Rising Scholar:

The Long-term Effects of Redlining on Climate Vulnerability and Food Insecurity

Segregation promulgated by lending and real-estate institutions since the 1930s continues to impact historically marginalized communities today. Nearly a century ago, the Home Owners Loan Corporation (HOLC) denied credit to individuals of color seeking housing in urban areas, effectively creating racially segregated neighborhoods. Private banks and mortgage companies relied on color-coded maps created by the HOLC to channel people of color into neighborhoods deemed low-yield investments.[1] Residents in redlined communities, who were predominantly Black, continued to face systemic barriers when trying to access loans or credit for business or other ventures. This made it difficult for them to invest in their communities, expand their employment opportunities, access education, and improve their homes. Redlining policies, and subsequent restriction of funding to Black residents, reinforced racial inequities.[2] Redlining created lasting inequities that span far beyond the realm of real estate and finance.

Since redlined neighborhoods were designated as undesirable for investment, they received less public and private funding. Over time, this lack of investment led to deteriorating infrastructure. Roads, public transportation, schools, and utilities were underfunded and fell into disrepair, further hindering business development. Underinvestment in these communities and insufficient infrastructure further depressed property values and intensified poverty.

In addition to poor infrastructure, redlined neighborhoods lacked grocery stores, greenspaces, and health care facilities.[3] This made it harder for residents to access nutritious food, enjoy recreational spaces, and receive adequate medical care, contributing to poorer health outcomes and lower quality of life. Furthermore, the lack of green space created “heat zones.” As temperatures rise, these areas bear the brunt of climate change.

Climate change exacerbates both food insecurity and heat vulnerability in historically segregated communities.[4] Evaluating the impacts of climate change and food insecurity through the lens of historically racist lending policies sheds light on the intersection of environmental impacts, socioeconomics and social justice.

The Impacts of Climate Change on Redlined Communities: Green Spaces Aren't Just for Fun

Denial of investments in environmental capital, combined with continued underinvestment in historically redlined communities, intensifies climate vulnerability. As climate change worsens, regions lacking shade and heat absorbing greenspaces grow dangerously warm. Known as the "urban heat island" effect, temperatures in marginalized neighborhoods are on average significantly higher than in non-redlined areas. This makes these low-income communities more vulnerable to heatwaves, a growing concern as climate change intensifies.[5]

Foliage plays an equally important role in urban ecosystems as it does in natural environments. Leafy trees shield neighborhoods from the sun, providing respite from spells of extreme heat that will only increase in frequency as climate change intensifies. Redlined areas still experience lower property values which impact local taxes and prevent neighborhoods from investing in vegetation, trees, and green infrastructure.[6] As a result, these neighborhoods tend to be deficient in "environmental capital," such as tree canopy coverage and parks, that naturally mitigate the impacts of climate change.[7] As shade coverage is often sparse in redlined communities, residents are more vulnerable to heat waves.[8]

In addition to tree canopy, ground surface perviousness is a valuable measure of environmental capital: regions with more permeable surface area are better able to absorb rainfall and intercept storm water runoff, whereas regions with impervious surfaces are prone to

flooding, erosion, and water pollution.[9] In their study on *The Long Term Effects of Environmental Risk Exposure,* Conzelmann et al. found that redlined neighborhoods have significantly reduced permeable surface area compared to their wealthier counterparts. The lack of permeable surfaces in redlined neighborhoods directly contributes to the increased flood risk.

Since environmental and economic capital are inextricably linked, a lack of either results in a series of mutually reinforcing consequences: the absence of tree canopy coverage and flood management techniques depress property values in historically deprioritized communities, perpetuating the underinvestment in sustainable infrastructure.[10] The relationship between ecological and fiscal wealth is bidirectional: Financial disadvantage prevents climate resilience, while climate vulnerability complicates socioeconomic disadvantages in racially segregated neighborhoods.[11]

Economic Impacts Resulting from Low Investment in Environmental Capital

As climate change worsens, lower-income households will face unprecedented financial strains as they navigate health-care costs and property damage caused by environmental catastrophes.[12] Reluctance to invest in historically redlined communities siphons resources away from sustainable development initiatives. Cash-strapped neighborhoods struggle to invest in environmental capital that could mitigate the effects of climate change, even as climate-related disasters and their financial repercussions jeopardize basic needs. Capital investments and infrastructure improvements are funneled to wealthier communities, where resources for safe and accessible food and water, education, healthcare, transportation, and recreation are not only expected but readily available.[13]

Infrastructure extends to building codes and housing construction that impact the lives of low-income residents. Poor building insulation can exacerbate the effects of extreme

temperatures. Many buildings in low-income neighborhoods lack air conditioning. When it is available, it is expensive to operate and maintain. Meanwhile, inadequate drainage systems can lead to more severe flooding, causing property damage and loss of housing. The disproportionate financial strains caused by heat stress, flooding, and other climate events, compounded by a lack of solid infrastructure reinforce the vicious cycle of low property values, underinvestment, and health vulnerability in historically redlined communities.[14]

The Intersection of Climate Change and Food Insecurity

The dual effects of climate change and redlining further impact the many forms of social vulnerability and health consequences that stem from food insecurity. As climate change intensifies, food prices rise precipitously.[15] Droughts, shifts in seasonal weather patterns, extreme heat, changes in precipitation pose a direct threat to crops.[16] Lack of tree canopy plays a role here, as well.

Forests, which are not intuitively associated with domestic crop production, play an important role in agricultural resilience: they stabilize temperatures and water distribution within woodland ecosystems, and harbor crucial crop pollinators. Historically redlined communities, already lacking tree coverage, suffer even more from nearby forest damage. As climate change damages forest ecosystems, nearby food crops will grow more vulnerable.[17]

Climate change exacerbates global food insecurity through decreased food production and nutrient value, as well as through increased pricing. This can result in food shortages, particularly for fresh and healthy foods, which are already scarce in many low-income areas. The Food and Agriculture Organization of the UN asserts:

> 'Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (World Food Summit, 1996).' This definition gives rise to four dimensions of food security: availability of food, accessibility (economically and

> physically), utilization (the way it is used and assimilated by the human body) and stability of these three dimensions.[18]

Low-income communities of color are particularly sensitive to shifts in food availability and affordability. Food insecurity often forces people to rely on cheaper, less nutritious food options. As climate change exacerbates food scarcity, this issue is magnified, leading to higher rates of malnutrition and diet-related diseases like diabetes and heart disease, particularly in vulnerable populations already at increased risk for these health consequences. Food deserts, areas without easy access to affordable, healthy food, are more common in low-income neighborhoods, compounding health disparities.

As climate change drives up food prices and reduces the availability of essential goods, residents of historically redlined communities may need to spend a larger portion of their income on basic necessities. This financial strain can push families deeper into poverty, making it even harder to escape the cycle of deprivation.

Climate change threatens food security on a global scale, which in turn impacts food systems at the community level.[19] As reported in the Intergovernmental Panel on Climate Change (IPCC) study modeling the projected impact of climate change on food security, "the highest scenario of warming found a mean effect on yields of four crop groups (coarse grains, oil seeds, wheat and rice, accounting for about 70 percent of global crop harvested area) of minus 17 percent globally by 2050 relative to a scenario with unchanging climate."[20] If climate change causes these staple food groups to grow more scarce, they will become increasingly expensive. Rising food prices form yet another barrier to access for low-income communities where nutritious food is already in short supply. Urban-rural linkages between consumers and farmers are therefore threatened by climate change. Failed crop yields not only hurt growers financially

but reduce access and affordability of fresh produce in nearby cities. In lower-income urban neighborhoods, rising food prices can be devastating.[21]

Population growth and concomitant increases in food demand, coupled with declining agricultural productivity, pose a dilemma for the farming industry. In their quest to maximize crop and livestock output, some farmers are changing their land use practices in ways that exacerbate the very limiting factor they seek to overcome: climate change. In the effort to counteract low yields resulting from drought, soil nutrient depletion, and heat waves, they compound the issues. The overapplication of synthetic nitrogen fertilizers, intended to boost crop yields, accounts for an increasing proportion of anthropogenic nitrous oxide (N_2O) emissions—a direct cause of global warming.[22] Agricultural land expansion, a seemingly obvious tactic to augment harvest output, is ultimately counterproductive: broadening arable land and pastoral acreage sometimes comes at the expense of existing forests, which absorb atmospheric carbon dioxide (CO_2). It also requires the decimation of meadows that support crucial crop-pollinators.[23] Deforestation and soil management increase CO_2 emissions, furthering the greenhouse effect that drives climate change, and consequently undermining crop resilience.

Cities and rural agriculture businesses depend on each other, and this mutual relationship is crucial for poor urban communities in particular. Sustainable farming practices, like food forestry and multi cropping, are emerging as potential solutions to crop vulnerability, agricultural carbon emissions, and the resulting cycle of food insecurity.[24] According to Saithwaithe, “many urban dwellers have relations with rural dwellers to guarantee their food supply.” These connections include farmers markets and food cooperatives that simultaneously boost the local economy and improve the accessibility of fresh, nutritious produce. Even if city residents do not have direct connections with rural farmers, the accessibility and affordability of their produce

heavily depends on the success of the local agricultural sector. Meanwhile, rural farms rely on urban consumers to afford and purchase their produce. Both sides of the urban/rural linkage must be considered when assessing the causes and implications of food insecurity at the community level.[25]

Not only does climate change diminish agricultural productivity, increased atmospheric CO_2 concentrations actually decrease the nutritional value of the crops themselves.[26] In addition to a physical lack of food, food insecurity can also manifest as malnutrition. As stated by a study on climate change and nutrition-associated diseases, "the nutritional quality of certain grains and legumes will also decline with elevated atmospheric CO_2 concentration, leading to increased risk of zinc and iron deficiency among the nearly two billion people living in low and middle income countries whose zinc and iron uptake depends ~70% on these crops."[27] Many low income urban communities in the U.S. have health outcomes more similar to those in less developed countries than to the general population of the U.S.[28]

As both food quality and availability decrease, food costs rise. Climate-related food shortages disproportionately impact lower income redlined communities by driving up produce prices. As stated by Fanzo and Downs, "this reduction in food affordability will be compounded by an increase in economic losses (for example, lost livelihoods) related to climate change and extreme weather events." The same study found that in 2019, "every 1°C temperature increase was associated with a 1.64% global increase in the probability of severe food insecurity, which in turn drives malnutrition (both undernutrition and overweight/obesity)."[29] Not only will fresh produce become less affordable, staple crops like rice, wheat, maize, oats, and barley will grow more expensive. By 2050, cereal prices are projected to increase in cost by up to twenty-nine percent as a result of climate change.[30] Climate change exacerbates food price volatility by

destabilizing supply and demand dynamics, shifting agricultural production and trade patterns, and reducing overall food availability.[31] While climate change negatively impacts food security on a global scale, redlining further exacerbates food insecurity in vulnerable urban populations.

Global Events Have Local Impacts

The Lasting Impacts of Redlining on Food Insecurity Today

Independent of climate change, historically redlined neighborhoods are more vulnerable to food insecurity due to the proliferation of fast-food chains and supermarket disinvestment, perpetuating socioeconomic inequities. The inordinate rates of food insecurity in historically Black and marginalized communities are well documented, but the connections between redlining and unhealthy food environments are sometimes overlooked by current-day policymakers and researchers.[32] Redlining contributes to a cyclical pattern of stagnating socioeconomic mobility, lack of economic development, and relocation of grocery stores. Historic systematic underinvestment in "undesirable," predominantly Black neighborhoods turned this label into a self-fulfilling prophecy: devoid of funding and economically stagnant, redlined communities were characterized by crumbling infrastructure and dense populations of low-income individuals.[33] Even after the Fair Housing Act outlawed redlining in 1968, the disparity between desirable white neighborhoods and underfunded Black neighborhoods persisted.[34] "Redlining basically blocked Black families from accumulating socioeconomic resources. This practice impeded the upward mobility of disadvantaged Black families, prevented the accumulation of generational wealth, and impeded the ability of families to break the existing patterns of racial residential segregation."[35]

Redlining contributes to the reluctance of grocery stores to locate in historically undesirable communities, thus preventing future economic development and reinvestment.[36] The

tendency of supermarkets to purposely avoid minority neighborhoods, with the assumption that residents cannot afford enough produce to boost the store's profit, bears an uncanny resemblance to redlining. Supermarket redlining is a term used to describe a phenomenon in which major chain supermarkets are disinclined to locate their stores in inner cities or low-income neighborhoods and usually pull their existing stores out and relocate them to suburbs.[37] During their brief sojourns in redlined communities, supermarkets tend to push out smaller grocery stores that historically served residents. When the grocery chains relocate to wealthier white neighborhoods, vulnerable communities end up stripped of healthy food sources–both from small-businesses and commercial.[38] The resulting food deserts present lucrative opportunities for convenience stores and fast food vendors to position themselves where hungry residents have nowhere else to turn.[39] Communities in which residents have difficulty accessing affordable, nearby, and nutritious food are called food deserts. As stated by the USDA, "a census tract is considered a food desert if it meets a certain threshold of poverty, and if at least 500 people or one-third of the population reside more than a mile from a large grocery store."[40] A given community still qualifies as a food desert if existing food is accessible and affordable, but not nutritious.

The Economic and Climate Consequences of Supermarket Redlining

The residual socioeconomic impacts of historical redlining exacerbate food insecurity and in low-income communities, priming them to ultimately become food deserts. Residential racial segregation localizes unemployment, economic disinvestment, transportation inequities, and unsustainable landscaping techniques that drive away healthy grocery markets and attract fast-food chains.[41] Supermarkets are dissuaded by the residual stigma surrounding neighborhoods

deemed undesirable, deterred by deteriorating infrastructure, suspicious of elevated crime and poverty rates, and drawn to wealthier suburban neighborhoods that can afford pricier produce.[42]

Supermarket redlining also reinforces patterns of racial residential segregation. Food insecurity lowers the property value of neighborhoods, perpetuating historical disinvestment. A reputation as an unhealthy food environment contributes to the long-established stigma attached to these communities, deterring new businesses and prospective homeowners.[43] The absence of supermarket chains in these residences signifies a dearth of local job opportunities in the grocery industry.[44] Community members in food insecure neighborhoods often face a long commute into the suburbs in order to purchase healthy foods or work in the supermarkets located there. In fact, residents of redlined neighborhoods must travel an average of 1 to 1.25 miles more to the nearest supermarket than residents from predominantly white neighborhoods.[45] The carbon costs of this extra transportation contribute to climate change.[46] As noted previously, higher atmospheric CO_2 concentrations diminish the nutritional value of produce,[47] while the greenhouse effect exacerbates global climate-related food shortages. The reciprocal relationship between food insecurity and carbon emissions is self-perpetuating.

In addition to indirectly exacerbating climate change, the disparity between commute distance to grocery stores has direct socioeconomic consequences. As explained by Li and Yuan, "such physical isolation from suburban jobs, together with discrimination in the housing market and lack of public transit, exacerbated a rising spatial mismatch and fueled the psychological distrust." Thus, the impacts of supermarket redlining actually exacerbate the symptoms of poverty and underinvestment that cause supermarkets to abandon and eschew historically redlined communities.[48]

Not only does supermarket redlining strip historically marginalized neighborhoods of nutritious food, but it also introduces the opposite; fast food chains and convenience stores take advantage of community members lacking the means to prepare healthier options. It is important to note that low quality food is not necessarily less expensive than more nutritious choices. For example, a McDonalds Big Mac, weighing 220 grams, costs nearly $6. On the contrary, 454 grams of lentils (equivalent to thirteen servings) costs less than $2.49. Thus, the barrier to nutritious choices in a food insecure community may not be the price of the food itself, but a combination of educational, cultural, infrastructural and socioeconomic factors. Members of historically redlined neighborhoods frequently face precarious housing conditions. The disproportionate climate vulnerability of these residents can partially be attributed to faulty or absent infrastructure; many homes in redlined communities lack air conditioning systems, an inequity growing increasingly dangerous as heatwaves intensify.[49] Similarly, food insecurity in redlined communities is in part caused by a lack of cooking essentials, including stoves and pressure cookers, which are often necessary for the preparation of nutritious meals.[50]

Health Consequences of Supermarket Redlining

Residents of redlined neighborhoods may not be familiar with or know how to prepare healthy food choices.[51] From this vantage point, it is understandable that a Big Mac would be a more feasible option than a pound of lentils. Food insecurity is still an economic issue, because the ability to cook depends on whether residents have access to expensive food preparation technology. Furthermore, nutritious food options may not be accessible simply because, unlike fast food chains that position themselves conveniently in low-income neighborhoods, healthy grocery stores are often not in close proximity to residents.[52]

Historically redlined neighborhoods are disproportionately exposed to these fast-food chains, which deliberately target low-income Black populations. “Because African Americans have high rates of poverty, and segregation spatially contains poverty in discrete neighborhoods, it thereby concentrates fast food."[53] Fast food chains strategically exploit these historically redlined, food insecure neighborhoods communities by profiting off of supermarket disinvestment. Fast food chains seem to be drawn to the very same characteristics that deter healthy grocery stores in vulnerable communities: a low-income customer base, high crime-rates, underfunded public services, disintegrating infrastructure, and low-quality competition. Their presence and success further discourage potential supermarkets and small-business grocers from locating in the area. By positioning themselves as an easy and affordable option for food insecure residents, fast food chains increase community receptiveness.[54]

In historically redlined food deserts, fast food positions have become convenient job options for low-income residents. However, these chains hurt low-income neighborhoods more than they help them; the jobs they provide are neither secure nor well paid.[55] Additionally, a diet that largely consists of fast food, which lacks essential nutrients, can lead to health consequences like malnutrition. Malnutrition can interfere with education, reinforcing socioeconomic divides that perpetuate the effects of redlining.[56] Unhealthy food environments impede residents' overall health, which can prevent upward mobility and reinforce existing social stratification and racial segregation. Increased healthcare costs due to nutrition-related illness, combined with economic stagnation and low property values associated with food deserts, further exacerbate the historic inequities impacting low-income redlined communities.[57]

As stated by researchers Clark and Nicholas, “malnutrition is a major component of food security that is expressed not only through undernutrition and hunger, but also overnutrition and

obesity, both of which are rapidly growing global epidemics closely linked to poverty."[58] Fast food is characterized by high calorie, fat, and cholesterol contents, combined with low nutrient density. As a result, its consumption is correlated with obesity and other health issues. According to Kwate, "regions with greater numbers of fast-food restaurants have higher morbidity and mortality and from coronary syndromes." The highest obesity rates occur among the most disadvantaged groups, which also face the greatest rates of food insecurity and climate vulnerability. Obesity rates are disproportionately high in historically segregated Black communities.[59] For example, in Washington D.C., one in three Black residents are obese, while fewer than one in ten white residents are obese.[60] The highest rates of obesity occur in two of D.C.'s historically segregated wards.[61] It is important to acknowledge that this racial disparity in obesity rates is caused by a multitude of socioeconomic and cultural factors, not a failing on the part of historically redlined neighborhoods or residents. It is possible to address food insecurity and obesity-related health issues without stigmatizing or blaming the Black community.[62] In order to fully understand the underlying causes of this health condition, cultural norms must be taken into account. Although the lack of access to fresh produce, cooking equipment, and nutritional education is a large factor, there are other elements at play. According to a study on obesity among Black individuals in the United States, "African American people have a more accepting view of larger body sizes than White people. Being curvier is often seen as desirable, with many women striving for a fuller figure. Many African American women have misconceptions of normal weight, describing their weight as healthy despite being overweight by BMI and underestimating or under-reporting their weight category."[63] It is imperative to use cultural sensitivity in addressing obesity among African-American people, while simultaneously understanding the drastic health consequences of the issue. Scientists agree that "Obesity

increases the risk for complications, including cardiovascular disease, type 2 diabetes, and nonalcoholic fatty liver disease."[64] As with mitigating climate change's impacts on historically marginalized communities, effectively managing malnutrition and obesity in food deserts requires the input of residents and a thorough understanding of the cultural, social, socio-economic, historic, and present day factors that contribute to the issues. Indeed, the disproportionate impacts of climate change and food insecurity in redlined neighborhoods coalesce with regard to obesity and malnutrition.

Dual Impacts of Climate Change and Food Insecurity in Historically Marginalized Communities

Climate change worsens the risk of malnutrition by reducing the nutrient content in fruits and vegetables. Health risks like obesity and malnutrition may make individuals more susceptible to climate change: obesity increases individual vulnerability to climate-related heatwaves.[65] Since climate change and obesity disproportionately impact residents of redlined communities, and because it is more difficult for these individuals to afford healthcare, malnutrition-related climate vulnerability places additional financial strain on redlined households. Thus, fast food chains exacerbate health stratification, perpetuating income inequalities, and therefore simultaneously contribute to social and climate vulnerability.[66] Furthermore, citizens in redlined neighborhoods must travel further to access healthcare, compared to individuals in predominantly white, wealthy neighborhoods.[67] The added transportation distances increase greenhouse gas emissions, contributing to the climate crisis.

Additionally, fast food chains themselves exacerbate climate change: they primarily serve meat-based products, which have tremendous carbon emissions.[68] As climate change worsens, nutrient-dense foods like fruits and vegetables will continue to rise in price. Meanwhile, low

quality, energy-dense foods from commercial retailers will continue to proliferate in marginalized neighborhoods.[69]

The compounding impacts of redlining, climate vulnerability, and food insecurity are manifesting in historically marginalized communities in cities across the nation. Washington D.C.'s Wards Seven and Eight exemplify these intersectional issues. These redlined sectors have the highest unemployment rates in the District, as well as the highest rates of food insecurity.[70] Wards Seven and Eight are also home to the greatest number of residents vulnerable to the effects of climate change.[71] A report by the D.C. Food Policy Council found that, "an increased focus on these populations is needed to combat persistent food insecurity that stems from systemic challenges such as the racial wealth gap, high costs of living, and a history of disinvestments in communities of color."[72] In 2022, DC Mayor Bowser invested $58 million into funds that encourage new grocery stores and small food businesses to locate in neighborhoods where historically racist real estate policies and disinvestment have led to food insecurity.[73] In addition to brick-and-mortar food markets, DC's lower income communities are implementing urban agriculture to simultaneously improve food access and combat climate vulnerability. These projects will be addressed in further detail in the forthcoming pages.

Health is linked to social mobility; improving food security in low income communities could help affected residents break out of cyclical unemployment, economic decline, and low property values—essentially, the consequences of historical discrimination.[74] Therefore, the benefits of fostering healthy options in redlined communities are two-fold: limiting fast food consumption not only reduces climate vulnerability by minimizing overall health risks, and lessens the socioeconomic consequences of added healthcare costs, but actively mitigates greenhouse gas emissions. According to Koch and colleagues, "diets lower in meat such as a

Mediterranean diet, have been estimated to reduce greenhouse gas emissions by 72%, land use by 58%, and energy consumption by 52%." Low income and historically marginalized communities face double vulnerability to food insecurity/health risks and climate change. Improving food security enables residents to eat climate-friendly diets that also improve individual climate resilience.[75]

The unprecedented financial strain of climate change will make it more difficult for historically redlined communities to afford healthy food, a basic necessity growing more costly as agriculture succumbs to extreme weather. However, urban food forestry offers solutions to three of redlining's infinite and interconnected consequences: it mitigates climate change, alleviates food insecurity, and begins to mend racial gaps and social vulnerability.[76] The concept of urban food forestry stems from agroforestry, a centuries-old agricultural technique first discovered by Indigenous communities around the world. Agroforestry is the purposeful integration of domestic agricultural crops and wild edible plants. This system increases food output, enhances biodiversity and soil quality, and requires less water and fertilizer than western agriculture methods.[77] Urban food forestry incorporates agroforestry techniques in urban settings, creating opportunities for community involvement and improving overall climate resilience. One study found that "food forests on underutilized lands could provide: 192+ million pounds of food/year (worth $995M; enough to feed nearly 314,000 households); $3.5M worth of urban cooling services that mitigate the urban heat island effect; Additional co-benefits include carbon sequestration, flood retention, and green space access."[78] In historically redlined communities that lack green spaces, urban food forests can combat climate vulnerability.

A Case Study: Washington, DC

Washington D.C. exemplifies how racial residential segregation exacerbates extreme heat in lower-income neighborhoods with less environmental capital. Parts of the district are up to 17° Fahrenheit warmer than their wealthier counterparts.[79] Urban food forests can begin to counteract this disparity: studies show temperatures in urban forests average nearly 3° Fahrenheit cooler than unforested urban areas.[80]

Food forestry also helps reverse the food insecurity caused by racist real estate policies. Eighty percent of D.C.'s food deserts are found in Wards 7 and 8, historically segregated communities. These wards possess one supermarket per 51,470 residents.[81] Additionally, Wards 7 and 8 exhibit the highest obesity rates in the district.[82] In 2020, D.C's urban forestry department planted apple, pomegranate, peach, cherry, persimmon, and jujube trees in the District's poorest wards. Not only are these urban fruit trees providing much needed shade, but residents of all ages are also congregating to enjoy the free produce and engage with the environment.[83] Urban food forestry minimizes the health issues that disproportionately impact historically redlined communities experiencing food insecurity. This food system offers a nutritious, easily accessible, and inexpensive (or free) food source to residents of food deserts. As climate change-related food shortages drive up produce prices, urban food forests could offer a reliable and climate-resilient alternative.[84]

Urban Food Forests: A Possible Solution

Larger scale urban food forests can also counteract the impacts of fast-food chains that position themselves as convenient employment opportunities in low-income neighborhoods; implementing food forestry initiatives in these communities promotes the creation of green jobs centered around food production, agro-processing, and marketing.[85] It's important to note that

civic engagement, grassroots leadership, and community input are crucial to successful food forestry initiatives. If executed carelessly, urban agriculture programs can inadvertently reinforce racial inequities and historic patterns of systemic racism. Siegner et al. argue that "Designating land for agricultural use in urban areas may conflict with other city planning priorities around affordable housing, gentrification, and living. Because of the persistent legacy of systemic discrimination, it is neither inevitable nor guaranteed that urban agriculture will redress food system inequities; in fact, urban farms can sometimes lead to displacement through eco-gentrification."[86]

Eco-gentrification is a phenomenon in which urban greening projects raise property values to the point that the original residents cannot afford to remain in the area; they are displaced by more affluent buyers. To truly benefit historically redlined communities, urban food forests must be implemented on public lands and treated as a public resource. It is essential that any policy makers or outside organizations involved in food forestry projects are attentive to the needs of residents. Neighborhoods and government institutions must maintain open communication, fostering participatory action and community-based leadership when developing food forestry programs.[87]

Conclusion

Redlining exacerbates both climate vulnerability and food insecurity in disadvantaged communities; it is also a self-reinforcing phenomenon, perpetuated by systemic underinvestment. The relationship between redlining, climate change, and food insecurity is a vicious cycle where each factor exacerbates the others. Historically redlined communities are particularly at risk because they face the compound challenges of environmental vulnerability, economic

disadvantage, and lack of access to essential services. Understanding and addressing these interconnected issues is crucial for creating more equitable and resilient communities.

Addressing food insecurity and climate vulnerability in redlined communities requires solutions that tackle both issues simultaneously. This could include investing in green infrastructure to cool urban heat islands, improving public transportation to increase access to food, and supporting local food systems that are resilient to climate change.

Effective policy interventions might involve redirecting investment into these historically neglected areas to improve infrastructure, increase access to healthy food, and build community resilience to climate change. Policies could also focus on promoting climate justice, ensuring that the most vulnerable populations are prioritized in efforts to mitigate and adapt to climate change.

Urban food forestry begins to break this vicious cycle by increasing natural capital and improving property values, thus reducing the historical disparity between the real-estate desirability of predominantly Black and white neighborhoods.[88]

Finally, this novel agricultural technique offers social benefits that could potentially help reverse the de facto segregation that exists in redlined cities. It provides educational opportunities for individuals from all nearby neighborhoods, regardless of income, and facilitates collaboration between residents of any race or socioeconomic status. Managing a communal food forest engages citizens of all backgrounds, and tasting fresh, locally-grown fruits and vegetables is generally rewarding for members of every community.[89] These benefits may seem aspirational, and even utopian; however, successful food forests are cropping up across the nation, and cities are allocating considerable resources to the initiatives. The Department of Energy and Environment awarded a total of $93,000 to various urban agriculture projects in Washington D.C. in 2021. The District's Urban Agriculture Infrastructure Grant program

continues to operate, with $70,000 awarded in 2024.[90] The effects of redlining, climate change, and food insecurity are reciprocal; this feedback loop exacerbates the socioeconomic inequities faced by historically marginalized communities. Redlining compounds the effects of climate change and food insecurity; however, addressing food insecurity through urban food forestry also has interdisciplinary benefits: it simultaneously improves climate resilience and counteracts the socioeconomic consequences of historical redlining. Food forestry is a cross-cutting solution for a cross-cutting problem, and it is sustainable in every sense of the word.

ENDNOTES

[1] Sebastian Linde et al., "Historic Residential Redlining and Present-Day Social Determinants of Health, Home Evictions, and Food Insecurity within US Neighborhoods." *Journal of General Internal Medicine* 38, no. 15 (June 9, 2023): 3321–28. https://doi.org/10.1007/s11606-023-08258-5.
[2] Ibid
[3] Min Li and Faxi Yuan. "Historical Redlining and Food Environments: A Study of 102 Urban Areas in the United States." *Health and Place* 75 (May 2022): 102775. https://doi.org/10.1016/j.healthplace.2022.102775.
[4] Claire Conzelmann, Arianna Salazar-Miranda, Toan Phan, and Jeremy Hoffman. "Long-Term Effects of Redlining on Environmental Risk Exposure." *Federal Reserve Bank of Richmond Working Papers* 22, no. 09 (November 18, 2022): 1–18. https://doi.org/10.21144/wp22-09.
[5] Min Li and Faxi Yuan. "Historical Redlining and Food Environments: A Study of 102 Urban Areas in the United States." *Health and Place* 75 (May 2022): 102775. https://doi.org/10.1016/j.healthplace.2022.102775.
[6] Conzelmann, "Long-Term Effects of Redlining on Environmental Risk Exposure."
[7] Ibid.
[8] Dongying Li et al. "Modeling the Relationships Between Historical Redlining, Urban Heat, and Heat Related Emergency Department Visits."
[9] Dongying Li et al. "Modeling the Relationships Between Historical Redlining, Urban Heat, and Heat Related
[10]Dongying Li et al. "Modeling the Relationships Between Historical Redlining, Urban Heat, and Heat Related Emergency Department Visits."
[11] Dongying Li et al. "Modeling the Relationships Between Historical Redlining, Urban Heat, and Heat Related Emergency Department Visits."
[12]Conzelmann, "Long-Term Effects of Redlining on Environmental Risk Exposure."
[13] Sebastian Linde et al., "Historic Residential Redlining and Present-Day Social Determinants of Health, Home Evictions, and Food Insecurity within US Neighborhoods."

[14] Sebastian Linde et al., "Historic Residential Redlining and Present-Day Social Determinants of Health, Home Evictions, and Food Insecurity within US Neighborhoods."
[15] M.E. Brown et al. "Climate Change, Global Food Security, and the U.S. Food System." *USDA,* 2015, 1–146. http://www.usda.gov/oce/climate_change/FoodSecurity2015Assessment/FullAssessment.pdf.
[16] FAO, "Climate Change and Food Security: Risks and Responses."
[17] M.E. Brown et al. "Climate Change, Global Food Security, and the U.S. Food System."
[18] "Climate Change and Food Security: Risks and Responses." FAO, 2015. www.fao.org/3/i5188e/I5188E.pdf.
[19] M.E. Brown et al. "Climate Change, Global Food Security, and the U.S. Food System."
[20] FAO, "Climate Change and Food Security: Risks and Responses."
[21] David Saithwaithe, "Urban/Rural Linkages." *Urban/Rural Linkages,* 1 Oct. 2000. web.mit.edu/urbanupgrading/upgrading/whatis/UrbanRural-Linkages.html.
[22] P.R. Shukla et al. "Summary for Policymakers." Special Report on Climate Change and Land, 2019. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/.
[23] P.R. Shukla et al. "Summary for Policymakers."
[24] Alana Siegner, Jennifer Sowerwine, and Charisma Acey. "Does Urban Agriculture Improve Food Security? Examining the Nexus of Food Access and Distribution of Urban Produced Foods in the United States: A Systematic Review." *Sustainability* 10, no. 9 (August 22, 2018): 2988. https://doi.org/10.3390/su10092988.
[25] David Saithwaithe, "Urban/Rural Linkages."
[26] P.R. Shukla et al. "Summary for Policymakers."
[27]Jessica C. Fanzo, and Shauna M. Downs. "Climate Change and Nutrition-Associated Diseases." *Nature Reviews Disease Primers* 7, no. 1 (December 9, 2021). https://doi.org/10.1038/s41572-021-00329-3.
[28] FAO, "Climate Change and Food Security: Risks and Responses."
[29] Jessica C. Fanzo, and Shauna M. Downs, "Climate Change and Nutrition-Associated Diseases."
[30] P.R. Shukla et al. "Summary for Policymakers."
[31] FAO, "Climate Change and Food Security: Risks and Responses."
[32] *"*The Road Ahead: 2021 Update on Food Access and Food Security in the District of Columbia*" DC Food Policy, 2021.* http://dcfoodpolicycouncilorg.files.wordpress.com/2021/12/food-security-progress-report-2021_final.pdf.
[33] Min Li and Faxi Yuan, "Historical Redlining and Food Environments."
[34] Hannah Mosiniak et al."Extreme Heat in Washington DC." *ArcGIS*, 4 Dec. 2020, storymaps.arcgis.com/stories/0e9360ddb8b445a295e02c21856f254e.
[35] Min Li and Faxi Yuan. "Historical Redlining and Food Environments."
[36] Min Li and Faxi Yuan. "Historical Redlining and Food Environments."
[37]Mengyao Zhang, and Debarchana Ghosh. "Spatial Supermarket Redlining and Neighborhood Vulnerability: A Case Study of Hartford, Connecticut." *Transactions in GIS* 20, no. 1 (26 Mar. 2015): 79-100. *PubMed*, https://doi.org/10.1111/tgis.12142.
[38] Mengyao Zhang, and Debarchana Ghosh. "Spatial Supermarket Redlining and Neighborhood Vulnerability."

[39] Naa Oyo Kwate. “Fried Chicken and Fresh Apples: Racial Segregation as a Fundamental Cause of Fast Food Density in Black Neighborhoods.” *Health & Place* 14, no. 1 (March 2008): 32–44. https://doi.org/10.1016/j.healthplace.2007.04.001.
[40]M.E. Brown et al. “Climate Change, Global Food Security, and the U.S. Food System.”
[41] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[42] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[43] Min Li and Faxi Yuan, "Historical Redlining and Food Environments.”
[44] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[45] Mengyao Zhang, and Debarchana Ghosh. "Spatial Supermarket Redlining and Neighborhood Vulnerability.”
[46] Mengyao Zhang, and Debarchana Ghosh. "Spatial Supermarket Redlining and Neighborhood Vulnerability.”
[47] Jessica C. Fanzo, and Shauna M. Downs, “Climate Change and Nutrition-Associated Diseases.”
[48] Min Li and Faxi Yuan. "Historical Redlining and Food Environments.”
[49] Dongying Li et al. “Modeling the Relationships Between Historical Redlining, Urban Heat, and Heat Related Emergency Department Visits.”
[50] A.R Oakley et al. “Food Insecurity and Food Preparation Equipment in US Households: Exploratory Results from a Cross-sectional Questionnaire.” *Journal of Human Nutrition and Dietetics* 32, no. 2 (November 26, 2018): 143–51. https://doi.org/10.1111/jhn.12615.
[51] A.R Oakley et al. “Food Insecurity and Food Preparation Equipment in US Households.”
[52] Mengyao Zhang, and Debarchana Ghosh. "Spatial Supermarket Redlining and Neighborhood Vulnerability.”
[53] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[54] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[55] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[56]Patricia Ballamingie et al. “Integrating a Food Systems Lens into Discussions of Urban Resilience: A Policy Analysis.” *Journal of Agriculture, Food Systems, and Community Development*, May 22, 2020, 1–17. https://doi.org/10.5304/jafscd.2020.093.021.
[57] Min Li and Faxi Yuan. "Historical Redlining and Food Environments.”
[58] Kyle H. Clarke, and Kimberly A. Nicholas. "Introducing Urban Food Forestry: A Multifunctional Approach to Increase Food Security and Provide Ecosystem Services." *Landscape Ecology* 28, no. 9 (16 July 2013): 1649-69. https://doi.org/10.1007/s10980-013-9903-z.
[59] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[60] “Obesity.” DC Health, accessed July 29, 2024. https://dchealth.dc.gov/service/obesity-overview#:~:text=Obesity%20is%20a%20national%20and,(Wards%207%20and%208).
[61]DC Health, “Obesity.”
[62] Jerry Shannon. “Food Deserts: Governing Obesity in the Neoliberal City.” *Progress in Human Geography* 38, no. 2 (April 29, 2013): 248–66. https://doi.org/10.1177/0309132513484378.
[63] Holly Lofton et al. “Obesity among African American People in the United States: A Review.” *Obesity* 31, no. 2 (January 25, 2023): 306–15. https://doi.org/10.1002/oby.23640.
[64] Holly Lofton et al, “Obesity among African American People in the United States.”
[65] Christian A. Koch et al. “Climate Change and Obesity.” *Hormone and Metabolic Research* 53, no. 09 (September 2021): 575–87. https://doi.org/10.1055/a-1533-2861.
[66] Min Li and Faxi Yuan. "Historical Redlining and Food Environments.”

[67] Muhieddine Labban et al. “Disparities in Travel-Related Barriers to Accessing Health Care from the 2017 National Household Travel Survey.” *JAMA Network Open* 6, no. 7 (July 27, 2023).
[68] “Carbon Footprint Factsheet.” Center for Sustainable Systems, 2023. https://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet.
[69] Naa Oyo Kwate, “Fried Chicken and Fresh Apples.”
[70] DC Food Policy, “The Road Ahead: 2021 Update on Food Access and Food Security in the District of Columbia.”
[71] Tommy Wells et al."Vulnerability and Risk Assessment." Department of Energy and Environment, February 2016. https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/AREA_Vulnerability_Assessment_DRAFT_2016-06-21lowres_.pdf.
[72] DC Food Policy, “The Road Ahead: 2021 Update on Food Access and Food Security in the District of Columbia.”
[73] Krista Gehlhausen, Fatema Alzaabi, and Joseph Flores. “INNOVATIVE APPROACHES TO ADVANCE CLIMATE AND FOOD EQUITY--Washington DC.” Glasgow Declaration, October 2021.
[74] Sebastian Linde et al., “Historic Residential Redlining and Present-Day Social Determinants of Health, Home Evictions, and Food Insecurity within US Neighborhoods.”
[75] Christian A. Koch et al, “Climate Change and Obesity.”
[76] “The Benefits of Food Forests and Urban Farms in San Antonio.” Natural Capital Project, May 2023. https://naturalcapitalproject.stanford.edu/sites/g/files/sbiybj25256/files/media/file/san_antonio_urban_agriculture_-_2023.pdf.
[77] Kyle H. Clark, and Kimberly A. Nicholas. "Introducing Urban Food Forestry.”
[78]Natural Capital Project,“The Benefits of Food Forests and Urban Farms in San Antonio.”
[79] Hannah Mosiniak et al. "Extreme Heat in Washington DC."
[80] “Compendium of Strategies - Urban Heat Island Basics.” EPA, 2008. https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_1.pdf.
[81] “Where We Work.” The Green Scheme, April 28, 2018. http://www.greenscheme.org/what-we-do/where-we-work/.
[82] DC Health, “Obesity.”
[83] Caroline Patrickis. “Dozens of Fruit Trees Growing in the D.C.’s Ward 8 Are Free for Picking to the Community.” WJLA, September 18, 2020. https://wjla.com/news/local/gallery/dozens-of-fruit-trees-growing-in-the-dcs-ward-8-are-free-for-picking-to-the-community?photo=4.
[84] Kyle H. Clark, and Kimberly A. Nicholas. "Introducing Urban Food Forestry.”
[85] Patricia Ballamingie, “Integrating a Food Systems Lens into Discussions of Urban Resilience.”
[86] Alana Siegner, Jennifer Sowerwine, and Charisma Acey. “Does Urban Agriculture Improve Food Security?”
[87] Alana Siegner, Jennifer Sowerwine, and Charisma Acey. “Does Urban Agriculture Improve Food Security?”
[88] Kyle H. Clark, and Kimberly A. Nicholas. "Introducing Urban Food Forestry.”
[89] Patricia Ballamingie, “Integrating a Food Systems Lens into Discussions of Urban Resilience.”
[90] DC Food Policy, “The Road Ahead: 2021 Update on Food Access and Food Security in the District of Columbia.”