Botany & Environmental Justice

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Hello! Welcome to ***Anthropozine:*** the ***Botany and Environmental Justice*** issue.

This publication is going to share original written works as well as really cool articles and sources that may not strictly cover botany.

In this e-newsletter, you'll find the bare bones outline of the articles for this issue, as well as the links to the full written pieces. You can read just this newsletter and rest assured you have some new trivia related to botany and environmental justice, or read this and the articles for a deeper dive.

Feel free to peruse the topics to the right and jump to your favorite articles from there.

I hope you learn something new, or at the very least learn something more about what you already know.

Too Long, Didn't Read:

Plants and People:

- Archaeobotany
- Ethnobotany
- Plants and psychology

Budding Botanical Research:

- Arctic greening
- Soil carbon storage
- Geoengineering via plants

Redwood Reads:

- GMOs
- Urban plant ecology

Recommended Reading:

- The Uninhabitable Earth
- Microbes and Methane
- Permafrost Thawing
- Ethnobotany

"Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

Plants and People

What is "Plants and People"?

Plants and People is the first section of the ***Anthropozine*** e-newsletter. Here, you'll find original content that explores multiple sources to create works that explores the amazing, odd, and sometimes counterintuitive ways that humans and plants interact.

No, it's not just you: houseplants make everyone happy

Houseplant sales skyrocketed during COVID-19 lockdowns. This isn't a coincidence: green plants have been shown to improve our moods and mental health. This effect is also prevalent in larger green spaces, so consider buying an *Epipremnum aureum* and stepping outside today.

How early humans shaped the course of plant evolution

You probably know a bit about how early humans domesticated dogs from wolves. How about how early humans domesticated maize from teosinte? The evolution of modern plants is rooted in human intervention and the benefits we reap, like nutrient rich seeds and large sweet fruits, are awarded to us because we aid plants' reproduction.

Western science is finally acknowledging what other cultures knew all along

Historically, plants were used as medicine. Contemporarily, plants are used as medicine, although Western medicine isolates their active compounds first. The frequent denial and dismissal of traditional medicinal knowledge denies the benefits of intellectual property to the original discoverers of these plants. This article uses aspirin as a case study of this phenomenon.

Budding Botanical Research

What is "Budding Botanical Research"?

Budding Botanical Research is the more traditional science journalism portion of ***Anthropozine***. Here, you'll find articles that take a look at emerging research that involves botany. This issue maintains a focus on plants in climate change research.

More plants are growing in the Arctic. This is bad news for climate change.

Arctic greening, a term referring to the plant cover of the Arctic tundra, has been shifting to a pattern that doesn't bode well for climate change. Earlier greening leads to less productivity and less carbon dioxide conversion —this, plus permafrost melting, is a sign of the present climate crisis.

Long-term soil carbon sequestration doesn't exist. Why do plant scientists insist it does?

The basic premise of soil science is humus, a long-lasting and resilient molecule that is composed of extensive carbon chains. Botanists have suggested genetically modifying plants to store more carbon in soil in the form of humus from plant roots. The issue is that humus doesn't exist.

Stop placing bets on plant physiology in the fight against climate change.

Bioenergy with carbon capture, or BECCS for short, is the darling of techno-utopians and proponents of geoengineering. It proposed growing crops to mitigate carbon dioxide emissions, burning those crops for fuel, and capturing the carbon from burning to store in underground structures. This plan is misguided at best: plants don't store that much carbon and there isn't enough agricultural land to make this a feasible project.

Redwood Reads

What is "Redwood Reads"?

Redwood Reads is named after one of the world's largest trees (*Sequoia sempervirens*) because it contains articles that are a bit longer than the previous sections. Content warning: this issue of the newsletter pertains to environmental justice, and as such the articles here contain mentions of systemic racism and socioeconomic discrimination, as well as some mentions of human illnesses and death.

The good, the bad, and the unseen ugly of GMOs

Are genetically modified organisms really that bad? It depends who you ask. While human beings have a long history of interfering with natural plant evolution, genetic modification of organisms allows for a direct and almost immediate intervention in the physiology of plants. This can be good: some GMOs, like golden rice, can provide disability preventing nutrients. Others might be drought resistant, important for increasingly arid farmlands around the world. But GMOs can also threaten genetic diversity, contribute to unsustainable models of agriculture, and are distributed by exploitative corporations that add to the burden that subsistence farmers face.

Urban greening, climate change, and environmental justice: why more plants need to be in cities.

Urban areas that were historically redlined have less green spaces and tree cover than other urban areas. This exacerbates the urban heat island effect, which explains why cities experience hotter temperatures than surrounding areas. This extreme heat burden in redlined cities will only get worse with climate change, exacerbating the public health crisis that heat presents. The people most affected by this phenomenon will be people of color and those of low socioeconomic class—communities that already bear the burden of systemic discrimination.

Recommended Reading

Recommended as in I personally think you should read it.

U.S. Forest Service: Ethnobotany.

"Since our earliest origins, humans have depended on plants for their primary needs and existence."

Challenging the Status Quo in Ethnobotany. — Katherine Barrett and Kelly Banister

"Through direct or indirect means, ethnobotanists have been drawn into the biological prospecting movement [and] researchers are not legally required to ask permission, recognize indigenous rights to intellectual property, or provide compensation for use or misuse of cultural knowledge. The public domain, simply put, is free game for free enterprise."

How microbes in permafrost could trigger a massive carbon bomb. — Monique Brouillette

"Genomics studies are helping to reveal how bacteria and archaea influence one of Earth's largest carbon stores as it begins to thaw."

The methane time bomb. — Andrew Glikson

"Global warming...is leading toward the release of billions of tons of methane into the atmosphere, from permafrost, lakes, shallow seas and sediments. This release threatens to melt large parts of the polar ice caps, leading to meters to tens of meters of sea level rise."

The Uninhabitable Earth. — David Wallace-Wells

"Famine, economic collapse, a sun that cooks us: What climate change could wreak — sooner than you think."

Extreme Heat Is a Disease for Cities. Treat It That Way. — Matt Simon

"The urban heat island effect creates extra-hot temperatures that kill. But cities can prescribe powerful treatments, like green spaces and reflective roofs."

Western science is finally acknowledging what other cultures knew all along.

Plants are the original medicine. This isn't just the slogan of the hippie movement, but empirical fact. Despite the botanical origins of many pharmaceutical compounds, credit is rarely given to the Indigenous and alternative users of the source plants. Modern ethnobotanists are trying to change this pattern.

Strictly defined, ethnobotany is the study of how people from different cultures use plants. Ethnobotany can consider broad use patterns, such as agriculture, weaving, or shelter, or specific use patterns, such as religious rituals or medicine. The medicinal use of a plant can be contentious to write about, due to the interplay between the need for laboratory confirmation in Western science and the fear of pseudoscience. However, even when a plant has confirmed medicinal properties (as in, "it's the basis for pharmaceutical derivatives") these plants and the people who use them are written about in a borderline condescending manner.

Before elaborating on this, I want to define what I mean by "medicinal." Frankly, it's a nebulous term in colloquial use; anything from a cup of tea to a walk outside to chemotherapy could be considered medicinal depending on the person who wants treatment. As defined by Oxford Languages, medicinal is defined as "(something) having healing properties." [1] As this definition only muddies the water further (what is "healing", exactly?), I'll present a working definition for this article alone. Medicinal refers to a substance that is administered to a person with the intention of mitigating an affliction they are experiencing that has shown efficacy in treating similar afflictions in other people. Wordy, but the distinction is necessary as we consider "efficacy" and observations of it in medicine.

Let's discuss aspirin as an example. Aspirin is a pain-relieving (analgesic) drug belonging to a medicine class called non-steroidal anti-inflammatory drugs (NSAIDs). [2] As you likely already know, these NSAIDs work by reducing swelling and inflammation in the body; you may not know that aspirin works by targeting and reducing prostaglandins, molecules that can trigger pain responses in cells. [3], [4]

Aspirin is one of the oldest NSAIDs that was mass-produced for consumption, having been patented by Bayer and distributed to physicians for prescription starting in 1899. [5] However, aspirin has a much longer history than this, and pharmaceutical history disrespects the botanical origin of aspirin and its original discoverers by positing the drug's start in 1828 when it was isolated from willow leaves. [5]

Instead, the use of the active chemical compound in aspirin dates back thousands of years to Egypt and Sumeria, where physicians would prescribe willow leaf tea to patients to reduce pain and inflammation. [5] Additionally, willow bark was commonly used by Indigenous Americans for its analgesic properties. [6] Despite the literal thousands of years of observational data supporting the efficacy of willow in treating pain, modern day accounts of aspirin often have statements like this written on the topic: "Of course, these observations were made long before the advent of modern evidence-based medicine....Nevertheless, the claims of willow bark's analgesic properties stood the test of time and were scientifically validated in the modern era."

I maintain that this attitude towards the history of different medicinal plants stems from a place of arrogance and is generally hypocritical considering the history of Western pharmaceuticals.

The criticism that anecdotal or observation evidence makes Indigenous or ancient epistemes inferior is flawed for several reasons. The nature of Western science as an investigatory tool is only as advanced as the technology that assists it; it wasn't so long ago that performationism was considered science de rigeur. [7] As our collective capacity for scientific investigation increased while technological advances rolled out, we were able to generate deeper understanding in how life is actually created.

Additionally, not understanding the exact chemical compounds involved in a medicine or the exact pathway that it targets is fairly frequent even in conventional medicine. Drugs called SSRIs have been prescribed to people with mental illnesses since 1988, but the landmark paper describing how these drugs actually work in the brain wasn't published until 2021. [8], [9] I'd like to suggest that even though technological advancement is frequently unilateral, other cultures outside Western societies have standards for and methods of gathering data that frequently support the continued medicinal use of plants.

Of course, this leads to the argument that because technological tools are so refined in Western science all drugs/pharmaceuticals/medicines need to go through processes of chemical isolation, clinical trials, patent and FDA approval, and several rounds of marketing before claiming the title. This argument has a lot of merit: proper dosage can be administered by laypeople as opposed to a doctor or trained ethnobotanist, and overdoses on dangerous compounds can be less likely. I'm not going to pretend that dose standardization and double-blind clinical trials are somehow bad.

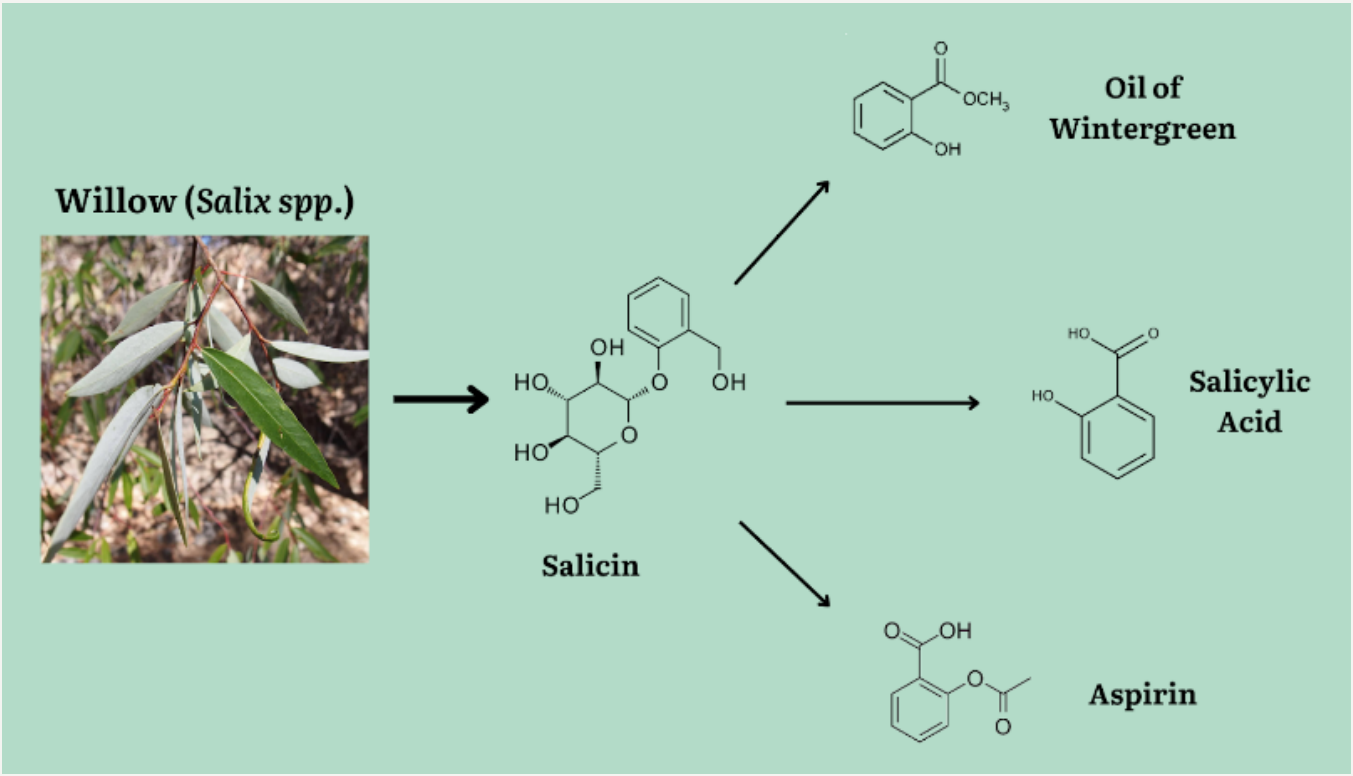
However, less lightheartedly than preformationism, I can point to thalidomide being prescribed to pregnant women without clinical trials and extended opioid therapy as being examples of Western medicine failing to adhere to its own standards of evidence gathering. [10], [11] I'm not calling for a medicinal plant free-for-all (many Indigenous cultures have strict protocols on who can administer botanical medicine and how that knowledge is disseminated [12], which hopefully emphasizes my point that plants shouldn't be indiscriminately consumed), but an acknowledgement that Western methodology isn't infallible would be nice.

What's unfortunate about the case study of willow/aspirin is that it isn't unique in the realm of ethnobotany. Other plants that have well-known medicinal uses outside of Western pharmacies include dong quai and ginger, both of which are used to treat painful menstruation, nausea, and menopause symptoms among other ailments. [13], [14] Odds indicate that in 100 years, the active compounds in these plants will be "discovered" by science and isolated into Western drugs. This already happened with wild yam, which has traditionally been used to treat reproductive and menstrual symptoms and is now used to isolate precursors to estrogen and progesterone. [15]

I'd like to state that I'm not trying to promote pseudoscience, homeopathy, or self-medication via botany, nor am I trying to promote the division between Western and Indigenous methods of knowing. Instead, I'm trying to point out a pattern that's common in Western science (exampled here by botany, pharmacy, and pharmacology) that echoes the familiar and violent narrative that began when someone "discovered" Quisqueya (Hispaniola) in 1492.

I use the word violent because denying acknowledgement and credit to Indigenous peoples for initially discovering the importance of different medicinal plants is a form of violence. Without credit, Indigenous people are denied the social and monetary compensation that should theoretically be theirs under the Western paradigm of intellectual property. [16] Although it might seem insignificant to someone outside of the fields involved or to the non-Indigenous, it's the slow drip of injustice that maintains paradigms of colonization.

If you were expecting a fun article on how plants have traditionally been used by different Indigenous cultures, check out this resource. I'll have this linked in my newsletter. In the meantime, please enjoy all the ways we've managed to manipulate salicin from willows into different compounds: oil of wintergreen is commonly used in Bengay and other topical analgesics (and in candy!) and salicylic acid is a common skin exfoliant and acne medication.



More plants are growing in the Arctic. This is bad news for climate change.

I don't think that the impact of climate change can be understated. The climate crisis will be the most pressing issue facing the world by the end of this century—and every other problem on this planet, including socially constructed ones, will be exacerbated by it.

There's a lot of misinformation about climate change that circulates on the Web and in discussion, but I've noticed there's a particularly pervasive topic that tends to crop up periodically. A frequent talking point from climate change naysayers involves the thought that plants will simply adapt to use the increased CO2 emissions from anthropogenic causes. Following this line of reasoning, areas that are experiencing higher rates of plant growth in the face of warming temperatures (like, say, the Arctic) should therefore become more efficient carbon sinks and save us all from the greenhouse gas effect as they proceed to suck up prodigious amounts of carbon dioxide and turn it into plant material. Scientists use the shorthand "carbon sequestration" for this process. Therefore, we should try and plant more vegetation, and the increasing plant growth in places like the Arctic—historically plant-limited areas—is actually great news for the fight against climate change. Climate crisis averted! Except this isn't what happens at all—especially not in the Arctic.

While the scenario above has some basis in logic (plants do use carbon dioxide in their metabolic processes, and are great at temporary carbon sequestration) it fails in reality. Plants, like all other living things, do have limits to the amount of carbon they can utilize and turn into living tissue. Stating that increased carbon dioxide is going to somehow induce increased plant growth is a fallacy: it's akin to saying that giving an extra bottle to a baby is going to make them hit toddlerhood faster. It's a statement that isn't rooted in biological reality.

The next aspect of the argument, that increased plant cover should lead to dips in atmospheric carbon dioxide, is not true. We know it's not true because a large amount of emerging research gives no credibility to the idea. The Arctic is a particularly great case study for this scenario, because of the phenomenon known as Arctic greening.

Arctic greening, or the increased plant cover of the Arctic area, has been increasing since the 1980s. [1] Some scientists colloquially refer to Arctic greening as the "shrubification" of the area, as low-lying mats of plants have been overtaken by larger shrubs. This trend has accelerated in recent years, and provides scientists with the opportunity to explore plant growth and its effect on carbon dioxide emissions in real time.

Arctic greening is not a year round phenomenon (yet). It generally occurs during the summer months of June, July, and August—the traditional plant growing season of the Arctic. As shown in the image above, and through various studies using different metrics, greening doesn't occur universally throughout the Arctic. [2]

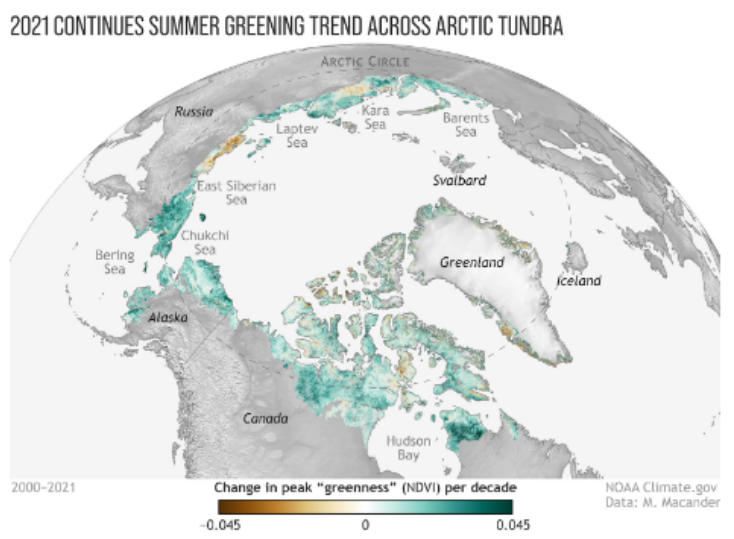


Figure 1: Satellite data indicates that areas in the Arctic are looking more "green" as plant cover increases. Taken from source 2.

And while greening does lead to increases in plant productivity in some cases, and sometimes even leads to dips in local carbon dioxide concentrations [2], this isn't the case universally. That's also the reason why Arctic greening probably won't lead to an appreciable difference in atmospheric carbon dioxide levels. Additionally, more recent studies have even suggested that carbon dioxide sequestration decreases even as Arctic greening increases. [3]

The reason for this counterintuitive decrease has to do with the timing of Arctic greening. That narrow growing season mentioned earlier might expand as climate change continues and accelerates but for now, earlier snowmelt in the Arctic encourages a quick boost of earlier plant productivity. [4] In other words, the plants max out their carbon uptake in the early portion of the growing season, and taper off by the end of summer. This shift in timing has serious consequences for the entire Arctic ecosystem, including the human populations who rely on it for sustenance and livelihoods, but in terms of climate change the lack of an appreciable difference in carbon sequestration despite the earlier and higher rates of greening is bad news.

This bad news stems from the drivers of Arctic greening: warmer temperatures and wetter soils. The effects of climate change aren't being mitigated by the greening it causes, and increased plant cover may even induce a faster cycle of increasing temperatures.

This cycle is due to the loss of albedo—once the ice melts in the Arctic and plants increase their ground cover, this area loses its highly reflective properties and sunlight will no longer be bounced back into the atmosphere, but absorbed. [2] Furthermore, the loss of the permafrost layer in the Arctic tundra could spell catastrophe for the planet: as a major storage point for terrestrial methane, the defrosting of the tundra may lead to increased methane emissions. [5], [6] As a greenhouse gas with potency 86 times that of carbon dioxide, more methane in the atmosphere could bring disastrous consequences upon us earlier than we expect.

As it's an area of active study, there isn't much in the way of solutions for Arctic greening—if there even is such a thing as "solutions" in this situation. As both a result and driver of climate change, Arctic greening is an important example of the ecological shifts we can expect in the coming decades. The best we can do now as concerned citizens is challenge the paradigms that lead to inaction on climate change.

If this topic interests you, you might want to check out my additional resources section on the newsletter to read more about the Arctic tundra, permafrost thaw, and microbial activity driving climate change.

Urban greening, climate change, and environmental justice: why more plants need to be in cities

Snowbirds, summer lovers, and Floridians, prepare to weep: humans don't tolerate heat very well. You might enjoy warm weather and think of sunny beaches, long days, and plenty of sunshine, but the truth is that human beings—like most other organisms—have a limited range of thermal tolerance. Too cold, too humid, and too hot conditions can cause physiological distress and illness. [1]

But in true all-powerful fashion, the Earth doesn't care about human thermal tolerance ranges. Extreme temperatures are found everywhere on the planet, including extreme heat: the Yellowstone Geyser Basin, California's Death Valley, and Middle Eastern nations like Bahrain and the United Arab Emirates are testaments to this planetary indifference. These literal hot spots are only going to get worse as average temperatures climb due to the climate crisis.

The United Nations International Panel on Climate Change has suggested that 2° C is the upper limit for "safe" global warming in terms of the ramifications this temperature rise will have on human and nonhuman life, as well as on ecosystem processes. [2] This is the "best case scenario" in that we'll be very lucky to keep warming within this limit, but the temperature increase range provided by the IPCC ranges as high as 8° C. This would be catastrophic in a way that's outside the scope of this article to describe (and others have written about it more eloquently than I can: please read "The Uninhabitable Earth" linked in the additional resources section). This level of warming would be considered "extreme heat": with average temperatures increased upwards of 8° C, many places already considered to be at the upper limit of human thermal tolerance would become uninhabitable. Climate refugeeism and mass death are sure to follow, a grim development that's hurtling down on humanity at an unbelievable speed.

This is because some places are already at this extreme edge of temperature increase. Global warming is not global. This misnomer is the reason why scientists typically use "climate change" as their title of choice; climate change can cause warming temperatures as well as cooler seasons in some areas, and different precipitation regimes in others. [3] Extreme heat is already here and here to stay, particularly in cities and urban areas. Many people, often already disadvantaged members of U.S. society, live in extreme heat conditions.

This intersection between social marginalization and environmental problems is frequent in the U.S., and is the basis for the concept of the environmental justice movement. The history behind housing and urban development in this nation is the reason why some urban areas are hotter than others—and why these urban areas are prematurely experiencing extreme heat conditions.

The issue of extreme heat in urban areas begins with the historical process of redlining. Defined as the process of denying federal (and later, private bank) loans to homeowners purchasing property in "financially risky" areas. [4] The name derives from the colors used on the maps denoting the values of different areas: red was used to color the areas that were considered "no loan zones." Today, the term is used as a general reference to any racially discriminatory practice in housing or urban development, because the areas considered risky investments were typically Black and brown neighborhoods. [4] As a result, redlined neighborhoods possess infrastructure that is unable to cope with extreme heat.

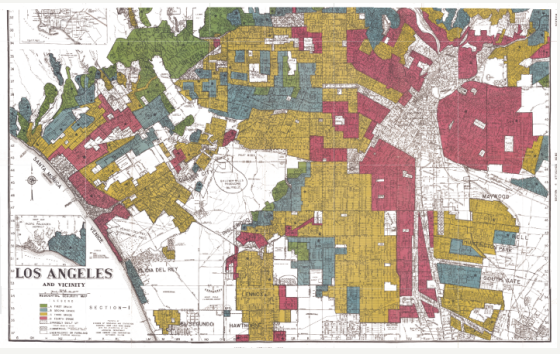


Figure 1: Redlined map of Los Angeles from *Mapping Inequality*.

Another part of the issue of extreme urban heat is the pre-existing urban heat island effect. This refers to the tendency of urban areas to be hotter than surrounding rural or suburban areas. This isn't due to a difference in climate, per se, but the way cities are designed. Most cities have been paved over with asphalt, concrete, and buildings—impermeable surfaces that, in the case of asphalt, trap heat instead of reflecting it outward. [5] However, historically redlined areas have another compounding issue that intensifies the urban heat island effect, which is the lack of green spaces. While some better funded urban areas may have public parks, landscaping, and the occasional rooftop garden, redlined cities tend to lack sufficient vegetation to mitigate the effects of the urban heat island effect.

Green space heat mitigation is due to plant physiology. Plants perform something called transpiration. It's a fancy term for what's essentially vegetation's version of sweating. As the air around a plant is typically drier than inside the plant, water is drawn from inside the plant through its stomata (specialized pores) into the atmosphere. [6] Unlike humans who sweat to solely cool themselves down, plant transpiration is remarkably good at cooling surrounding areas. It's basically outdoor air conditioning without the energy use or carbon demands of actual air conditioning.

Given the amazing properties of transpiration, it's no wonder that paved over urban areas would be hotter than surrounding non-urban locations. Redlined cities are more likely to show a pronounced urban heat island effect. One study that looked at 108 urban areas indicated that redlined land surfaces are typically 2.6° C hotter than non-redlined urban land, and redlined cities can be as much as 7° C hotter than non-redlined cities. [7] This is an unsettling difference, as it is directly related to the lack of green spaces due to systemic discrimination.

The lack of green spaces and subsequent extreme heat in urban areas, particularly redlined areas, would be less troubling if it wasn't a public health crisis that is going to get worse. As you guessed by my ominous introduction on climate change, extreme heat is going to become more intense and more commonplace, even if (and that's a huge if) we can collectively keep within IPCC's recommendation of 2° C. As climate warming doesn't occur uniformly, some places have already hurdled past that limit and are now facing the sort of extreme heat that represents both an ecological and public health crisis. [8] Long-term heat exposure can exacerbate existing health conditions and threaten the very young and old, as well as posing a danger to those working and living outside or without the intervention of air conditioning. [9]

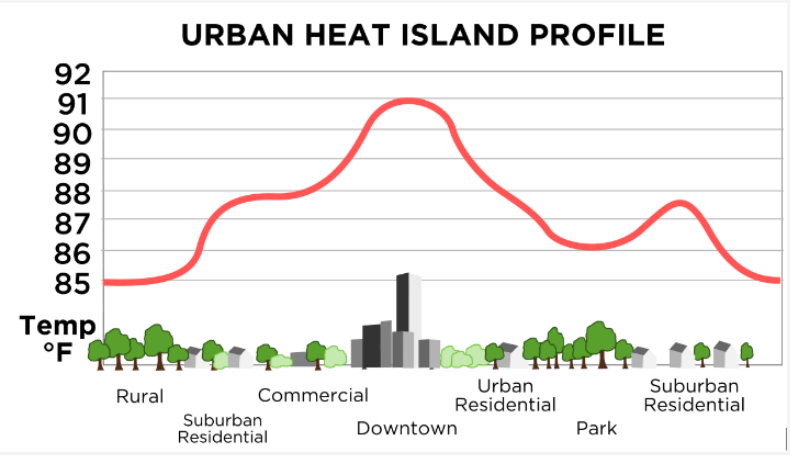


Figure 2: Public domain image taken from Wikipedia commons demonstrating how the lack of green spaces within urban areas leads to temperature increases.

Grappling with issues around climate change is complex, and like every other aspect of it, extreme heat and the urban heat island effect requires a faceted approach in order to make a difference. Although this article wasn't solely focused on the botanical aspects of the urban heat island effect, an important aspect of alleviating extreme heat in cities will be retrofitting them with green spaces. [10] Trees have the most pronounced cooling effect, but any permeable green surface (preferably one composed of native plants) is useful when addressing urban heat islands. Retrofitting current cities with things like green roofs and rooftop gardens and high albedo surfaces that reflect sunlight should also be considered during urban design (or redesign, as it were). [11] This twofold combination will both reflect sunlight, preventing excess heat absorption, and cool down existing spaces. The possibilities for sustainable urban design go beyond the consideration of bike paths and public transportation; instead of treating urban heat as an ecological issue or threat to public health, understanding it as both allows for solutions that are actually effective at treating the issue.

This cross-field analysis is an evolving but established field of research known as the environmental humanities. Considering the way discriminatory housing practices may have influenced present day temperature patterns in cities is just one small study question. Other aspects of the environmental humanities might include analyzing illness rates in different races and ethnicities, whether those illnesses are infectious or not. [12], [13]

Patterns that enforce the marginalization of different populations depending on race, sex, and socioeconomic status emerge across all STEM disciplines. Part of the solutions for an equitable future requires an understanding of the origins of those problems, including aspects of social discrimination. It's not enough to compare the temperatures between different cities and surrounding suburban and rural areas—understanding how those cities were built and the ramifications that has in the face of climate change is necessary for creating a sustainable future for all.

Figure 3: The ideal city has large proportion of green spaces, including areas where rainwater can seep through permeable land, and plenty of trees. This will mitigate the extreme heat effects of climate change, and provide leisure spaces for those living in the city.

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