

# Redlining Maps and Terrains of Sustainability:

Interdisciplinary Mapping of Racialized Redlining to Present-Day Sustainability Agendas in HCI

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## ABSTRACT

We ask how historic redlining, a US government run, racially discriminatory practice of assessing and mapping property values for federally subsidized home loan eligibility in the 1930s, is tied to current issues of sustainability. We frame redlining as a historic data practice, tied to ongoing exposure to environmental harms and difficulty building generational wealth in African American communities in Indianapolis. To address this, we made maps to ground interdisciplinary discourse between the authors: two who research sustainable human computer interaction (SHCI) and one who researches sustainable food systems, including issues of food security. Our maps, which combine historical redlining maps and contemporary sustainability issues facing Indianapolis, helped us explore the ongoing impacts of redlining across our disciplines. We develop the term ‘sustainability’ for HCI across racial, socioeconomic, and environmental tensions and reflect on how SHCI’s emerging posthuman emphasis on human/non-human relations are associated with human/human challenges like redlining.

## CCS CONCEPTS

• Human Centered Computing; • HCI; • Design;

## KEYWORDS

Sustainable HCI, Redlining, Sustainability, Ecological Posthumanism, Socioeconomic Sustainability

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## 1 INTRODUCTION

ACM’s There is increasing tension and discussion in HCI around addressing human issues, issues of injustice, the psychological impacts of trauma, climate change, and economic disparity in late capitalism. A range of emerging work in HCI has brought forward

discussions about hidden cultural biases like caste [69], set forward manifestos for anti-racist HCI [1], trauma-informed computing [16], and asked new questions about how best to address climate change and sustainability [35, 41] in HCI. Emerging agendas are tied to a cultural sea change, amplified in part from a heightened sensitivity to the injustices which intersected and played out in plain view during COVID: the intersections of race, class, and exposure to risk, the world-wide broadcast and reaction to racialized police brutality, and the various international and national political divisions COVID highlighted. There is also an awareness that while these issues were so traumatically and clearly exposed, the groundwork for them was already laid, and it simply took the pressure of a pandemic to expose these inequalities in an eruptive, and overwhelming way. In this paper, we examine some of the groundwork of inequity, through the lens of historic redlining and its intersections with sustainability. We see the intersection of sustainability and discriminatory historic data practices like redlining as laying the groundwork for multifaceted challenges of sustainability. We discuss these challenges and interdisciplinary definitions through conversations grounded in map making, to externalize the data, spatial relations, and geographies of historic redlining and contemporary socioeconomic and environmental issues in Indianapolis, Indiana and ask how we should think of sustainability and its intersections with data practices moving forward.

While many scholars argue that artificial intelligence and machine learning are ‘world building’ [17, 56] as well as defining the terms of who is ‘legible’ [2, 43], this is no new phenomenon. In this work, we ask how historic redlining, a US government run, racially discriminatory practice of assessing and mapping property values for federally subsidized home loan eligibility in the 1930s, is tied to multiple sustainability agendas. We see redlining as a historic data practice with ongoing ‘world building’ and geography-defining impacts. Redlining, at a high level, was part of federal government programs that sought to increase home ownership after the great depression through subsidized loans. However, maps were made to grade neighborhoods in cities from A-D, A being the most desirable property, and D being the least [33] – these maps defined the probability of getting a home loan. Due to histories of racialized zoning and segregation, African American neighborhoods were rated D, often alongside foreign and low-income people, which made receiving government subsidized home loans a near impossibility [50]. This has led to disinvestment in certain geographies [65], geographies of worse air and heat pollution [36, 38, 52], and in some cases, food scarcity, called ‘supermarket redlining’ [25]. In our research we create maps to ground our discussions on redlining to better understand inter-disciplinary approaches to sustainability.

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This research project was stimulated by a question posed by A2 – an agricultural economist who researches sustainable food systems. She wondered how historic redlining might be impacting food access and sustainable food systems in Indianapolis. A2’s interest in redlining and sustainable food systems in Indianapolis was interesting to A1 and A3 as both have a vested interest in SHCI, and specifically, were interested in answering the question of how emerging ecological posthuman agendas in SHCI intersect with issues of race and class, responding to critiques of posthumanism which we discuss in more detail in the related works. Ecological posthumanism is a branch of posthumanism that discusses how we might decenter the human in ecological systems and include non-human others like plants, animals, or other non-human beings. This use of posthumanism (seeing the human as entangled or extended among assemblages of non-human others like technology or ecological actors) responds to climate change, which shows just how reliant and related humans are to the health of non-humans in ecological and environmental settings. However, some scholars critique ecological posthumanism for not looking at the racial and colonial histories or non-western epistemologies.

Because redlining was materialized in a set of maps in the 1930s, as A1 started to think about this problem, one of the ways they began to explore redlining and its impacts was to make maps, as map making helped them ground some of the stories and various pieces into spatial and interactive relations. A1’s approach was influenced by their background in environmental sustainability and ecological posthumanism and therefore, they looked at ways redlining is tied to environmental issues and how historically redlined communities faced greater environmental hardships than non-redlined neighborhoods. Building off of A1’s map making practice, we realized that A2 also uses maps in her work as an agricultural economist using R to visualize census data to understand the economic factors affecting local populations. We therefore ended up using map making of historic redlining and contemporary sustainability issues (from our cross-disciplinary lenses) as artifacts which helped us talk through and externalize our epistemic approaches, our individual and sometimes conflicting definitions of sustainability, and possible ways we might think of intersecting sustainability agendas moving forward, or even the utility of the word ‘sustainability’ at all.

We contribute to SHCI methodologically and conceptually by extending definitions and case studies of sustainability through cross-disciplinary discourse guided by design and making of maps. We use this approach to specifically challenge and expand A1 and A3’s understanding of ecological posthumanism as it has been taken up by the SHCI community so far and continue to work toward finding intersections of social justice and environmental sustainability in SHCI research. As A1 & A3 are SHCI researchers with a focus on ecological posthumanism, we devoted time thinking through the complexities of challenging ecological posthumanism when compared or held next to the socioeconomic positionality offered by A2. Together, through our duoethnographic approach, scaffolded around disciplinary map making, we began to trace multiple entry-points and positionalities of sustainability which enrich and temper each other, yet don’t collapse disciplinary orientation or homogenize our distinct voices. We see this work as an opening provocation on transdisciplinary approach to sustainability, leaving room for the unknown and welcoming additions and alterations

in the future. More specifically, we offer 3 takeaways for SHCI: 1) a call to explore potential ways that posthuman approaches in SHCI could tackle socioeconomic oppression and human/human problems; 2) a case to leverage the combination of duoethnography and disciplinary map-making as an exemplar of a method which can reorient researchers to their disciplinary and ideological assumptions toward more nuanced framings of sustainability for HCI, and 3) an occasion to think of “data work” as part of sustainability work. Data work is the unglamorous work of building datasets that are inclusive, just, and fair according to Sambasivan et al. [60]. We hope that the approaches of this paper showcase expanded definitions, multiple pathways, layered entanglements, and future directions for SHCI that takes race and class seriously as matters of concern and to welcome fellow SHCI researchers to engage with these issues collaboratively moving forward.

## 1.1 Positionality

A2 (Shellye Suttles) is an agricultural economist and sustainable food system researcher. She is interested in the complex interactions across the food system that lead to the lack of environmental, economic, and social sustainability, particularly within the realm of food and agricultural policy. A2 has lived in Indianapolis, IN since 2015 and spent her first three years in the city working as the food policy coordinator for the mayor’s office. A2 identifies as a Black woman from the United States. She acknowledges her positionality has influenced this project’s methods and findings. Born and raised in Taiwan and with a background in the humanities, A3 (Shaowen Bardzell) is an ethnic minority HCI scholar interested in feminist and posthuman approaches to SHCI. She has been engaging in a decade-long multi-sited ethnography on making/innovation culture and participation, sustainable agriculture, and transformation in creative and tech industries. She takes the position that climate change, gender/racial equality, and social justice are intertwined, and that women and minorities are disproportionately affected by environmental issues. A1 (Heidi Biggs) is a SHCI researcher trained in design and the humanities. Their research uses queer theory and ecological posthuman theory to think about critical approaches to climate change and environmental sustainability. A1 identifies as white and gender non-binary (they/she), from a relatively middle-class upbringing in the United States. As we will discuss in the methods, we tried to keep our voices and disciplines partial and in dialogue through our use of quotes and comments from our live discussions about our maps.

A2 is a researcher who is deeply embedded in many committees and small farms in Indianapolis and intimately aware of food access, food security, and attempts at sustainable food systems in Indianapolis. and A1 and A3 live in Bloomington and have been conducting ethnographic fieldwork in Indianapolis on sustainable agriculture since 2019 and are therefore familiar with the setting of these case studies and research questions.

## 2 RELATED WORKS

In the following we introduce key concepts and prior works around how HCI has taken up social justice, sustainability and ecological posthumanism, and a background of historic redlining and overview the contemporary cases we engage with in Indianapolis.

## 2.1 Race, Social Justice, and HCI

Literature about design of technologies and intersections with racism or social justice issues has emerged in the last five years as an important emerging focus in HCI. These calls, observed together, clearly demonstrate how racism and social justice issues are caused by intersections of institutions (including SIGCHI), technologies, and research methods and approaches. Recent work asks how HCI and interaction design grapples with social justice issues [23] and show how technologies and emerging data-based practices inherit pre-existing racial biases [4, 30, 53]. Agendas toward including critical race theory [54], intersectionality [63], and active anti-racist approaches in HCI [1] are proliferating. Some are studying how data and technologies enact specific histories of illegibility and dispossession for Black farmers [43], others argue for algorithmic reparations [19] while others are broadly examining the importance of curating data sets that are actively non-racist [62]. Importantly for our research, some researchers have begun to ask how design as a discipline can better engage with community design projects around gentrification in historically Black communities [55], research that specifically challenges HCI to connect social justice and environmental issues [23] and an emerging critical data studies agenda that explores how data constructs ideas of “nature” and how that intersects with ongoing issues like racism and colonialism [29]. Building on this body of work, our project examines how historic redlining, a US government run, racially discriminatory practice of assessing and mapping property values for federally subsidized home loan eligibility in the 1930s, is tied to current issues of sustainability. We expand the notion of the term sustainability and ask how this definition might challenge emerging ecological posthuman agendas in SHCI, asking how its emphasis on cultivating human/non-human relationships are associated with human/human challenges like redlining.

## 2.2 SHCI & Ecological Posthumanism

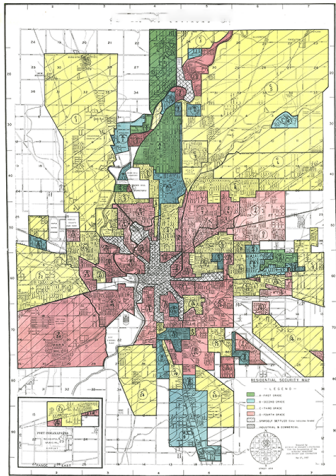
Sustainability research in HCI has always been meta-critical of the systems, methods, and practices of HCI and how they might contribute to unsustainable outcomes. Early works in SHCI asked how design of technologies are tied to systems reuse and repair [10], political and economic factors [22, 24], and the ontological impacts of design and how it can potentially reduce the possibility of futures on earth [10, 27, 71]. We see that there are works in SHCI that expand notions of sustainability to labor and globalization [11], that suggest limits through ideas like collapse informatics [67] and re-imagine technology for sustainable food systems through farming within limits [3] or small farming practices [6]. Yet, the scale of environmental sustainability in the field does not consider socioeconomic sustainability within these environmental programs of action. In the following we argue we cannot forget or sacrifice human sustainability from an environmental sustainability standpoint.

A1 and A3’s research is often invested in the emerging SHCI agenda tied to ecological posthumanism, which asks how we might design to consider non-humans in the face of climate change and

the Anthropocene era – a geologic era where humans are the leading cause of geo- or global- scale change on earth [18]. The Anthropocene, as a name or concept, has taken flight, igniting debate, critique, and generative ideation, but has begun discussion around human’s impacts at a planetary scale and geological timelines. The Anthropocene and climate change have also spurred an emerging agenda in SHCI research which has begun to ask how we can include non-humans/more-than-humans (like plants, animals, ecologies, and materials) in the design process. This agenda often borrows from posthuman theory, applied to environmental critiques, which we call ecological posthumanism. Posthuman theory, in a nutshell, is a shift from enlightenment era constructions of the human toward postmodern constructions which see people as entangled in complex systems of becoming [15]. Applying it to ecological challenges shows how humans are existentially entangled with planetary limits and health, the lives and wellbeing of more-than-humans. This phenomenon has been written about by scholars in science and technology studies (STS) and other critical theorists who advocate for ecological posthuman care [59], human/fungus collaborative survival [68], human/non-human kinship [32], and the concept of ‘natureculture’ which highlights the non-separation of nature and culture [31]. This emerging agenda has been taken up in SHCI scholarship in a number of ways such as reflecting on the longer-term timelines and entanglements of materials used in design [20, 21, 45, 57], designing experiences that put people into contact with non-human points of view and ecologies [8, 42, 58], build room for non-human participation and cohabitation [2, 21, 44, 76], explore ecological posthuman possibilities of data [6, 46], and sustainable farming [44]. This way of conceptualizing design of technologies aligns with a larger emerging paradigm of HCI research which advocate for designing with more-than-humans [57, 70] or noticing multi-agent entanglements [26] and which also considers the agency and liveliness of data [28].

However, while the posthumanist SHCI agenda is promising, it comes into some difficulty when it also must address human difference. The Anthropocene and some posthuman agendas have been critiqued for their flattening of ‘the human’ and erasure of colonial histories. The Anthropocene has been critiqued by geographer Kathryn Yusoff for erasing colonial histories in geological timelines, “this planetary analytic has failed to do the work to properly identify its own histories of colonial earth-writing, to name the masters of broken earths, and to redress the legacy of racialized subjects that geology leaves in its wake” [72:13]. Posthuman scholar Zakiyyah Iman Jackson stresses that current uptakes of critical animal studies, new materialism, and posthumanism still don’t work towards diverse human perspectives or liberation from Humanist binaries, and she offers critiques of the philosophic and scientific construction of the human/animal binary through African American art and literature, which she argues reconfigure relations between humans and non-humans in ways that, “resignify and revalue humanity such that it breaks with the imperialist ontology and metaphysical essentialism of Enlightenment man” (670). She essentially argues for non-white or non-colonial starting places for posthuman theory and examples that fundamentally reimagine posthuman subjects from multiple, non-universal starting points.

We think that these scholars bring up an important challenge to posthumanism, and we ask how discriminatory human/human



**Figure 1: Redlining map of Indianapolis**

problems like redlining are associated with human/non-human relations that posthumanism encourages. This is the terrain of sustainability we engage in this paper. One might ask why we don't use the lens of environmental justice, which would also be a fruitful analysis, but we believe in the potential of posthuman theory to tell new stories and build new subject sensitivities, but which will perhaps not reach their potential without addressing the complex racial and colonial histories that are part of environmental and socioeconomic challenges.

### 2.3 Redlining

Because redlining is part of our exploration of the history of the intersection environmental and social factors in Indianapolis, a brief history and definition of redlining follows. We frame redlining as a historic data practice that will most likely impact and shape ongoing statistics and analysis if left unchecked (for example, SAVI, a Indianapolis based statistical think tank, argues that home loans in formerly redlined neighborhoods are still harder to get than non-redlined neighborhoods [66]). Redlining stems from a home loan program which was part of the New Deal in the US, run by the Home Owner's Loan Corporation (HOLC). According to [26:394], "Between 1933 and 1936, HOLC made new low-interest, self-amortizing mortgages to one million homeowners who were in default or had already lost their homes" to help slow rates of foreclosures. However, as part of this project the HOLC parent organization the Federal Housing Administration (FHA) asked that lending risk maps be made in major US cities which resulted in different areas in cities to be rated A – D, where A was the best property and D was the worst. D properties were often near industry, housed poor, foreign, and African American populations, and had less desirable or older home types (figure 1). These 'red' zones have led to 'redlining' a practice where "redlining refers to lending (or insurance) discrimination that bases credit decisions on the location of a property to the exclusion of characteristics of the borrower or property. Usually, it means that lenders would not

make loans to areas with African Americans or other perceived "hazardous risks" to real estate investments." [33:395].

Even after redlining practices were outlawed by the 1968 Fair Housing Act, which "prohibited discrimination concerning the sale, rental, and financing of housing based on race, religion, national origin, sex, (and as amended) handicap and family status" [74], tactics for racialized geographies and the long-term impacts continued and the effects of redlining can still be felt in many areas. Scholars have discussed redlining's relationship to disinvestment in certain neighborhoods [65] lack of local access to fresh food [25, 64] and exposure to environmental harms like air pollution [36], heat [38], and exposure to industrial contaminants like lead or brown zones [51]. We would like to mention that understanding, tracking, and telling the story of redlining (as we discovered through our maps) was by no means clear cut or linear. The interim history, policy, movement, economics, and infrastructures between the late 1930s and today make tracing the impacts redlining a complex narrative to relay. We warn against seeing this as an easy, one-dimensional, wholistic, or totally clear picture of redlining's impacts.

### 2.4 History of Racial Relations in Indianapolis

Indianapolis has a long history of racial discrimination. Indiana is known for being the home of the white supremacist group, the Klu Klux Klan, and the first state constitution banned African Americans from living in the state at all, which was of course eventually overturned by federal constitutional amendments after the Civil War [14]. As a major US city, Indianapolis was redlined in the 1930s along with many other cities. In our maps, we focused on the connections between food security and sustainable food systems and redlining, as well as some cases where Indianapolis's redlining led to low-income and historically African American communities to environmental harms like lead in soil, and infrastructures that led to flooding and sewage overflow.

Indianapolis, situated in Marion County, has an interesting history of racialized politics and local government. In January 1970, the Indianapolis and Marion became a consolidated unified government. At this time, geographically, the boundary of the county also became the boundary of the city, which originally only encompasses the center of the county [37, 75]. The goal of the unified government (or "Unigov") effort was to establish a single executive body (i.e., mayor), a single legislative body (i.e., city-county council), and a single judiciary body (i.e., county court) to make local government more efficient and effective in administering public services. There, however, is a common understanding that another, more subversive goal of Unigov was to diminish Black political power in the "old city" by including 250,000 White residents from the rest of the county overnight [12, 73]. Moreover, researchers have found that the goal of fiscal efficiency has not been met [12, 48] and may have created additional fiscal inequities [49]. This geographic and political history of the city and county make it a unique case study of the long-term implications of redlining in the "old city" for new city-county's geography, environment, and society. This shift in city boundaries becomes a critical part of our discussion of redlining impacts on sustainable food systems through our shared map making processes.



**Figure 2: A1's early maps used for sensemaking in earlier projects.**

### 3 METHODS

Methodologically, we use map making across disciplines to ground discussions about historic redlining in Indianapolis and its ties to contemporary sustainability issues. We were drawn to the site of Indianapolis due to its unique history with racial discrimination, its current state as a site of widespread food insecurity, and history as an industrial and agricultural center of the Midwestern United States. While it is a city, we see it as adding to emerging agendas in HCI to focus on more rural spaces and non-coastal locations for HCI research [refs].

This research is a crystallization of two-year long intellectual relationship as collaborators, developed slowly over time. A2 first brought the possibility of researching sustainable food systems and redlining to the attention of A1 and A3 after the three had already established a research relationship through collaboration on small-scale agriculture in Indianapolis. A2 introduced A1 and A3 to important interlocutors for that project like local soil and water conservation experts and local small farmers in Indianapolis. A1 used maps of Indiana (Figure 2) to discuss place-based agriculture with these interlocutors as a ‘ticket-to-talk’ – or an artifact to ground conversations as described in [13]. This research relationship resulted in a publication about small farming in Indiana [6]. This initial relationship opened the door to this further exploration of food and sustainability in Indianapolis, but with additional considerations of race and redlining.

As a tool for sense-making, maps have long been a part of A1's research repertoire, a part of prior research probes [8] and as a self-orientation tactic to align with new places and research agendas, as in figure 2. In response to A2's suggestion to explore connections between redlining and sustainable food systems, A1 was naturally drawn to map making as a familiar sense-making strategy. A1 tried many different iterations, styles, materials, and strategies for making these maps (figure 4-6), and again used these maps as a ‘ticket-to-talk’ and get feedback from A2. Through these discussions A1 and A3 were familiarized with histories of food systems in Indianapolis, and A2 was familiarized with ecological posthumanism. Over time, the research team realized their ongoing discussion

about the maps, small farms, and food systems, which pointed out their different research orientations and framings of sustainability, was more interesting as a contribution than the maps in and of themselves. It was at this point they started considering how they might build a research product that preserved the intellectual exchange and positionalities as points of difference, learning, and growth. In the present work, we prioritize our most recent discussions about the intersections of redlining and sustainability in Indianapolis, through cross disciplinary discussion grounded in map making. These discussions are scaffolded on two years of ongoing discussion and relationship building (including multi-day in-person site visits, virtual meetings, and email exchanges).

As A2 is trained as an agricultural economist who studies sustainable food systems, she made maps using US census data, historic redlining areas graded C or D, and grocery stores that accept SNAP (Supplemental Nutrition Assistance Program) as a means of payment. She built her maps using R code. These data sets and map building tools are familiar to her and are part of her socioeconomic research on a regular basis. A1 used art and design methods to try to build and understand maps, using tools like painting, printouts, photoshop, illustrator, and photography. While maps have been used as design research probes in the past [9], in our project, they become a cross-disciplinary artifact that grounded our duoethnographic approaches.

We see our map making dialogue as a mode of duoethnography, where scholars highlight nuances and development of knowledge through interdisciplinary discussions. Duoethnography is becoming a more common approach in HCI research, as researchers think together and meta-reflect on processes and methodologies [7, 34]. According to Sawyer and Norris, “In duoethnography, two or more researchers work in tandem to dialogically critique and question the meanings they give to social issues and epistemological constructs. Working with a critical partner, duoethnographers select social phenomenon or themes to investigate” [61:2]. Duoethnography has been used in several qualitative research fields, for example, it has been used in education research to build theory across researcher experiences of the complexities of their racial identity [4] and experiences of women from working class backgrounds in academia [43]. Duoethnography in these cases bring forward incredible nuance and difference in shared experiences through dialogue and discussion. Duo- and trio- ethnography is also an emerging way of working in HCI research. In Almeida et al. [3] the editors of a special issue on women's health and the body used multi-voiced approach to surface key issues concerning women's health which formally expressed how, “talking, responding, and reflecting is simultaneously an individual and collective task” [3:3] and challenges homogenized, ‘objective’ epistemologies often used to study women's health within dominant science. The approach has also been used to talk about failures in design processes [41] and uncover nuances in shared design methods [11]. Through the use of this approach, we sought to capture the questions, nuances, and interdisciplinary discussion our map-making and map-based discussions generated through drawing sections from our transcribed discussions and pulling out tensions in definitions of sustainability that add to SHCI theory and practice moving forward.



We took turns walking the other members of the research team through our map-making process, allowing the team to ask questions of the process. In our research dialogs, we asked how the other made their maps, what data they used, how they defined sustainability, what they hoped to show about sustainability and redlining through their maps, and what they believe their final results conveyed. However, we often strayed from these topics into discussions about our epistemic and disciplinary lenses, our understanding of Indianapolis' history, revisited lines and clarifications from former discussions we had had about redlining and sustainability in previous meetings, and discussed hypothetical data we wish we had to map redlining impacts differently. We held these conversations over Zoom and recorded each session so that we would have transcripts of our discussions that capture our questions, reflections, and processes. Our recorded material consists of two 1.5-hour long discussion sessions for each set of maps, but the lead up to these sessions comprises of countless hours of relationship building and intellectual exchange around redlining and sustainability in Indianapolis.

As a research team, we use an interpretivist approach pragmatically borrowed from critical discourse analysis, combining close reading [7] and inductively identifying and categorizing themes to understand map-making process, sustainability, and redlining as manifested in these dialogues.

#### 4 TALKING OVER THE MAPS: DISCUSSING RELATIONS BETWEEN HISTORIC REDLINING AND SUSTAINABILITY

In the following, we craft the findings which stem from our own reflections and collective discussions about making our maps, what they meant to us, how they reflect our disciplinary practices and perspectives on sustainability, and how they helped us reflect on redlining. As such, we pass back and forth, framing quotes from our discussions with each other with details and background information about our work to help clarify these moments of discussion for the reader. Ultimately, we share a non-homogenized, dialogical approach to interdisciplinary understanding, showing the differences, tensions, and misunderstandings, alongside attempts at building understanding of sustainability and its ties to redlining together. We ask how redlining can help HCI think about longer-term impacts of data, as well as how redlining can point to how human/human socioeconomic sustainability agendas like impacts of redlining on people over time are associated or in conversation with to human/non-human agendas like ecological posthumanism. The maps enabled us to have an artifact to talk through and with and draw observations from.

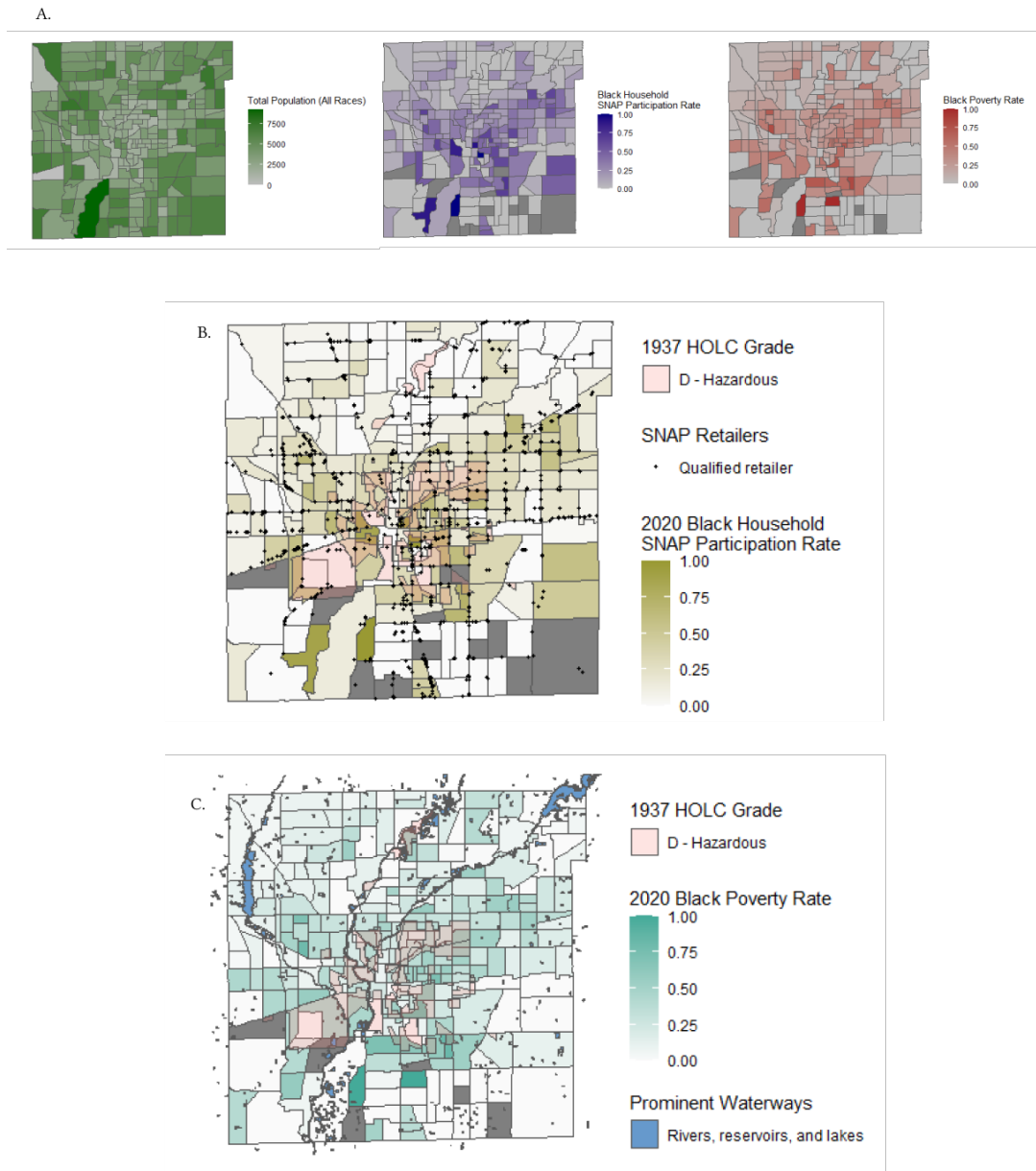
In the following, we start with the basics: how we made our maps. We discuss the disciplinary specific tools and framings we use, the data we work with, and the ideas of sustainability we tried to capture. In the next section, we go into more depth about the techniques we used to try to really get at meaning in the redlining maps in relation to contemporary maps or sustainability outcomes. Finally, using the maps we made and our combined insights, we discuss connections between sustainability and redlining that align and don't align, both geographically and disciplinarily.

#### 4.1 Making the Maps: Different Entry Points and Definitions of Sustainability

We began by discussing how we used maps from our disciplinary angles and how maps helped us understand historic redlining in relation to contemporary sustainability issues. We discuss the cases or challenges we were interested in seeing correlations between, how we build our maps to try to understand these issues (the tools, the data sets), and what types of sustainability we hoped our maps would reflect. We also made a lot of maps that we will reference throughout the findings. Please find them on pages 10-12 or find larger images in the supplementary material.

*4.1.1 A Socioeconomic Approach to Map Making.* A2 is trained as an agricultural economist, and she studies sustainable food systems. As an applied economics researcher, she was very familiar with making maps using R and RStudio to visualize census data. She also used available polygons from the University of Richmond's Mapping Inequality project that quickly helped her integrate the redlining maps into her R code. During our discussions, A2 noted her positionality on sustainability from an economic perspective: "When I was making the maps, I was thinking about poverty. I was thinking about needing food assistance and like having household sustainability. I [realized] when you guys talk about sustainability, maybe it is from what I would consider environmental sustainability." She quickly points out her positionality as well one possible high-level way to characterize the differences in our approaches. Her focus on poverty, which she frames as human and socioeconomic sustainability, influenced the data she chose and the types of sustainability problems she was interested in represented with her maps: "As an economist, we would say largely your quality of life is to some degree determined about your economics," – in other words, your ability to meet your needs and participate in the economy. To these ends, she imported data from the census that would help her gauge a general economic climate around food security and poverty in Black populations in Indianapolis. "I imported data from the census, just the total population of Marion County, the total African American population, poverty status in the last 12 months by age and sex for the Black population and, food stamp or currently what's called SNAP, the Supplemental Nutrition Assistance Program, in the last 12 months by the race of the household."

She chose to map out two different cases to explore the history of redlining in the present context of sustainability. The first map showed an exploration of what she called 'social sustainability' (Figure 3B), she first created a map of the share of Black households participating in SNAP, by census tract, in 2020. She then layered over a subset of the HOLC grade D data, highlighting "hazardous" areas where lending was refused. Finally, she added a layer to represent the social infrastructure of SNAP-authorized retailers (e.g., supermarkets, grocery stores, convenience stores, etc.) that provide SNAP-participating households the opportunity to access groceries using their benefits. She chose to examine SNAP-participating households and SNAP-authorized retailers to represent how the lack of economic sustainability is ameliorated by a public policy that seeks to create social sustainability by providing food assistance.



**Figure 3: A2’s Maps; A. Preliminary explorations of population, Black SNAP participation, and Black poverty; B. Socioeconomic Sustainability Map of Food Insecurity, Historic HOLC grade D tracts, and contemporary SNAP retailers. C. Environmental Sustainability map of Black Poverty, HOLC Grade D, and prominent waterways.**

A2 chose SNAP data because it serves as a proxy for food security. A2 explained, “if your household is 150% of poverty or less, you most likely qualify for this food assistance benefit. I was thinking from a sustainability perspective in terms of, can this household feed itself, given its socioeconomic situation? . . . There’s actually no sub-state measure of food insecurity by race, so this is the closest we can get to know if a [Black] household is food insecure.” In addition, she created variables in R code to target specific data from the historic redlining map. A2 reflected on how for comparisons

between current sustainability and historic redlining, “what is most interesting for Black households is [regions of] HOLC grade D, which were [marked] ‘hazardous’ and were denied loans . . . households that received a C grade, most likely were not going to get a loan.” In these reflections we see her attempts to correlate historic redlining, the denial of loans to Black households, and the ability for contemporary Black households to ‘feed themselves.’ Using her disciplinary expertise, she frames sustainability as the ability to sustain oneself and one’s family in a socioeconomic environment.

She made another map that in some ways was a response to some of the maps that A1 made and about A1's interest in the connection between waterways, pollution, and redlining in Indianapolis (A1's maps were in some ways a response to A2's research in food security as well, as we shall see shortly). In this map (figure 3C), A2 combined waterways, Black poverty rates, and historic redlining marked HOLC grade D. She was looking for connections between the economic value of living near water – which is an opportunity for exercise (health) and increased property value. A2 reflected on how low-income Black families seem to not live near water, but that due to the high value of living by ecological or environmental features like bodies of water could help build wealth, and there is an opportunity to buy homes near polluted water at a low cost, and then clean the waterways, resulting in higher valued homes in the future. Conversely, she reflected on how not living by water could leave more low-income people (without the wealth to afford such properties) out of environmental clean-up efforts which are directed towards bodies of water. This economic angle to environmental value was also something A1 and A3 had never considered before but was really fascinating to discuss.

Framing sustainability through a socioeconomic and food security lens led to the use of specific tools for map making (R and RStudio). It is a very human way of seeing sustainability: to sustain oneself, to sustain a family, to sustain a daily intake of calories, and to make sure basic needs are met. This is perhaps a level of human need and sustainment that can be lost in environmental approaches to sustainability, at times.

*4.1.2 Ecological Posthuman Design Approach to Map Making.* A1 is a design researcher most recently working in the space of ecological posthumanism in SHCI. When asked by A2 what their definition of sustainability was as an HCI researcher, they answered in a very 'process-oriented' way: "well, my research started with climate change . . . so [my definition] has been like colored by that genre of thinking . . . and then I got really interested in posthumanism because I was like . . . I think there's some fundamental weirdness about how we relate to like the environment. Then the longer I look at posthumanism, and the more I'm listening to critiques about it . . . I'm slowly working my way into like, seeing more of like the socioeconomic pieces of climate change." So, in other words, somehow it takes time to begin to connect definitions or genres of sustainability together – but perhaps they do relate (part of the interest in this research stems from this desire to better understand their relationships).

In regard to finding ties between historic redlining and contemporary sustainability issues, A1 was interested in two different case studies. One, supported and inspired by conversations with A2 and prior research [6], they tried to investigate how historic redlining was entangled with food access and security in Indianapolis. To do this, A1, made maps of African American run small farms in relation to food access and historic redlining maps in multiple different ways, using design-related tools like painting contemporary farms alongside historic redlining (figure 4A), overlaying redline maps with contemporary food access maps in Adobe Photoshop (figure 4B), and building a modular interactive map in Adobe Illustrator (figure 6A). In this exploration they wondered if they could draw connections between historic redlining, contemporary food access,

and Black small farms who were working at a community level of food security issues.

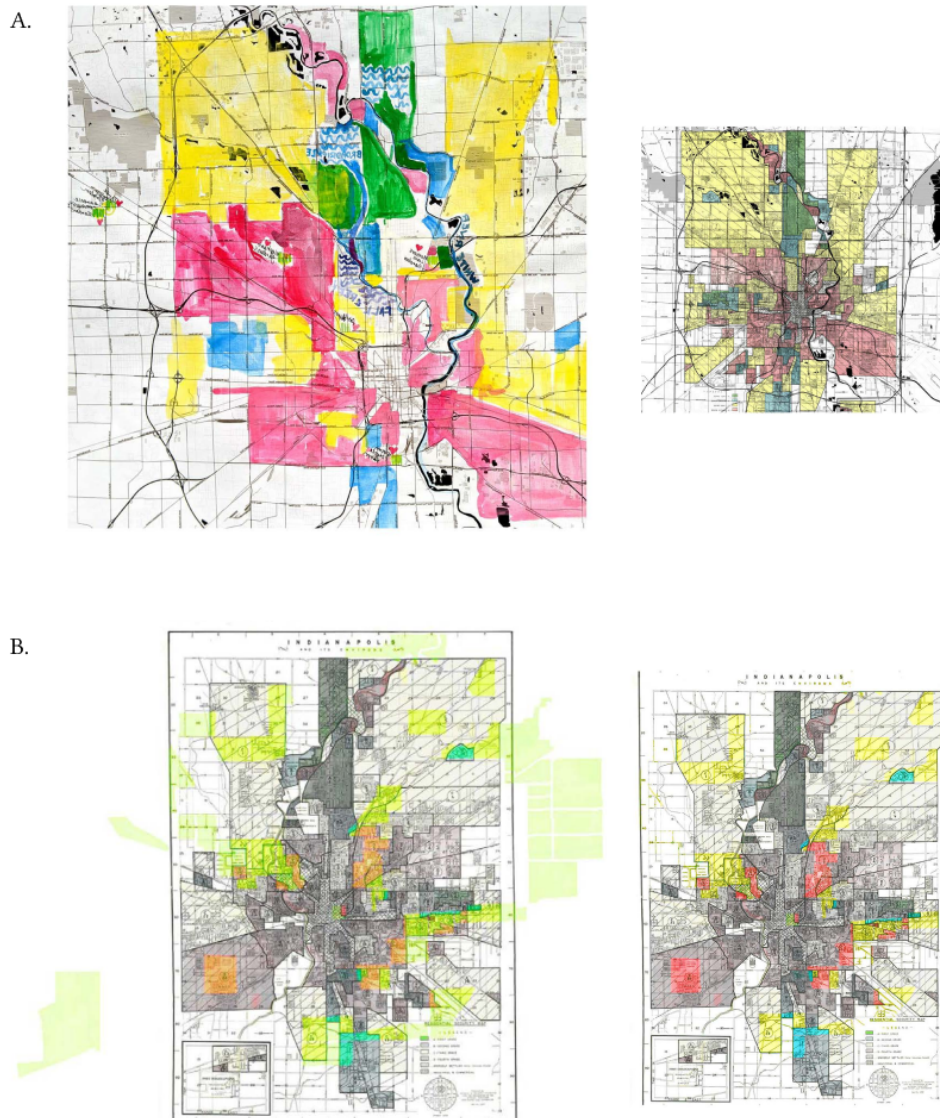
Second, A1 was interested in a story they read in the Indy Star newspaper where flooding and sewage backup was ported from a wealthy neighborhood in the northern part of Indianapolis, called Broad Ripple (which was historically redlined HOLC grade B) through an underground pipe to a historically redlined and poor neighborhood called Fall Creek [18]. This problem was eventually brought to the EPA, after city officials didn't act sufficiently to rectify this environmental challenge. New infrastructure is being built to rectify this situation which will be finished in 2025, but citizens wonder who these improvements will benefit. They wanted to better understand how this infrastructure and flooding case study, that also seemed to involve the Green River and Fall Creek as actors, was tied to redlining more specifically. They explored this throughout their research and they also discovered there are correlations between redlined land associated with factories and current lead content in Indianapolis' soil.

A1 explored these cases by painting the rivers and infrastructure alongside historic redlining (figure 4A), going to the Green River and taking photos of wastewater infrastructure (figure 5A), turning a painting into a video to reflect on water systems and redlining (figure 5B), and maps produced using a modular interactive redlining map in Adobe Illustrator (figure 6A-F). Maps were a way for A1 to grapple with redlining data in a posthuman way, and they have used this method in prior research as well as a way to connect with other people about ecologies in place in other research projects. When asked how mapmaking helped her make sense of these redlining maps, A1 observed, "I guess like as a posthuman [method], the very first set of maps I made (figure 2) helped me understand the geography, the history of the land of Indiana . . . what forces acted on it . . . it just like helped me 'get it.' . . . Like when I would drive to Indianapolis, you know, all of a sudden it's like flat and you're like, "oh, why?" And you're like, "oh, because like glaciers went like over it, you know?"

Finally, thinking of other posthuman theory, like that of Deleuze who discusses non-linear metaphors of becoming and orientation like rhizomic structures and mapping [25], A1 pointed out, "but I also think posthuman-wise also mapping is a way to talk about relationships and show how things are related in a way that's not so linear, so you can kind of see a lot of information at the same time" We notice the multiple ways A1 was thinking about posthumanism here – in a way, posthumanism is an applied theory, for thinking along longer-term timelines or to think about human-non-human environmental relations, on the other hand, it is a philosophical project, with associated concepts, wherein maps serve a theoretical purpose of resisting hierarchies and supporting many paths.

In this specific case of exploring redlining and sustainability, A1's choice of map making was also quite simply or purposefully 'literal.' A1: "I think very naively, I was like, 'redlining is a map. I'm going to make maps with this map.'" But again, they found map making around redlining helped them synthesize and make sense of the redlining data in relation to contemporary places/phenomenon: "I make sense through making, [for example], by tracing this redlining map multiple times, I feel it, I understand where it falls in space and then I go visit [places in Indianapolis] and I remember where [the redline map] was – what I traced – and then I can put those



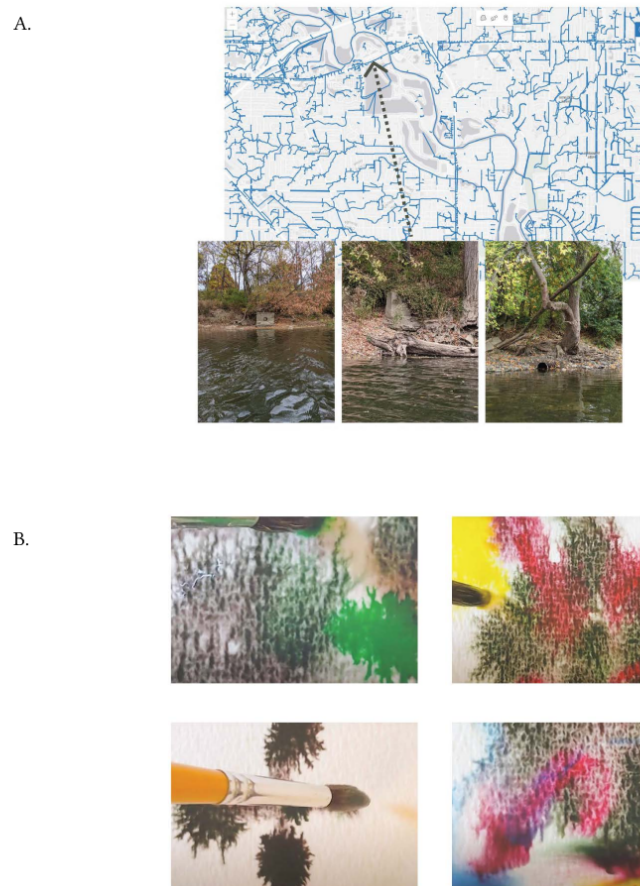


**Figure 4: A1's maps: A. Initial painting of case studies and reference; B. Overlaying redlining maps with USDA food access research atlas maps;**

things together for myself.” They admit to being a very visual and spatial thinker, and that making maps, building things, observing materiality, helped them understand phenomenon and make connections between historic redlining maps and contemporary maps of environmental concern or cases of environmental injustices. Although a different approach and epistemology, and a different way of map making, A1 brought a more ‘ecological’ or environmental lens to the discussion – which can sometimes be a bit undervalued or misvalued in economic analysis (for example, the value of a river on its own terms – as an agent or entity – outside of its value for humans).

## 4.2 Techniques – Material Strategies for Understanding Redlining and Sustainability

So far, we have discussed the basic tools, techniques, and data we used to make our various maps, as well as how those things translated into our own disciplinary understandings and questions about how redlining might relate to contemporary sustainability issues. In this following section, however, we go into more detail about how each author used map making to work through and attempt to answer their questions through map making using map making techniques. In the final section we discuss and sense-make



**Figure 5: A. Sewage map of Indianapolis and photos from the river. B. Still frames from video reflecting on redlining and Indianapolis waterways**

together what we could and couldn't figure out using our maps, what is missing, what aligned and didn't align.

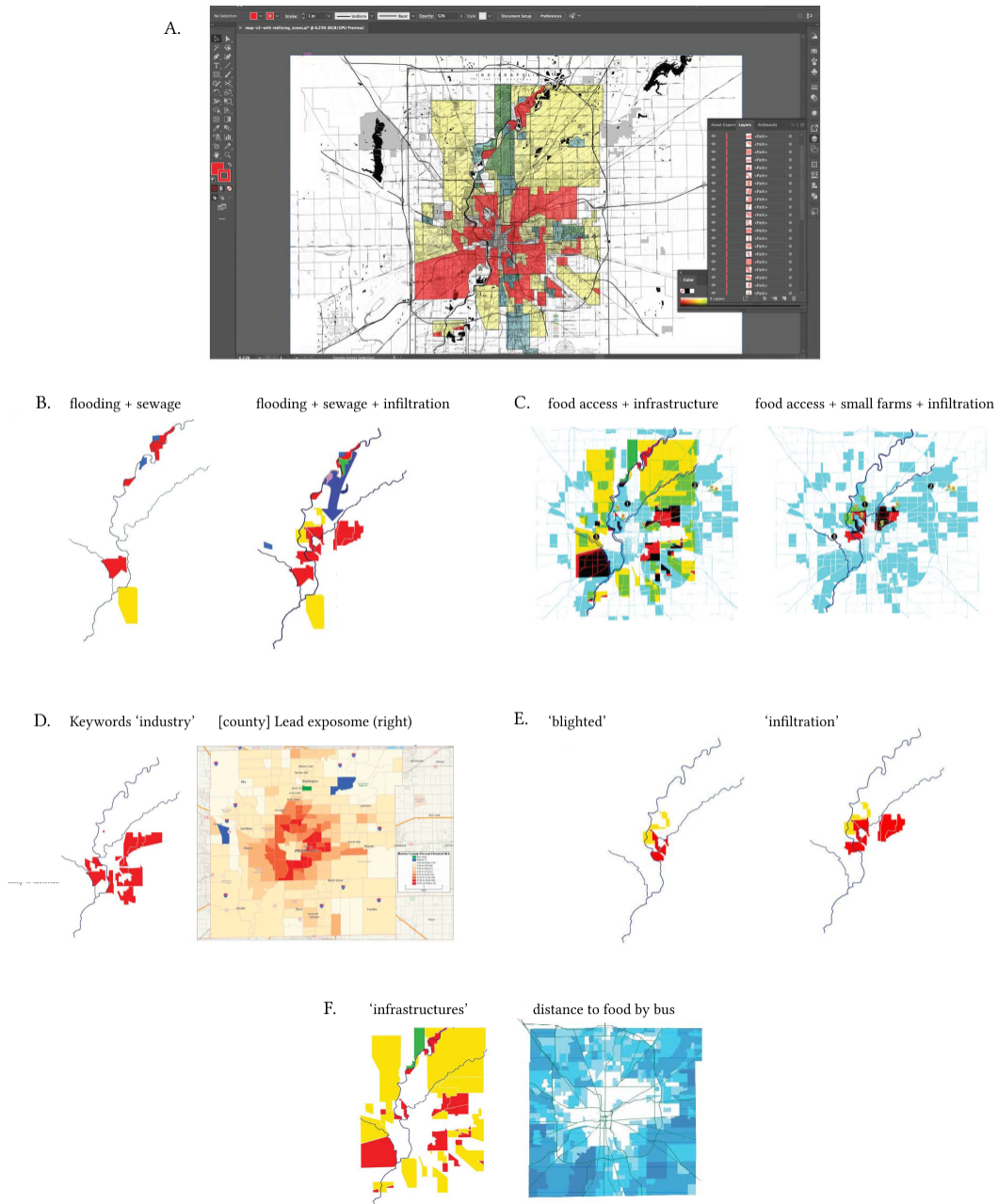
*4.2.1 Layering and Modularity: Answering Questions through Building Relations.* Both A1 and A2 layered historic maps onto contemporary maps. While A2 is good at working with data as a data set that can then be transformed into polygons in R – she made maps by pulling data and building maps using code. A1, however, used material processes and found maps to create layers in Photoshop. A2 specifically discusses layering maps in R.

A2 starts by showing the redline map in R: “This is just me mapping the map that A1 shared of the redlining” She points out the different grades and colors, “so these are the HOLC grades: good, pretty good, not so, and hazardous” Then she describes how she started to layer maps: “I just went ahead and I was overlaying the two maps, so the poverty and food assistance maps I was making with these, other maps.” She then describes her map (figure 3B), “this is a Black poverty rate with the full boundaries of the redlining map overlay.” This map exposes how the original redlining map and city limits were much smaller than the current city limits” as we discussed in the related works. Without layering we might not have noticed this phenomenon so quickly or obviously. There are

tracts and data points in both A1 and A2's maps that lay outside of the historic redlining boundaries which we discuss more in section 4.3.

A1 also did some layering of maps to start their process of trying to understand the connections between USDA and SAVI food access maps (figure 6C, figure 4B) as well as, later to understand more specific aspects of the redlining map made through keyword analysis like the relationship between HOLC grade D tracts related to industrial use and the relationship to lead in the soil (figure 6D). Layering was one of the ways that A1 began to build spatial, visual, material relations between historic redlining and present sustainability challenges.

In their first experiments A1 connected the USDA food access map for Indianapolis with the historic redline map. Interestingly, A1 relayed it was hard to do these overlays using just the straight lines of city streets, especially as the historic map was smaller than the current city limits, therefore they often used rivers as a more organic shape they could follow to line up contemporary and historic maps. They describe their process: “I took it into Photoshop and was playing with layering effects and trying to get only the places where this historic Redline map and this little USDA a map



**Figure 6: A1’s Modular Map Making. A: The map in illustrator; B. Keywords ‘flooding’ and ‘sewage’ then combined with ‘infiltration’; C. Connection between SAVI food access maps and small farms; D. Redlined due to ‘proximity to factories’ and present day lead exposome; E. Redlined due to keywords ‘blight’ and ‘infiltration’; F. Redlined due to lack of infrastructure and current population distance by bus to food.**

connected to show.” This refers to layer properties in Adobe Photoshop – A1 applied settings like ‘saturate,’ ‘hard light,’ and ‘exclude’ to the maps. When layered together, surprising effects can occur like all colors being removed except where the layers overlap, or colors fluorescing where they intersect. A1 reflects on Figure 4B, “it’s almost nonsensical to lay these two maps on top of each other.

Too much time has passed, but as a way of thinking visually, I was just trying to kind of show the colors popping through the surface. Like there’s still impacts here today.” At least in this case, we see that while the correlations are not clear between the redlining map and contemporary food access maps, there are ways of thinking



The figure shows a historical ledger on the left and a modern spreadsheet on the right. The ledger is a form titled 'AREA DESCRIPTION' for Indianapolis, with fields for name of city, description of terrain, favorable influences, detrimental influences, inhabitants, buildings, history, occupancy, sales demand, rental demand, new construction, and availability of mortgage funds. The spreadsheet on the right has columns A through E, containing data for various tracts (B13-B17, C1-C2) with descriptions of their characteristics and influences.

	A	B	C	D	E
1. NAME OF CITY	Indianapolis				
2. DESCRIPTION OF TERRAIN	Level				
3. FAVORABLE INFLUENCES	Negro Park and Municipal Golf C				
4. DETRIMENTAL INFLUENCES	Older type houses. RR tracks a Part of section occupied by low				
5. INHABITANTS	a. Type Negro ; b. Estimated ann c. Foreign-born Nominal ; \$; d. Negro Yes e. Infiltration of Negro ; f. Relief famili g. Population is increasing ; decreasing				
6. BUILDINGS	a. Type or types 1-4 Poor, White ; b. Type of const c. Average age 40 years ; d. Repair. Ve				
7. HISTORY	SALE VALUES YEAR RANGE PERIOD-STARTING \$ RA 1929 level \$1000 to 4000 \$2000 100% \$19 to 1889 low 0 to 2000 1000 50 0 to 16 current 500 to 5000 1500 75 0 to Peak sale values occurred in 1927 and were 110 % of Peak rental values occurred in 1927 and were 110 % of				
8. OCCUPANCY	a. Land 88 % ; b. Dwelling units 108 ; c.				
9. SALES DEMAND	a. Poor ; b. Singlees \$1,500 ; c.				
10. RENTAL DEMAND	a. Fair ; b. * \$14.00 ; c. Activity is Fair				
11. NEW CONSTRUCTION	a. Types None ; b. Amount last year None				
12. AVAILABILITY OF MORTGAGE FUNDS	a. Home purchase Poor ; b. Home building None				

Figure 7: Left, historic ledger, Right, a sample of A1's spreadsheet for compiling redlining keywords.

materially and visually that try to show an idea – that through comparison or overlay, one could see that redlining is still permeating the contemporary landscape of Indianapolis. In another example of layering the lead exposome (or how much lead is in the soil) with historic maps of land graded hazardous (D) due in part to proximity to industry, A1 found a much clearer correlation. The maps look almost identical (figure 6D).

While there was a natural modularity to A2's code which allowed her to quickly put together various versions of her maps, A1 also ended up making a modular, interactive map after using methods that gave them impressionistic notions about the connections between sustainability and redlining and wanted more concrete answers. A1 explained, in her first maps "I was making stuff and just observing what happened materially . . . but, then I was like, okay, I have real questions that don't know how to answer. I'm going try to make this map that at least to me feels like I can have more detailed explorations with." This resulted in their modular map, which allowed A1 to highlight keywords of the redlining map towards comparison and analysis of sustainability. They made this map in Adobe Illustrator by drawing around each individual redlined tract, for each HOLC grade, A-D, and putting each tract on a layer that they could toggle on and off and named each layer with the number and letter the tract was given on the original reports written as justification for how each tract was graded (figure 7). Simultaneously, they made a spreadsheet with all the data from the HOLC redlining sheets so that they could find and use keywords to create modular maps that related to the two case studies they were interested in: food access and flooding of the Green River. This allowed them to create unique maps of specific keywords (figure 6) which they could then overlay with other found maps of food access (figure 6C and 6F) and lead (figure 6D) as well as combined

flooding and infiltration (figure 6B) to ask questions about redlining's connection to flooding, infrastructure, food access, and soil quality. It might seem like extra work to work like this given the power of modern GIS software, but A1 reminds us, that, "I'm a really visual thinker and like spatial thinker. this is just helpful . . . building things is helpful" to allow them to internalize and sense make with data.

4.2.2 *Including Bodies of Water: Thinking with Non-Humans.* Finally, both sets of maps attempted to include water. In A2's maps, she included bodies of water as a way to think through and express the economic value of living near water, and the ways that owning waterfront property would build wealth and add health benefits for homeowners. Conversely, she asked how it might shape ecological, environmental interventions – lower income Black populations who live away from bodies of water might not benefit from publicly-funded 'sustainability' projects in their neighborhoods if these projects solely frame sustainability in relation to 'environmental' landmarks like bodies of water. However, A1 was very interested in the way that the bodies of water extend beyond the city limits, signaling a kind of scope or agency and impact outside of human-defined city boundaries. This reminded A1 of how they used rivers as guides for aligning maps – while human boundaries shifted within 100 years, the rivers running through Indianapolis remained relatively stable. In another map-making exploration (Figure 5B), A1 had created a video, after visiting the Green River (viewing it as an actor, or part of the entangled factors in the history of redlining and sustainability in Indianapolis), to reflect on the difficulty of creating 'hard lines' around bodies of water or in relation to historic wetlands (A1 loved this exercise, but might have had a misunderstanding of the historical prevalence of wetlands and swamps in Indianapolis when they made it).

We were trying to grapple with the data of redlining maps and find relations between with contemporary sustainability issues, when there is almost a 100-year gap between the original redlining maps and the contemporary city of Indianapolis. We did this by layering, drawing forth variables and keywords from our specific cases, and in some cases, including non-human elements to foreground things such as bodies of water and rivers. Despite their different disciplinary backgrounds and tools, A1 and A2 used similar strategies to answer difficult questions about sustainability's relation to redlining. The materiality of maps lent themselves to asking these questions by choosing data which we could build relationships with through layers and modular components. This led us to see some of the challenges and gaps of data in the socioeconomic case of food security given human mobility, but some more slow-moving and stable relationships in the ecological cases of flooding, infrastructure, and soil contamination.

### 4.3 Collaborative Sense Making with the Maps

While we did describe our process and our map making, the various strategies we used to bring the data sets we found to life and bring them into our research questions about how historic redlining relates to contemporary issues of environmental and socioeconomic sustainability through issues like flooding, sewage infrastructure, and food insecurity in Black communities in Indianapolis, our conversation began to converge on alignments and misalignments – both between our maps and our disciplinary orientations.

*4.3.1 Difficult Alignments between Redlining and Socioeconomic Sustainability in the Unique History of Indianapolis.* In the case of socioeconomic sustainability, questions of whether redlining impacted people's ability to feed themselves and their families, we had a much more difficult time finding clear spatial relationships between contemporary statistics and historic redlining maps.

A2 remarked on the need for a longitudinal study to better see the shifts in socioeconomic sustainability over time: “a lot happened in almost 100 years, you know, the map is almost 100 years old now I believe . . . I feel the longitudinal dimension is missing from my maps and maybe even missing from publicly available data. So maybe if HCI is looking for a solution, you know, data mining historical data perhaps could be more illuminating than like trying to figure out a ‘solution’ right now to this. From 1930 to 2022 there are just many, many gaps, for us just taking the 2020 map and layering a 1930 map, it's almost nonsensical, even though I did it, but that's all we can do because there's so much missing data in between.” A1 also mentioned the nonsensical quality of overlapping maps of contemporary food access and redlining above. While they thought there was a promising visual metaphor in layering and finding places where colors ‘break through’ – correlations were somewhat random.

What A2 noticed in her social sustainability map (figure 3B) was that there was a strong concentration of food insecure, poor Black households in a few tracts of the southern part of Indianapolis. A1 also noticed that there were Black run small farms way out on the east side of Indianapolis, outside of the bounds of the original redlining map. A2 reflected on how this relates to the shifts in populations, property values, and gentrification over time. As we discussed prior, the city limits of Indianapolis were expanded

in the 1970s. A2 commented: “when the geography changed, the socioeconomic dynamic changed . . . As property values downtown increased or as coming back downtown became more desirable, black households were moved out of Center City to the east side and the west side. That's why you see a lot of the food insecurity on the east side, because you know, what was ‘red’ [HOLC grade D] in Center City in 1937 is now black and Latino communities, uh, on the outskirts.” Similarly, in Black families were pushed south of Center City, where there is a lack of public transportation on weekends, according to A2. It became clear that understanding the period of time and change in the 1970s would be a very beneficial layer to add to understand more about redlining longitudinal impacts.

*4.3.2 Some Longer-term Alignments: Ecological Sustainability's Relation to Redlining.* While many of the relationships were complex and hard to see perfectly in the relationships built by the maps, there were also some cases where relationships were apparent, and these relationships usually had to do with intersections of land, people, and redlining. Although, again, it is hard to tell exactly the order of causality of some of these relationships.

A1 explained how they saw some relations clearly once they started using their modular keyword map: “I explored keywords that I thought had to do very specifically with race. I explored how those keywords connected to keywords of flooding in sewage infrastructure. And I would say that was probably the clearest story I saw was how flooding from Broad Ripple got pushed into Fall Creek neighborhood and how it's based on redlining” – But to be clear, these neighborhoods had always been dealing with flooding. Broad Ripple was graded B (not A) in part due to flooding and sewage infrastructure, but neighborhoods directly across the river were graded D because poor and African American residents (according to the map documents [63]) were often servants of those rich homes.

This made A1 curious how other keywords were entangled with current sustainability issues. For example, “there was a lot of [low HOLC grading] based on lack of infrastructure. And when you look at like food access mapping today, they look relatively similar (figure 6F)” Similarly, there is a very visual, spatial correlation between lead in the soil and tracts graded ‘D’ for being close to industry (figure 6D). In the case of infrastructure, land use, water ways, and people, there seemed to be some more stable relationships in place that both contributed to HOLC grading, on the one hand, but also relegated poor and non-native-white residents to being in proximity to environmental hazards.

## 5 DISCUSSION

In this project, we used map making to ground cross-disciplinary discussions about how redlining is related to sustainability. Unpacking how we made our maps, and how the maps reflected our own lenses on socioeconomic and environmental takes on sustainability, helped us discuss and consider multiple disciplinary and epistemological orientations to the relations between sustainability and historic redlining. In turn, this helped us interrogate ecological posthumanism by considering how human-human problems are associated with human/non-human relations. While there is an emerging body of work in HCI which argues for anti-racist [1],

intersectional [74], critical race theory informed [66], and justice-oriented approaches to HCI [29], there are less examples of how those agendas intersect with ideas of environmental or socio-economic sustainability. There are some exceptions, like research that examines community design projects in historically redlined neighborhoods [67]. Socioeconomic sustainability doesn't often enter the discourse of environmental sustainability in SHCI, which often concerns itself at a systems level in relation to design and technology, on issues such as production cycles [14], possible political and economic approaches [28, 30], or designerly cases of use and repair [27, 36, 45, 65]. In the case of ecological posthumanism, SHCI frequently engages with friendly others, like birds and mushrooms [9, 53], but we wanted to push posthumanism into a case where human/non-human intersections intersect with human/human issues like historic redlining which has long-term impacts of African American populations' socioeconomic sustainability. Suppositively, ecological posthumanism is a tool for redirection and grappling with climate change – but how can we deal with futures of ecological insecurity without examining the past which lays the groundwork for emerging terrains of sustainability? In our discussion we think through our definitions of sustainability and the tensions we uncovered in comparing our maps of sustainability as well as the missing and speculative data we could use to think through these concerns further.

## 5.1 Mapping Terrains of Sustainability

In this project, we tried to keep the spirit of our discourse alive, because more than definitive answers about how we should define sustainability in SHCI, or which approach to sustainability is better or best, what we found informative were our differences, moments where we were at a loss, where we found ourselves learning totally new ways of thinking about sustainability, where we used maps to think through what was missing, and what else we would want to know.

Immediately, A1 and A2 found interesting dissonances in their definitions of sustainability, things they hadn't perhaps realized they held for granted. In one discussion, A2 observed that a lot of activism and sustainability work within minority communities is focused on human sustainability. At one point, A2 mentioned Maslow's hierarchy of needs, and that to think beyond 'today' – into futures or environmental sustainability, one needs one's basic needs met like food and housing. It made A1 reflect on how their own ecological focus as a sustainability researcher must rely on some baseline of socioeconomic stability. By this logic, in some ways ecological posthuman research agendas would not be realistic or concrete without baseline socioeconomic stability, and therefore, socioeconomic and human stability should be a primary concern for ecological posthumanism. While design theorists like Tony Fry talks about *sustain-ability* (our ability to sustain life on earth) [33] in terms of re-designing design, he may be thinking of it at a secondary level which takes for granted a more primary level of sustain-ability, the ability to sustain oneself and one's family and provide basic needs.

One benefit of ecological posthuman thinking is it seeks to fundamentally reorganize human exceptionalism and exposes the ways that a human/non-human binary construct unsustainable

conditions for living on a shared planet. As has been noted elsewhere [5, 57] this is a sensitivity researchers develop which, we believe, is part of untangling the human/human hierarchies that human/nature binaries enable. However, ecological posthumanism, when attending too much to non-humans, can lose track of human oppression and difference, and a socioeconomic perspective and focusing on historic redlining brought nuance and trouble to ecological posthumanism. We call for SHCI researchers interested in posthumanism to continue to explore sustainability and new orientations without assuming western starting points or losing sight of the unequal impacts of environmental entanglements.

On the other hand, in A2's map about environmental sustainability, when she described environmental value in human economic terms, A1 reflected on the way ecological posthumanism opens up the possibility of valuing bodies of water as beyond of values to humans – or in ways that decenter the human. While A2 argued water is valuable for humans for recreation and health reasons (yes), A1 was thinking about how water is also often used as a resource or a sink for 'permissible pollution,' in the words of Max Liboiron [51], which can lead to pollution which 'trickles down' to residents who, through perhaps racist and classist socioeconomic factors and policy like redlining, are pushed into contact with these environmental harms. There may be no one 'correct' starting point for thinking through the complex problem of sustainability. Coincidentally, a map is the perfect metaphor for taking multiple, possible paths within a similar terrain – we argue that it is not useful perhaps to argue for an approach which is 'best' but to begin to map the terrain of sustainability from many starting points.

In our collaboration, we began to think about the entanglements of human/human problems with human/non-human relationships in specific redlined geographies. When A2 introduced the research team to the possibility of investigating food systems and historic redlining, A1 thought it was also the perfect way to put ecological posthumanism into a stress test that began to address critiques like how it homogenizes human experience and thinks at scales that erase histories of colonialism and racism. But beyond that, A1 hoped that this example would push cases of human/non-human relations away from the scale of animals and mushrooms into historical, challenging orientations that also have associations with human-human problems. Ecological posthumanism, to A1, might also explore in what ways humans guide certain human relationships with non-humans based on hierarchies of power and racial policy, as in the case of redlining. Who gets to own property and afford food? Who gets exposed to raw sewage? These are also human/non-human relations built through human/human problems like historic redlining.

Does this case turn ecological posthumanism inside out? Are all human/non-human relations derived from human-human problems or relations? We contend that human/non-human relations and human/human problems can intersect without perfectly overlapping. They deal with intersecting, but non-identical terrains. Imagining them as the same problem space or research area would limit the multiple possible ontologies or ways of seeing the world that exist for building relationships to land, like Indigenous ontologies [46,79] or alternative starting points for posthumanism as in the case of Zakiyyah Iman Jackson's work which uses human/non-human relations in African diasporic literature as a 'way in' to posthuman



thinking [42]. A2 even brought this in one of our earlier discussions, reflecting on how frustrating it was to be in discussions about food security that assumed a dominant white lens. Applying this logic to posthumanism, she suggested there may be multi-humanisms that connect to multi-non-humans, in other words, there may be niche ways that some humans interact with some non-humans in ways that escapes an assumption of a universal humanism. There are many entry points from which to imagine human/non-human relations, just as there are many entry points to sustainability, and while we tried to bring multiple views of sustainability into this work, investigating multiple human/non-human relations is perhaps something we could develop more in future work.

Layering maps was simultaneously a practical map-making method and a meaningful metaphor for how we might see the intersections of our two sustainability agendas, as hinted at in the end of section 4. The layering was multi-faceted. First, we noticed the disciplinary differences we expressed materially through the maps we chose to make, the methods we chose to employ to make them, and the ways in which we chose and worked with data. While A2 was committed to finding ways to represent socioeconomic sustainability through publicly available data like census and social welfare data, A1 worked with digital and analog materiality, historic ledgers, texts, and even contemporary newspaper articles to build out maps and search through keywords. Both sets of maps used layering to produce meaning and drawing from our disciplinary training, we expressed and attended to different subject and material sensitivities, ways of seeing data, people, ecological actors, and geographies through the disciplinary framing and research questions of the research team. We contribute this method to the HCI community, suggesting maps can be used beyond geographers as artifacts helped us think through redlining's connections to sustainability, and further helped us sense our orientations as researchers and collectively work toward an alternative and even a totally new orientation built through our exchanges.

In addition, through our mapping activities, we started to notice two different paces, or speeds, at which our sustainability agendas moved. In the case of socioeconomic sustainability, while we believe there are connections between redlining and food security, seeing those relationships in the maps was difficult. We believe this is due to the expansion of city limits and multiple shifts in the demographic terrain of Indianapolis over the course of 100 years. However, in the case of more 'environmental' conditions or human/non-human relations associated with redlining – like flooding, lead pollution or infrastructures – it was easier to see how these factors shape the terrain or relate to redlining in the form of flood plains and lead levels in soil, for example. Yet, these ecological and infrastructural challenges sometimes set the stage for socioeconomic geographies through redlining. Therefore, through the metaphor of layering, we can see how there are different factors of sustainability moving at different speeds that intersect and impact one another, not always in perfectly linear ways. As noted throughout this paper, layering (in various exchangeable configurations) is a way of seeing two perspectives together without collapsing them. These perspectives have their own unique latitudes, temporalities, and gaps, that held together are perhaps either made obvious by, challenged by, and at times helped by the other mapping. Holding together two points of view makes new paths

possible and allows new patterns to emerge. We hope that SHCI practitioners can build multi-story, hearty and layered terrain by acknowledging the importance of working on sustainability from many approaches together, with different starting points. This adds to emerging agendas of ecological posthuman decentering, noticing, and design [5, 20, 21, 42, 45, 57] while striving to connect this agenda to social justice and environmental justice [1, 23, 43].

## 5.2 Historic Data, Missing Data, and Shifting Impacts – Speculations and Next Steps

Another challenge we hoped to raise in this research was to ask how we, in HCI or SHCI deal with historic data, and, building off of data scholars like Loukissas who argues all data are local [47], how we understand data, and issues of sustainability, as grounded, locatable, and historically situated. While many scholars point out the ways that contemporary data practices like machine learning and artificial intelligence, are 'world building' – the example of historic redlining shows is one of many examples that showcase how historic data practices have already always been shaping material geographies and economic outcomes.

The policy of redlining and redlining maps are around 100 years old, and yet the reverberations of the impacts are still being measured and felt today [36, 38, 39, 66], even after the Fair Housing Act declared redlining illegal [74]. In the following we showcase some of discussion about the difficulty of measuring food security and food access by race, possible speculative data sets we would like to have access to better understand the intersections of sustainability and redlining, and the shifting terrain of challenges to wealth building and discrimination for African American communities that occurred even after redlining was made illegal, and offering possible things to consider when thinking about historic data practices and how they carry through to today.

While describing the data used to build her maps, A2 actively questioned the ways data reflected reality. For example, when describing her 'proxy' method for measuring Black food insecurity by pulling statistics for Black families who use SNAP benefits, she first thought aloud, "this is assuming like the head of household is black. I think as society gets more multicultural and households are not homogenous census will probably have to do something about this . . . maybe my husband would count as head of household, so then does that mean my household is white because my husband is white?" In addition, A1 asked about the policy and access to SNAP benefits in Indianapolis. The state of Indiana is notoriously conservative, and automation in the early 2000s made social services harder to access social services [eubanks]. A2 admits that conservative states like Indiana often turn federal TANF (Temporary Assistance for Needy Families) block grants to states into family values programs instead of simply providing cash for families in need. These discussions highlight the complexities in measuring food insecurity in Indianapolis.

Secondarily, we discussed the difficulty in tracking complex shifts in how redlining distributes wealth and shapes geographies after redlining was eased at a federal level. There were clearly major shifts in the 1970s to the city boundaries of Indianapolis which changed the demographics and geography of Indianapolis. This geographic reorganization makes seeing linear relationships between

past and present impacts of redlining difficult. We discussed the possibility of creating a secondary set of maps or analysis of major changes in the 1970s, which included extending the city limits as well as the construction of disruptive freeways through historically black neighborhoods. A2 also observed that perhaps it would be interesting to see data, starting in the 1960s about the race of grocery store ownership in Indianapolis. She wanted to know when black ownership of grocery stores started to decline – before it seemed there were more black-owned grocery stores. After redlining was eased, Black people could leave black neighborhoods, and white-owned grocery stores were coming to Black neighborhoods. However, this also distributed wealth differently, as white grocers didn't hire Black residents, or paid them less (Kroger was sued over this in 2001 [76]) – and wealth from Black communities was no longer going into Black-run grocery stores.

Imagining how else we might collect data across, inspired by A1 bringing up generational wealth, generationally, A2 reflected on her own family, suggesting maybe there is a way to create maps that view A2 builds possibilities for data collection by reasoning through her own familial generations, “my grandma was born in 1932, so this for me would be three generations and I have kids, so maybe four generations old of a map” referring to the redlining map. If we are curious about generational wealth, maybe we could make with layers “at each generation” to track changes in redlining, geography, and its impacts. These considerations open up questions about how we can grapple with historical data, and the kinds of challenges we face when tracing the shifting terrain of racist data practices like historic redlining into contemporary sustainability issues. Through this project, we hope to open provocations, joining other recent work on environmental data's ties to colonialism and racial histories in the United States [29, 40, 43], about how environmental challenges have specific, racialized, embodied histories in place, tied to historic data practices. We suggest one emerging way to work with problems of sustainability is to incorporate historic research as part of the broader research practice and proactively and creatively engage in “data work” [60] to help surface and tell lost or difficult stories. In addition to looking back at historic data, SHCI researchers can also use this as a provocation to forecast and continue to consider the potential long-term impacts which data products generate and how they may negatively impact under-resourced humans and the environment. We hope this paper provokes practitioners of SHCI, and especially those interested in more-than-human design, to more actively seek ways to trace the intersections between how human/non-human challenges are scaffolded on and related to human/non-human relationships. For the ecologically posthuman agenda in SHCI to be radical, and for the SHCI agenda to be meaningful more broadly, we must keep working toward addressing these relationships collaboratively.

## 6 CONCLUSION

In this research we hope to open a dialogue about the historically situated nature of racialized data practices and how they connect to socioeconomic and ecological posthuman agendas in sustainability. While not a perfect coupling, these two lenses bring to light various scales, speeds, and relationships at which data practices materialize human/human and human/non-human relations. Over time, and as

intelligent data practices and systems permeate the world, as a field we must examine how historic cases of sustainability tied to data practices will shape and permeate future cases of sustainability – both socioeconomic and environmental – across intersectional axes. This is a dimensional, generational, geologic, political, and social problem. We must look for many ways ‘in’ to sustainability in HCI – with sensitivity to the various worlds these ‘ways in’ intersect with and build across multiple goals and framings of sustainability.

Even if inconclusive, we can see, through this analysis, the entanglements of the human and non-human, and the different kinds of timescales and data sets required to capture some of the more fast-moving changes that occur in a city over the course of a lifetime or a generation. Through explaining our map making processes, our different disciplinary training and definitions of sustainability, and the techniques we used to better understand our data, we found some tenuous relations between both socioeconomic and ecological sustainability and redlining. While we could use more data to flesh out a more detailed picture of food security's ties to historic redlining in Indianapolis, using the metaphor of layering that we began to explore with our maps, we see these two disciplinary approaches as perhaps layered, showcasing moments of dissonance, entanglement, and complement. We wonder if sometimes plurality can be visualized not as totally different worlds, but possible lenses or layers, which although partial, can in conjunction, bring forward tensions as well as moments of emergent understanding.

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