

Empathetic Reverberations

Tianyue Wang

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Tianyue Wang
MLA Landscape Architecture, RISD

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Deep Mapping of Plant Cell Reaction
to Pollution: Resistance, Rift,
Resilience

Plants play a crucial role in sustaining life on Earth and remediating pollution, making them indispensable components of ecosystems. However, their efforts in combating pollution are often overlooked and underappreciated by humans. This oversight can lead to a failure to recognize the severity of pollution and raises ethical concerns about using plants merely as tools for pollution control. This thesis advocates for acknowledging the essential role of plants in mitigating pollution caused by human activities and emphasizes the need to respect and protect their intrinsic value.

The methodology of this research involves developing landscapes that honor and recognize the vital contributions of plants to the survival of the planet and its human inhabitants, while fostering empathy and transformative behaviors in humans. Strategies include highlighting the brutal battles and sacrifices of non-human vulnerable groups within ecosystems in their fight against pollution and revealing the pivotal role

plants play in healing our shared environment. By exploring the similarities between human and plant life milestones, the project aims to create a multispecies ethnography that fosters empathy for plants.

The significance of this thesis lies in its dual approach. In the short term, it aims to raise awareness about the role of plants in phytoremediation and encourage human participation in pollution mitigation efforts, leading to more consistent actions against pollution. In the long term, it calls for a reevaluation of natural rights and the ethical relationships between humans and other non-human species, ultimately promoting a future of multispecies harmony and sustainable development.

Thesis Question

How can landscapes be developed that recognize and honor the role plants play in the survival of the planet and its human inhabitants, while fostering empathy and transformation in human behavior?

Preface

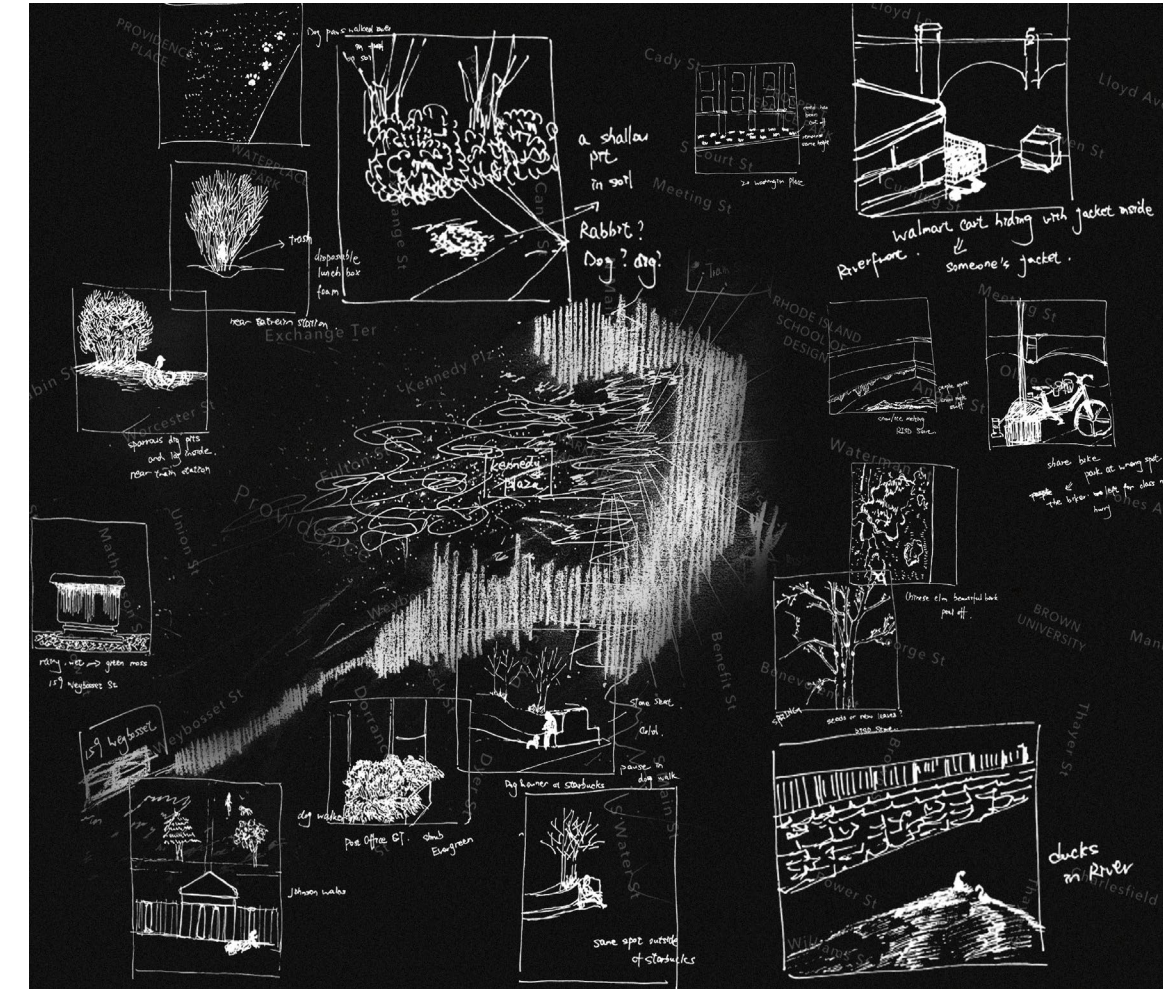
After completing the design phase, I found myself stuck, struggling to begin writing the text content of this thesis book until I engaged in this deep self-reflection and recollection that I could move forward. This personal approach is essential because my journey with this thesis has been long and arduous, with many thoughts and ideas intertwining in my mind, much like a silkworm cocoon. Only by continually drawing out that single thread can I unravel a long, continuous silk strand and see the entire cocoon clearly.

My interests have always been closely tied to nature and plants. I first encountered the concept of Multispecies Agency in the Fall of 2022, reading Cheryl McEwan's article "Multispecies Storytelling in Botanical Worlds: The Creative Agencies of Plants in Contested Ecologies."¹ This introduced me to the potential of multispecies storytelling to more intimately connect plant and human lives. In the Spring of 2022, Professor Ann Kearsley introduced me to the Rights of Nature, where I read Christopher D. Stone's "Should Trees Have Standing?" and David R. Boyd's "The Rights of Nature." These works made me ponder the rights plants should enjoy as part of nature and imagine a world where plants and humans share equal rights. While McEwan's work claims to view multispecies ethnography through the lens of plants, it still somewhat anthropomorphizes plants,

looking at them from a human perspective. On the other hand, Stone and Boyd's discussions, though placing nature in a more dominant position, seem more like concepts understandable and acceptable only to a minority and are challenging to fully realize at this stage. I will explore these articles in more detail in the Literature Review section in this book.

In the Spring of 2023, during the Urban Systems Studio, I first learned about the mechanisms of phytoremediation and used this as an entry point for an urban project that simultaneously addressed water pollution and developed educational and recreational landscapes. Conversations with Professor Jacob Mitchell about designing systems to manage plants post-phytoremediation planted a seed in my mind, ultimately leading me to decide to tell the story of human-plant interaction and pollution remediation through the lens of phytoremediation using multispecies storytelling.

This thesis is the result of my contemplation on how to develop landscapes that help people recognize the importance of plants, respect their role, and effectively elevate their status, all framed within my personal worldview and understanding. I present this book as a record of that journey.



The Rights of Nature Course
Exercise: Discovering Nature
in a Day

Cover Page. Fig. 1. Waldemar Strempler, "Untitled," Slash Zine, accessed May 24, 2024, <https://www.slash-zine.com/en/daily/WALDEMAR-STREMPLE>.

1. Cheryl McEwan, "Multispecies Storytelling in Botanical Worlds: The Creative Agencies of Plants in Contested Ecologies," *Geoforum* 88 (2018): 179-188.

To all the plants that silently work to purify our environment
and to everyone dedicated to understanding and protecting
our natural world.



01 Introduction
Introduction
Thesis Statement
Glossary
Post-Phytoremediation Plants

02 Build a Bridge of Empathy
Evocation of Empathy
Fostering Understanding - Nature & Humans Relationship
Sharing Vital Life Milestones
Shifting Perspectives

03 Experimental Design
The Test Plot
blah
blah

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01 VEILED INDEPENDENCE



The existence of pollution has widespread and severe impacts, particularly affecting vulnerable groups. Many countries and regions are struggling with severe pollution while trying to improve their economies through industrialization. For example, water pollution in Bangladesh significantly impacts lower-income communities who rely on contaminated sources for their daily needs². Similar patterns are observed globally, where marginalized communities disproportionately suffer from environmental degradation³.

2. “Dead Rivers: The Cost of Bangladesh’s Garment-Driven Economic Boom,” France 24, June 21, 2022, accessed May 24, 2024, <https://www.france24.com/en/live-news/20220621-dead-rivers-the-cost-of-bangladesh-s-garment-driven-economic-boom>.

3. Robert D. Bullard, *Dumping in Dixie: Race, Class, and Environmental Quality* (Boulder: Westview Press, 2000).



Fig. 3. Image of a polluted river with a man wading,” in “Dead Rivers: The Cost of Bangladesh’s Garment-Driven Economic Boom,” France 24, June 21, 2022, accessed May 24, 2024, <https://www.france24.com/en/live-news/20220621-dead-rivers-the-cost-of-bangladesh-s-garment-driven-economic-boom>.

Just as marginalized humans silently endure unfair treatment in society, plants, the organisms at the forefront of environmental pollution, similarly endure this silent assault. Phytoremediation is a mechanism that reduces the amount of pollutants in the environment by having plants absorb contaminants while they take up the nutrients and water needed for their growth from soil and water⁴. Therefore, plants are studied for their capabilities and increasingly utilized in large-scale, long-term, and relatively low-budget brownfield remediation projects. While this approach effectively reduces pollutants in the environment, it raises several ethical concerns:

- **Human Neglect of Pollution’s Harms:** The relatively low cost of using plants for pollution control might lead to a disregard for the broader harms of pollution, as it offers a seemingly easy solution without addressing the root causes.
- **Ethical Misplacement:** Using plants as tools to manage pollution suggests an ethical misplacement. Are we transferring the responsibility and consequences of pollution—originally ours—to plants simply because they can mitigate it and cannot resist our actions?

Drawing on the perspectives from Christopher D. Stone’s “Should Trees Have Standing?”⁵ and David R. Boyd’s “The Rights of Nature”⁶, it becomes evident that plants should be granted natural rights that humans should respect and protect. Stone argues that natural entities, including plants, possess intrinsic value and should be granted legal standing, challenging traditional anthropocentric views. Boyd emphasizes the importance of recognizing the rights of nature as a transformative framework for environmental law, advocating for a shift in how we interact with the natural world.

Many plants are harmed and sacrificed while absorbing pollutants, yet this struggle goes unnoticed and unappreciated by humans, much like our underestimation of the actual negative impacts of pollution. This thesis advocates for recognizing the critical role plants play in mitigating the damage and degradation caused by human activities. It aims to highlight the brutal battles and individual sacrifices of non-human vulnerable groups within ecosystems as they combat pollution, revealing the pivotal role plants play in healing our shared environment. By exploring the similarities between human and plant milestones in life, this work seeks to craft a multispecies

ethnography that fosters empathy for plants.

In the short term, this approach aims to raise awareness about plants, their role in phytoremediation, and encourage human participation in these efforts, leading to more concerted actions

against pollution. In the longer term, it calls for a reevaluation of natural rights and the ethical relationships between humans and other non-human species, ultimately promoting a future of multispecies harmony and sustainable development.

4. Kennen and Kirkwood, *Phyto: Principles and Resources for Site Remediation and Landscape Design* (New York: Routledge, 2015).

5. Stone, *Should Trees Have Standing? Law, Morality, and the Environment* (New York: Oxford University Press, 2010).

6. Boyd, *The Rights of Nature: A Legal Revolution That Could Save the World* (Toronto: ECW Press, 2017).

Phytoremediation/Percolation

- Phytoremediation/Percolation is the use of plants to remove contaminants from soils.
- Design plants that can extract specific pollutants based on known contaminants.

Phytoextraction

- Plants' bodies gather pollutants
- Several months growth
- composted or incinerated to recycle the metals

Rhizofiltration

- Rhizofiltration is the adsorption onto plant roots or absorption into plant roots of contaminants that are in solution surrounding the root zone (rhizosphere), for water contamination
- the plants are usually cultivated in green house hydroponics conditions
- Roots & Shoots: acclimated to polluted water with roots, when pollutants take over the roots, plants will be harvested
- composted or incinerated for recycling the contaminants

Phytostabilization

- uses plant cover to immobilize contaminants in soil, reducing off-site pollution, for soil contamination, etc.
- Improving plant species to enhance performance

Phytodegradation/Phytotransformation

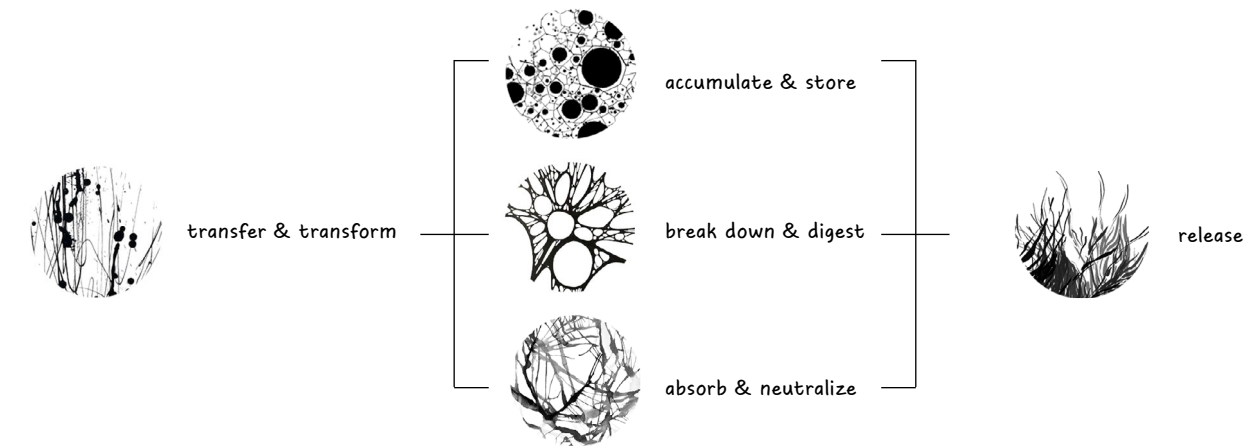
- plants break down pollutants and absorb pollutants for its growth

Phytostimulation/Rhizodegradation

- plants assist micro-organisms, bacteria, fungi, yeast to consume and digest most of the organic substances to obtain energy and nutrition

Phytovolatilization

- plant roots absorb contaminants, converting them into less concentrated contamination gaseous compounds, and releasing them into the atmosphere, as a common process in growing trees
- contaminated gas emission is still an issue



7. Pidlisnyuk, Valentina, et al. "Phytotechnologies for remediation of heavy metal-contaminated sites." *Frontiers in Environmental Science* 10 (2022): 963463. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9634634/>.



Human and Nature

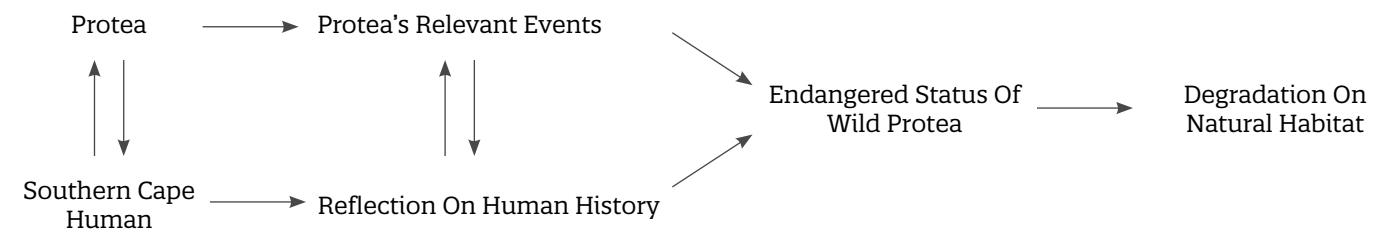
Fig. 4. Nikoline L. Rokkjaer, "Human and Nature," Flickr, August 9, 2011, accessed May 24, 2024, <https://www.flickr.com/photos/nikolinelr/6026049337>.

“What if you were a teacher but had no voice to speak your knowledge? What if you had no language at all and yet there was something you needed to say? Wouldn’t you dance it? Wouldn’t you act it out? Wouldn’t your every movement tell the story? In time you would become so eloquent that just to gaze on you would reveal it all. And so it is with these silent green lives.”⁸

8. Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (Minneapolis: Milkweed Editions, 2013)



Multispecies storytelling in botanical worlds: The creative agencies of plants in contested ecologies



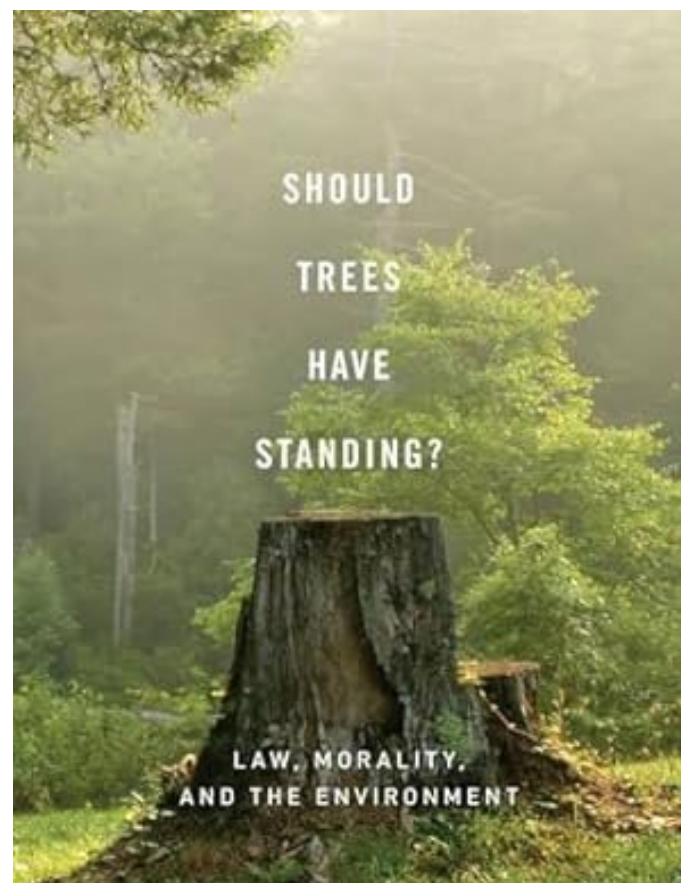
McEwan cites Robin Wall Kimmerer to reflect on how to effectively tell the stories of other species. In “Multispecies Storytelling in Botanical Worlds: The Creative Agencies of Plants in Contested Ecologies”⁹, McEwan elaborates the intertwining of plants and human history from the plants’ perspective, explore the creative roles of plants in ecosystems, and foster human understanding and empathy towards non-human species. He chose a culturally significant and commercially popular plant species, Protea, known for its high recognizability, to trace its commercialization and its intertwining with human history. By connecting knowledge about this species with existing historical knowledge, McEwan narrates the plight of a wild species, Mace Pagoda, which faces extinction due to the reduction of its natural habitat. Using poetic language, McEwan tells this story to provoke deeper reflection. I believe this anthropological narrative method can temporarily distance readers from an anthropocentric mindset, allowing them to immerse in the experiences and emotions of others, thus effectively linking non-human species more closely with human lives.

In the conclusion, McEwan further reflects on the ethical and empathetic challenges posed by such narratives in the human-

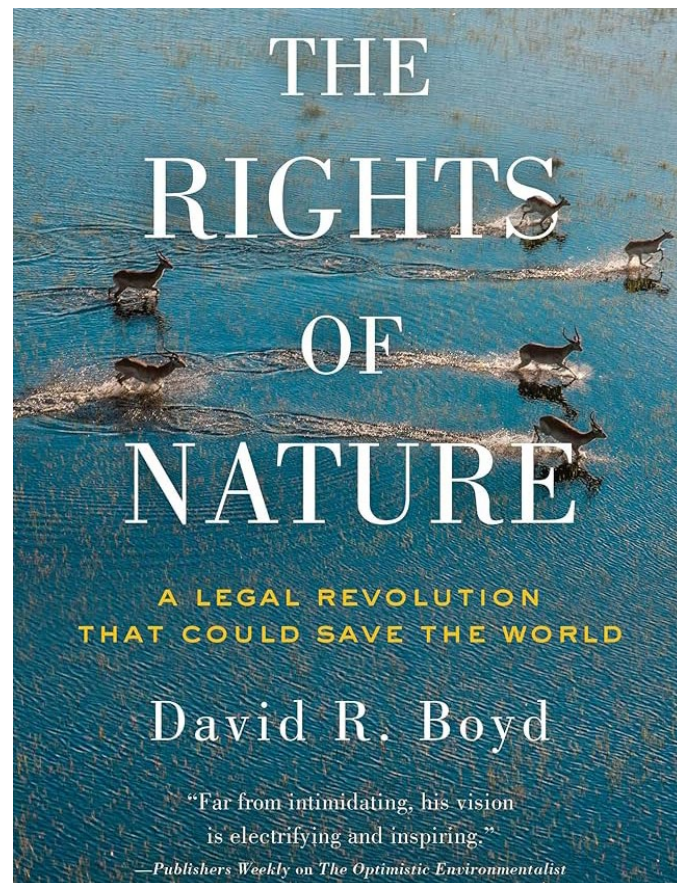
plant relationship: “Humans can never fully understand proteas because they are unable to inhabit their perceptual worlds – to us, like their namesake in Greek mythology, proteas can be elusive tricksters and not always reliable narrators.” I agree with his view, but as he mentioned, this narrative can help people understand the impacts of biodiversity loss and climate change. We first need to make more people aware of these non-human species and willing to understand them before we can discuss other issues. Therefore, despite the fact that from the perspectives of ethics and natural rights this narrative may not be the most appropriate, it aids in understanding and spreading awareness among the public, and is more likely to engage people’s emotions, making it a suitable method.

9. McEwan, “Multispecies Storytelling,” 183.

Fig. 5. Tony Rebelo, “Cultivated specimen of the Mace Pagoda, with orange-breasted sunbird,” photographed March 3, 2015, Kirstenbosch National Botanical Garden, in Cheryl McEwan, “Multispecies Storytelling in Botanical Worlds: The Creative Agencies of Plants in Contested Ecologies,” *Geoforum* 88 (2018): Figure 1. Source: Tony Rebelo – <https://www.inaturalist.org/observations/11023088>, CC BY-SA 4.0, accessed August 12, 2021.



Should Tree Have Standing?



The Rights of Nature

The concept of the Rights of Nature has gained significant attention in recent years, reflecting a shift in environmental law and ethics. This literature review examines key texts and research that have contributed to the development and understanding of the Rights of Nature, highlighting their implications for environmental protection and sustainability.

Christopher D. Stone's seminal work, *Should Trees Have Standing?* (2010)¹⁰, is often cited as a foundational text in the Rights of Nature discourse. Stone argues that natural entities should be granted legal standing, enabling them to be represented in court. His proposition challenges the anthropocentric legal framework and suggests a radical rethinking of legal rights and responsibilities. Stone's work has been influential in inspiring legal reforms and philosophical debates about the intrinsic value of nature.

David R. Boyd's *The Rights of Nature: A Legal Revolution That Could Save the World* (2017)¹¹ builds upon Stone's ideas, offering a comprehensive overview of how different countries have implemented the Rights of Nature. Boyd examines case studies from Ecuador, Bolivia, and New Zealand, where natural

entities like rivers and forests have been granted legal rights. He argues that recognizing the Rights of Nature is essential for addressing environmental crises and achieving sustainable development. Boyd's work highlights the practical implications and challenges of implementing these legal frameworks.

These two books have provided me with intellectual guidance, but due to the lack of reference cases and more detailed background knowledge, they have not inspired me methodologically. Moreover, in my view, neither of these works currently offers broadly replicable results. I believe that the cases studied by Boyd all occur in regions with abundant forest resources, relatively high per capita income, and low reliance on industries likely to cause industrial pollution. While these cases can serve as references for similar regions and countries, they may not be applicable to more general situations.

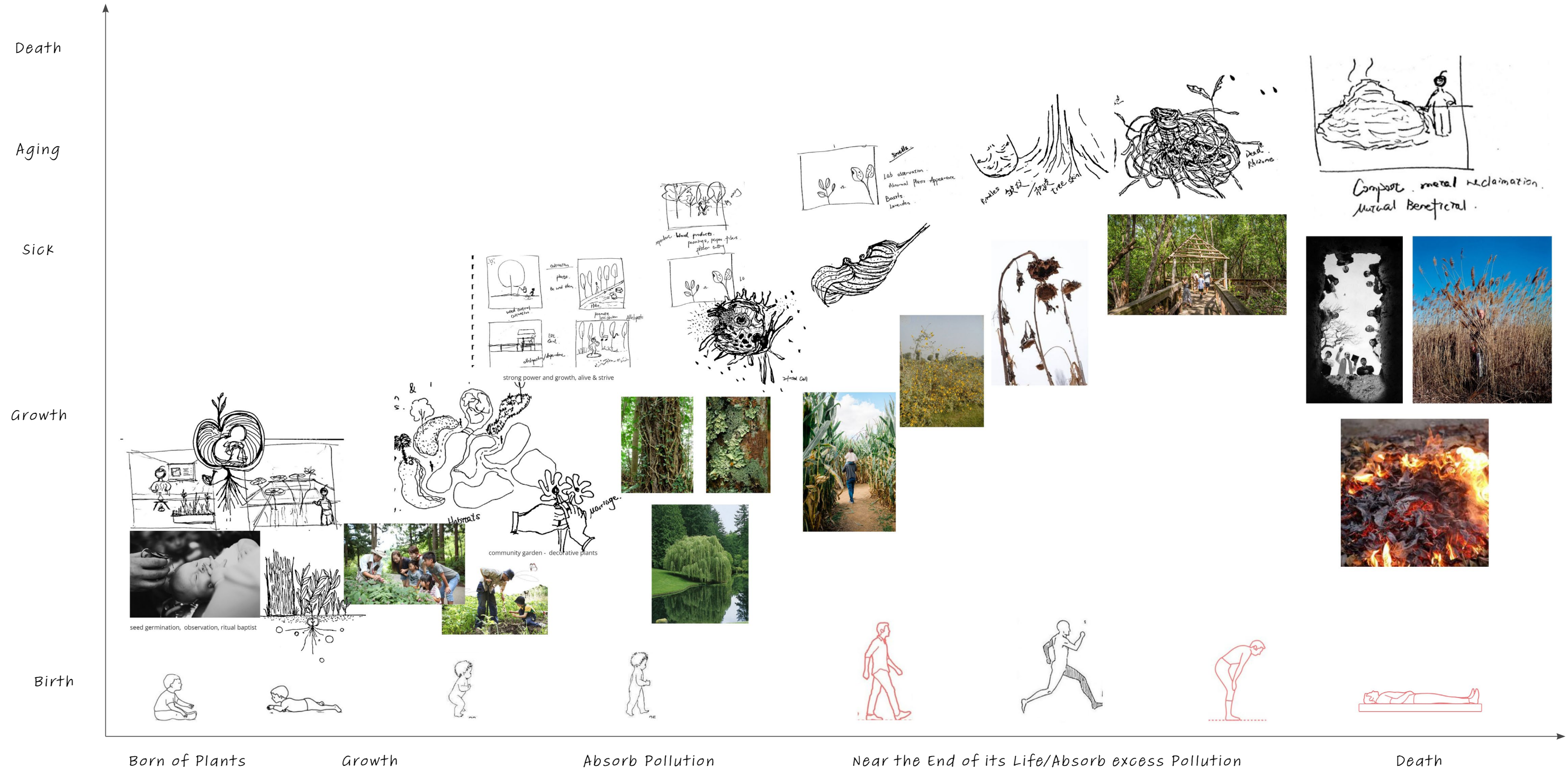
¹⁰. Boyd, *The Rights of Nature*.

¹¹. Stone, *Should Trees Have Standing?*

Fig. 6. Cover image of David R. Boyd, *The Rights of Nature: A Legal Revolution That Could Save the World* (Toronto: ECW Press, 2017).

Fig. 7. Cover image of Christopher D. Stone, *Should Trees Have Standing? Law, Morality, and the Environment* (New York: Oxford University Press, 2010).

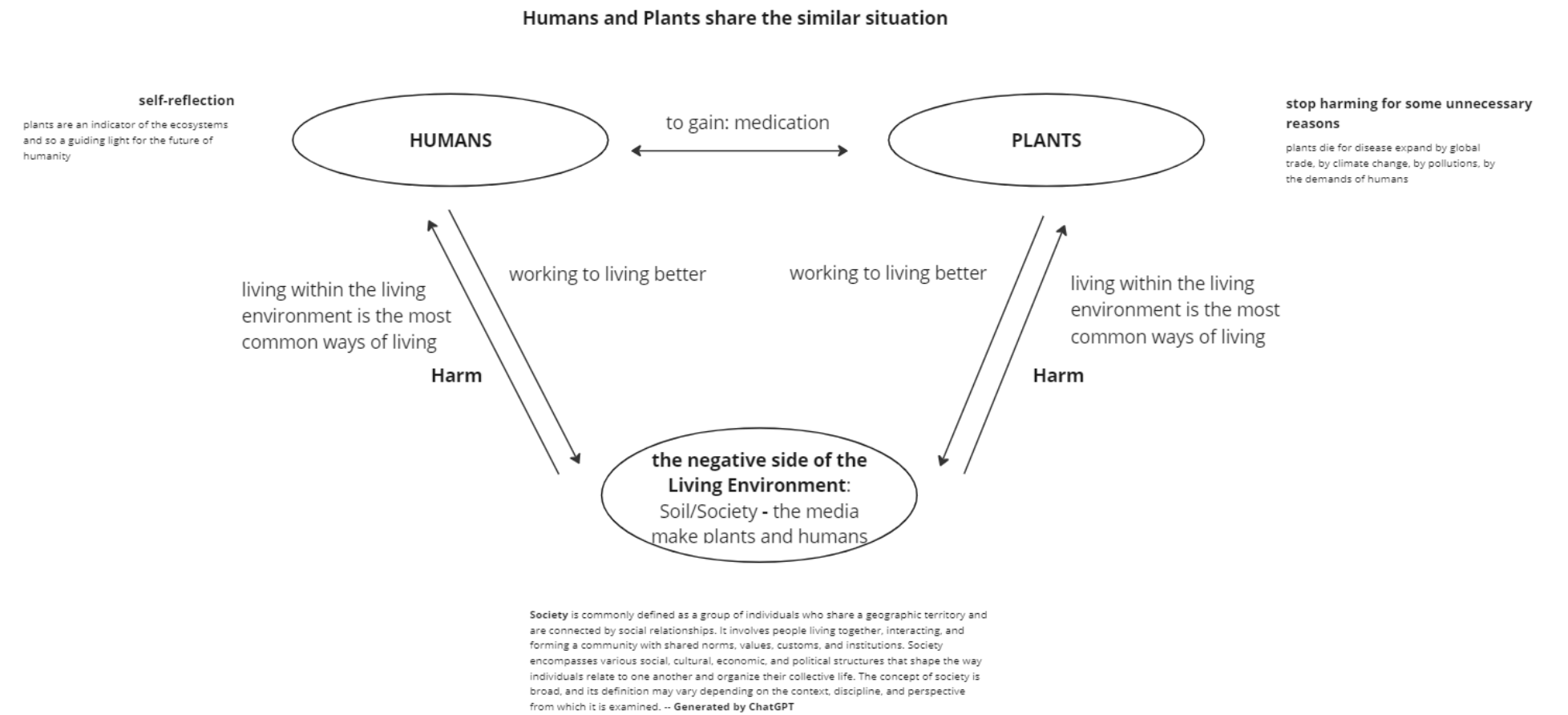
02 BUILD A BRIDGE OF EMPATHY



a diagram to show what the bridge is build on

Plants distribute and share the burden of toxins to make toxins less harmful, then transform some toxins into nutrients vital for their growth, breaking down and absorbing those beneficial elements.

For the elements cannot be dissolved, plants will try to neutralize, and then release them into the sharing environment waiting for further interactions.



Case study: Empathy Cultivation in Nurse Schools



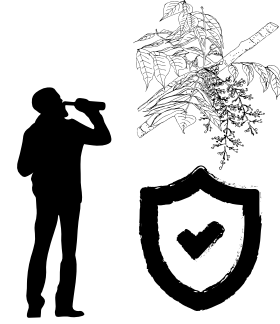
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Case study: Power Plants Phytoremediation Garden



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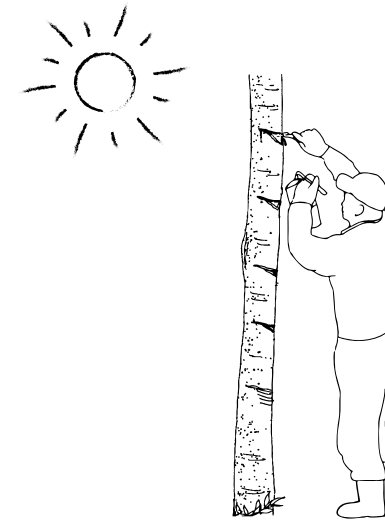
Case Study: Emerging Significant Otherness between Japanese Lacquer Trees and Humans

Japanese lacquer tree harvesters have developed a unique symbiotic relationship with lacquer trees through long-term interaction. The workers cultivate the lacquer trees for about ten years until they reach the standard suitable for harvesting lacquer. The process of harvesting lacquer requires the trees to be in good health since only healthy trees can produce high-quality lacquer.

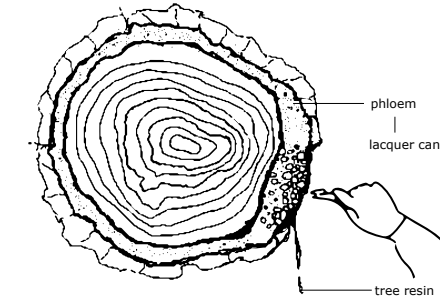
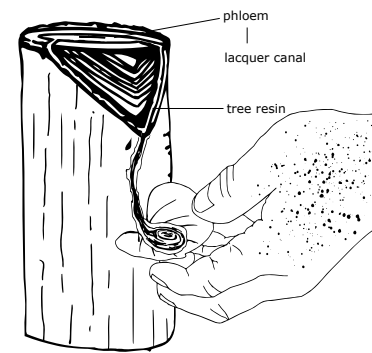
Lacquer harvesting follows a five-day cycle. On the first day of the cycle, the act of harvesting injures the trees, prompting them to secrete sap to heal themselves. Since most humans have

a strong allergic reaction to lacquer sap, the workers also suffer from skin allergies, albeit unintentionally from the trees. Over the next four days, both the workers and the trees recuperate and heal. On the sixth day, which marks the beginning of the next cycle, the harvesting process starts again.

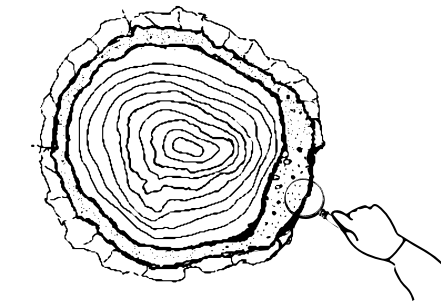
Over time, workers gradually develop a tolerance to the allergic reactions caused by the lacquer, and the trees increasingly adapt to the damage, managing to heal themselves within each cycle. This cyclical interaction fosters a unique coexistence between work and nature.



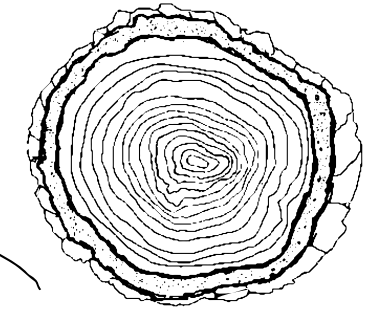
Lacquer Collection



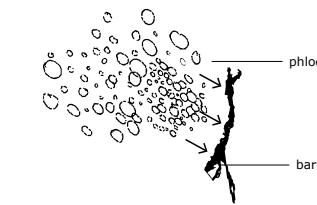
The First Day Workday



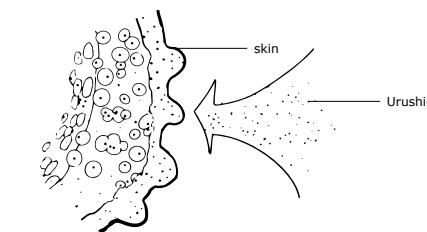
The Next Four Days



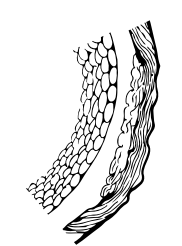
Years Later



Harm



Self-Healing



Almost Recovered

10. Boyd, The Rights of Nature.

11. Stone, Should Trees Have Standing?

Fig. 6. Cover image of David R. Boyd, The Rights of Nature: A Legal Revolution That Could Save the World (Toronto: ECW Press, 2017).

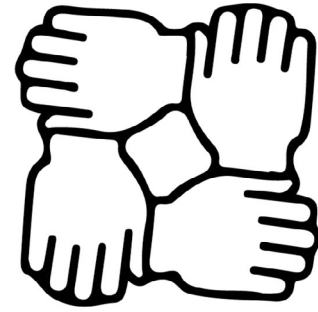
Fig. 7. Cover image of Christopher D. Stone, Should Trees Have Standing? Law, Morality, and the Environment (New York: Oxford University Press, 2010).



competitive relationship



mutual beneficial relationship



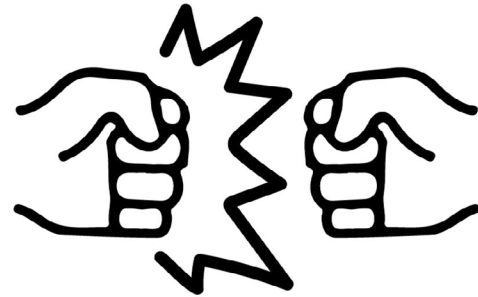
community relationship



symbiotic relationship



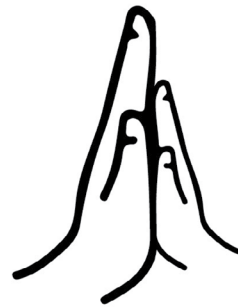
allelopathic relationship



antagonistic relationship



dependent relationship



parasitic relationship

•Competitive relationship: Just as humans may engage in competition for resources, status, and power, plants may compete for light, water, and nutrients.

•Mutually beneficial relationship: Humans may form mutually beneficial relationships by cooperating, collaborating, or supporting each other to achieve common interests, similar to plants attracting pollinators or predators to protect each other.

•Community relationship: Humans may form various social groups such as families, tribes, or cities, where members interact and live together, akin to plant communities.

•Symbiotic relationship: Similar to the feeding on and benefiting from one another. This can be observed in families, communities, or work environments.

•Allelopathic relationship: Humans may communicate through language, behavior, or other means,

influencing each other's actions and emotions, similar to plants releasing chemicals to affect surrounding plants.

•Antagonistic relationship: Humans may also experience antagonistic relationships, such as competition, conflict, or hostility, similar to resource competition or mutual exclusion among plants.

•Dependent relationship: Much like how certain plants rely on others for support or nutrients in symbiotic partnerships, humans may form dependent relationships where one party relies heavily on the other for various needs or support

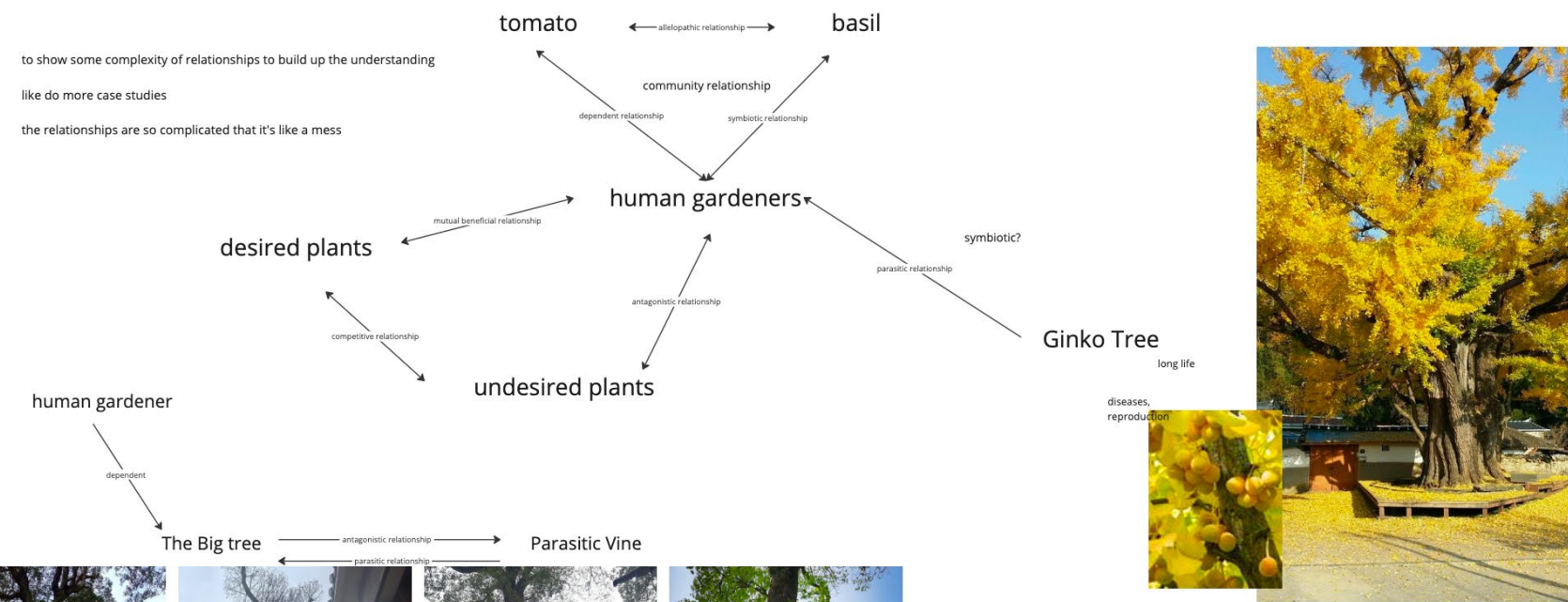
•Parasitic relationship: Just as some plants may act as parasites, extracting nutrients from host plants and harming them in the process, humans may engage in parasitic relationships where one benefits at the expense of the other, causing harm or detriment to the host.



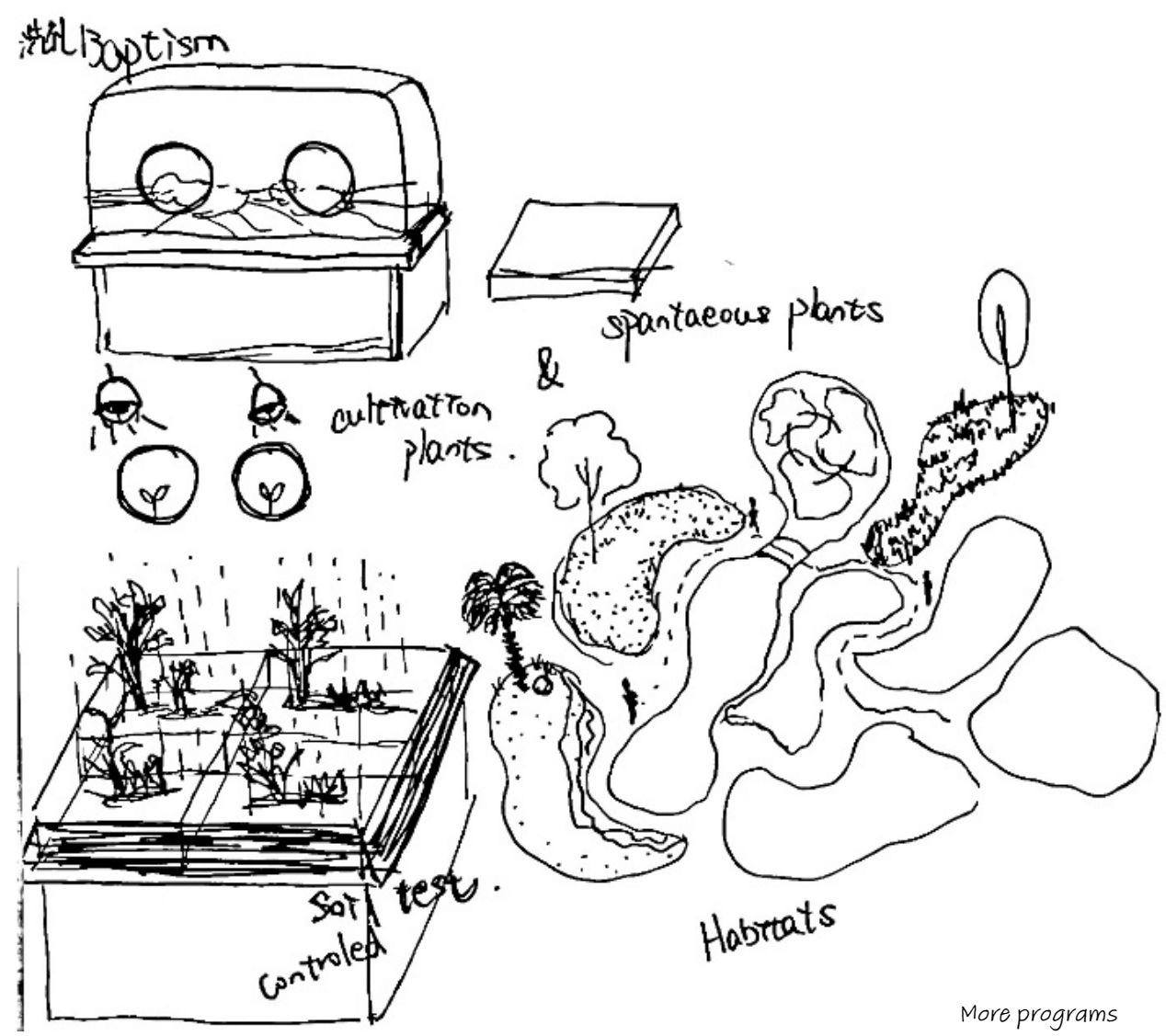
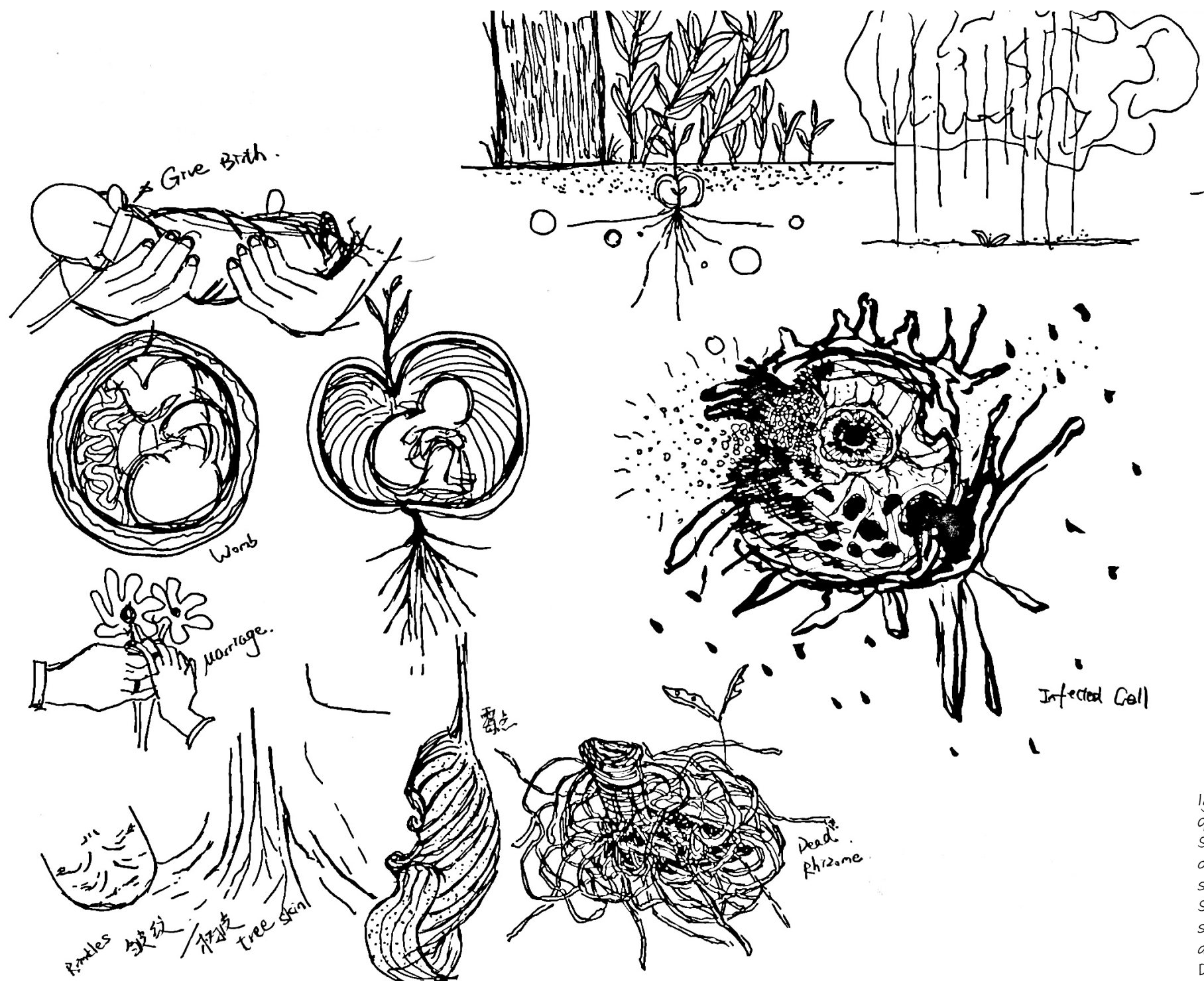
good plants partners

weed control: desired plants, undesired plants, human gardeners

to show some complexity of relationships to build up the understanding
like do more case studies
the relationships are so complicated that it's like a mess



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Life is a Journey

Life



born of plants

growth

absorb pollution

near the end of its life/absorb excess pollution

death

process of phytoremediation

body positions / visions to subject (plants)

02 BUILD A BRIDGE OF EMPATHY





Citation*

The existence of pollution has widespread and severe impacts, particularly affecting vulnerable groups. Many countries and regions are struggling with severe pollution while trying to improve their economies through industrialization. For example, water pollution in Bangladesh significantly impacts lower-income communities who rely on contaminated sources for their daily needs². Similar patterns are observed globally, where marginalized communities disproportionately suffer from environmental degradation³.

2. "Dead Rivers: The Cost of Bangladesh's Garment-Driven Economic Boom," France 24, June 21, 2022, accessed May 24, 2024, <https://www.france24.com/en/live-news/20220621-dead-rivers-the-cost-of-bangladesh-s-garment-driven-economic-boom>.

3. Robert D. Bullard, *Dumping in Dixie: Race, Class, and Environmental Quality* (Boulder: Westview Press, 2000).



Fig. 2: Image of a polluted river with a man wading," in "Dead Rivers: The Cost of Bangladesh's Garment-Driven Economic Boom," France 24, June 21, 2022, accessed May 24, 2024, <https://www.france24.com/en/live-news/20220621-dead-rivers-the-cost-of-bangladesh-s-garment-driven-economic-boom>.

Strategies



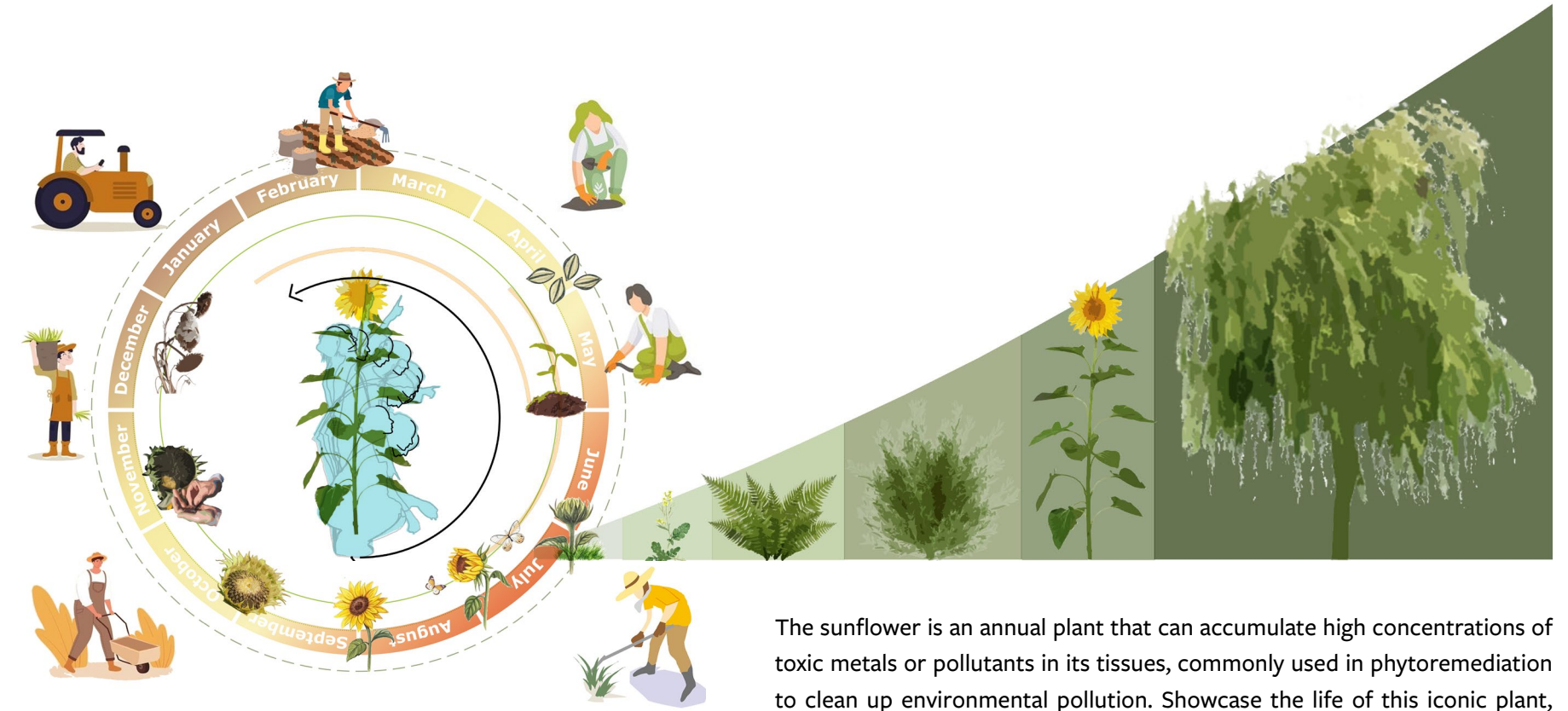
make people be aware of plants, see plants



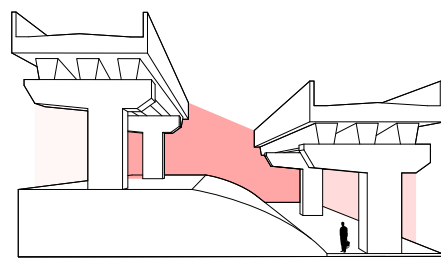
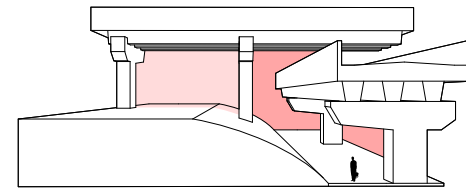
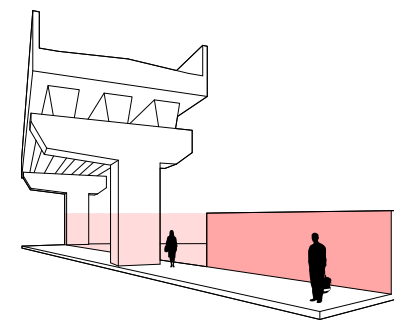
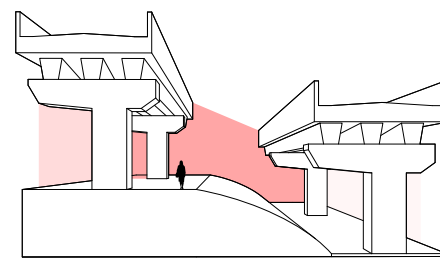
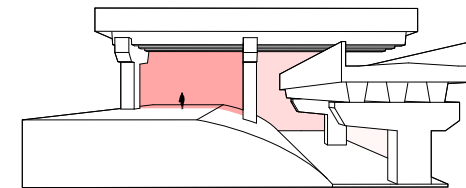
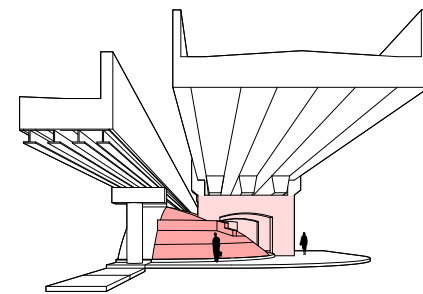
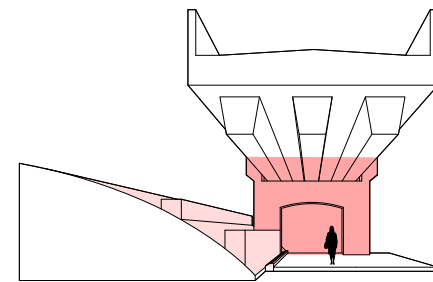
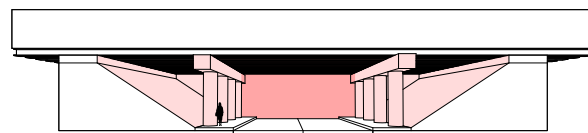
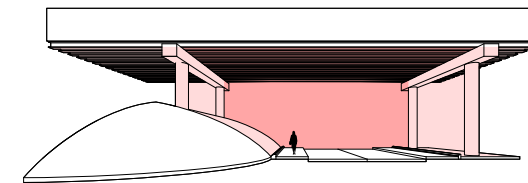
make people gain knowledge about plants, about phytoremediation, about plants painful labor work



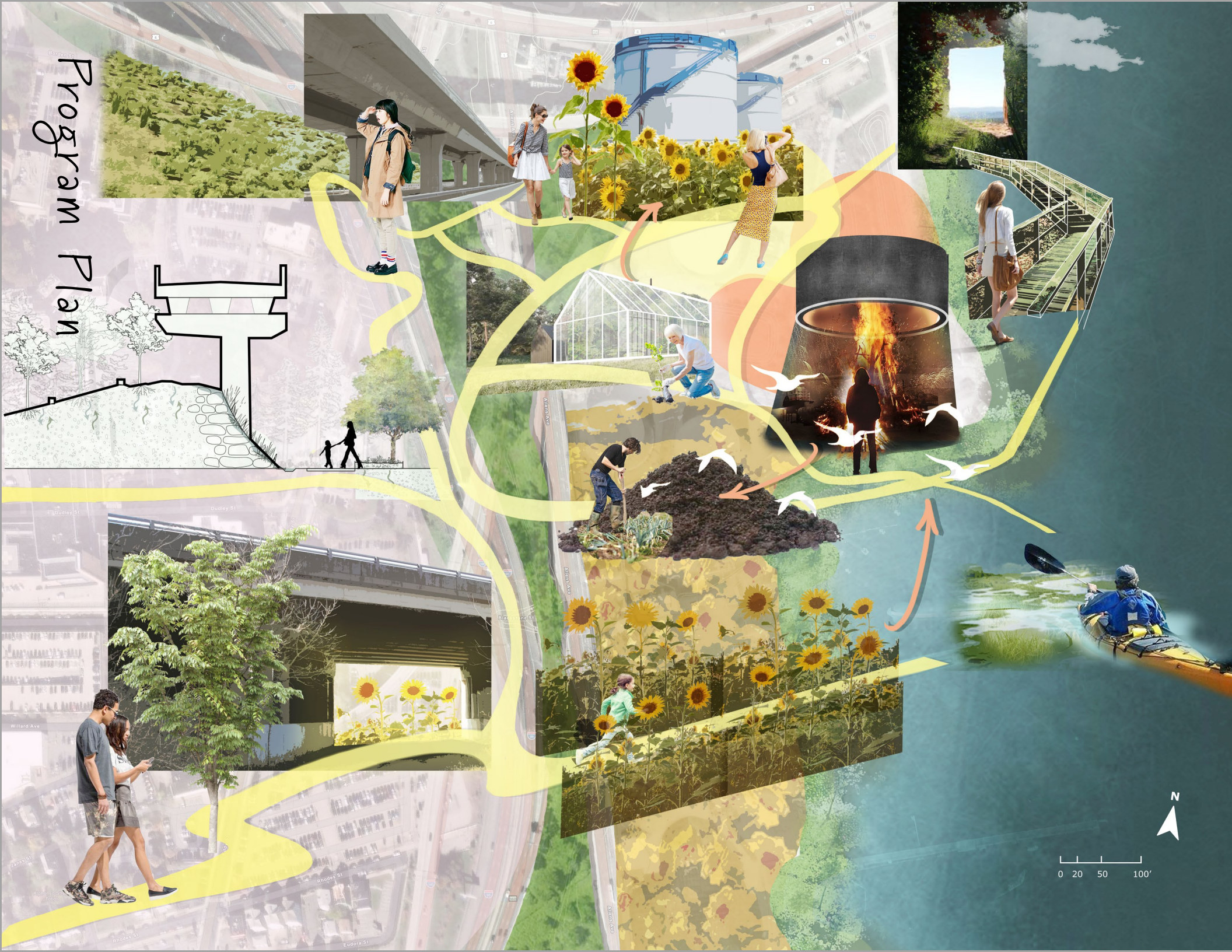
change people's attitude towards plants, call for less pollution



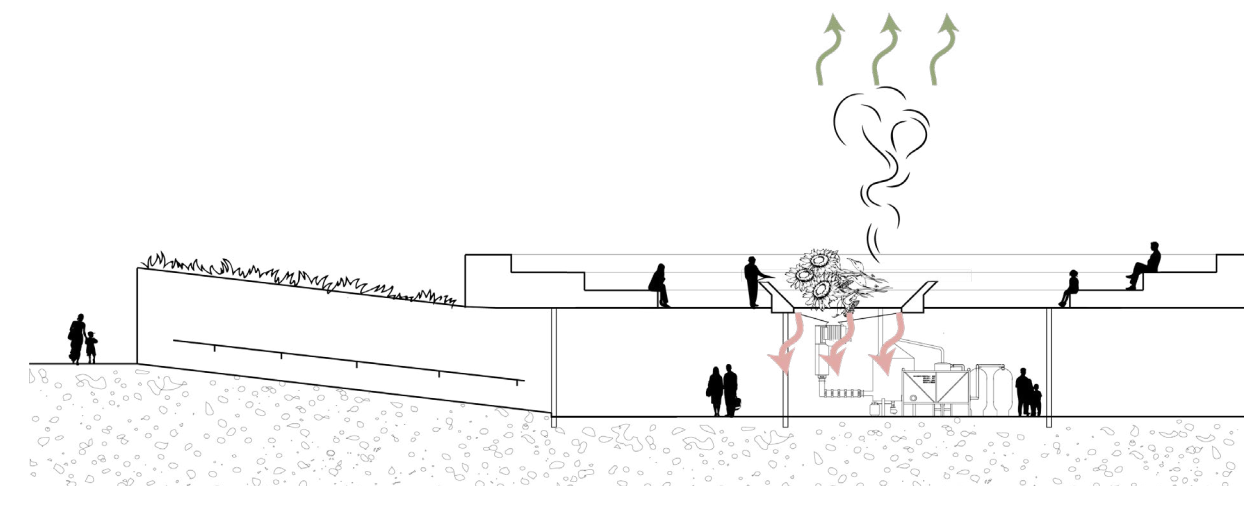
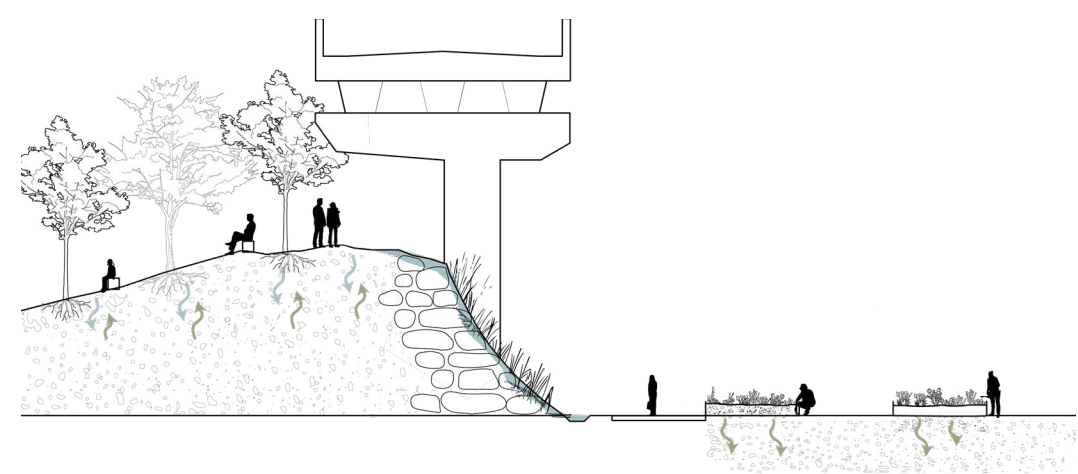
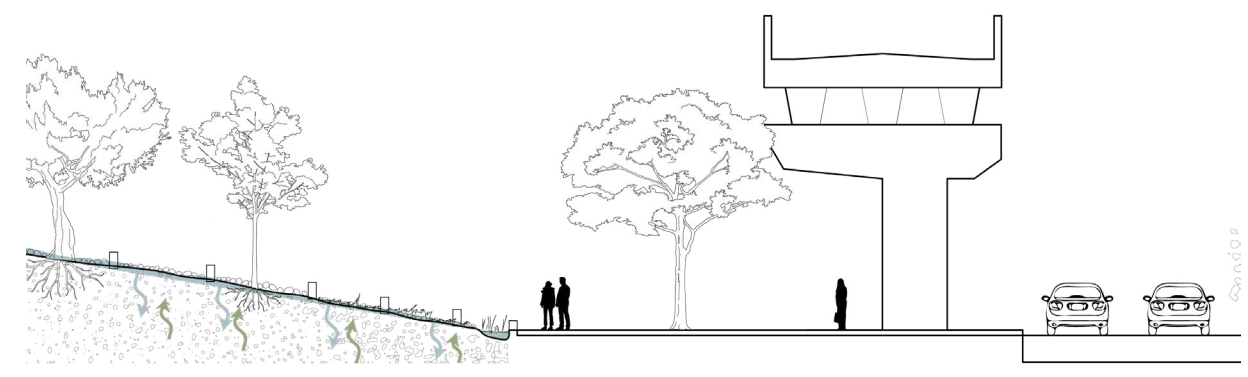
The sunflower is an annual plant that can accumulate high concentrations of toxic metals or pollutants in its tissues, commonly used in phytoremediation to clean up environmental pollution. Showcase the life of this iconic plant, the sunflower, and encourage people to engage with its entire lifecycle as a phytoremediation plant.



Program Plan



Site Design





In 5 Years



In 30 Years



In 50 Years



Kennen, Kate, and Niall Kirkwood. *Phyto: Principles and resources for site remediation and landscape design*. New York: Routledge, 2017.

Kumar, Vineet, Maulin P. Shah, and Sushil Kumar Shahi. *Phytoremediation technology for the removal of heavy metals and other contaminants from soil and water*. Amsterdam: Elsevier, 2022.

Koch, Peter Rutledge, Samuel Pelts, Dina Pollack, Jonathan Gerken, and Edwin C. Dobb. *Extraction: Art on the edge of the abyss*. Berkeley, CA: The CODEX Foundation, 2020.

My Octopus Teacher. *South Africa: Off The Fence The Sea Change Project, 2020*.
<https://www.netflix.com/title/81045007>.

Picard, Caroline, and Devin King. *Imperceptibly and slowly opening*. Chicago, IL: Green Lantern Press, 2016.

Rainer, Thomas, and Claudia West. *Planting in a post-wild world: Designing Plant Communities for Resilient Landscapes*. Portland, OR: Timber Press, 2016.

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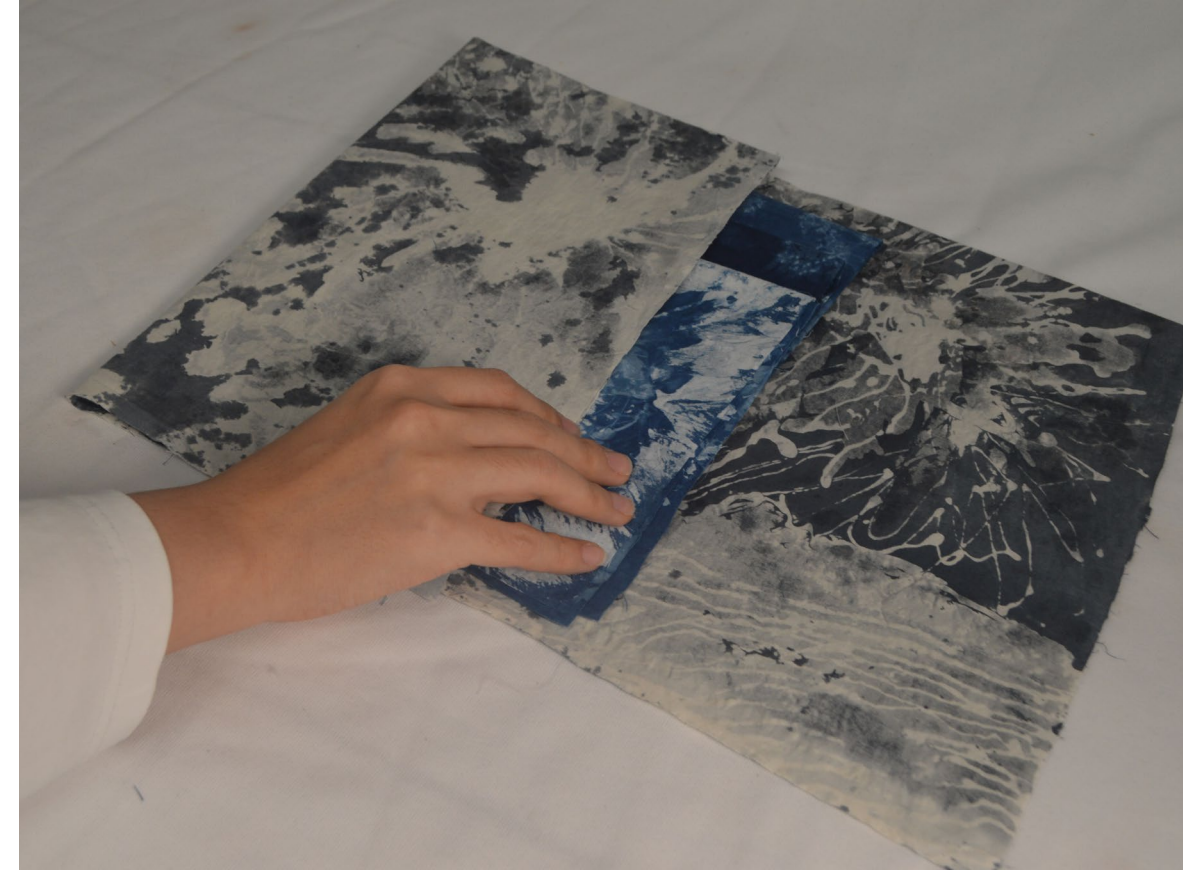
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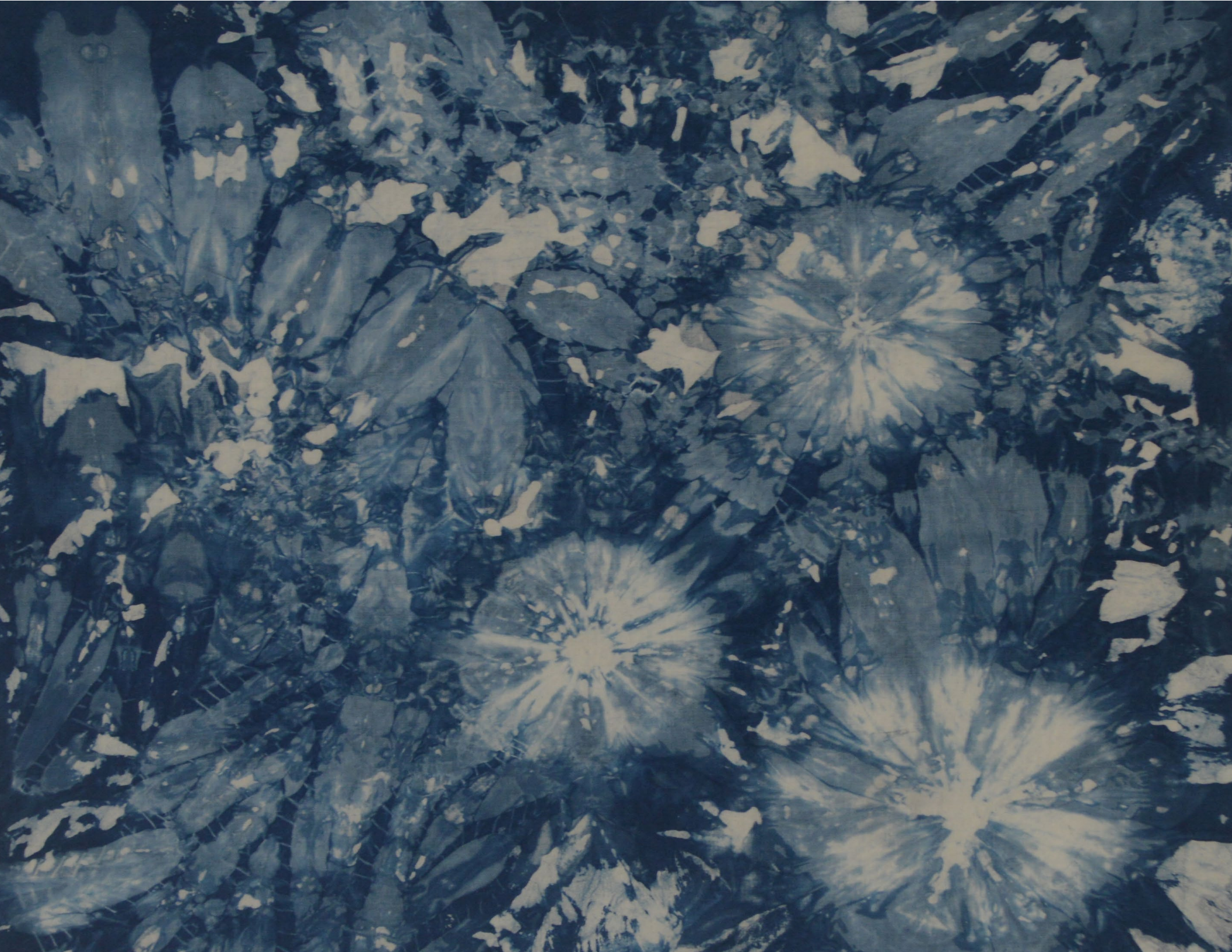


JOURNEY TO THE CENTER OF PLANTS



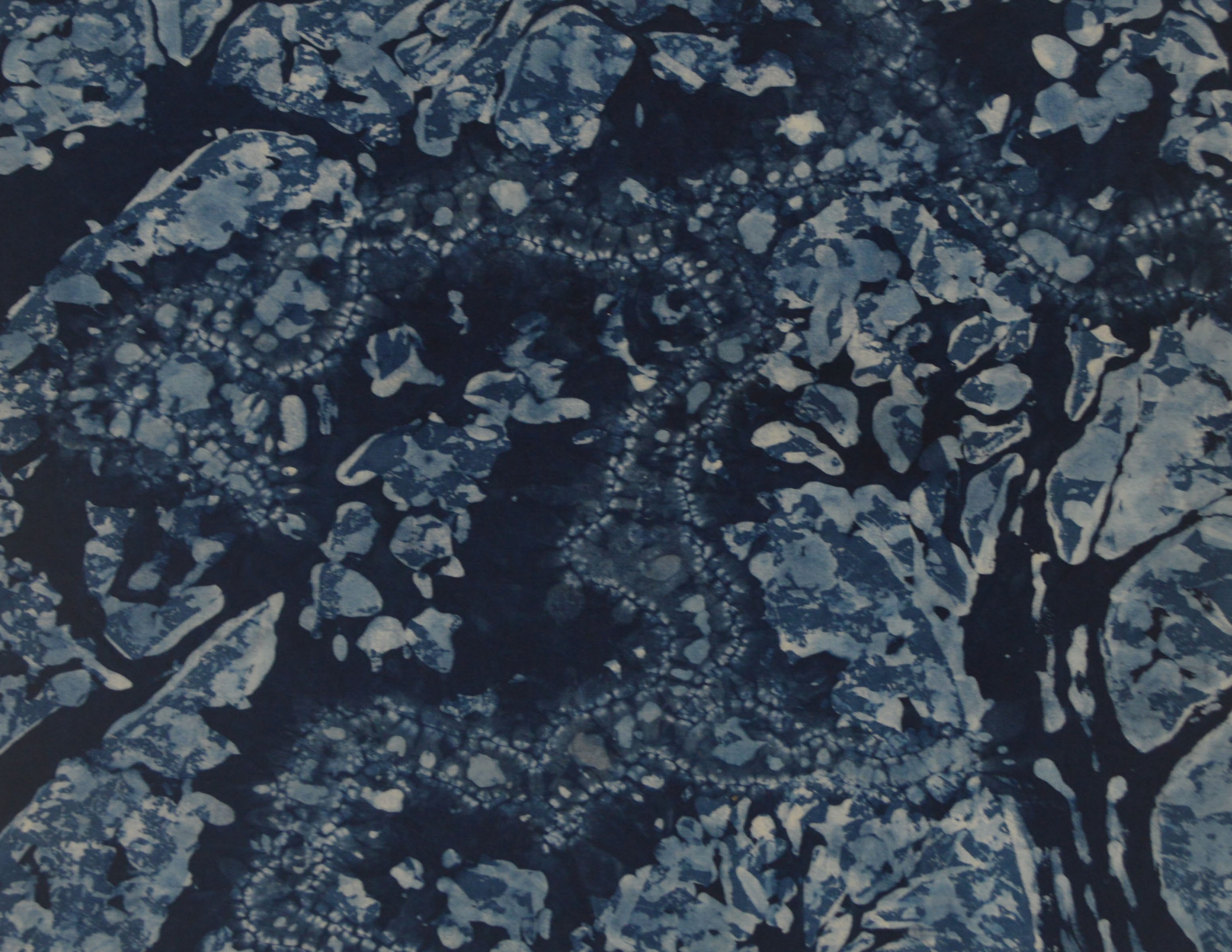
"Pressures of the earth such as faults, folds, wind, and rain create dramatic natural resist landscapes of cliff, desert sands, and canyons."

Memory on Cloth: Shibori Now



When plants take up heavy metals from the soil, these substances can be very harmful to them at a microscopic level. Heavy metals like lead, cadmium, and mercury can interfere with the plant's normal functions by attaching to proteins and enzymes, which are crucial for the plant's health. This can stop processes like photosynthesis, which the plant needs to make food, and disrupt the plant's ability to absorb nutrients.

These metals can also cause oxidative stress in the plant's cells. This means they create harmful molecules that can damage the plant's proteins, fats, and DNA. This damage can weaken the cells' structures, like walls and membranes, leading to the cells breaking and eventually dying.



Tree shyness, also known as crown shyness, is a captivating natural phenomenon observed in some tree species where the crowns of fully grown trees do not touch each other, creating a striking pattern of gaps or channels in the forest canopy. This peculiar behavior results in a mosaic-like pattern from above, with the edges of the tree crowns forming a clear boundary as if shy to touch one another. The exact cause of tree shyness is not definitively known, but several theories suggest that it could be a protective adaptation to avoid the spread of harmful insects, minimize damage from physical contact during windy conditions, or optimize light exposure and reduce competition for sunlight among trees.



"Pressures of the earth such as faults, folds, wind, and rain create dramatic natural resist landscapes of cliff, desert sands, and canyons."

Memory on Cloth: Shibori Now

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Contaminated red water polluted from a copper mine

Geamana, Romania

*In a world where water was once colorless,
light enriched our eyes' finesse.
We witnessed waters green and blue,
imitating, we created a vibrant hue.
Red, yellow, purple, and black,
muddy and toxic, a perilous track.
Humans drank the ailing stream,
trees nourished with a poisoned gleam.*

*Yet in the dance of colors so profound,
nature's essence, a spectrum unbound.
The reflection of choices we've made,
in the water's palette, a world displayed.*

*I know it's not your turn to drink this water yet.
Don't be hasty,
perhaps you're already sipping on it.*



low resolution image

What about plants?
How should we treat plants?

What about plants?
How should we treat plants?

PLANTS

TAKE UP

POLLUTANTS

BECAUSE

THEY CANT REFUSE.

Weekly Reflections

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