. The second principle is an emphasis on bottom-up organizing: This principle is a reminder that the constituency of a movement is the embodiment of the movement, and that actions happen through networks which start at the community level (EJN, 1996). Organizations which maintain a close relationship with their base are more likely to mobilize this base. The third principle is a reminder to let people speak for themselves; This principle acknowledges that spokespeople from affected communities are representative, and also that organizations in affiliation should be disclosed (EJN, 1996). This recognizes that everyone speaks from a certain perspective, and that different perspectives hold different truths. The fourth principle asks members to work together in solidarity and mutuality; This principle calls attention to the importance of resource sharing, as well as coordinated actions between groups with aligned goals (EJN, 1996). This also identifies the long term goal of adopting principles from aligned groups where relationships have been built (EJN, 1996). The fifth principle asks members to build just relationships among ourselves; This principle asks members to "treat each other with justice and respect, both on an individual and organizational level, in this country and across borders" which must happen in order to be inclusionary (EJN, 1996). This acknowledges the existence of differences between group members which must be navigated in order to be efficient as a movement. Finally, the sixth principle calls for a commitment to self-transformation; This principle requires that "we must be the values we say we're struggling for and we must be justice, be peace, be community" (EJN, 1996, p. 1). In order to envision change, one must see themselves as an agent of change even beyond membership in a movement (EJN, 1996). These principles are helpful in understanding the social structures that create a democratized organization.

Methods

To collect data about the nature of air quality activism in the Hudson Valley, I decided to collect data from two main sources: semi-structured interviews with local activists and publicly available resources. My interview sample was a convenience sample, which was appropriate due to my history of involvement working with this community as an intern in the community sciences lab. My participants are all part of a group that meets in Kingston, New York (or over zoom) which is the Hudson Valley Air Quality Coalition. I focused on the stories of the founding members to get an idea of the entire trajectory from citizen to established citizen scientist. I conducted 4 interviews in total and asked six guiding questions. Those questions are as follows:

1. How did you get involved with your activist group?
2. What was your process to becoming a citizen scientist?
3. What keeps you involved in your community activism?
4. Can you describe a challenge you feel is unique to air quality activism?
5. What is an action taken by you or your group that you would describe as a success?
6. What do you feel is the most valuable part of being a member of a larger group? (This could be in comparison to individual actions if they have experience with that.)

With these questions, I hoped to uncover the process by which people came to have a personal interest in environmental science. I believe that to be the first step into becoming a citizen scientist. But the next step, arguably more important, would be the process by which people take that personal interest and connect it to their local community. I also asked a question

specifically about air quality, because I believe that air quality activism comes with unique challenges that result in air quality activists approaching things differently than other environmental activists. I asked questions about both challenges and successes to give an opportunity for participants to speak to the breadth of experience while doing this work, and to avoid leading the responses towards a certain end. When conducting these interviews, I allowed participants to choose whether or not they would like their identity revealed in my work. While I recognize that it is common practice to conceal the identities of research participants, I also hope to document the story of a group of people in my research. This is a group of people who are totally dedicated to their communities and the health of their fellow community members, and rarely get due credit for the work that they do. I hope that by including their identities I can represent their story as faithfully as possible and give recognition to the work that they have done on behalf of the Hudson Valley community at large.

When conducting my research I took audio recordings of each interview. These interviews ranged in length, the shortest being just 13 minutes long, and the longest totalling at 57 minutes. These audio files were transcribed into text which I then coded for common themes. The codes I sought to identify in these texts were as follows: #responsibility, #compromise, #conflict, #government, #institution, #education, #selfstudy, #health, #community, and #action. I coded “responsibility” for instances where participants described feelings of responsibility or similar moral burdens such as humanitarian cause or civic duty. I coded “compromise” for when a participant described a situation in which they had to make a compromise. I coded “conflict” for when a participant described a situation where they experienced an interpersonal conflict. I coded “government” for any mentions of governmental actions by federal, state, or municipal

branches. I coded “institution” for any mentions of institutional involvement by entities other than the government which could include community organizations or other academic and social bodies. I coded “education” for any participant mention of formal education. I coded “self study” for situations in which participants describe educating themselves. I coded “health” for any time a participant made a mention to human health whether that was sickness or wellbeing. I coded “community” for instances where participants explicitly mentioned community or described assembly. Finally, I coded “action” for each time a participant made mention of any techniques used to seek change. These codes were utilized to find patterns within my data.

Findings

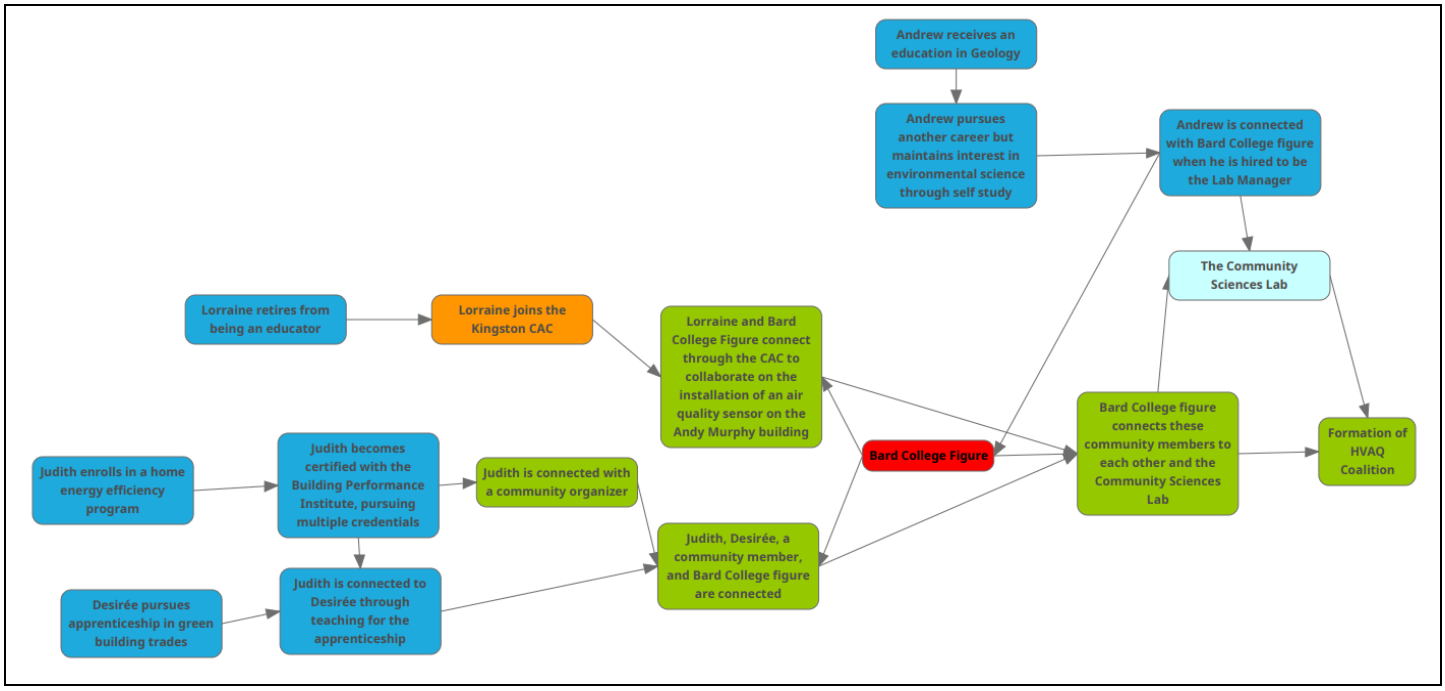
To begin, I observed that a number of interpersonal connections led to the formation of the Hudson Valley Air Quality Coalition. These connections were key to condensing individuals with similar goals and interests into the same space. All participants reported having interest or doing work in this field previous to the formation of the community group. These people became connected in a number of ways. Several participants made reference to a figure at Bard College, who acted as an orchestrator to connect community members with similar concerns and goals (Figure 1). Lorraine Farina, a founding member of HVAQC, describes “That making that connection was just pivotal. Because as I've said to you, we just were able to work together via the CAC to get this research grade air quality monitor in Kingston, and this entire infrastructure going here. So that was certainly a huge success,”. Lorraine refers to making the connection to this figure at Bard as a turning point, and she mentions working on and continuing another project. The project she mentions here is Kingston Air Quality Initiative. This initiative is a

collaboration between the City of Kingston, the Kingston Conservation Advisory Council, and the Community Sciences Lab. The initiative began in 2020 with the installation of a MetOne 212 Profiler sensor, which was replaced after a year in January 2021 by a QuantAQ Modulair-PM sensor (Bard CESH, n.d.). KAQI provides real-time data collected from the sensor on their website, as well as an archive of historical data (KAQI, n.d.). In 2023, the CSL published a report on the data collected over three years, also accessible via the website. This project not only connected Lorraine with the Bard College figure, but was also able to inspire other similar projects to serve the larger community.

Lorraine makes reference to a larger infrastructure, which is the project to collect more data from the Hudson Valley area manifested in the Hudson Valley Library Air Quality Network. This network uses less complex, but also less invasive air quality sensors called Purple Air Classic Air Quality Monitors. The network is composed of thirteen different library locations, which also make real-time and historical data accessible via the network website (HVLAQN, n.d.). While this project is not in direct collaboration with the Hudson Valley Air Quality Coalition, the data is accessible to all community members and is discussed with some frequency at meetings. The celebration of this connection speaks to the resources that Bard College has to offer the community when prompted. As a result of the initial connection via the CAC, this Bard College figure was able to connect individuals in the community to form the group which is HVAQ Coalition (Figure 1). This figure also connected HVAQ Coalition to the Community Sciences Lab, a laboratory at Bard that is a part of the Center for Environmental Sciences and Humanities, therefore connecting the community to data and other scientific resources.

Figure 1

Map of affiliation to HVAQ Coalition



Note. Blue denotes an educational setting, Orange denotes a political context, Green denotes collaborative work, Red is used to highlight a central figure, and light blue represents the CSL.

This lab has a history of community outreach, providing opportunities for students to get involved, and providing testing resources for the community. I spoke to Andrew Patterson, the Community Sciences Lab manager about his role: “It's very unique. It's not like other job positions in sciences. It's much more applied, in, not a research focus, but it's applied in a community science focus. Which feels more impactful to me…”. This suggests that the nature of the lab is distinct in the way it approaches science. Andrew elaborated on this, saying, “You know, our role is to listen to community members and community groups, hear their concerns and questions, and then do our best to answer and validate those concerns and questions. Yeah, I think in large part, in a more general sense, it's about diverting money that would typically be

used for innovative research and using it towards more impactful research that directly aids people.”. Here, we get a sense of the research process that the lab follows. In this method, the voices of the community come first. This science originates from the lived experience of community members, who have an organized forum where a lab representative can ingest those testimonies as initial data. This forum also serves as a feedback mechanism, where the lab representative can present findings from research done by the lab (Mahajan, 2022). The lab representative is a key part of maintaining the relationship between this community group and the institution that the lab is a part of. Because the lab is primarily informed by local concerns, the resources of the institution are then given the opportunity to enrich the lives of the community where the institution is located. Andrew makes a distinction here about the types of research that institutions typically publish: one being innovative research, and the other being impactful research. This is less about whether the data is “innovative” or “impactful”, and more about the intention behind the funding and resources. Some laboratory settings are more concerned with breaking ground and discovery. This laboratory setting, however, is more concerned with responding to the needs of the community constituents (Irwin, 1995). This creation of hyper-local data is crucial when it comes to air quality research. While there are national programs for monitoring “ambient” air quality, it is difficult to contextualize that data in connection to local events (Dedoussi 2020). The Community Sciences Lab is unique in its capability to help residents make connections between their observations of their surroundings and the data generated by the lab.

Another finding is the importance of identified community that comes with being a part of a citizen science group. When I asked Desirée Lyle about what keeps her involved in her

community group, she shared, “I think it's really the quality of the people that I get to work with. Everyone who has been an HVAQ Coalition founding member has been, has brought something to the table, that I personally don't have, and that's something that I admire…It’s community.”. Desirée is also a founding member of HVAQ Coalition. Her answer speaks to the connection she is able to find with her colleagues in this group, and also to the fact that the complexity of air quality research is conducive to a diversity of perspectives. She also said that the members of the group do have a central shared interest: “I think having the shared interest in making sure that people have access to clean and healthy living spaces is just something that's kind of bound us together.”. Other participants shared a similar perspective. Lorraine responded by saying, “A congenial group that is like minded and recognizes that air is important for all of us. Clean air is important for all of us,” when I asked her what the most valuable aspect of being a part of a larger group was. These shared sentiments act as a binding agent for the group and as a basis for social interactions between members, as well as motivation for continued participation (Schaefer, 2020). Both of these sentiments imply a need for change: an increase in accessibility to healthy living spaces, and ensuring the human right to clean air. Because members have a shared goal, it is not difficult for members to find themselves in community with one another.

Desirée, who is self-employed as a building analyst, also shared the personal benefits she obtains with her membership of HVAQ Coalition, saying that “...this brings me outside of myself, and also gives me new perspectives on the local community, and what the larger problems are. It keeps me from being myopic.”. The diversity of perspectives available at the HVAQ Coalition meetings are able to give individuals a sense of perspective when thinking about their own concerns. Because Desirée is embroiled in conversations around issues of indoor

air quality for work, HVAQ Coalition is able to widen her knowledge beyond her expertise. Issues of indoor and outdoor air quality must be approached in totally different ways, and require totally different contextual knowledge and skills. This perspective, that other community members are experiencing and tackling different but similar issues, can be both a comfort and a resource. There is also the sense that there is strength in numbers, so to see like-minded people assembled in a room is a visual and emotional reminder that one is not alone in their fight.

My next finding is that participants reported feelings of responsibility towards others as the inspiration for their commitment to advocacy. Judith Karpova, another founding member of HVAQ Coalition said, “My process was really, it's almost not political, but almost like a humanitarian thing.” when I asked her about her journey to becoming a citizen scientist. Judith is also a building analyst, so her life in and outside of paid work is dedicated to this cause. This air of altruism was consistent with what other members reported. Desirée connected this iteration of advocacy with a life-long commitment to doing-good, stating, “I've always kind of been involved in community service. So it wasn't, you know, a leap at all. It's a way to bring my knowledge to the community.”. She implies that this project has utilized transferable skills from her history of community service, and describes that this is exacted through the means of education. I think it would be fair to say that a history of civic engagement may be a phenomenon particularly consistent within founding members of a group. Lorraine, an educator in her career, remarks, “I just have always since then felt a responsibility to let people know what I know, what I've learned about this, and try to make people aware so that they can make informed decisions, and that hopefully, eventually there'll be political action on this.”. Lorraine goes further to explain the intended result of her identified feeling of responsibility to educate. She hopes that with the

dissemination of knowledge, the community will be able to make improvements in their own lives by way of informed decision making. This speaks to the desire to be a part of a larger community that experiences better quality of life. When people make informed decisions about reducing air pollution, or maintaining the quality of inhabited structures, the result of that informed decision has the power to affect everyone positively, in the same way that a poor decision can affect a community negatively. She also touches on the potential for political action to be a result of that education (Mahajan 2022). Policy is another avenue which has the power to improve quality of life for the constituents of the governing body.

Another finding of this research is the identification of culture as the main challenge encountered in this advocacy (Moses 2022). This manifests in a few different ways. The first situation, described by Judith, portrays the way that indoor air quality issues often initially become apparent through the declining health of the occupants. She reports, “I've been in many houses, where mostly, but not always, the woman of the house has unexplained illnesses.”. She goes on to describe the difficulty one would encounter getting an accurate diagnosis. This is partly due to the nature of being sick with mold toxicity, which is something that doesn’t show up on a traditional blood test or toxicity screening and requires a mycotoxin test (Ruscio, 2021). But it is also due to the fact that it is largely women who become sick, as homemakers who spend more time in the affected conditions. Women often face medical sexism, and their symptoms are not taken seriously, instead getting recommended to visit a mental health professional, per Judith’s observations. Issues of indoor air quality are typically not identified until her condition worsens. The compounding factors of sexism and invisibility of air quality contaminants can be dangerous, and create obstacles even when a problem is identified.

Another way this manifests is through the normalization of proximity to combustion, and the involvement of combustion appliances in cultural practice. Desirée shares the observation, "... the role that combustion plays, whether it's fossil fuels, or woodfire, or candles…I mean, all of those things are cultural. And so, when you start messing with people's culture, in the name of air quality, it's sticky.". The idea that we should abandon campfires and candles may seem absurd upon first mention. That reaction would perfectly illustrate her point. The average person, who is not embroiled in discussions of air quality, might feel a strong connection to practices like lighting a candle or sitting around a campfire, which typically turns into defense in favor of doing these things. Lorraine echoed this point: "...that's a huge challenge, you know, challenging people's emotional connection with the burning of wood.". Lorraine had done some of her own research on this topic, and introduced me to the concept of the 'affect heuristic' (Slovic, 2002). This is a psychological theory stating that people make suboptimal decisions when in an 'affected' state; In Layman's terms, especially when people get older, they let their emotional connections to the variables in a decision cloud their rational judgment (Slovic, 2002). This causes people to choose to engage in behaviors that make them feel good despite the potential risks. Taking part in cultural practices can bring people together and also bring them comfort, putting them in an affected state when it comes to making risk analysis decisions (Slovic, 2002). This is something that is difficult to approach as a clean air advocate, because the science is up against the majority opinion of choosing comfort and culture (Moses, 2022). Until issues of air quality become a part of popular culture, this will likely continue to be a challenge.

Despite these challenges, participants were able to identify the impact of air quality advocacy. These impacts are multifaceted. On the topic of education, Lorraine shared, "I'm

happy to report over 12 years, there has been some progress in terms of much more awareness.". This process towards a better informed general public has been gradual, spanning over a decade of her own involvement. Desirée was also able to speak to education, saying, "There's no other way to describe that than success. Yeah, I think that that education piece is critical. And I think one of the things that we're learning how to do more and more, which I find exciting, is to move from that education into action. And I think what we've done, wonderfully, is create a space where everybody is a resource, and everybody can give what they have.". This evidence suggests that the process of learning is also tied to the process of learning how to take action. Becoming educated is the first step, and discussing the topic in a group setting allows for the exchange of information as well as ideas (Mahajan, 2022). One example of this is the result of a cultural shift around the idea of using fossil fuels. When information about the costs associated with burning fossil fuels moved into the milieu of the early aughts, it resulted in widespread action. Judith actually credits a rebate program that subsidized a home energy efficiency education program as being the genesis of her interest, explaining, "I moved into the field because I felt well, I like this…and it addresses getting people off of fossil fuel. We're using less of it. Now, significantly less of it.". She suggests that as a result of increasing educational opportunities around energy efficiency that there has been a significant decrease in dependency on fossil fuels. Because she pursued a career in home energy audits, she was able to impact far more than just her own home and decisions. Her experience in this career has given her firsthand insight into how the structures of providing power to residential dwellings is evolving. We spoke briefly about the kinds of alternatives that homeowners are adopting, such as heat pumps powered by solar energy. Her most important takeaways from this shift are the realities that the alternatives are notably

more affordable, and that it has become possible to be completely divested from fossil fuels, with dedication. People are able to make these informed decisions to improve their home's health and their personal finances as a result of effective education.

Another impact is focused around the human health benefit. As mentioned previously, issues of indoor air quality typically manifest as illness in residents. There are multiple illnesses associated with poor indoor air quality, depending on the contaminant (Dedoussi, 2020). This is where the Community Sciences Lab can be of service. Andrew states: "We're basically, like, we're providing some level of health care intervention. These are reports that a doctor will definitely consider, that an immunologist will definitely consider. So that's a huge success as well.". Because the typical medical intervention process has no infrastructure for considering environmental factors, doctors are not well equipped to understand a patient's situational needs. But when an environmental concern, such as a primary dwelling with contaminant issues, can be quantified into data, this can be provided to those medical professionals who are then able to get a better understanding of what the cause of illness may be. These reports are resources that have applicability in multiple ways. This data can also inform the steps towards remediation. Judith was also able to speak to the importance of providing evidence about the condition of buildings. She recounts her involvement in this process, saying, "I do the audits. Other contractors do audits. RUPCO is able to fund remediation. That impacts the community. I mean, one individual at a time. But here's an individual that now is much more economically viable. And is much healthier in their home. And has a home of much greater value.". Remediation can be costly, meaning that these issues of indoor air quality affect poor communities disproportionately. Judith and other local building analysts have been able to partner with an organization called RUPCO,

originally named the Rural Ulster County Preservation Company, whose mission has evolved into creating housing equity in the community (LinkedIn, n.d.). Judith mentions that a positive externality of improving the health of the home is the economic benefit. Structures that are in good condition are more valuable, and increasing property value can have a number of benefits. Healthy people have more ability to contribute to the local economy. Organizations such as RUPCO are able to provide funding for critical infrastructure that has the potential to markedly improve individual lives and the function of the community as a whole (LinkedIn, n.d.). In the most literal sense, health is wealth.

A particularly interesting result of this research was the attitude of participants towards governance. All activism has this in common to an extent, because there would be no need for advocacy if there were no perceived violations of human rights or quality of life. In this case, these critiques called upon all levels of government to be more involved. This is less of a condemnation of incorrect policy, but the lack of policy (Moses 2022). Lorraine calls upon fellow citizens to expect more, saying, “One of the things that keeps me going is the idea that it must be made clear to people that municipalities have a responsibility to alert people to what they're breathing, and to the dangers of those pollutants.”. She posits that municipal governments have a duty to keep its constituents informed about the different aspects of their local environment. She also implies that one of the issues that awareness must be brought to is that simple concept. In order for a government to be in service to its constituents, the constituents must have an idea of what they expect from local government. This speaks to the need for education on both the civilian and administrative levels about the potential issues of air quality facing this locale.

This inactivity from the government so far has led to feelings of distrust for the state. Lorraine's journey to becoming a citizen scientist started with her position as an educator, but developed further during her time as Air Quality Chair on the Kingston Conservation Advisory Council. She spoke to the difficulties she encountered while holding that position, a role that was developed for her involvement, which had not previously existed. She describes the result of the disconnect from data to policy: "You assume that the powers that be are taking care of you, that your water will be clean when it comes out of the tap. And that the air you're breathing is clean. But that is really unfortunately not the case". Bureaucracy, by nature, is a slow moving process. It would be very difficult to update policy at the speed with which scientific data is produced. However, because the state is involved in the rationing of essential utilities, like water, the quality of these utilities is something assumed as part of the social contract. This could explain part of the reason why air quality policy is lacking; Clean air is a human right more than it is a quantifiable utility. Because it is necessary for survival, it should be protected under the right to life, liberty, and the pursuit of happiness.

There is evidence on the dangers of certain contaminants. Particulate matter, especially in the form of PM 2.5, has been substantiated to be a potentially deadly component of air pollution (Arts Council England, 2024; Dedoussi, 2020). Andrew was able to weigh in on this matter, stating that, "... We don't even have a good grasp on the simplest thing, which is particulate matter…Let's just focus on this. And figure out policy around it.". Particulate matter is one of the most well documented pollutants, so the data about the impacts of this pollutant are generally well understood (Dedoussi, 2020). Andrew's mention of the uncertainty could be a reference to the incomplete understanding of all the potential sources of particulate matter, and the impact of

those sources beyond particulate size (Dedoussi, 2020). One thing is certain however: “You can save lives, you can forever impact the lives of complete generations through pretty simple policy,” according to Andrew. Enacting simple policy around particulate matter emission could have a multitude of benefits. Not only would it benefit the planet, but it would benefit the people living in the region, and it could restore trust in the legislative body that passes it (London City Hall, 2023). Policy is able to make widespread and lasting change in a way that social movements do not typically have the power to do. It also introduces the possibility of consequence for those who knowingly violate the standard. This is especially important for issues of air quality, because the atmosphere must be a commons. Managing the utility of shared resources is increasingly important in a world that is changing as a result of global warming.

Judith was able to share with me another example of how distrust in the current political situation is garnered. She determined this moment to be the beginning of her own political understanding. After conducting an evaluation of a particularly dilapidated home, she attempted to help the resident seek justice from their landlord. She found a plethora of contaminants in the home, one of which was leaking natural gas. She recalls that, “The landlord was totally unresponsive until he was legally forced to take action. So when Central Hudson actually put tape around the front door, then he had the leaks repaired. Nothing else. He didn't touch anything else. He blamed her for everything else.”. She illustrates the limitations of inadequate policy in this situation. Because regulations around gas leaks are quite strict, this issue was resolved after an extended period of extreme negligence from the landlord, under threat of consequence. But the multiple other issues within the home remained, because the tenant had little legal recourse for those issues. Judith explained to me that they appealed to multiple municipal, state, and

federal agencies to try and force the landlord into taking remediation for the property seriously. They were given many condolences, but essentially turned away at every door. Judith explains that, “Up to that point, I had been running around, very enthused, about all the NYSERDA programs, and that changed my viewpoint and shifted it to… How essential it is to deal with air quality within a home.”. This was a pivotal moment for many reasons. The first was the realization that remediation must be a holistic process. NYSERDA, or the New York State Energy Research and Development Agency, that Judith mentions here was offering programs that would “seal” the air leaks in people’s homes (NYSERDA, n.d.). This can have economic benefits, like reduced heating and cooling bills (NYSERDA, n.d.). It can also be dangerous if the other aspects of a home’s indoor air quality are not considered. Proper remediation should consider the home as a unit to avoid further exacerbating an issue. This segmented approach done by government agencies, and practiced as a result of inadequate policy, often have negative effects despite being well-intended. The reality of these negative effects result in the decreased quality of life for the affected. This does not foster trust in the state and damages the social fabric as a result. Simple but effective policy has the power to change this dynamic. The goal of many clean air advocates is to create relationships with state officials and inspire policy, despite individual members possessing skepticism towards current politics.

The final discovery from my research is that the complexity of the air quality issue within our socioeconomic parameters differentiates it from other modes of environmental advocacy, which results in a strong humanitarian focus in air quality activism. The reader may have noticed that very few mentions to “the environment” at large have been made in this work. While air and the atmosphere are very much a part of the environment, the conversations around air quality

typically stem from concerns about lived experience rather than the inherent value of the resource. As previously mentioned, our atmosphere and breathing air exists as a commons. When we think about resource management in the United States, we often attach a monetary value to the rate of consumption. This manifests in the cost of real estate and the cost of your monthly water bill. But air resists that commodification. Because it is nearly impossible to quantify the rate of consumption for the air we breathe, we cannot incentivize good practices through the cost-benefit analysis. Andrew speaks to this, saying, “Air is kind of the final frontier a little bit. It hasn't been defined yet, very well.”. In the figure of speech, air is the final frontier when it comes to regulating resource management and policy. But really, it is not a frontier at all, because it cannot be owned. This presents a huge problem when it comes to the development of policy under a capitalist framework.

In order to fully understand air pollution, one must reject the urge for taxonomy altogether. It is more helpful to think about the Earth as an organism where each system feeds into another, and nothing is divided into “ownership” but connected as a whole. Andrew describes this as the following:

> “Those boundaries aren't real…Pollution moves through the Earth, pretty much freely, depending on the timescale you're talking about. But you cannot control the things that you're putting into the Earth, you're impacting everyone else with whatever you're putting out there. And so that kind of segmentation of like, land, water, air is a little bit imaginary. And that's kind of just, like, the thing that people need to be convinced of. And we're so far away from that. But that's the thing that people need to be convinced of

is like, that basic principle of what you put out there, no matter what it is, where you're putting it out, it's going to impact other people. And you have to be conscious of that."

In fact, where Andrew uses the term imaginary, I posit that a more accurate way to describe this segmentation is using the term colonial. Many indigenous knowledge frameworks have expressed the unity between humans, all other living organisms, and the environment long before Western understandings of science have circled back to that conclusion. Max Liboiron, an indigenous scholar in environmental research, delves into the history of how Western societies treat pollution in *Pollution is Colonialism* (2021). One of the primary theses of this work is as follows: "Pollution is best understood as the violence of colonial land relations rather than environmental damage," (Liboiron, 2021, p. 6). The violent living conditions that have occurred as a result of inaction, not just by the government but by all citizens as stewards of the Earth, is colonial in nature. The way that air in particular has been neglected because it cannot be commodified is colonial in nature (Liboiron, 2021). Air pollution is very real despite being generally intangible, and the local activists acknowledging this fact do a great deal to act in service to one another.

Air cannot be designated into conservation areas. One could not organize a volunteer air clean-up event. Because air resists segmentation, it forces concerned parties to draw upon connection and shared responsibility. Not only are we called upon to think about our connections to the atmosphere, but also our connections with one another, which asks us to be in community (Liboiron, 2021). Andrew describes this connection, stating,"it's just really important for people to consider [that] you cannot isolate yourself from air pollution. It's everywhere, and it affects everyone.". This is especially relevant for issues of outdoor air quality. However, if we expand

our idea of everywhere and everyone, it becomes clear that creating livable structures is not only important for the present but for posterity. This is something that every participant touched on in some way or another, the ubiquity of the issue. I believe that engaging in coordinated efforts, such as the Hudson Valley Air Quality Coalition, is key to approaching these issues with this person-forward mindset. When you are continuously confronted with real people from your community giving personal testimony, it keeps the mind focused on the human impact. Therefore, this prompts members to think of solutions that directly address the lived experience of fellow community members, creating an engaging and meaningful method of advocacy unique to the clean air advocacy space.

Discussion

My findings reflect many concepts identified in my research. While the HVAQ Coalition and the Community Sciences Lab do not explicitly use the Evidence Co-Creation Framework, the process by which the lab practices science does follow the four steps of mapping, sensing, analysis, and sharing (Mahajan, 2022). The lab is able to collect "data stories" as input during meetings, combining lived experience with quantitative data for more fruitful and place-based analysis (Mahajan, 2022). The sharing stage features both accessible platforms as well as a feedback mechanism, adhering to the definition used in the Mahajan work. As a result of this framework, research suggests that the cycle has the ability to strengthen the "science-policy-society interface"(Mahajan, 2022). This works to engage citizens, and to update the accuracy of both the research and policy around this issue. The existence of the feedback mechanism, as well as the lab's commitment to doing "impactful" research, suggests that the Community Sciences Lab is a "flexible" institution as described by Irwin (Mahajan, 2022; Irwin,

1995). Such institutions are necessary in doing citizen science (Irwin, 1995). These institutions make their resources available and make their data applicable, which in turn inspires increased scientific literacy in the community (Irwin, 1995). The evidence of the lab as a flexible institution practicing the co-creation framework suggests that this is a case of true participatory citizen science.

Also identified in this research is the difficulty in turning data into policy, as identified in the Moses article (2022). It is true that the HVAQ Coalition has not been tied to concrete policy at this time. But it is also worth taking into consideration that the bureaucracy of policy creation takes time, which the relative newness of the project has not allowed for just yet. The institutional partnership between the Community Sciences Lab and HVAQ Coalition has been productive in other ways. The lab has been able to identify and collect data about specific "relevant" pollutants through the Kingston Air Quality Initiative as well as the Hudson Valley Library Air Quality Network (Moses, 2022). The identification of relevant pollutants is crucial in formulating actionable plans for regulation and prevention (Moses, 2022). The KAQI project also demonstrates collaboration between the City of Kingston and the Community Sciences Lab, which is an important relationship to establish in the "science-policy-society interface" to create pathways for conversations about developing local policy (Mahajan, 2022). The data collected through these networks is visible to community members as well as partners of the lab. Something that was identified in the Moses article was the common difficulties one faces in air quality citizen science (2022). I believe that my research confirmed both of these to be present in this context. The first difficulty being the challenge in educating the masses on an extremely complex topic (Moses, 2022). One of the successes listed by participants was the increase in

awareness and in community knowledge on the subject of air quality. This speaks to the complexity of the issue being one of the foremost concerns for the group, which resulted in an effort to improve education on the subject. The second difficulty was the frustration at the lack of action in response to data (Moses, 2022). I found that this frustration manifested in the attitude of participants towards governance. When these frustrations were left to build, these feelings of frustration became attitudes of distrust in the local and larger structures of governance. While this has the potential to lead to hopelessness and inaction, I observed that participants reported persevering through this frustration, even citing it as inspiration for commitment to advocacy. This attests to the applicability of these difficulties across efforts of clean air advocacy.

In my research I also found that the positive association created by participants attending HVAQ Coalition meetings played a part in commitment to advocacy. This is reflected in the Schaefer et. al article where participants offered to continue participance and even adopt more roles after reporting a positive experience while practicing citizen science (2020). Participants reported getting enjoyment out of the social aspect of meetings, as well as valuing the embodiment of community espoused in fellow members. These positive associations keep individuals involved and maintain an efficient group dynamic. Positive experiences in advocacy work are fostered by relationships built on trust and respect between members, as well as between structures like HVAQ Coalition and the Community Sciences Lab (EJN, 1996). The importance of the nature of these relationships is outlined by the Jemez Principles for Democratic Organizing (EJN, 1996). These groups have goals that are aligned, which allows for cooperation (EJN, 1996). Over time, the groups have adopted core principles from the other, using the information learned through collaboration to inform further work (EJN, 1996). This is

evidenced by the development of the Hudson Valley Library Air Quality Network, which uses a similar strategy as the Kingston Air Quality Initiative. The accessibility of this data via the Bard Center for Environmental Sciences and Humanities website, as well as the discussion of this data at HVAQ Coalition meetings, takes the collected content informed by community concern and feeds it back to the community group to use for advocacy purposes.

Another finding of my research is that the techniques used for citizen science air quality advocacy require particular nuance because of the nature of air as a natural resource. I found that when citizen scientists were confronted with the difficulties of creating policy frameworks around air in a capitalist governmental structure, the focus of their advocacy shifted towards the human impact. This manifested as a distinct concern with human health, and strategies that seek to improve material well being for the community rather than "the environment" at large. I argue that this framework is anti-colonial in the way it rejects the current policy structure for other natural resources in the United States, which is based upon commodification and compartmentalization (Liboiron, 2021). This advocacy more closely adheres to the goals put forth by the Principles of Environmental Justice. These principles explicitly declare the human right to clean air as well as a recognition of interdependence (EJN, 1991). This work seeks to undo the violence of colonial land relations which precede the act of pollution, and create a future of justice where every being is cared for, not only out of concern for the planet, but out of concern for one another (Liboiron, 2021).

Conducting this research was both engaging and frustrating. I quite enjoy the act of conducting interviews; I think it is important to document the voices of people who are leaders in the community. The process of developing questions, and then getting to experience each

participant's interpretation of that question is fascinating. Finding focus within the broad category that is air quality was challenging. As an Environmental and Urban Studies student, there are an abundance of theoretical frameworks and methods I could have pursued. Qualitative methods and a sociological perspective seemed like a good fit for this project. I also think it is really interesting to write about situating science within its cultural context. I find that a lot of scientific literature is concerned with validity and specific data collections, which is obviously important. But I think that there is a rich possibility within sociology to follow culture into the sciences as it inspires research, becomes data, leads to conclusions, and goes back into culture through application. Citizen science has a clear link to culture, but I don't think the other disciplines like biology, chemistry, or physics escape those connections. As with all research, I wish my time frame had allowed for more data collection. Such are the realities of senior projects. One additional thing to note is the extraordinary accessibility of literature on the topic of citizen science. Not only was the language accessible, but the documents were all accessible for free. This observation is something that I admire about the researchers and the institutions creating this knowledge.

Some limitations of my research are as follows. To begin with, my sample size was smaller than I had originally intended. While I was able to conduct four interviews, I had originally intended on doing as many as ten. Due to the timeframe I had to work within after gaining IRB approval to conduct research in the community, I was only able to contact and schedule interviews with so many people. I would have liked to be able to talk to other groups within the Hudson Valley region to understand the applicability of these concepts, and use this project as an opportunity to do some snowball sampling. I am, however, just one person and

needed to keep this research manageable. While I agree that more interviews would have added to the validity of my findings about the nature of creating citizen scientists, I would hope that my deep dive into the Hudson Valley Air Quality Coalition as a case study will be able to provide a unique insight into this community. Ideally, it would also become a part of a larger literature about air quality activism within citizen science community groups that consider other contexts and cases. Another vice that comes with being a one-person research team in qualitative data collection and analysis is the fact that most of my analysis is dependent upon the interpretation of spoken language. In this project, my interpretation of the responses I collected is assumed to be correct, but I recognize that there are possibly figures of speech, or tones of voice, with connotations that I may have missed. There is a diversity of perspective that can come with having a team of researchers in sociological work that is unable to be replicated by a single researcher.

Conclusion

In conclusion, my research was able to identify several key factors that inform the citizen science process in the Hudson Valley context. The first factor is the establishment of relationships that formed and maintained the group. These relationships are both interpersonal and between organizations. Making connections with those who have similar goals allows a community to form. The second key factor is the connection to a flexible institution such as the Bard Community Sciences Lab. This serves to connect members of the community to the institutional resources of Bard College. The willingness of the lab to generate data based on community interests shows dedication, fosters trust, and leads to impactful research. I also found that participants found fulfillment and enjoyment by participating in membership of HVAQC.

The social aspect of regular meetings allows for individual satisfaction, and the significance of being a part of a larger movement working towards a common goal acts as a venue for altruistic and humanitarian motivations. I learned that despite considerable challenges, participants were able to identify multiple instances of success over the course of their involvement. The looming challenge of changing culture is one reason why this work is engaging, and the progress made along the way rewards the effort. My research also suggests that participants share the perception that current policy is lacking. This shared perception also creates a shared goal of generating evidence to use in engaging elected officials to inspire the creation of new policy. Finally, my biggest discovery in this research is the principle that issues of air quality prompt using human-centered approaches that result in stronger, healthier communities, which is distinct from other forms of environmental activism. Clean air advocates often encounter issues of air quality manifesting in health issues, for themselves or others, and addressing these issues can impact the material conditions of those in the community. The nature of the resource of air, which resists commodification, forces the consideration of universal connection through the space of the commons. Because air quality advocates cannot practice common methods of environmental protection such as conservation, preservation, or small-scale clean-up, their focus shifts towards the human impact for the good of the community which resists recreating the colonial land relations typically found in environmental advocacy.

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