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Envisioning Healthy Soil Futures: Planning and Policy Inertia in Addressing Soil Contamination in a Postindustrial City

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Abstract

Soil health is critical for healthy cities, yet little is known about how communities experience and address soil contamination. Contamination of soils can expose residents to heavy metals, which may have detrimental health effects. This study focuses on Buffalo, NY, using a mixed-methods approach to understand community experiences surrounding soil contaminants, planning, and policy. Findings reveal that spatial patterns of lead contaminants mirror segregation patterns, echoing environmental justice concerns. Residents engage in individual self-help actions, but some adopt risk-averse behaviors. Key takeaways include how policy tools are used to address issues of soil contamination and recommendations for addressing this issue.

Keywords

urban soil, environmental justice, urban planning, lead contaminants, community engagement

Introduction

In November 2020, the City of Buffalo's Common Council unanimously passed an amendment to the city code, with the Proactive Rental Inspections (PRI) Program. This program required inspection of all rentals included in the city's rental registry (City of Buffalo Department of Permit and Inspections 2020). A key policy measure to address lead poisoning in city housing, the PRI Program had garnered unanimous support within city hall and among community members. On February 13, 2024, nearly forty community groups submitted a letter to the City of Buffalo regarding the city's failure to comply with the 2020 PRI program (Investigative Post 2024). In response, the city highlighted challenges, including COVID restrictions and prohibitive financial costs of implementation. The city blamed the county, stating they were the entity responsible for lead hazards in Buffalo. In turn, the county responded by reminding the city that community groups are demanding accountability for the city's own PRI program. The exchange in the above back-and-forth illustrates that addressing toxic substances in cities depends on municipal politics that may constrain planning, policy, and community advocacy efforts.

Contaminants in cities have been discussed for decades within the environmental justice (EJ) movement and literature. Many understandings of EJ refer to the equitable distribution of "environmental ills and benefits," but definitions of EJ go beyond distributive impacts (Schlosberg 2004, 517). EJ involves claims of equity, representation and participation in achieving justice, and the link of "justice as equity, cultural recognition, and democratic participation" (Schlosberg 2004, 528). For Agyeman (2005, 44), the decoupling of environment and social inequality has resulted in "equity deficit," in environmental discourses and policies. EJ remediates this deficit by emphasizing the bottom-up, community reactionary efforts in righting the wrongs of environmental "bads," such as toxic facilities and contaminants, which disproportionately impact communities of color and low-income communities (see also Bullard 1994, 281). The role of urban planning and policy in righting these environmental wrongs remains an ongoing dialogue among scholars and practitioners. A historical view leads Agyeman and Evans (2004) to conclude that EJ can serve as an opportunity for political mobilization and action, and as a guiding principle for policy decisions and actions that avoid causing harm,

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especially to particular groups. We provide a brief history of the EJ movement.

In 1978, the state of North Carolina dumped soils contaminated with polychlorinated biphenyl in a county with 60 percent Black and 25 percent of families below the poverty line (in 1980) (Banzhaf, Ma, and Timmins 2019; Bullard and Wright 2008). Since then, the EJ movement has invited planners to think through the racial and spatial geography of urban pollutants or contaminants. Studies also explored risk exposures by various demographic groups to large air polluters (Wolverton 2009), and landfills and hazardous waste sites (Bullard et al. 2007; T. A. Cameron, Crawford, and McConnaha 2012; Depro, Timmins, and O'neil 2015). The presence of Black populations was found to be a strong predictor of ambient particulate matter (Pope, Wu, and Boone 2016), while Native American populations were strong predictors of nitrogen dioxide (Demetillo et al. 2021). Other analyses looked at the disproportionate burdens experienced by racial minorities around flood hazards (Hardy 2023; Messager et al. 2021) and critical physical infrastructure, including stormwater systems (Hendricks and Van Zandt 2021; Rivera 2023). Planners can address issues of EJ in various ways, such as through land use planning, transportation planning, and urban greening (Forkenbrock and Schweitzer 1999; Liotta et al. 2020; Salkin 2003). Scholars find that most headway in addressing EJ in California—which had a state mandate in 2018 to address EJ—occurred in cities where a majority of the population was made up of people of color (Brinkley and Wagner 2024). Additionally, EJ policies in planning (via comprehensive plans) address exposure prevention rather than decades of environmental injustices (Brinkley and Wagner 2024).

The present study is an exploratory inquiry into lead soil contamination in Buffalo, a postindustrial city. We ask three questions. First, how do policies in Buffalo and Erie County address soil contamination? Secondly, how do residents' demographic, social, and housing profiles overlap with environmental contamination? Lastly, what are residents' experiences and perceptions of soil contamination and remediation efforts? Our study details residents' concerns and the planning/policy approaches in addressing soil contamination as critical for healthy and environmentally just outcomes. Soil contaminants, including lead and other heavy metals, are a major issue in postindustrial cities, partly due to old housing stock and legacy industrial sites (Kirkwood 2003; Magavern 2018). Studies have found that high lead levels in soil tend to be in low-income Black neighborhoods (Bravo et al. 2022; Egendorf et al., 2021; Heafner and Paltseva 2024; McClintock 2012; Wong et al. 2018; Yeter, Banks, and Aschner 2020), and exposure to lead can have detrimental cognitive and behavioral health impacts, especially for children (Billings and Schnepel 2018; Leech et al. 2016; Naranjo, Hendricks, and Jones 2020).

The literature is less clear about the role of urban planning and policies in addressing lead and other soil contaminants. Since the 1990s, the term "brownfield" emerged as an approach to repurposing vacant land with previous uses that lead to contamination, recognizing the challenges and opportunities these contaminated sites offer (Hollander, Kirkwood, and Gold 2010). Contamination (or perceived contamination) of these sites is the main barrier to putting this vacant land back into use (Hollander, Kirkwood, and Gold 2010). Planning's focus on brownfield redevelopment, including planning efforts to regenerate polluted industrial sites such as former factory buildings and vacant or abandoned properties in declining areas of the city, has been questioned as lacking an understanding of brownfield characteristics and typologies (Loures and Vaz 2018). Additionally, brownfield redevelopment projects embody significant gentrification effects (Essoka 2010; Pearsall 2013). For instance, Essoka (2010) found that brownfield redevelopment projects led to Black racial displacement 61 percent of the time. While the numbers of Black and Latino residents in the overall metropolitan area stay the same, brownfield redevelopment projects lead to community displacement (Essoka 2010). The planning approaches to addressing lead and other contaminants may need to first start with the people: a better understanding of the experiences and perceptions of residents around the toxic environment they live and interact with. Absent such understanding, planners and policymakers risk falling into the brownfield gentrification trap, repeatedly documented in the literature (Becerra 2013; Schusler, Krings, and Melstrom 2023) and not understanding communities' resistance to cleanup of contamination sites when such efforts are removed from residents' experiences and thoughtful engagement (Anguelovski 2016; Pearsall 2013). Some scholars and practitioners now center residents' experiences through descriptions of their experiences around contamination and remediation measures (Schusler, Krings, and Melstrom 2023). This study contributes to these conversations by querying resident experiences and perceptions of lead and other soil contaminants in a postindustrial city and the planning and policy efforts to address such contaminants.

The remainder of the article is structured as follows. We review the literature on urban contaminants, including types, pathways, residents' experiences, and planning and policy efforts in addressing them. We then present the empirical case of Buffalo, NY, beginning with the study design, data, and methods for the empirical analysis, including the use of a survey, focus group sessions, and content analysis of local government policies around lead, contaminants, soil, land use, and health in the city and county. The methods section is followed by results from the case analysis. We then distill key insights from the results by discussing how they relate to conversations in the literature. A brief summation section concludes the article, highlighting planning and policy implications and gaps for further research.

Exposure, Experiences and Collective (In)actions Around Soil Contamination: A Review of the Literature

Urban environments are hotspots of environmental pollutants in soil, air, or water. The economic expansion of postindustrial cities was a double-edged sword: increased economic growth and prosperity alongside increased contamination of soil and other urban ecosystems (Ahmad et al. 2021). Contaminants included the deposition of heavy metals from different products, such as fertilizers and pesticides, vehicles and power plants, and batteries (Sharma, Basta, and Grewal 2015). Today, many postindustrial cities confront the prevalence and health risks of per- and polyfluoroalkyl substances, colloquially known as “forever chemicals,” and the legacies of heavy metals, all contributing to certain types of cancer, higher levels of cholesterol and other markers of cardiovascular ill-health, and pregnancy-induced hypertension and preeclampsia (Dasu et al. 2022; Denny et al. 2022; Miller et al. 2020).

First, we present an overview of the legacy of heavy metals in postindustrial cities, or what some describe as “toxic heritage” (Kryder-Reid and May 2023). The legacy and health risks of lead (Pb) contaminants in soils and other heavy metal(loid)s remain a priority in urban health conversations in postindustrial cities. A study by Sharma, Basta, and Grewal (2015) in low-income neighborhoods of Columbus and Cleveland, Ohio, found that Pb concentration in Cleveland is a concern in 54 percent of vacant lots. Studies on urban gardens have found extreme levels of lead contamination (as high as 10,900 parts per million) in garden soils in Baltimore (Mielke et al. 1983). Metal concentration sampling of soil and vegetables in New York City (NYC) and Buffalo revealed that lead contamination exceeded the permitted European Union (EU) standards (McBride et al. 2014). Another study analyzed 564 soil samples from fifty-four community gardens in NYC, finding that Pb guidance values were exceeded in 44 percent of gardens (Mitchell et al. 2014).

Contamination sources and pathways are varied. Lead in soils is associated with housing age and proximity to roadways (Schwarz et al. 2012). Wastes and stack fumes, vehicular exhaust, and metals in the exterior paint of houses were identified as sources and pathways of soil heavy metal contamination in Columbus and Cleveland, Ohio (Sharma, Basta, and Grewal 2015). The accumulation of soil Pb has been influenced by gasoline-fueled motor vehicles, as lead was used in gasoline until the mid-1980s (and finally banned in 1996) (Laidlaw et al. 2005). Urban soils may contain lead from paint from old homes (either existing or demolished), which was only banned in 1978. Furthermore, atmospheric deposition of trace elements on soils and urban gardens can be a source of contamination in addition to contaminations from the site (Engel-Di Mauro 2021). Ingestion and inhalation are commonly discussed as exposure pathways for humans (Laidlaw et al. 2017), and an increase in children’s blood Pb levels results due to activities outdoors. For instance, the ingestion of Pb-contaminated soil and dust occurs through soil particles attached to shoes, pet fur, and direct contact with soils when children play outdoors or adults garden (Hegedus et al. 2023; Hunt and Johnson 2012; Jafari 2022). Eating contaminated foods is a major source and pathway for lead ingestion by humans (Morais, Costa, and de Lourdes Pereira 2012), and this is a major concern for postindustrial cities with increasing urban garden and agriculture activities (Kirkwood 2003; McClintock 2012; Sharma, Basta, and Grewal 2015; Sharma, Cheng, and Grewal 2015).

Community Experiences and Collective (in)Actions Around Soil Contamination in Cities

As earlier discussed, the EJ literature documents a long history of disproportionate burdens of contaminants experienced in low-income neighborhoods with predominantly African American, Hispanic/Latino, and other racial/ethnic minorities (Banzhaf, Ma, and Timmins 2019; Bullard and Wright 2008; Pope, Wu, and Boone 2016). For instance, urban gardens had higher levels of soil Pb concentrations in West Oakland, the oldest area in Oakland, with predominantly low-income and African American neighborhoods (McClintock 2012). Apart from experiencing these disproportionate burdens, urban gardeners also experience eviction, such as in the case of Sacramento, when lead toxicity was used as a ploy to evict and gentrify neighborhoods (Cutts et al. 2017). In this instance, the local government used soil contamination as justification for displacing a garden (Engel-Di Mauro and Martin 2021). Without activists having data on soil contamination or prevention approaches, they are unable to develop their own management plans (Engel-Di Mauro and Martin 2021). Thus, a local government may take ownership of a garden space.

While the existence of soil contamination in cities is a systemic failure, unsurprisingly, actions to address the problem follow a neoliberal ethos: most actions to address the structural problem of soil contamination occur at the individual or community level, rather than structural solutions. Experiences around soil contamination have often translated into different forms and levels of action to address the issue. For instance, due to their awareness of the long history of organizing against discriminatory property owners and land use policies, African American and Latino/a gardeners in NYC organize around cleaning and planting on vacant lots (Reynolds 2015). Soil remediation solutions include adding biosolids to contaminated soils to dilute Pb concentrations, such as the TAGRO program by the City of Tacoma (Defoe et al., 2014), covering lead-contaminated soils with geotextile fabric and clean soil cap to prevent ingestion and inhalation in childcare centers and public playgrounds in New Orleans (Mielke et al. 1999), and using clean soil bank sediments as an alternative for covering contaminated soils and growing healthy produce in NYC (Egendorf et al. 2018). Other low-cost solutions have included re-seeding or tilling old soil and covering soil with gravel or plastic sheeting (Clark et al. 2011). For urban gardeners, collective actions included importing clean soil and compost, gardening in raised beds (Mitchell et al. 2014), and frequent soil sampling and testing (Schwarz et al. 2022).

Community members do not always act to address soil contamination. Inaction occurs due to limited knowledge about contamination history, sources and pathways of contamination, lack of funds for testing, and lack of education about contamination risks (Harms et al. 2013; Hunter et al. 2019; Kim et al. 2014). A study by Hunter et al. (2019) involving five hundred community gardeners across the United States found that soil testing intentions are heavily influenced by attitudes, subjective norms, perceived behavioral control, and barriers like costs and accessibility. Another study of Atlanta residents found disparities in knowledge of heavy metal soil contamination and remediation across demographic groups, with barriers such as cost, convenience, and lack of access to information further hindering testing and remediation efforts (Balotin et al., 2020). A study of gardeners and key informants in Baltimore suggested they had low levels of concern and inconsistent knowledge about heavy metals and other soil contaminants, limited knowledge of approaches to remediate or mitigate the risks of exposure, and were less likely to investigate the site's history and test their soil due to prohibitive costs and cumbersome process (Kim et al. 2014). While most gardeners were not concerned about soil contamination in a study of community gardens in Missouri, Black or African American gardeners were more likely to be concerned about soil contamination (Wong et al. 2018). A study of community gardeners in Boston also suggested about half of those with knowledge about soil contamination and interest in soil testing were unable to test their soil due to testing costs (Ramirez-Andreotta et al. 2019). A study of four low-income neighborhoods in Ohio showed that residents were concerned about both soil quality and soil contamination and highlighted the need for information on soil quality, testing, remediation approaches, and costs associated (Kaiser et al. 2015). Other factors for not addressing soil contamination involve challenges to soil testing (e.g., sampling uncertainty, interpretation of results, spatial variability of contaminants) and lack of clear screening guidelines for some contaminants (Ramirez-Andreotta et al. 2019; Schwarz et al., 2016). Those participating in community gardens may primarily be focused on the community social capital and benefits from the gardens and less likely to focus on or be aware of potential contamination; even when aware, there is often a false assumption that promoting organic farming practices will mitigate exposure to all contaminants (Defoe et al. 2014; Malone 2022).

Planning and Policy (in)Actions Around Soil Contamination in Cities

Planning and policy approaches to addressing soil contamination in cities are often murky. Some city governments played a direct role in addressing soil contamination, from soil testing to remediation strategies, such as the earlier referenced case of the TAGRO program by the City of Tacoma (Defoe et al. 2014), and the childcare centers project in New Orleans (Mielke et al. 1999). The work of Laidlaw et al. (2017) presents a detailed review of some of these cases. Still, there is little planning and policy scholarship on the role of municipal governments and planning authorities in addressing soil contamination as a public health priority (not simply as an economic development goal). For instance, some have noted that current government efforts (especially funding from state and federal entities) focus on home visits and remedial actions around Pb paint, childhood Pb poisoning prevention programs, and dust (Laidlaw et al., 2017; P. A. Meyer et al. 2005). These Pb paint hazard education programs and dust clean-ups are considered less effective on a community-wide scale (Kennedy et al. 2016), and the ad-hoc nature of some of these Pb programs makes them less effective in addressing intergenerational patterns and health impacts of soil contamination, particularly in inner parts of cities within low-income and historically marginalized neighborhoods where these contaminants are concentrated (Leech et al. 2016). Some scholars call for a federal Clean Soil Act (much like the Clean Air and Clean Water Acts enacted in the 1960s) to protect soil health (Gewin 2020).

The land use and zoning regulatory tools available to planners and other expert planning domains (e.g., housing, food systems, economic development) offer avenues to address the intergenerational and ad-hoc nature of soil contamination interventions in municipalities. Yet, most studies reviewed do not explicitly focus on the role of municipal planning and policies or lack thereof in addressing soil contamination. For instance, inconsistent soil quality and risk standards and enforcements thereof are variously discussed in the literature as a barrier to addressing soil contamination (Jennings and Petersen 2006; Kim et al. 2014). These standards and enforcement could be codified in municipal land use and zoning regulations for shared information, understanding, and awareness of contamination risks and remediation efforts. Similarly, the cost of soil testing and remediation remains a considerable barrier to addressing soil contamination, especially within low-income and racial minority neighborhoods in cities (Hunter et al. 2019; Ramirez-Andreotta et al. 2019). However, urban planners' push for brownfield redevelopment or the recycling of industrial sites, especially in postindustrial urban centers, have often resulted in multiple approaches, including financial incentives for the cleanup of contamination sites, such as tax incentives, direct loans, land value write-downs, and site assembly (P. B. Meyer and Lyons 2000). While many of these incentives are wrapped in economic development planning strategies, the explicit use of these financial incentives to drive public health outcomes (rather than economic gains) is less highlighted in plans and policies.

The role of the state and its practices and tools, including urban planning, remains crucial to this paper's discussion on EJ, yet scholars argue that the state historically falls short in doing so (Agyeman 2013; Pellow 2018). In Agyeman's influential work, he argues that the state has addressed issues of sustainability by mostly focusing on the environment or "green" issues, yet achieving sustainability also entails improving the quality of life (Agyeman 2013). Drawing from the arguments of Agyeman and Evans (2004), an EJ-informed urban planning must wrestle with how and whether the current urban planning status quo within municipalities can leverage EJ as a political opportunity for mobilization and action around soil and other contaminants and as a guiding principle to ensure that no harms are suffered from urban planning and policy decisions, especially by particular social groups. Additionally, Pellow argues that historically, scholars and activists have used venues through the state to address issues of EJ, despite the state continuously reinforcing inequities. He includes Robert Benford's argument, stating that "the environmental justice movement continues to seek justice through a system that was never intended to provide justice for marginalized peoples. . ." (Benford 2005; Pellow 2018, 24). Crucially, EJ seeks to critique these unjust systems by also shifting focus from the often state-sanctioned, expert-led processes to identifying environmental risks/burden to a bottom-up, transparent, democratic and accountable processes of defining, assigning and remediating environmental risks to healthy living (Agyeman, 2005, 2013).

This article's empirical case will review the contents of municipal policies at the city (City of Buffalo) and county (Erie County, where the city of Buffalo resides) levels to examine the extent to which such policies address or move toward addressing soil contamination. The goal is to synthesize the findings from this content review of policies and the analysis of community experiences and perceptions around soil contamination to distill key entry points for urban planning in addressing soil contamination, especially in postindustrial cities.

Study Design, Data, and Methods

This study employed an exploratory sequential mixed-methods design (Berman 2017; Cameron 2009; Fetters, Curry, and Creswell 2013). It involved a three-stage process: (1) collecting and analyzing qualitative data from plans and other policy documents and reports, (2) gathering quantitative data from secondary sources and developing a survey instrument to collect and analyze quantitative data, and (3) using insights from stages 1 and 2 to design focus group discussions for in-depth understanding, interpretation, and contextualization of insights.

Stage one was to understand the policy landscape of soil contamination in Buffalo and Erie County. Forty-six policy documents were identified between January and September 2022, focusing on zoning and land use regulations, housing, water, public health, and food systems. Policies were obtained from a database maintained by the Food Systems Planning and Healthy Communities Lab at the University at Buffalo and updated by the research team by visiting the City of Buffalo and Erie County websites [see Appendix A for the list of policies reviewed]. Three research assistants used QDA Miner (qualitative data analysis software) to code/extract information from the policy documents, mostly around (1) soil [and water] contaminants mentioned, (2) sources and pathways of contamination, and (3) strategies and guidelines to address soil contamination. To ensure intercoder reliability, the research assistants piloted the coding process by coding two sample policy documents and met with the principal investigators to review, discuss, and clarify. Weekly meetings were held throughout to update, review, and discuss the coding process and initial insights gained from the policy documents. Results from the coding process were summarized into tables and charts, accompanied by extracted statements/quotes from the policy documents. The principal investigators used the results to track key reports and newspaper stories about soil contamination in Buffalo, including a detailed technical report on soil contamination by the University at Buffalo Research Institute (UBRI 2012), the Environmental Protection Agency's (EPA) historical account of the Love Canal soil contamination events (U.S. EPA 2024), and technical notes on soil contamination by the New York State Department of Environmental Conservation (NYSDEC 2005). The results from policy document review were summarized in a PowerPoint presentation and shared with a broader team of researchers and community practitioners for feedback and reflections.

The second stage involved gathering quantitative data from both secondary and primary sources. We gathered geospatial data from the 2023 U.S. EPA EJ Screen (U.S. EPA 2023) on the spatial spread of contaminations around lead paint, proximity to Superfund sites, and proximity to hazardous waste. Demographics, social, and housing data were obtained from the 2022 American Community Survey (five-year estimate; American Community Survey, n.d.). The EJScreen and ACS data were overlaid on the designated planning neighborhoods in Buffalo, gathered from the City of Buffalo's OpenData Buffalo (Open Data Buffalo, n.d.). These secondary data allowed us to map and characterize the demographic, social, and housing profiles of residents in Buffalo's designated planning neighborhoods, the level and spatial distribution of contamination experienced in these neighborhoods, and which groups are most impacted. A survey was conducted to learn about Buffalo residents' experiences and perceptions of soil contamination and remediation efforts. The survey was administered electronically (via Qualtrics) or on paper to Buffalo residents eighteen years and above from September to November 2023. The survey was distributed via email, social media platforms and participants were recruited using flyers distributed in offices of community partners and retail stores. A sample of 193 completed survey respondents was obtained. Survey data were analyzed and represented using tables and charts, cross-checking with insights from the policy documents and reports, and mapping from the secondary data.

Lastly, two focus group sessions were conducted to gain further insights and engage in context-relevant interpretations of the analysis conducted in the previous two stages. Participants from the first focus group session were conveniently sampled from the survey respondents (e.g., emailing and calling respondents from the survey). Participants for the second focus group session were based on snowball sampling—mostly individuals referred to the research team by the first focus group participants. In all, there were eleven participants for the focus group sessions, who engaged in discussion topics around (1) sources and pathways of soil contamination in Buffalo, (2) individual and community actions or inactions around soil contamination, and (3) planning and other policy support and strategies around soil contamination. Both focus group sessions lasted for an hour and thirty minutes and were audio-recorded, supported with notes taken by two field assistants. A hybrid of inductive and deductive thematic analysis was employed (Fereday and Muir-Cochrane 2006; Proudfoot 2023). The research team developed a set of themes a priori and revised the themes (modified, removed, added) during the coding process to arrive at a final set of themes focused on sources and pathways of soil contamination, individual and community actions/inactions, and planning and other policy support and strategies for remediation. To ensure intercoder reliability, we followed the same procedures as explained in stage 1. Results were summarized in a PowerPoint presentation and shared with a team of researchers and community practitioners for feedback and reflections. The survey and focus group methodology were approved by the institutional review board (IRB) at the University at Buffalo.

There are methodological limitations, which could also inform future research directions. First, while surveys were conducted online and on paper, most survey responses were collected online. To take part in the survey, eligible participants had to be at or above eighteen years and must live in the City of Buffalo; because of this, the survey did not target those who may be most impacted by soil contamination. The large number of online responses may have skewed responses in favor of those with access to and the capacity to use Internet-connected devices. Secondly, the U.S. EPA's EJ Screen geospatial data use point-based data aggregated at the census tract level, which is limited in accounting for discrepancies in the spatial distribution of contamination relative to the modifiable unit problem. For instance, aggregating point data on lead contamination at the census tract or planning district level may mask or exaggerate the exposure level. Similarly, the data do not account for the inhalation of resuspended lead particles, which may underestimate the level of exposure for communities downwind of areas where lead-contaminated soil is present. These present methodological challenges for future studies but also require planning considerations in discussing and addressing soil contamination. Additionally, while questions in the focus group discussion were framed around soil, the conversation shifted to one about lead. Soil and lead are sometimes used synonymously in the conversation in Buffalo due to its postindustrial past and have come up in conversations about safe water and housing. Moving forward, being explicit about the nexus of contaminations is necessary, particularly about how lead soil contamination intersects with water.

Results

Results are structured into three main sections. First, we provide an overview of the contamination environment in Buffalo, followed by an understanding of residents' knowledge, perceptions, and experiences around soil contamination. Lastly, we present results on planning and policy measures (or lack thereof) and recommendations from stakeholders on how to address soil contamination in Buffalo at individual, community, and planning/policy levels.

Characterizing the Soil Contamination and Social Environment in Buffalo, NY

Buffalo's spatial pattern of socio-economic segregation mirrors the spatial spread of contamination areas. We begin with an overview of the socio-economic pattern, which serves as a valuable background for contextualizing and interpreting the analysis. Like many American cities, Buffalo is spatially segregated along racial/ethnic lines (Figure 1). Four communities (Kensington-Bailey, Fruit Belt, Schiller Park, Genesee-Moselle, and Masten Park) account for more than 30 percent of the Black/African American population and feature prominently in discussions around adverse health and socio-economic outcomes experienced by residents in their neighborhoods due to discriminatory policies and practices (Silvermam, Patterson, and Lewis 2013; Taylor, Jung, and Dash 2021). Majority Black and Hispanic neighborhoods are home to most immigrants in Buffalo. Four of these neighborhoods alone—Riverside, West Side, Broadway Fillmore, and Genesee-Moselle—host more than 31 percent of the immigrants in the city.

Socio-economic differences are stark between majority White neighborhoods and neighborhoods of color, which have implications on experiences and remediation options around soil contamination (see Table 1). For example, the highest median household income is, on average, around \$69,950 (2022 Inflation-Adjusted Dollars) in the North Park neighborhood (predominantly White). In comparison, the lowest median household income is, on average, around \$26,971 (2022 Inflation-Adjusted Dollars) in the Broadway Fillmore neighborhood (majority Black/African American and immigrant populations). Similarly, many majority Black,

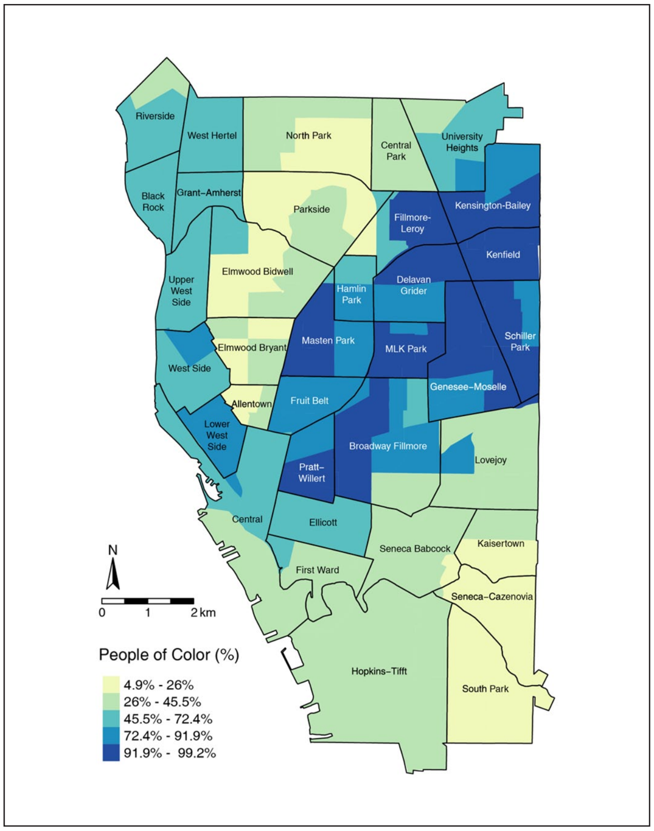

Figure 1. Spatial distribution of people of color across Buffalo's neighborhoods.
Source: U.S. EPA EJScreen data, 2023.

Hispanic, and immigrant neighborhoods have a high percentage of the population with less than a high school diploma, between 14 and 17 percent. As discussed in the literature, issues around cost, education, and information about soil contamination feature prominently in discussions about how residents perceive the history and causes of contamination and affordability of remediation solutions. Buffalo's story highlights areas with relatively low income and a significant population without a high school diploma, disproportionately burdened by contamination, as discussed subsequently.

Figure 2 uses EJ Screen Index data to provide an overview of lead paint contamination (2A), Superfund proximity (2B), and hazardous waste (2C), showing the average percentile score of neighborhoods with these contamination levels. The percentile scores for lead paint are higher, with the average for neighborhoods starting at 66th percentile, compared with 32nd percentile for Superfund proximity (areas near abandoned or uncontrolled hazardous waste dumps on the National Priorities List) and 58th percentile for hazardous waste proximity (areas near operating Treatment, Storage, and Disposal Facilities or TSDFs, and Large Quantity Generators or LQGs, such as surface impoundments, waste piles, tanks, and incinerators). Lead paint contamination is ubiquitous in U.S. cities, especially postindustrial cities like Buffalo (Kirkwood 2003; Magavern 2018). This is evidenced by the relatively high percentile scores in Figure 2B. The NYSDEC Superfund Sites indicated Erie County as the second county in New York State with the highest number of Superfund sites (eighty-seven)—of those, twenty-two were classified as class 2 sites, meaning they pose a threat to human health and action is required (UBRI 2012).

The maps of contaminants in Figure 2 follow a similar pattern as the socio-economic profiles of neighborhoods. The predominantly Black and Hispanic, low-income, and immigrant neighborhoods show up as areas with the highest number lead paint (measured by the percentage of houses built prior to 1960) (Figure 2B), proximity to Superfund sites (Figure 2B), and proximity to hazardous waste sites (Figure 2C), all showing up as the darkest areas on the maps. From the 2022 American Community Survey (ACS, five-year estimates), these neighborhoods of color also have the highest percentage of vacant properties—Masten (26%), Genesee-Moselle (19.8%), Upper West Side (19.1%), Fruit Belt (18.8%), and Pratt-Willert (17.6%)—and high rates of housing abandonment and demolition (Yin, Yin, and Silverman 2023). The areas with high levels of contaminants overlap with zip codes identified as "Communities of Concern" due to confirmed elevated blood lead levels by the NYS Department of Health (Gardner 2017). Buffalo ranks among the top ten cities in the United States for elevated blood lead levels in young children.

The high number of vacant properties and number of renters (average of 49.8%) in these neighborhoods impacts how we discuss and address soil contamination. For instance, solutions that rely on homeowners to test and remediate soil may take time and require additional costs in contacting property owners, some of whom may be absentee. More importantly, low home-owner occupancy may limit collective efforts and advocacy in neighborhoods of color. Owner-residents of color in these neighborhoods have a long history of organizing to address soil contamination, relying on a collective sense of owning, advocating, and rooting themselves in healthy neighborhoods. For example, there was a well-documented case of auto-immune disorders from the lead-contaminated Superfund site at 858 East Ferry Street,[1] within Masten Park, a predominantly Black neighborhood (Nakazawa 2009). Residents and elected officials in Masten investigated the health outcomes (e.g., auto-immune disorders) and contamination pathways, leveraging information for collective action. A key result of their efforts was getting the then-head of the city's Office of Strategic Planning to write to the NYSDEC, requesting the site to be remediated to the—at the time—residential standard of 400 mg/kg of lead[2] rather than the earlier intended industrially zoned standard of 1000 mg/kg (NYSDEC 2005).

Community Experiences and (In)actions

Community experiences were gathered from survey and focus group participants. Table 2 presents an overview of survey participants, including Buffalo residents who have lived in the city

Table 1. Demographic Estimates by Planning Neighborhoods in Buffalo, NY.

Buffalo planning neighborhoods	Population	Race/ethnicity (%) % White	% Black	% Hispanic	% Foreign born	% Less than high school degree	Median HH income ($)
South Park	16697	88.7	2.6	6.1	3.3	3.7	66,143
Seneca-Cazenovia	7610	83.7	8.1	7.7	1.4	8.4	50,195
Seneca Babcock	2218	79.5	9.3	12.7	2.4	18.4	38,823
Kaisertown	4515	79.2	7.4	6.5	4.3	10.2	41,432
Allentown	3517	76.0	11.7	10.8	5.9	2.1	45,068
Elmwood Bryant	12018	75.7	13.0	9.9	10.0	4.0	56,507
Parkside	7959	75.2	17.1	5.2	5.2	3.5	64,932
Hopkins-Tifft	7156	74.8	7.4	24.1	2.3	7.5	53,463
Elmwood Bidwell	17758	72.1	15.4	9.1	7.6	2.7	58,265
First Ward	1045	71.5	13.4	13.9	5.0	14.4	40,712
North Park	17656	71.3	15.3	9.8	5.5	4.3	69,950
Central Park	5934	63.8	30.9	3.8	10.2	5.6	64,196
Lovejoy	10343	60.8	15.8	12.0	8.6	14.4	31,096
Central	5319	56.6	20.0	22.3	10.9	9.2	39,899
Grant-Amherst	4029	56.0	10.0	30.2	27.4	9.5	42,280
Ellicott	2780	54.7	25.0	20.8	4.9	22.3	35,645
Black Rock	5217	47.6	13.2	25.0	13.7	10.8	35,759
Riverside	11596	42.7	13.0	23.4	20.9	15.0	41,604
West Side	11448	41.3	12.7	26.5	21.1	16.9	53,806
Upper West Side	8435	39.7	32.3	20.0	17.7	15.2	49,217
University Heights	11573	37.0	40.8	6.9	15.5	3.0	53,523
Lower West Side	7060	32.8	25.4	49.1	14.3	12.9	47,413
West Hertel	4897	32.0	38.1	21.7	8.3	9.3	40,238
Broadway Fillmore	12997	25.9	41.7	9.4	21.4	15.2	26,971
Fillmore-Leroy	6869	22.6	50.6	7.5	18.6	14.7	56,444
Hamlin Park	6513	18.9	66.8	5.3	9.0	8.2	52,028
Kensington-Bailey	14989	14.4	77.2	2.5	6.9	6.6	37,037
Fruit Belt	2752	13.6	76.2	8.8	9.3	14.6	37,654
Schiller Park	8892	11.0	68.2	9.1	9.2	9.8	35,121
Genesee-Moselle	9500	10.2	60.5	11.4	19.9	11.9	31,706
Masten Park	7329	10.1	79.8	3.5	8.6	9.6	44,874
Pratt-Willert	3777	8.4	82.0	9.6	8.3	14.3	31,870
Kenfield	7600	6.0	74.2	6.4	4.9	8.8	32,882
Delavan Grider	4838	4.5	89.4	1.1	6.7	10.5	36,755
MLK Park	3843	3.3	75.4	13.6	16.6	11.4	28,694

Source: Date Estimates from the American Community Survey, 2022 (five-year estimate).

for more than six years (82% of respondents) and were primarily homeowners (57%). The respondents' ages are relatively well spread across the age cohorts, showing a youthful sample (around 61% are within the eighteen to forty age cohort, which aligns with median age in Buffalo). The racial/ethnic composition of the survey sample closely mirrors the racial/ethnic composition of Buffalo, with a majority White population (56% of respondents), followed by Black population (21% of respondents). The remaining analysis will focus on the major themes from analyzing the survey and focus group sessions.

Responses highlighted three main themes related to community experiences with soil contamination and actions. First, respondents were concerned about soil quality, contamination, and threats to human health. Of the 193 survey respondents, 73 percent report concerns about soil quality and contamination in Buffalo. Most respondents (85%) indicated they grow plants in their back and front yards, and 18 percent in community gardens. Around 58 percent of respondents indicated that their plants do not grow well due to the soil quality. Around 68 percent of survey respondents were concerned about soil contamination, with one noting, "I purchased my home a few years back, and I'm honestly scared to use my soil given the volume of paint chips until I can remediate" (Survey respondent, 2023).

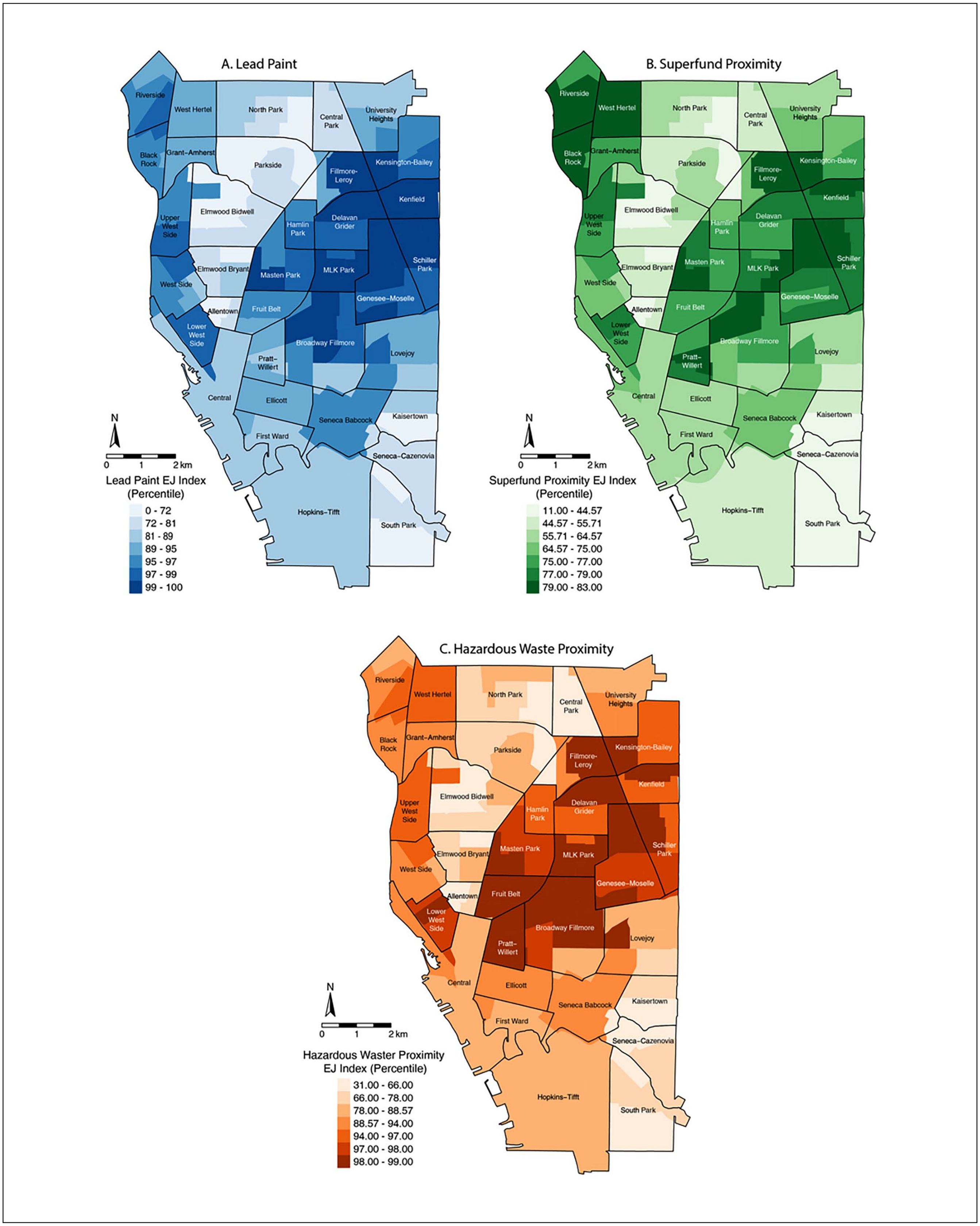

Figure 2. Average estimates of Environmental Justice Index (EJI) percentiles for lead paint (A), superfund proximity (B), and hazardous waste proximity (C) across Buffalo's planning neighborhoods.

Table 2. Summary of Demographic Profile of Survey Respondents.

Indicator	Frequency	(%)
Length of stay in Buffalo		
Less than 1 year	2	1.0
1-2 years	10	5.2
3-5 years	21	10.9
More than 6 years	160	82.9
Housing situation		
Homeowners	111	57.8
Renters	72	37.5
Rent-free	9	4.7
Age		
18-24	10	5.2
25-29	34	17.7
30-39	74	38.5
40-49	34	17.7
50-59	20	10.4
60-64	3	1.6
65 and above	17	8.9
Gender		
Male	58	30.2
Female	129	67.2
Non-binary	5	2.6
Race		
American Indian or Alaska Native	5	2.5
Asian or Asian America	22	11.5
Black or African American	40	20.8
Hispanic or Latino	4	2.1
Native Hawaiian or other Pacific Islanders	6	3.1
Other races	3	1.6
Two or more races	4	2.1
White	108	56.3
Level of Educational Attainment		
Less than a high school diploma	10	5.2
High school graduate	45	23.3
Bachelor's degree or higher	79	40.9
Some college or associate degree	53	27.5
Other college credentials	6	3.1
Income		
Less than 20,000	14	7.4
20,000-39,999	22	11.5
40,000-49,999	29	15.1
50,000-74,999	55	28.6
75,000-99,999	26	13.5
100,000 and above	16	8.3
Prefer not to say	30	15.6

Source: Study Survey, 2023.

Health implications of soil contamination (especially lead) were also of concern to survey and focus group respondents. Around 22 percent of survey respondents indicated that they know someone who is exposed to lead or has experienced lead poisoning. A survey respondent shared that "my friend believes she got lead poisoning from the soil" (Survey respondent, 2023), another shared that "my stepmom believes soil made her sick" (Survey respondent, 2023), and a parent also revealed that "my children have lead exposure, so I am careful with plants and soil" (Survey respondent, 2023). These experiences and concerns may have impacted how some residents perceive crops grown: "previously in an apartment, we had the soil tested and found it to be contaminated with lead from the house paint . . . Cornell cooperative did the testing. We stopped eating the food grown there" (Survey respondent, 2023).

The second theme explores how soil testing and remediation may address some of these experiences and health concerns. The survey respondents highlighted multiple avenues of learning about the contamination of their soil, including checking or asking about the soil history (23% of respondents), asking an expert or testing organization to test the soil (13% of respondents), and using at-home soil testing kit (40%). Although most survey residents expressed concerns about soil contamination, not many are testing their soil, and some of these testing methods (e.g., at-home soil testing kit or asking someone about the soil history) are limited in providing reliable tests for soil contamination. However, using less reliable avenues to check soil contamination is only a symptom of larger structural issues, including the cost of soil testing and remediation. Furthermore, some survey respondents mentioned the use of several self-help or do-it-yourself measures to remediate the soil, including growing in raised gardens, adding organic manure, and purchasing clean soil from elsewhere:

> I have been amending the soil for +30 years. I make my compost and do not use pesticides or artificial fertilizer. (Survey respondent, 2023)

> I have used safe gardening techniques that I researched and found myself. (Survey respondent, 2023)

The third theme examined the actions of residents, community groups, and municipal governments (City of Buffalo and Erie County) to address soil contamination. For education on soil contamination, survey respondents indicated that individuals and community groups are more active in providing education on issues related to soil contamination. Some focus group discussants (FGDs) noted, "Frequent community and policy dialogues on soil health" (FGD, 2023) as helpful for their learning about soil contamination and health, and others emphasized the need for education:

> I think the big issue here is soil education. If you don't know what you don't know, you're going to be digging in your ground and putting vegetables in your soil . . . people need to get the word . . . let people know . . . if you do have your soil, you know, make sure it gets tested. (FGD, 2023)

Survey respondents shared that community groups assist with soil testing, remediation, and education efforts. Some groups focus on select contaminated, low-income neighborhoods of color earlier highlighted in the maps. For instance, a FGD noted,

> Open Buffalo is doing an initiative to do some soil testing in the neighborhood around the Delavan Grider neighborhood and they're doing it for free. (FGD, 2023)

While many of these individual and community actions are helpful, some FGDs called out structural issues limiting system-level solutions to the soil contamination problem in Buffalo. Structural issues include the following:

1. The limit of offering individualized solutions to the collective problem of soil contamination

> I think education is important, but I get really salty about offering individualized solutions for collective problems. (FGD, 2023)

> . . . this is a collective problem, lead pipes in the ground is a collective problem, poisoned soil is a collective problem. . . this is an infrastructure problem. (FGD, 2023)

2. Not fully accounting for the costs of soil testing and remediation at the city-wide scale

> I think we talk from generality, so it could be very interesting. . .If the house gets scraped, then the paint goes into the land, what is the cost to take the first foot of soil away and put it back? . . . I'm not saying it shouldn't be done, but there is an associated cost . . . (FGD, 2023)

> We need to look at the cost to remediate soil. If I spend 3 years digging my soil and then make a dollar profit, that is okay. (FGD, 2023)

> Many individuals recommend the use of raised beds for gardening, but the expense involved can be a major concern . . . (FGD, 2023)

3. Renters' dilemma around soil contamination

> . . . Ideally I'd like landlords to take more responsibility, but I'm also worried that's going to be another thing that affects the [rent] prices or . . . if that like becomes an incentive, like this is a luxury apartment because of the sound soil, so like I can charge a whole other $500 a month, and I'm like no! (FGD, 2023)

> I have been renting for a long time and do not have the option to clean the soil, so I use raised containers on my porch. (FGD, 2023)

> I think housing policies are changing too slowly for landlords to ensure a safe unit for their renters. . . And in a dreamworld, . . . how cool would that be if my landlord and I have a great one [agreement to clean the soil] . . . Again I don't think it's one landlord-by-landlord solution. (FGD, 2023)

While also recognizing efforts by the municipal governments to address soil contamination, such as grants and information around lead and other contaminants by Erie County, other structural issues touched on policy and planning considerations. The next subsection presents results on how policy and planning documents have captured soil contamination and strategies offered to address such contamination. The results from the policy/plan content reviews are interlaced with quotes from the focus group discussions for clarification.

Planning/Policy (In)actions

A gap exists between planning and policy efforts at the city and county levels. Overall, in the policies, heavy metals, including lead, were the most mentioned contaminant, and industrial sources (e.g., defunct industrial areas) were the most mentioned contamination sources. Though some plans and policies note soil contamination, lead paint remediation is the predominant focus. City-level plans and policies were less clear about strategies for remediation, while those at the county were more explicit. For example, the City of Buffalo's chapter 261: Lead-Based Paint Abatement provides extensive guidelines on lead paint and dust and penalties for violations, but less clarity on lead soil contamination. The city's zoning code (Buffalo Green Code, or chapter 496 Unified Development Ordinance) provides minimum guidance on soil contamination. For instance, section 6.1.7, discussing community and market gardens, regulates most things, including storage (seed, fertilizer, etc.), dust and odors, and products to sell and where (e.g., onsite or offsite), but the ordinance is primarily silent on soil contamination. The few instances hinting at soil contamination are in section 7.3 (Stormwater Infrastructure) and section 7.6 (Site Impacts). The provisions under stormwater mainly focus on requiring a Stormwater Pollution Prevention Plan (SWPPP) from developers if there is soil disturbance, and the provision under site impacts provides guidance on dust and air pollution:

> Any land development activity that will involve soil disturbance of one-quarter acre (10,890 square feet) or more, or soil disturbance of less than one-quarter acre that is part of a larger development plan consisting of at least one-quarter acre in area, requires submission by the applicant of a Stormwater Pollution Prevention Plan (SWPPP) prepared per the requirements of the Buffalo Sewer Authority. (Section 7.3.1 p. 7–10)

> Where on-site green infrastructure BMPs are not feasible for all or a portion of stormwater runoff volume due to factors including, but not limited to, contamination, high groundwater table, shallow bedrock, or poor infiltration rates, or where it can be proven that such practices would cause property or environmental damage, the remaining

> portion may be treated by another stormwater management practice acceptable to the Buffalo Sewer Authority. (Section 7.3.4B, p. 7–11)

> Dust and other types of air pollution that can be borne by the wind from the use must be controlled through appropriate landscape, sheltering, paving, wetting, collecting, or other means. (Section 7.6.1, p. 7–17)

Erie County presents various planning and policy strategies around lead poisoning. The LeadSAFE Erie County Program by the Erie County Department of Health (ECDOH) provides training and shares resources around lead. This includes training around renovation and repairs and low-cost remediation for qualifying families and home-based daycares, and investigating and providing information and resources for parents of children with elevated blood lead levels. Additionally, there is the Lead Safe Tool Borrowing Program, a collaboration between the ECDOH and the Tool Library, which provides education and tools (e.g., high-efficiency particulate air [HEPA] vacuums) for families to use in their homes and gardens. The ECDOH has an educational flyer about lead in soil, but it states that the county does not provide soil testing. The Erie County Soil and Water Conservation District had no specific plan or policy around soil contamination except language on its website indicating that it assists "Erie County landowners with requests for technical assistance regarding soil and water quality."

FGDs report that planning and policy landscapes around soil contamination are inadequate. There is limited focus on soil contamination in city plans and other policies reviewed. Conversely, the county government does provide training and information sharing, but less on testing and remediation. Commenting on their perception of the planning and policy landscape, FGDs emphasized the following:

1. Lack of prioritization and institutional support around soil contamination

   > Gardening and soil cleaning have never been a part of the agenda. It seems they do not consider the importance of gardening and soil cleaning, but I strongly believe they should be given due attention. (FGD, 2023)

   > A couple of years ago, the city held several meetings to discuss its budget. During these meetings, it was discovered that the city needed to replace all the lead pipes. However, the issue of contaminated soil was not given much attention. (FGD, 2023)

   > I may have access to institutional support, but I believe that many people in my neighborhood don't have the same level of access and support. (FGD, 2023)

2. Plans and other policy strategies tend to decouple soil and water contamination

   > We think a little bit about water, but we don't think about the soil, we just haven't made that connection. (FGD, 2023)

   > While we are aware of the issue of water [contamination], we tend to overlook the connection between water and soil [contamination]. (FGD, 2023)

The city-county gap in plans and policy strategies around soil contamination remains critical. To bring the results section full circle, you may recall the earlier example in the introduction about the February 13, 2024, letter. The issue is two-fold. Policies are typically reactive to problems. For example, lead in housing and lead in water is being addressed through policies, but lead in soil has not yet been addressed in the policy landscape. This stems from a larger issue: a lack of a systems approach to lead contamination. Even if policies are proactive and responsibilities are clear, the connections between different contamination sources need to be addressed. For example, paint and water contribute to soil lead contaminations, soil can be tracked indoors and become an indoor contaminate, and soil remediation at the parcel scale does not address redistribution of contaminated soil. Additionally, there is a gap between the City of Buffalo and Erie County around soil contamination, and the policy documents do not clarify where the locus of responsibility lies. The gap between these two local government authorities remains crucial to addressing soil contamination, which we will reflect on further in the discussion and conclusion sections.

Discussion

The results from our analysis highlight the disproportionate burden of contaminants in Buffalo's low-income neighborhoods of color, community experiences, factors informing (in)actions around soil contamination, and planning and policy efforts or lack thereof. The main findings are summarized into four points, which we also relate to insights from previous studies in the literature.

Buffalo's spatial pattern of contaminants closely mirrors the city's segregation pattern across space and race. Neighborhoods with low-income populations and majority Black, Hispanic, and immigrant populations also contain the highest lead paint contaminants and proximity to Superfund sites and hazardous wastes. Our findings support concerns among EJ scholars that such toxicity disproportionately impacts low-income and neighborhoods of color (Banzhaf, Ma, and Timmins 2019; Bullard and Wright 2008; Pope, Wu, and Boone 2016).

The legacy of contaminants is significant in Buffalo and Erie County, including the contamination incident and resulting health outcomes in Love Canal (e.g., skin rashes, miscarriages, and birth defects; U.S. EPA 2024). Our findings speak to the persistence of such contamination legacy, highlighting the burden and challenges of soil contaminants and other toxicities in postindustrial cities (Kirkwood 2003; Magavern 2018). The toxic heritage of postindustrial cities, suggested by Kryder-Reid and May (2023), holds for Buffalo.

Residents' experiences with soil contamination, especially around Pb in soil, have translated into behaviors that distance residents from the benefits and services that urban soils can provide (e.g., unwillingness to grow or consume crops) and individual self-help actions. For some Buffalo residents, being exposed to and getting sick from soil among children and adults were concrete examples of their experiences with soil contamination. Although no survey and focus group participants reported specific illness, health consequences related to exposure to lead is well documented (Dasu et al. 2022; Denny et al. 2022; Miller et al. 2020). For some Buffalo residents, primarily urban growers, low soil quality and low crop yield were cited as their experiences, which made some scared and unwilling to grow crops in the city, and others cautious or reluctant to consume crops. These fears and resulting behaviors are not unfounded, as lead contamination is a significant issue for soils used in urban agriculture and among root crops and leafy vegetables grown in postindustrial cities (McBride et al. 2014; Sharma, Basta, and Grewal 2015; Sharma, Cheng, and Grewal 2015). For others, such concerns around lead and other contaminants have translated into do-it-yourself measures, including at-home soil testing kits, asking someone about the soil history, gardening in raised beds and hydroponics, or buying clean soil, which have been documented in other studies as measures employed by urban growers (Kaufman and Bailkey 2000; Mitchell et al. 2014).

Buffalo's history of community organizing around soil contamination remains a potent catalyst for change today, but such community-driven initiatives also reveal underlying structural challenges. Community groups often shoulder the responsibility of addressing soil contamination in Buffalo through educational programs or awareness campaigns. Participants in the focus groups emphasized the need for education and information about soil history, contamination sources and pathways, exposure and risks, soil testing opportunities, and soil remediation options and costs. The need for education and information is consistent with previous studies that suggest that barriers to addressing soil contamination often include limited education and information about contamination risks, inconsistent knowledge about heavy metals and other soil contaminants, and limited knowledge of soil history and quality (Harms et al. 2013; Hunter et al. 2019; Kim et al. 2014; Ramirez-Andreotta et al. 2019). Similarly, community groups and local researchers serve as resources for free soil testing, especially in Buffalo's majority Black, Hispanic, and immigrant neighborhoods, which addresses the cost barrier facing residents, especially gardeners (Kaiser et al. 2015; Kim et al. 2014; Ramirez-Andreotta et al. 2019). While community-driven initiatives are helpful, they spotlight structural concerns, including the heavy cost implications of addressing soil contamination at the city level or relying on individual- and community-level initiatives to address a problem affecting the entire city.

Fourth, Buffalo's planning and policy landscape seems inadequate for addressing the challenges of soil contamination, and some residents find this landscape unsupportive. The analysis of policies, including Buffalo's zoning code (Green code), provides minimum guidelines for addressing soil contamination. For the most part, the regulatory guidelines focus on lead paint, which is necessary but insufficient to address the sources, pathways, exposures, and risks of soil contamination. Some studies have earlier called attention to the lack of guidelines (e.g., screening, testing, and remediation) for soil contamination in cities (Kirsten Schwarz et al. 2016; Ramirez-Andreotta et al. 2019). Some survey and focus group participants point out how city and county governments are not prioritizing soil contamination or supporting individual self-help and community-driven initiatives.

An unsupportive planning and policy landscape around soil contamination has profound implications. For some residents, especially renters, the conversation around soil contamination presents questions, such as the role of tenants versus property owners in cleaning the soil, who bears the cost of cleaning the soil, how cleaning the soil could drive up property values and rents, and the rights of tenants to live in clean and healthy soil environments. As discussed, neighborhoods with such contaminants are disproportionately co-located with majority Black, Hispanic, and immigrant populations, with low income, a high percentage of renters, and a high percentage of people with less than a high school diploma. Many of these questions revisit the concerns of EJ scholars around the gentrification effects of cleaning or regenerating brownfields (Essoka 2010; Pearsall 2013).

Another implication is the decoupling of planning and other policy efforts to address soil and water contamination. For example, the City of Buffalo's focus on lead pipes without discussing lead in soil undermines the complex interplay of water and soil systems as contamination sources, pathways, and risks for healthy living. Municipal and county entities are part of a Lead Safe Taskforce, suggesting that information is shared; however, a lack of action regarding soil indicates that this information is not operationalized across departments. Comprehensive policy integration is necessary, including linking soil health to other environmental, housing, health, and economic development initiatives. The bottom-up, community reactionary efforts to EJ discussed by Agyeman (2005) point to empowering communities to drive solutions, supporting grassroots organizations, and ensuring that these efforts are part of broader urban redevelopment strategies as essential steps (see Appendix B of suggested action steps for coordinated actions around soil health using multiple avenues).

Conclusion

Soil health remains central to planning for healthy cities. This article distills key conversations in the literature, particularly those raised among EJ scholars regarding the disproportionate burdens of contaminants and health risks faced by communities of color and low-income communities. These conversations are used to frame empirical observations around soil contamination in Buffalo, NY, a postindustrial city. The key findings suggest how the city's spatial patterns of lead contaminants mirror its segregation patterns, with historically marginalized neighborhoods disproportionately burdened by soil contaminants. The findings also reveal a rich history of community organizing around soil contaminants and health risks, amidst structural challenges, including planning/policy inertia in addressing these contamination and health risk issues, which disproportionately impact communities of color and low-income neighborhoods in Buffalo.

These key findings make at least two significant contributions to urban planning literature and EJ literature, in particular. First, an EJ-informed lens of urban planning suggests that communities have leveraged environmental and health risk concerns, such as soil contamination in Buffalo, as a political opportunity for mobilization and action. However, the Buffalo case demonstrates that state practices and tools around urban planning are limited in using EJ as a guiding principle for ensuring that no harms are suffered from urban planning and policy decisions. From the insights of Agyeman and Evans (2004), EJ as a political opportunity for mobilization and action, and EJ as a guiding principle for urban planning and policy action are symbiotic. That is, the mobilization and action of communities to right the wrongs of environmental and health risks is more effective if they operate within an urban planning institutional context that has EJ as its guiding principle. Buffalo's case cautions urban planning (and planners) to avoid the risk of "romanticizing" local collective action by refocusing attention on redressing underlying state-sanctioned, institutional logics, incentives, and practices that reinforce environmental and health burdens on particular social groups. These could include initial steps such as planners being explicit about soil contamination in zoning ordinances, and advocating for soil testing and remediation resources for communities of color and low-income groups, including homeowners and renters.

Relatedly, the Buffalo case also contributes to our understanding of how local collective action around EJ can be constrained if urban planning and policy tools and practices inadvertently undermine or fail to factor in the incentives and behaviors of actors. When local government planning and policy tools remain largely silent or unsupportive of remedies around soil and other environmental contaminants, the results often manifest in various ways, including shifting blame on who bears the cost of remedying the toxic heritage of soil contaminations and health burdens (e.g., owners vs. renters, community vs. developers), and gentrifying effects of cleaning or regenerating contaminated sites, which are all discussed by EJ scholars and practitioners. Context matters, as re-echoed variously by EJ scholars. People remain a key aspect of contextual factors often overlooked, including the experiences, knowledge, incentives, anxieties, fears, and hopes of individuals in their encounters with environmental burdens and health risks. The extent to which urban planning and policy reinforce these experiences, incentives, and anxieties of individuals to mobilize and act toward redressing environmental "bads" remains a necessary inquiry. The Buffalo case illustrates instances of collective action amidst risk-averse behaviors, as the urban planning and policy landscape remains largely silent on soil health and healthy living. How the silence of urban planning and policy landscape may have contributed to Pellow's critiques of the state's role in perpetuating social inequalities merits critical inquiry across multiple municipal contexts.

Appendix A

Collection of Policies Reviewed: The policy documents were identified and collected between January and September of 2022 from the official websites of government agencies and community organizations in Buffalo and Erie County.

1. Sanitary Code of Erie County
2. Erie County Design and Plan Review Requirements
3. Chapter 261: Lead-Based Paint Abatement [City of Buffalo, General Legislation]
4. Chapter 496, City of Buffalo Unified Development Ordinance
5. Erie County Lead Poisoning Prevention Strategies & Fact Sheets
6. Erie County Health Department Environmental Health Services Design and Plan Review Requirements
7. The Buffalo Public School Farm To School initiative
8. Local Food Action Plan 2020-2024
9. Queen City in the 21st Century: Buffalo's Comprehensive Plan
10. Community Gardens Resolution
11. Resolution: Fee Waiver for Maple Syrup Event
12. Resolution: Fee Waiver for Maple Syrup in Delaware Park
13. Resolution: Fee Waiver for Maple Syrup Event
14. Resolution: Authorizing Use of Public Water for Grassroots Gardens WNY
15. Grassroots Gardens Lease Agreement Renewal
16. Resolution No 58: creation & appointment of the Buffalo-Erie County Food Policy Council
17. Permission Request - Purchase of Prisoner Meals
18. Appoint Market Manager & Food Enterprises Coord(Peterson)
19. Resolution: Waive Permit Fees for North Buffalo Farmers Market

20. Erie County Lead Hazard Reduction Demonstration (LHRD) Program
21. Chapter 341: Property Maintenance Ordinance Amendment
22. Buffalo's Broadway International Public Market Business Plan
23. Resolution No 133: creation & appointment of the Buffalo-Erie County Food Policy Steering Committee
24. BPS Four-Year Financial Plan
25. Resolution: Request Tops Markets Explore Options for Broadway and Bailey Location
26. Resolution: Support Healthy Corner Store Initiative Within Corporate Stores
27. Resolution: Establish City-Wide Conditions for Food Stores and Increase Fine Schedule
28. Permission Request: Permission to Enter into Agreement with Buffalo River Compost, LLC for Yard Waste Composting
29. Erie County Right to Farm Law
30. Resolution: Waive Fees for Massachusetts Ave Project Farm Stand
31. Erie County Farms for the Future
32. EO 012: Implementation of the Erie County Agricultural and Farmland Protection Plan
33. Erie County Agricultural and Farmland Protection Plan
34. One Region Forward: Growing Together Report
35. One Region Forward: A New Way to Plan
36. Article 9: Mobile Food Vehicle Vendors, Mobile Canteen Truck and Mobile Food Vehicle Vendor
37. Proposed Annual Action Plan Amendments
38. Variance (denied): 36 Massachusetts Avenue - Establish Food Vending Use
39. Broadway Market Revitalization Plan
40. Resolution: Adoption of the Land Use Plan
41. Food Scraps Recycling Program
42. Permission to Waive Formal Bidding Procedures for Single Source Purchase of Food Waste Collection Service
43. Contract Amendment: Nutrition Program Contract-2017 Ordinance Amendment on the keeping of cloven-footed or hoofed animals
44. Scajaquada Creek Watershed Management Plan
45. Food and Industries: How to Prevent Water and Storm Sewer Pollution [Western New York Stormwater Coalition]

Appendix B

Action Checklist for Addressing Soil Contamination in Urban Planning

1. Targeted Soil Health Assessments

Action: Collaborate with local universities and organizations to conduct soil testing in identified high-risk areas.
Tools: Deploy portable X-ray fluorescence (pXRF) devices for lead detection; utilize GIS for mapping contamination levels.
Outcome: Develop a detailed map of contaminated areas accessible to planners and policymakers.

2. Community Engagement and Education

Action: Organize workshops in collaboration with NGOs and health departments focused on soil contamination awareness and remediation techniques.
Tools: Provide educational materials, online resources, and soil testing kits at community events.
Outcome: Empower residents with knowledge and tools to address soil contamination in their neighborhoods.

3. Support and Facilitate Self-Help Actions

Action: Distribute soil remediation supplies such as compost or clean soil at subsidized rates to affected communities.
Tools: Establish a "Soil Health Resource Hub" in community centers for easy access to materials and information.
Outcome: Enhance the capacity of residents to improve soil health and safely cultivate urban gardens.

4. Establish Cross-Scale Collaborations

Action: Form a working group that includes representatives from city planning, county health departments, and community organizations to coordinate soil health initiatives.
Tools: Utilize a shared digital platform for communication and data sharing among stakeholders.
Outcome: Ensure cohesive and sustained efforts across different government levels and sectors.

5. Implement Preventative Measures

Action: Require soil testing and necessary remediation in all new urban development projects before approval.
Tools: Use geotextiles and clean soil caps in playgrounds and gardens to prevent exposure to contaminants.
Outcome: Minimize future risks of soil contamination in urban environments.

6. Monitor and Evaluate Progress

Action: Set up regular monitoring to evaluate the impact of implemented actions on soil contamination levels.
Tools: Employ GIS to track soil quality changes and conduct periodic community surveys for feedback.
Outcome: Adapt strategies based on monitoring data and community insights to improve effectiveness.

7. Public Awareness and Communication

Action: Launch a public awareness campaign using social media, local news, and community meetings to educate residents about soil contamination and safe practices.
Tools: Develop clear and accessible communication materials that highlight key risks and solutions.
Outcome: Increase public understanding and engagement in addressing soil contamination.

8. Facilitate Community-Led Initiatives

Action: Provide training and resources to support community-driven projects like neighborhood soil testing and urban gardening.
Tools: Offer seed funding and technical assistance to empower community leaders.
Outcome: Promote sustainable, community-based solutions for soil health.

9. Address Policy and Regulatory Gaps

Action: Work with legal experts to identify gaps in current regulations and propose amendments to strengthen soil contamination management.
Tools: Draft legislative proposals that address outdated or insufficient policies.
Outcome: Create a robust regulatory framework that effectively mitigates soil contamination risks.

10. Secure Sustainable Funding

Action: Pursue grants and partnerships with foundations, government agencies, and private sectors to fund soil health initiatives.
Tools: Prepare detailed proposals outlining the scope, goals, and expected impacts of the initiatives.
Outcome: Ensure consistent financial support for long-term soil contamination mitigation efforts.

11. Safe Urban Agriculture Infrastructure

Action: Develop infrastructure such as raised beds and protective barriers to facilitate safe urban agriculture in contaminated areas.
Tools: Collaborate with urban planners and architects to design and implement these projects.
Outcome: Create safe, productive spaces for urban farming, reducing exposure to soil contaminants.

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Notes

1. Cleanup of the Superfund site by NYS DEC was completed in 2008 (New York State Department of Environmental Conservation 2008).
2. The Environmental Protection Agency (EPA) has since lowered this to 200 mg/kg (U.S. EPA 2024).

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