Alina Paias
Explore Lab 33
Research mentor
Stavros Kousoulas
Design mentor
Vanessa Grossman
Technology mentor
Hubert van der Meel

Minas as in mines

A HAUNTOLOGICAL APPROACH TO THE SITE OF DISASTER

Minas, as in mines 4
The nature of haunting 6
Hauntological investigations 10
Justice and gift 13
Response-ability and justice 19
Haunting and complexity 22
The hauntological investigation in architecture 30
Institutional and personal limitations to alternative practices —a reflection 44
Literature 47
Travelogue 56
Minas, as in Mines — or the Practice of Architecture as Response-ability 152

Minas, as in mines

On November 5, 2015, the Fundão tailings dam located in the municipality of Mariana in Minas Gerais ruptured, letting out around 40 million cubic meters of sediment. The wave crashed into a second dam, Santarém, and broke off its topmost part. From there, the material contained in both dams spilled into two small streams, also called Fundão and Santarém, flooding the area around them and destroying their channels irreversibly. After that, the mud slid over Bento Rodrigues, located three kilometers away from Santarém, destroying most of the village. After passing through Bento, the mud entered the Gualaxo do Norte river, covered it for over 55 kilometers, then joined in on the Carmo river, causing the mineral-filled water to flood over sections of towns such as Barra Longa, Rio Doce and Santa Cruz do Escalvado. In total, there were 19 deaths between residents and workers at the mine.

Besides the damage to constructions, the flooding of the rivers led to a destruction of the riparian vegetation and death of thousands of terrestrial and aquatic animals by asphyxiation. After traveling for 22 kilometers across the Carmo river, the wave entered the Rio Doce. Since the Doce is larger, only a few isolated contiguous areas flooded. Municipalities such as Governador Valadares, Baixo Guandu and Colatina, which were dependent on the river for water provision, had to shut down their plants and cut off the supply to their citizens for months. Most of the aquatic life in the river died. On November 21 the mud finally reached the Atlantic ocean, at the city of Linhares in Espírito Santo.[1]

Ironically, the toxicity unleashed on the landscape was the result of a quest for purity. Kathryn Yusoff points out how geology as a way of seeing (and changing) the world builds up a grammar of matter that dividuates it in order to form cognizable units. By denying a "geochemically communicative matter-state that is already situated in the earth,"[2] geology predicates contemporary life and all its technologies on the exploitation not of land or matter per se, in its physical-chemical "promiscuity,"[3] but a pure, charted material obtained through a complete separation between matter and its context. In order to "clean" the material of its unwanted properties, mining activities result in massive amounts of waste. In the case in question, the goal was to obtain high quality iron ore. In order to do that, the original material had to undergo a purification process. What the tailings dam contained was not even mined material, but simply an unsolvable and un-moveable mass of byproducts—metals, minerals, particulates and water.

1. All information extracted from *Denúncia*, by José Adércio Leite Sampaio, Gustavo Henrique Oliveira, Jorge Munhós de Souza, Eduardo Henrique de Almeida Aguiar, Eduardo Santos de Oliveira. Minas Gerais, Espírito Santo: Ministério Público Federal, 2016.

2. Kathryn Yusoff, "Mine as Paradigm," *e-flux Journal: Survivance* (2021), https://www.e-flux.com/architecture/survivance/381867/mine-as-paradigm/

3. Yusoff, "Mine as a Paradigm."

The dam belonged to Samarco Mineração SA, a joint venture between two multinational companies: Vale SA, from Brazil, and BHP Billiton, a British-Australian enterprise. In 2016, the Federal Prosecutor's Office presented a criminal complaint against the three companies. The complaint was archived and some of the crimes are currently bordering on statutory limitations. As an alternative, Samarco signed a TTAC (Transaction and Conduct Adjustment Agreement) through which Fundação Renova was founded. Renova is an NGO that manages reparations to those affected by the disaster in the entire Rio Doce basin. As such, it has handled anything from experimental aquaponics initiatives at the mouth of the river to the design and construction of Nova Bento Rodrigues three kilometers to the south of the ruined one.

If the name of the state does not make it explicit enough, Minas owes its economic development since the beginning of the colony to mining. The region is rich in several minerals including aluminum, iron, gold and precious stones. In this long history of extraction, floods are nothing new. Between 1986 and 2015, seven other tailings dams ruptured in the state.[4] In 2019, another massive rupture in Brumadinho led to the death of 270 people, mostly Vale employees. Capanema found indications of floods due to gold mining in the decades of 1730 and 1740 in Mariana, where the 2015 accident also took place.[5]

In the midst of these movements of incommensurable proportions, damage is permanent and lives are irreparably altered. In the search for purity, toxicity ends up infiltrating time and space. The 2015 event is entangled with others and they all reflect off each other multi-directionally, becoming specters upon specters. They are all different and yet the same. The justice of reparations is being carried out, albeit poorly. Fundamentally, somehow, nothing seems to change. The past is dead, the present is sick and the future has been laid out. Within this conundrum, could hauntology present a different rendition of justice, undoing past and future? And is this exercise one in which architecture could participate?

4. Márcio Zonta, Charles Trocate, *Antes fosse mais leve a carga: reflexões sobre o desastre da Samarco/Vale/BHP Billiton* (Marabá: iGuana, 2016), 30.

5. Carolina Capanema, "Mining and Environmental Destruction in Minas Gerais: A Historical Comparison," *Arcadia* 6 (Spring 2021), Rachel Carson Center for Environment and Society, doi:10.5282/ rcc/9217.

The nature of haunting

Jacques Derrida coined the term hauntology in his lecture-turned-book *Specters of Marx: The State of the Debt, the Work of Mourning and the New International*. The text, written in 1992, responded to a broader political debate, greatly conditioned by the fall of the Berlin Wall in 1989, during which the place of Marx and Marxism in contemporary society was being revised and even entirely questioned.

By positioning Marx himself as a specter, Derrida laid out the possibility for a beyond-ontology. The specter "does not belong to ontology, to the discourse on the Being of beings, or to the essence of life or death. It requires, then, what we call, to save time and space rather than just to make up a word, *hauntology*."[6] What haunts is what sits between the there and the not-there: "[o]ne does not know if it is living or if it is dead. Here is—or rather there is, over there, an unnameable or almost unnameable thing: something, between something and someone, anyone or anything, some thing … this thing that looks at us, that concerns us."[7] The ghost must be acknowledged because it meddles with the things of the living, "[w]e are in relation to it and it has designs on us such that we must reckon with it."[8] The central specter of Derrida's text is the prime example: there is a forced death of the spirit of Marx, a "conjuration" in the form of a "deafening consensus" that the dead thing is indeed dead. Yet, it continues to work and to cause to work, with little concern to this death that does not kill.

A defining characteristic of the haunting is its being and not being at the same time. There is room for the haunting to be taken as the un-actualized virtual (especially since the not presently there also refers to the not yet there), or simply as a "repressed or unresolved social violence,"[9] an unexpected manifestation of an economic or social system whose gargantuan contours cannot be made out and so it is mistaken for absent.

Karen Barad specifically chooses to name the ontological indeterminacy observed at a quantum level as hauntology. This indeterminacy is seen in Quantum Field Theory experiments that result in diffraction patterns generated by particles when their position is not being measured. These patterns are characteristic of waves, meaning that at some point the particle finds itself in a state of superposition, neither at one place or another, but simply "indeterminately" at a position and another.[10] This possibility leads to a shift in understanding presence at the ontological level, as superposition is not a result of insufficient means of measurement ("epistemological uncertainty"[11]) but to a *de facto* coexistence in time and space.

Barad takes Kyoko Hayashi's novel *From Trinity to Trinity* as the example of a truly hauntological work of mourning, where the narrator, a survivor of the bombing of Nagasaki, acts in a way that surpasses time as a linear succession of moments.[12] Derrida conditions the work of mourning to an acknowledgement of the thing made dead, an ontologizing of remains,[13] and Hayashi, through a deep understanding of how time is undone by nuclear disaster, joins in on this undoing, becoming a bodily present witness to all events diffracting across the one fateful day when the bomb was dropped. She finds herself simultaneously "in Nagasaki working alongside classmates," "on a U.S. Air Force base in New Mexico visiting the National Atomic Museum," "counting fifty-two empty chairs belonging to classmates who did not return," "recounting the history of sixteenth-century Spanish explorers colonising the land now called 'New Mexico' while walking next to Little Boy and Fat Man."[14] These are all are the same event, the bombing, happening now, before, and after, in places close and far away from each other.

Radiation infiltrates time and space indefinitely; that is why the ongoingness of disaster is so clear in the case of the bombing. But apart from the specificity of nuclear warfare, other events also diffract and entangle places and lives. Avery Gordon makes a hauntological investigation of Toni Morrison's *Beloved*, where Sethe, an enslaved mother, kills her child so it cannot be taken back into captivity, only to be forced to reckon with its ghost many years later. At a certain point in the story, Sethe, who escaped a plantation twenty years before, discusses the nature of time and the event with Denver, her daughter. The woman posits the idea of *rememory*, a picture of a place that stays "out there, in the world," "floating around … outside my head." Other people can even "bump into a *rememory* that belongs to somebody else." She then warns Denver about the dangers of events that are still happening, all the time:

> *Where I was before I came here, that place is real. It's never going away. Even if the whole farm—every tree and grass blade of it dies. The picture is still there and what's more, if you go there—you who never was there—if you go there and stand in the place where it was, it will happen again; it will be there for you, waiting for you. So, Denver, you can't never go there. Never. Because even though it's all over—over and done with—it's going to always be there waiting for you.*[15]

Sethe fears the ongoingness of the event that Hayashi chooses to embrace. In the story told by Morrison, she ends up consumed by the past, withering in the face of a catastrophe too great to deal with. Gordon refers to this same passage as an example of the opposition between the action of seizing the past versus the event of being seized by it.[16] The figure of the ghost as a past that moves in a logic beyond us is present for both Gordon and Derrida, who describe it, respec-

6. Jacques Derrida, *Specters of Marx: The State of the Debt, the Work of Mourning and the New International*, trans. Peggy Kamuf (New York: Routledge Classics, 1994), 63.

7. Ibid, 5.

8. Avery Gordon, *Ghostly Matters: Haunting and the Sociological Imagination* (Minneapolis: University of Minnesota Press, 2008), 64.

9. Ibid, xvi.

10. Karen Barad, "Troubling Time/s and ecologies of noThingness: re-Turning, re-membering, and facing The incalculable," *new formations: a journal of culture/theory/politics* 92 (2018): 65, muse.jhu.edu/article/689858.

11. Ibid, 68.

12. Ibid, 70.

13. Derrida, Specters of Marx, 9.

14. Barad, "Troubling Time/s and ecologies of noThingness: re-Turning, re-membering, and facing The incalculable," 70.

15. Toni Morrison, *Beloved* (New York: Vintage International, 2004), 35.

16. Gordon, *Ghostly Matters*, 164.

tively, as a set of "forces that lay claim to you whether you claim them as yours or not"[17] and as the "revenant," the one who pays a visit, who is an event, who sees us before we see it "or even before we see period."[18] The poet Dionne Brand uses the figure of the haunting to describe the Door of no Return, a presence that follows those who constitute the African diaspora like her. Every one of her movements is a movement towards the Door, as if everywhere she went, the Door was already there waiting for her. The haunting is a past that moves before us, it is a past ahead of us, it knows where to go before we do: "[h]istory is already seated in the chair in the empty room when one arrives."[19] And yet, some stories point out to a relationship with the past beyond being only overtaken by it: Sethe and Hayashi's bodies, crossed and shaped by tragedy, are somehow able to traverse the folds of space and time, showing us that there are points of access to the spectral movements that always seem to surprise us.

Dealing with ghosts is, then, a matter of understanding how the past seizes us and to what extent we are able to seize it. Alia Al-Saji's interpretation of Bergsonian intuition can help in this investigation. Sethe's description of a *rememory* already points to how the understanding of time as a chronological succession of episodes fails to account for the experiences of a haunted life. Al-Saji also directs her criticism to this interpretation of time and to how it relates to our tendency to equate reality to what is immediately present, useful or pertinent to action.[20] This shortsightedness is what leads to our often becoming surprised or confused by our experience of time and memory, since our expectations for a future that is only "the imminent prolongation of the present in action" can only be extremely narrow.[21]

Bergson describes our movement between past and present (which are different at an ontological level) as a leap which can place us *in* one or the other.[22] His diagram for these associated states is the cone of pure memory, representing the different planes of the past at different levels of contraction, where the present is the contraction of the entirety of the past as virtuality around a specific object and action.[23] Al-Saji's hypothesis is that the "virtual image," a never actualized image of the present as past formed during the event of perception, or an "image of the passing present,"[24] is what allows us to move between "the past in general" and present perception. It has the power to attract or repel the different sheets of memory, each one corresponding to a different past in terms of "rhythm of duration, style, speed, configuration and affective coloration."[25] Each of the non-representational, virtual memories can then be actualized into one or more single memories, usually the ones most useful to present perception. That way, "the virtual image makes possible concrete perception (or attentive recognition), by contracting into it not only the immediate past but also the memories that resonate with this immediate past."[26]

The consequence of this hypothesis is that we are not only connected to our memories as discernible, representational episodes, but to the whole of memory. The present is not only haunted by our past or the immediate past, but "the whole past."[27] This virtual past is not one's own; it is different than the actualized past that composes our processes of becoming. In that sense there is a collectiveness to the pure past that, if tapped into, can help with meeting ghosts where they are, given that they are "not other or alterity as such, ever," but instead an accumulation of "unfulfilled possibility" characterized most of all by repression;[28] from there comes the violence of certain apparitions, as they thrust themselves into becoming actualized. Al-Saji describes how the effort to access the deepest planes of memory relates to an openness to "others" as interrupted histories:

> *... although each line of evolution only actualizes one tendency within life (or one plane of the past), it holds simultaneously the trace of other non-actualized lines, other excluded or forgotten planes, all in virtual form. My body or sensori-motor schema may actualize a particular plane of memory, but other planes will continue to haunt it. The memory of other pasts which have never been present for me, of other lives that I have not lived, persist as a virtual "nebulosity" accompanying my own life or past. And it is through my plane of memory that I have access to the others, as the past is never simply mine ... It thus opens onto incompossible memories, onto different histories and onto other perspectives and planes.*[29]

One part of the question is answered: we cannot simply seize the past. We belong to it and we can move through it. Al-Saji points out that we *can* access planes of the pure past in a more conscious manner. There is a difference between automatic and attentive recognition, where the first represents an effort not to immediately actualize memories only from the plane of pure memory that we may access more often. But attentive recognition is still an interpretation of the past through the present, related to its usefulness in relation to actions executed or objects observed at this very moment.[30] Pure memory does not relate to the present either through "resemblance, causality, deduction or derivation."[31] As such it remains a "surplus" to the usual modes of perception.[32] We return to the remaining part of our question, which becomes: how can we access points in this whole of virtuality in a way that allows us to be more than just stricken by its actualized manifestations? The following text will attempt to approach an answer.

17. Gordon, *Ghostly Matters*, 164.

18. Derrida, Specters of Marx, 9.

19. Dionne Brand, *A Map to the Door of No Return: Notes to Belonging* (Toronto: Vintage Canada, 2001), 28.

20. Alia Al-Saji, "The memory of another past: Bergson, Deleuze and a new theory of time," *Continental Philosophy Review* 37, issue 2 (June 2004): 204, DOI 10.1007/s11007-005-5560-5

21. Ibid, 205.

22. Ibid, 207.

23. Ibid, 214.

24. Ibid, 212.

25. Ibid, 216.

26. Ibid, 215.

27. Al-Saji, "The memory of another past," 218.

28. Gordon, *Ghostly Matters*, 164.

29. Al-Saji, "The memory of another past," 226.

30. Ibid, 224.

31. Ibid, 205.

32. Ibid, 225.

Hauntological investigations

In the opening chapter to the investigations in *Ghostly Matters*, Avery Gordon declares a prevalent interest in "the relationship between what *assembles and joins* and what is gaping, detouring."[33] This is echoed in her description of Luisa Valenzuela's ability to animate a relationship between three "Open Doors" in Argentina. The first door is the title of Valenzuela's own book of short stories, the second is a well known insane asylum in the country, and the third is a torture method employed during the dictatorship, all with the same name.[34] This animation is a process of careful and responsible selection and articulation in order to bring about the ghost. It is an engagement with the object of study beyond gathering and associating information in order to extract causal and sequential relationships. It demands deep involvement and it is, fundamentally, a creative process, where a connection between two points of information can give rise to a third, new thing. Gordon's methodological reference is Walter Benjamin's materialistic historiography, which is inspired by montage techniques in modern cinema and, according to her, requires "not only attention to the thing thought, but also attention to the thinker's mode of engagement."[35]

Gordon herself is highly skilled in animating connections. On chapter four of *Ghostly Matters*, she connects the events in *Beloved* to the real life inspiration of Margaret Garner, a mother who killed her child in 1856 to avoid them being enslaved. She interweaves happenings from both stories, producing a new text with new meanings. At one point she brings together the episode of Levi Coffin, a white abolitionist lawyer present at Garner's trial who refused to remove his hat in court, [36] and Sethe's gut reaction to the sight of a hat which she thought belonged to her former captor. In Gordon's exercises of connection, the thread is as relevant as the dots, and the haunting that animates this small system of events is formed by relations of property, race, gender, class and trauma.

What I am attempting to define in this work is a hauntological practice of architecture, which means finding a way to approach an event or a system of events (many times difficult and disputed ones) that accounts for the ghosts that surround them. Centering the mode of engagement in my investigation is fundamental because of the nature of haunting: it eludes identification through deduction and derivation; it moves in unpredictable ways; it is inconclusive and ontologically indeterminate; it can remain unattainable even after all of the effort to establish its outlines.

Such characteristics prompt the question of whether establishing this approach as a *method* can lead to any form of animation between objects of inquiry. Gordon is of the belief that working at the level of method is insufficient. Instead, what she proposes is starting an investigative enterprise through the haunting of one's own: "[t]o be haunted and to write from that location, to take on the condition of what you study, is not a methodology or a consciousness you can simply adopt or adapt as a set of rules or an identity."[38] This critical stance is reiterated when she refers to Luce Irigaray's description of method as artifice and reduction, as that which can lead us astray and away from the true questions to be asked, fundamentally working as a detour.[39] The usual methodologically defined research is already a collection of correlations. However, a hauntological exercise is not one of gathering knowledge and then establishing connections between any two points of information. Instead, it is about understanding which of the gathered correlations will work in an exercise of communication with a ghost, a conjuration: "in and of themselves, ... correlations ... can be collected, but they will lie like the debris of a system barely thinkable and yet abounding in excessive significations."[40]

Gordon steps away from the method as detour and instead proposes something closer to the detour as method; that is, a pulling away from "abstract questions" and an admission of complicity and involvement with the object of study—something generally scientific standards of research would define as a failure.[41] The relationship between hauntology and scientific language will be better explored in the text *Haunting and complexity*, but Gordon's position can inspire a hauntological practice of architecture insofar as both share the understanding that the ghost works through a logic of deviation and uncertainty, so an objective or overarching account of events will never be achieved from assuming it as the object of investigation.

Even as a focus on the thinker's mode of engagement and a contaminated relationship with the object of inquiry foil any aspiration to a universally reproducible method, the possibility of cultivating an openness towards the ways in which ghosts are formed is available to anyone. This means that choosing to engage with a haunting through the haunting of one's own does not mean to simply be haunted, but to become haunted.

The idea of a cultivated openness to others has import both in defining a substitute for method in a hauntological practice and in the effort to navigate the planes of pure memory in order to better relate to ghosts. Al-Saji's theory is that this relationship to the world corresponds to a specific mode of perception, which Bergson calls intuition. Beyond the effort of attentive recognition, intuition is a "pulling back" from actualizing virtual memory into representational memory altogether, an exercise in remaining "within the cone of pure memory" and, very importantly, adjusting to a less familiar plane of memory instead of attempting to filter or reduce the past through present experience.[42] Keeping in mind that the cone is the representation of the entirety of the virtual past, with countless variations, the actualization of different virtual memories can lead to vastly different, even currently unimaginable

33. Gordon, *Ghostly Matters*, 27.

34. Ibid, 66.

35. Ibid, 65.

36. Ibid, 160.

37. Ibid, 161.

38. Ibid, 22.

39. Ibid, 40.

40. Ibid, 67.

41. Ibid.

42. Al-Saji, "The memory of another past," 225.

futures—this prospect is what accords a transformative and even revolutionary potential to such an exercise.

Also keeping in mind that the entire virtual past comprises planes that have configurations and levels of contraction subject to other rhythms of duration, intensities, "affective tonalities" and perspectives than one's own, moving between these planes is always an exercise of relation to an *other*: "[i]ntuition is the attunement to a plane different than that opened up by my body"[43] and thus "it is from the other that intuition takes its bearings, rather than from the self."[44] Sethe's (and Morrison's) notion of *rememory* is then very pertinent since, as Al-Saji confirms, the whole of memory is fundamentally "intersubjective."[45]

Intuition is not "a vague feeling," it is something that can be fostered through practice and preparation and that begins by a very concrete contact and coexistence with "others" as much as possible.[46] This concreteness makes it particularly interesting in the context of experimentally defining a hauntological substitute for method.

Bergson and Al-Saji describe intuition not as a way of seeing but as a "way of listening."[47] We are used, through vision, to identifying the contours of objects of interest, focusing on them exclusively and demoting the rest to the level of background. Sounds, however, cannot be separated and ignored; they remain present in our perception even as we make an effort to focus on only one sound or another.[48] If sound is a metaphor for how intuition operates, it would involve controlling our consciousness so it does not attempt to "impose coherence and univocity on the fluid and fragmented whole of pure memory," instead growing accustomed to an asynchronous cacophony of sounds and voices that can all be tapped into with some effort.[49]

In the context of a hauntological investigation (or an investigation into the possibility of a hauntological practice), I believe Al-Saji's interpretation of Bergsonian intuition can enhance Gordon's proposed state of a contaminated scholarship, and the two can then coalesce into the description of a becoming-haunted as the primary mode of engagement with the object of study. As the following texts will show, this insistence on an openness towards the "others" of history and memory is also related to a hauntological reinterpretation of justice and response-ability which expands upon the notion of contamination or incorporation of the other into the hypothesis of full co-constitution.

43. Ibid.

44. Ibid, 227.

45. Ibid.

46. Ibid.

47. Ibid.

48. Ibid, 223.

49. Ibid, 228.

Justice and gift

Derrida introduces the *Specters of Marx* by clarifying that speaking of ghosts is done fundamentally "in the name of justice."[50] His description of justice in this text is generally the same as the one detailed in 1989 for the symposium *Deconstruction and the Possibility of Justice*, in which he presented the text *Force of Law: The "Mystical Foundation of Authority,"* officially published in 1993. The central distinction with which the text is concerned is between law (*droit*) and justice. Derrida presents a chain of aporias through which he argues that true justice could never be practiced or made present, remaining, then, "a desire."[51] It is this impossibility of full actualization that renders justice as incalculable, in opposition to law:

> *Every time that something comes to pass or turns out well, every time that we placidly apply a good rule to a particular case, to a correctly subsumed example, according to a determinant judgment, we can be sure that law (droit) may find itself accounted for, but certainly not justice. Law (droit) is not justice. Law is the element of calculation, and it is just that there be law, but justice is incalculable, it requires us to calculate with the incalculable.*[52]

The rendition of justice and law as different but interrelated is useful in the context of this work, especially when common discourse applies them interchangeably to the site of disaster. Derrida notes that once the distinction is made, however, it should not lead to the conclusion that the law or calculation have no place towards the achievement of true justice. There is a genuine risk that the idea of an impossibility of justice can be misappropriated to justify acting in the most unjust ways. Calculation is what ensures, even if partially, that this is not the case. Thus, also paradoxically, "incalculable justice requires us to calculate … Not only *must* we calculate … but we *must* take it as far as possible."[53]

Denise Ferreira da Silva, a Brazilian artist and philosopher, is also concerned with the limits of justice, both in a practical sense given its reification into a mainly punitive system and at a conceptual level relating to the prevailing understanding of time and space. The first issue identified is relatively straightforward: even after advances from social movements that introduced notions such as equality and reparations to the legal lexicon, the judiciary powers still generally work by mandating punishments to whoever breaches the law.[54] As for the second limitation, it is what stands on the way of a transformative (global) theory of justice. To Ferreira da Silva, the global "scene of economic value" obscures "the total value expropriated from slave labor and native lands—in-

50. Derrida, *Specters of Marx*, xviii.

51. Jacques Derrida, "Force of Law: The "Mystical Foundation of Authority,"" in *Deconstruction and the Possibility of Justice*, ed. Drucilla Cornell, Michel Rosenfeld and David Gray Carlson (New York, London: Routledge, 1992), 16.

52. Ibid.

53. Ibid, 28.

54. Denise Ferreira da Silva, "Speculations on a Transformative Theory of Justice," *Hearings: The Online Journal of Contour Biennale* (April 2017): 5, http://hearings.contour8.be/2017/04/11/speculations-transformative-theory-justice/

cluding expropriations taking place right now by mining, drug, and mega-agricultural corporations."[55] A true vision of justice would contemplate the restitution of this value at a global scale. If the concept of primitive accumulation already takes these expropriations into consideration, Ferreira da Silva proposes a folding of space and time that surpasses the limitations of always trying to establish a causal relationship between colonialism and capitalism.

The author names three organizing concepts applied to reality: separability, determinacy and sequentiality.[56] Although a critique of the three is present in different texts, her study of Octavia Butler's *Kindred* offers all of the main points of her position. In the novel, Dana, a young black woman, is continuously thrust between two times and places, her house in 1976 and a plantation during the antebellum in the United States. As she meddles with the happenings in both, she ruptures lines of cause and effect between the lives of her predecessors and her own, undoing those three "onto-epistemological pillars … that sustain linear temporality."[57] This undoing is fundamental to Ferreira da Silva's defense of a transformative theory of justice done through decolonization—as diluted as this concept has become, here it means the actual restitution of value lost to slave labor and stolen land. If this seems unfeasible, Ferreira da Silva contends, it is because we tend to conceptualize time linearly and through causal relationships:

> *… at the experiential and the conceptual level, separability renders this particular articulation of the claim for decolonization incomprehensible because linear temporality (or sequentiality) organizes both. On the one hand, there are descriptions of what happens in our daily experience in terms of separate, successive, or simultaneous events, which may or may not relate to one another. When a relationship is ascribed it generally takes its shape from identity or effectivity: events are related because they are of the same kind or in terms of cause and effect.*[58]

In an argument very similar to Barad's, she underlines how uncertainty and non-locality observed in quantum experiments have deep ontological implications and transfers those to her vision of justice. To the idea of quantum entanglements, which will also ground Barad's conceptualization of response-ability, she gives the name "implicancy," concerning "all that has come and is yet to come into spatiotemporal existence."[59] The imagination of the world not as an ordered whole but as an ever changing composition where each "existant" is contingent upon the other collapses separability to the extent that the social use for difference is also compromised—this is where she wants this argument to lead, given her global theory of justice is also a theory of race:

> *Why not assume that beyond their physical (bodily and geographic) conditions of existence, in their fundamental constitution, at the subatomic level, humans exist entangled with everything else (animate and in-animate) in the universe … Without separability, difference among human groups and between human and nonhuman entities, has very limited explanatory purchase and ethical significance … Without separability, sequentiality (Hegel's ontoepistemological pillar) can no longer account for the many ways in which humans exist in the world, because self-determination has a very limited region (spacetime) for its operation. When nonlocality guides our imaging of the universe, difference is not a manifestation of an unresolvable estrangement, but the expression of an elementary entanglement. That is, when the social reflects The Entangled World, sociality becomes neither the cause nor the effect of relations involving separate existants, but the uncertain condition under which everything that exists is a singular expression of each and every actual-virtual other existant."*[60]

The undoing of separability, determinacy and sequentiality through the admission of entanglements is needed for the full conceptualization of a possible restitution of lost value. Returning to Dana, Ferreira da Silva identifies the excess, this outstanding value that corresponds to the wages never paid for slave labor, retained in the moment of colonial expropriation by an individual or family, and forever extant in negative form in the lives of descendants of slaves.[61] Yet, despite its crossing space and time, this is still a vision of justice that operates fundamentally on the basis of restitution—the excess was taken and must be given back; once that is done, balance is restored.

Still looking for a hauntological justice that concerns what is and what is not presently there and whatever lies in between, I return to *Specters*, where Derrida retrieves some of the concepts elaborated three years earlier. Here, he characterizes the law, or an incomplete justice, with several qualities related to its calculated application (distribution, restitution, symmetry, accountability), besides mentioning visions of justice as revenge or applied punishment and the idea that it would somehow set things right, restore a lost balance.[62] Conversely, the "incalculability of the gift and singularity of the an-economic ex-position to others" would designate true justice.[63]

Ex-position to others, it will be argued later, is the corner stone for acknowledgement and response-ability. As for the incalculability of the gift, it refers to Heidegger's formulation of justice as interpreted by Derrida. The original text already presupposes justice as gift and thus as something beyond punishment, retribution, debt and guilt.[64] Derrida further interprets the gift hauntologically in the sense that it is still restitution, but a restitution of what was never there and what one does not even have to give.[65] That is how the logic of the gift undoes past and future; it is an unexpected addition to a given set of entanglements, a restitution introduced from a line of past never actualized that has the ability to divert the expected course for the future.

55. Ibid, 10.

56. Ibid, 9.

57. Denise Ferreira da Silva, "Unpayable Debt: Reading Scenes of Value against the Arrow of Time," in *The documenta 14 Reader*, ed. Quinn Latimer and Adam Szymczyk (Munich: Prestel, 2017), 83.

58. Ferreira da Silva, "Unpayable Debt," 86.

59. Ibid, 85.

60. Denise Ferreira da Silva, "On Difference Without Separability," in *Catalogue of the 32nd São Paulo Art Biennial, "Incerteza viva" (Living Uncertainty)*, cur. Jochen Volz, Gabi Ngcobo, Júlia Rebouças, Lars Bang Larsen and Sofía Olascoaga (São Paulo: Bienal de São Paulo, 2016), 64.

61. Ferreira da Silva, "Unpayable Debt," 108.

62. Derrida, *Specters of Marx*, 26.

63. Ibid.

64. Ibid, 29.

65. Ibid, 32.

Brazilian philosopher Carla Rodrigues makes an effort to situate Derrida's restitution within a disjointed temporality by intersecting it with Aníbal Quijano's 'return of the future,' that is, a future that unfolds from a suppressed past instead of being a marginally altered repetition of the present.[66] This proposition echoes the Bergsonian movement between different planes of the past, yet it is admittedly made in the specific context of coloniality in Latin America and, ideally, as a directly applicable programmatic premise (basically, identifying counter-hegemonic ways of becoming and elevating them).

Nelson Maldonado-Torres, a Puerto Rican philosopher, works to situate the gift at a similar level to Quijano and Rodrigues, that is, as a tool in decoloniality. Importantly, he frames it as a "logic" and not as a single action or object;[67] not quite the same as Derrida's gift more akin to the event (or the revenant), something that "come[s] along."[68] Yet Derrida also calls it that which "come[s] back,"[69] implying previous action(s), ongoing outgoing and incoming movement. This movement (more precisely circulation) is what sustains "gift culture," according to Lars Spuybroek. In the cycle of gift, *Charis*, a less familiar form of pleasure, is not one's own, but exactly that which is being passed forward.[70] As grace circles back and forth, subjects and objects become temporary terminals and roles are continuously inverted. Spuybroek stresses that this is a movement that ruptures with causality: since what circulates is grace, the identity of the object as gift is not central to the diagram. The gift can be a feeling, an object, an action; there can be no apparent correspondence of value, no particular relationship between the gift one gives and the next one they receive.[71] To him, this cycle remains fixed within linear temporality, yet that is what makes it non-causal, since the return of the gift is always a return of the different:

> *... by desubjectifying gift exchange the object turns likewise into less of an obstacle and into more of a passage of generosity. Yet, at the moment we can speak of a passage any causal order is effectively suspended and the sequence of events starts to take on a cyclical shape, because the vector that comes before the object is the same as the one that comes out of it. As a matter of logic it applies accordingly in both directions of the equation: when A is equal to B, B is equal to A. However, the latter clause does not mean the cycle turns against the arrow of time. Precisely because the chronological order remains linear whereas the relationships in the equation are circular, the cycle changes from a simple back-and-forth duality into a three-stage model where positions of giving and receiving are transformed into one another. Not only is the given object received, but the received is turned into the given, in short, returned, making a third step the logical consequence: giving, receiving, and returning. More than a reciprocity between unchanging positions, the gift cycle involves a set of phased transformations. Lastly, it means that when we speak of transformations the form of return can never be fixed and be understood as a return of the same ...* [72]

66. Carla Rodrigues, Rafael Haddock-Lobo and Marcelo José Derzi Moraes, "Specters of Colonialidade: A Forum on Jacques Derrida's Specters of Marx after 25 Years, Part V" *Contexto Internacional* 42, no. 1 (Jan/Apr 2020): 152, http://dx.doi.org/10.1590/S0102-8529.201942010000

67. Nelson Maldonado-Torres, "On the Coloniality of Being: Contributions to the development of a concept," *Cultural Studies* 21, no. 2-3 (March/May 2007): 260.

68. Derrida, *Specters of Marx*, 29.

69. Ibid, 32.

70. Lars Spuybroek, *Grace and Gravity: Architectures of the Figure* (London: Bloomsbury, 2020), 4.

71. Ibid, 8.

72. Ibid, 6.

Maldonado-Torres's logic of the gift is similar to gift culture, but while Spuybroek describes it as a particular type of sociability, Maldonado-Torres sees it as a capacity that is still enacted with and through other(s) but must be restored at the ontological level. Starting from a critique of Heidegger's Dasein as a limited concept, he proposes the adoption of Frantz Fanon's *damné* as a more adequate description of the colonized and racialized Being. Put simply, "[w]hile Dasein is lost in the They and achieves authenticity when it anticipates its own death, the damné confronts the reality of its own finitude as a day to day adventure."[73]

The subjectivity of the *damné* is formed through what Maldonado-Torres calls the non-ethics of war, that is, a non-ethics that rationalizes the extra-ordinary acts of war—killing, maiming, raping, pillaging—transferred to a colonial context as ordinary, ultimately normalized.[74] The goal, then, would be to establish in which way a different, de-colonized Being could become. This is where ex-position to others returns to this discussion in the form of Emmanuel Levinas's self-Other relationship as the only possible moment for self-determination.[75] Maldonado-Torres borrows from Levinas's view of gifting and receiving as acts of self-Other communication that would structure this relationship and posits a restitution of a logic of gift as to counter the non-ethics of war as an alternative mode of subjectification:

> *War is the opposite of the an-archical relation of absolute responsibility for the Other that gives birth to human subjectivity. The obliteration of the trans-ontological takes the tendency of producing a world in which war becomes the norm, rather than the exception. That is the basic meaning of the coloniality of being: the radical betrayal of the trans-ontological by the formation of a world in which the non-ethics of war become naturalized through the idea of race. The damné is the outcome of this process. Her agency needs to be defined by a consistent opposition to the paradigm of war and the promotion of a world oriented by the ideals of human generosity and receptivity. This is the precise meaning of decolonization: restoration of the logic of the gift.*[76]

So far we have Derrida's definition of justice-as-gift as the restitution of something that was never there, Ferreira da Silva's idea of transformative justice as a restitution of that which was not stolen by nor from the present living, and Spuybroek's and Maldonado-Torres' understanding of gift as a logic or movement, also to be restored in the eyes of the latter. With these notions established, architecture as a new insert into already existing entanglements could work as a gift not in the sense of a charitable deed but as a diversion of ongoing cycles towards the future of pasts never actualized. Perhaps no one intervention would have the power to reintroduce the logic of gift into a given situation, and at the end who is one architect to affirm it was ever truly lost? Instead, if within a given configuration of relationships, architecture can redistribute, sever or engender new ones with more or less

73. Maldonado-Torres, "On the Coloniality of Being," 255.

74. Ibid.

75. Ibid, 258.

76. Ibid, 255.

force, when it comes to the cycle of gift as that of non-causally-determined restitution, then it should join this cycle's ongoingness in order to amplify it. The strengthening of gifting through a gift: that is the hauntological justice architecture can provide, besides but not against the calculated justice of law.

Response-ability and justice

The an-economic justice that Derrida speaks of is founded on what he calls responsibility. In order to achieve a justice beyond the law or rights, it is necessary to embrace the incalculability of ontological indeterminacy, that is, to talk "of the ghost" and "to the ghost".[77] At the same time, being constitutively in relation to ghosts means being charged with the indelible responsibility to address them. We, the now-living, can choose to bring them closer or push them away. Implicated in this choice is what Derrida calls a "principle of selectivity,"[78] as even those who decide to welcome the ghosts do so by before, even unwittingly, placing them in hierarchies, excluding some in favor of others:

> *... we must never hide from the fact that the principle of selectivity which will have to guide and hierarchize among the "spirits" will fatally exclude in its turn. It will even annihilate, by watching (over) its ancestors rather than (over) certain others. At this moment rather than at some other moment. By forgetfulness (guilty or innocent, it little matters here), by foreclosure or murder, this watch itself will engender new ghosts. It will do so by choosing already among the ghosts, its own from among its own, thus by killing the dead: law of finitude, law of decision and responsibility for finite existences, the only living-mortals for whom a decision, a choice, a responsibility has meaning and a meaning that will have to pass through the ordeal of the undecidable.*[79]

If the dead are anything but gone, this double killing only multiplies the ghosts—there is no way of escaping this responsibility. To Derrida it is the same as an inheritance[80]—*haunting will claim you even if you do not claim it.*

Donna Haraway turns responsibility into response-ability, the ability to respond, and by doing so makes the hinge between acknowledgement and action already present for Derrida even more visible. Response-ability can be cultivated, made more complex and more multiple through the recognition of what connects us and our actions to human and non-human others. A simple way to understand response-ability is through the anti-example that Haraway provides in Adolf Eichmann, one of the architects of the Holocaust. Haraway sees the "commonplace thoughtlessness"[81] that Hannah Arendt witnessed in him during his trial in Israel as a lack of response-ability. He was "a human being unable to make present to himself what was absent, what was not himself, what the world in its sheer not-oneselfness is and what claims-to-be inhere in not-oneself. Here was someone who could not be a wayfarer, could not entangle, could

77. Derrida, *Specters of Marx*, xviii.

78. Ibid, 109.

79. Ibid.

80. Ibid, 114.

81. Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham and London: Duke University Press, 2016), 36.

not track the lines of living and dying."[82]

To Barad, the ontological indeterminacy that results from quantum experiments exposes the limitations of a "classical ontology based on … determinately bounded and propertied objects"[83] as it shows that "[t]here are no separately determinate individual entities that *interact* with one another; rather, the co-constitution of determinately bounded and propertied entities results from specific *intra-actions*"[84] and even space and time would be intra-actively produced.[85] The entanglements also mentioned by Haraway would then not simply be connections between definitely separate things but "specific material relations of the ongoing differentiating of the world."[86] This immediately dissolves any hard conceptual boundaries between the self and the other, even the other no longer or not yet there. The debt to the other results from the fact that they are "threaded through" the self, indelibly, and intra-acting with the world is becoming mutually constituted with it. Every entanglement is an "irreducible relation of responsibility."[87]

The presence of trace metals as ghostly matter in the bodies of animals along the Rio Doce makes these relations immediately visible. Trace metals have this name because they are found in the bodies of living things at trace amounts. In these very small quantities, however, they are essential for living organisms to work. The river and its creatures are constantly exchanging molecules of water and also iron, cadmium, copper, zinc and manganese. They are co-constituted. After the disaster in 2015, the concentration of trace metals in the water increased, which means the concentration of trace metals in the bodies of fish increased. New fish were born and formed surrounded by more metals than their liver could process.[88] In the ongoing relation of mutual constitution between river and fish, a contaminated river produced contaminated fish, with gut that is deformed, cancerous and necrotic.

There is an alignment between how response-ability is formed and how an an-economic justice as ex-position to others is attained. Both are a result of the action-acknowledgement of this entangled becoming of things. This is also where Barad's argument arrives, adding that the indelible ghostly traces of the co-constitution with the world are precisely what tells us we cannot look for justice as a precise restitution of what was lost as in a calculation, since there is no such thing as setting things right, putting things back in order or expunging our impurities:

> *Only by facing the ghosts, in their materiality, and acknowledging injustice without the empty promise of complete repair (of making amends finally) can we come close to taking them at their word. The past is never closed, never finished once and for all, but there is no taking it back, setting time aright, putting the world back on its axis. There is no erasure finally. The trace of all reconfigurings are written into the enfolded materialisations of what was/is/to-come. Time can't be fixed. To address the past (and future), to speak with ghosts, is not to entertain or reconstruct some narrative of the way it was, but to respond, to be responsible, to take responsibility for that which we inherit (from the past and the future), for the entangled relationalities of inheritance that 'we' are …*[89]

Barad proposes new forms of action guided by a new "ethics of entanglement" where relations of differentiation are seen much more as connection than separation.[90] These new forms of action are better defined by a hinged understanding of action-acknowledgement, which simply cannot be decoupled. The manner in which one approaches the ghost is as relevant as the way one decides to deal with it, not only because the second results from the first but because both constitute a continued intervention on the becoming of all things. In the context of this work, there is no reason to absolutely separate "research" as a stage of passive consumption and "design" as the moment of active intervention. Each look at the river already makes the river anew and reconfigures its ghosts.

82. Ibid.

83. Karen Barad, "Quantum Entanglements and Hauntological Relations of Inheritance: Dis/continuities, SpaceTime Enfoldings, and Justice-to-Come," *Derrida Today* 3, issue 2 (2010): 253, DOI: 10.3366/E1754850010000813

84. Ibid.

85. Ibid, 261.

86. Ibid, 265.

87. Ibid.

88. See André Alberto Weber et al., "Effects of metal contamination on liver in two fish species from a highly impacted neotropical river: A case study of the Fundão dam, Brazil," *Ecotoxicology and Environmental Safety* 190 (March 2020), https://doi.org/10.1016/j.ecoenv.2020.110165

89. Barad, "Quantum Entanglements," 264.

90. Ibid, 266.

Haunting and complexity

The two images at the right corner of the entanglement map (page 36) are representations of the polygons within which distinct mineral extraction processes are currently taking place in Minas Gerais. These areas correspond to a concession by the National Mining Agency (ANM) of the right to extract and commercialize any mineral goods that might be present within those bounds. The orthogonal rectangles drawn over a map, unconstrained by the realities on the ground, are in their simplicity a most straightforward expression of *separability* and *absolute separation*, as defined by Ferreira da Silva and Barad respectively. The clear-cut borders are the first step in the process of dividuation and charting of matter identified by Yusoff, as they separate the mine from the not-mine, and here the convergence of meanings, possession and extraction, consolidate the view of mine as paradigm.[91,92] This paradigm extends beyond the borders of current concessions; it is the definition and valuation of all matter through separability and extractability. Even what is not property now can still be, potentially, *mine*. Within each polygon there is the ghostly presence of the colonial hereditary Captaincy, a massive slice of land spanning the entire colony, lent by the Crown for management and extraction. This ever-extending movement is also what drives the evolution from mine to megamine, a name given to open pit operations that can be tens of kilometers wide, larger than any surrounding town or village.

There are several megamines in Minas where either gold or iron ore are extracted. They are a result of developments in technologies of extraction that make it possible to obtain "high quality" material from soils with increasingly lower percentages of the desired minerals. With a less "pure" starting material, however, the need arises to excavate larger and larger pits to obtain the same amount of the final product.[93] This arrangement predicated on absolute separation drives, then, the expansion of the mine and also the increased complexity of the cleaning assemblages. What begun as a combination of a in-humanized black body and an instrument such as a *bateia* has grown into an infrastructural system with several steps, sites and dedicated machinery (FIG XX). Due to its size, this system also implicates the lives of workers, the villages nearby, the bodies of water that may end up contaminated by tailings, other animals, plants, infrastructure, the economy of municipalities, politics and environmental legislation.

Purity is the negation of the entanglements that result from the *ongoing differentiating of the world* and thus it needs to be strenuously sustained by a complex and ultimately toxic apparatus. That is the contradiction that pervades the reality of mineral extraction. In *Against Purity*, Alexis Shotwell details cases where the notion of purity is associated to systems of classification imposed upon material reality. In these situations, complexity is taken for impurity, since complexity is all that evades such abstracting schemes.[94] Hauntology provides a better framework for dealing with this surplus to categorization in two ways: first, as mentioned earlier, it incorporates a co-constitution and co-contamination of the world, against separation, into its proposition of a hauntological response-ability and justice. Second, as a non-method predicated on openness to other lines of becoming (a becoming-haunted by the object of study), hauntology is always concerned with minor stories—not necessarily in terms of scale but in their (lack of) usefulness in establishing a singular narrative or conducting a conventional scientific inquiry. As Gordon says:

> *What kind of case is a case of a ghost? ... It is a case of the difference it makes to start with the marginal, with what we normally exclude or banish, or, more commonly, with what we never even notice. It is often a case of inarticulate experiences, of symptoms and screen memories, of spiraling affects, of more than one story at a time, of the traffic in domains of experience that are anything but transparent and referential.*[95]

Gordon's reference to transparency is part of a larger argument against the "technologies of hypervisibility" that lead to the belief that "not only everything can be seen, but also ... everything is available and accessible for our consumption."[96] In a world where everything can be reached, brought to the fore, touched, decoded and schematized, there are no ghosts because nothing is left repressed or concealed.

The diagnosis of hypervisibility is akin to Donna Haraway's "god trick" as one that is based on limitless vision:

> *The visualizing technologies are without apparent limit. The eye of any ordinary primate like us can be endlessly enhanced by sonography systems, magnetic resonance imaging, artificial intelligence-linked graphic manipulation systems, scanning electron microscopes, computed tomography scanners, color-enhancement techniques, satellite surveillance systems, home and office video display terminals, cameras for every purpose from filming the mucous membrane lining the gut cavity of a marine worm living in the vent gases on a fault between continental plates to mapping a planetary hemisphere elsewhere in the solar system. Vision in this technological feast becomes unregulated gluttony; all seems not just mythically about the god trick of seeing everything from nowhere, but to have put the myth into ordinary practice.*[97]

Against the illusion of boundless seeing and boundless knowing, Haraway argues for knowledge that is "situated and embodied" instead of "unlocatable, and so irresponsible."[98] Barad is also concerned with the relationship between knowledge and responsibility. If Man believes he can see the world from a

91. Yusoff, "Mine as a Paradigm."

92. Yusoff uses the related binomial property-property, or property as a set of known mineralogical characteristics and property as possession, in her book *A Billion Black Anthropocenes or None*, arguing that the application of this paradigm has supported the establishment of the human-inhuman divide within the human, along racial lines.

93. See Lindsay Newland Bowker and David M. Chambers, *The Risk, Public Liability, & Economics of Tailings Storage Facility Failures* (Stonington, Bozeman: Bowker Associates Science & Research In The Public Interest, Center For Science In Public Participation, 2015).

94. Alexis Shotwell, Against Purity: Living Ethically in Compromised Times (Minneapolis: University of Minnesota Press, 2016).

95. Gordon, *Ghostly Matters*, 24.

96. Ibid, 16.

97. Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," *Feminist Studies* 14, no. 3 (Autumn 1988): 581, http://www.jstor.org/stable/3178066

98. Ibid, 583.

non-position, from infinitude, then he fails to acknowledge the entanglements that produce him and his reality:

> *Man's reward: a God's eye view of the universe, the universal viewpoint, the escape from perspective, with all the rights and privileges accorded therein. Vision that goes right to the heart of matter, unmediated sight, knowledge without end, without responsibility.*[99]

The critique of universal and disembodied knowledge has developed into the common ground of postcolonial, decolonial, feminist and antirracist theory; yet, for all its presence, it is still taken for an anti-scientific total relativism or a form of reparations in the sense of displacing and re-centering non-white or non-Western European *loci* of knowledge production and enunciation. What can be missed in Haraway's claim is how it is done for the sake of having a more complete and deeper grasp of reality, whatever that may be. A fully disembodied view is impossible, it is an intellectual falsification, and that is why it amounts only to a "trick":

> *I am arguing for politics and epistemologies of location, positioning, and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. These are claims on people's lives. I am arguing for the view from a body, always a complex, contradictory, structuring, and structured body, versus the view from above, from nowhere, from simplicity.*[100]

Gordon reiterates this position, with the addition of presenting the goal of an inquiry—truth—as something not only bodily produced but also constantly changing—or, to echo Barad, formed by discrete entities that are only impermanently constituted:

> *Warnings about relativism to the contrary, truth is still what most of us strive for. Partial and insecure surely, and something slightly different from "the facts," but truth nonetheless: the capacity to say "This is so." But truth is a subtle shifting entity not simply because philosophy says so or because evidentiary rules of validation are always inadequate, but because the very nature of the things whose truth is sought possesses these qualities.*[101]

The view from nowhere is upheld in a research or inquiry through "[b]lodless categories, narrow notions of the visible and the empirical, professional standards of indifference, institutional rules of distance and control, barely speakable fears of loosing the footing that enables us to speak authoritatively and with greater value than anyone else."[102] These are all part of a rationale that demands a defined and re-applicable method. The non-method of becoming-haunted by the object of study would then be considered a contamination of the researcher, no longer able to produce knowledge in a state of purity.

99. Barad, "Quantum Entanglements," 264.

100. Haraway, "Situated knowledges," 589.

101. Gordon, Ghostly Matters, 16.

102. Ibid, 21.

Since she is attempting to define a new form of sociological inquiry through hauntology, Gordon is concerned with elevating the social world, or that which is socially produced, above a state of untruth, as the social is not seen as real.[103] However, her intention is not to simply apply the language of science to the fragmented and non-hierarchical stories that belong in the social sphere. In *La hybris del punto cero* (*The hubris of the zero point*), Santiago Castro-Gomez criticizes not only the illusion that reality can be appreciated from a point outside of time and space (the zero point) but a sort of epistemological gluttony that structured modern knowledge and justified colonial expansion. The project of Enlightenment extended the scientific language — the purest and most perfect language — to historical events, social forms and belief systems, placing them into categories and hierarchies across space and also time, making it possible to affirm that even if any two cultures are *de facto* contemporary, being exercised at the same time in different places of the Earth, they can be distinctly located on a civilizational timeline.[104]

In order to avoid a reduction of the complexity of social life into more schemes under the universalizing language of science, a hauntological inquiry must take into account matters of language and format, beyond only the attention to minor stories and unusual objects of study.

When it comes to architecture, the language of nested scales informs much of its conceptualization and production. The language of scale is a tool for classifying and communicating complicated realities and in architecture it usually relates to the type and amount of information that any drawing or diagram must transmit. Often, however, the ordering of reality is taken for reality indeed, as architects deal with the hierarchical levels in this system of nested scales (city, neighborhood, house, room) as if they were transcendental categories.

Marston, Jones and Woodward point to a series of dangerous directions that thinking space through nested scales can lead to. This hierarchical approach brings with it a "trojan horse" of "affiliated binaries" that develop from placing what is situated—the local—at an opposition to what pertains to the entire planet—the global—, producing categories such as particular versus universal, atomistic versus holistic, subjective versus objective, feeling versus reason, concrete versus abstract, empirical versus theoretical, and, finally, complexity versus order.[105]

They propose instead to think of space through the concept of site, a unique spatial formation with a distinct duration across time and extension across space that can still share many characteristics with other sites as they endlessly emerge and dissolve but tend to be configured in repeating patterns. Understanding spatial formations as sites allows us to avoid incurring into the binary of global processes versus local consequences, as we often disregard the agency of a certain type of "local" (such as

103. Gordon, Ghostly Matters, 16.

104. Santiago Castro-Gomez, *La hybris del punto cero: ciencia, raza e ilustración en la Nueva Granada (1750-1816)* (Bogotá: Pontificia Universidad Javeriana, 2005), 60.

105. Sallie A Marston, John Paul Jones III and Keith Woodward, "Human geography without scale," *Transactions of the Institute of British Geographers New Series* 30, no. 4 (December 2005): 421, https://www.jstor.org/stable/3804505.

a vulnerable community in a disputed site) and elevate other practices to the level of "global," as if the sites of economic or political decisions that have a wide spatial reach were not themselves situated and embodied.[106] As they put it:

> *... once hierarchies are assumed, agency and its 'others' – whether the structural imperatives of accumulation theory or the more dynamic and open ended sets of relations associated with transnationalism and globalization – are assigned a spatial register in the scaffold imaginary. Invariably, social practice takes a lower rung on the hierarchy, while 'broader forces', such as the juggernaut of globalization, are assigned a greater degree of social and territorial significance.*[107]

The classification of space into levels of scale is one among many forms of abstraction of a complex reality and it is done through the same hidden "epistemological hoist" that Castro-Gomez criticizes, as if only a certain type of thinker were capable of completely removing themselves from the civilizational timeline in order to objectively place cultures at different positions on a universal teleological movement towards the modern metropolis; or of becoming un-situated in order to place sites into a neatly defined bracket somewhere between the infinitesimally local and the completely universal.[108]

Marston, Jones and Woodward propose defining space through a flat ontology, evading any type of transcendentalism and abandoning both vertical and horizontal hierarchies.[109] This does not mean that spatial analysis becomes impossible as if no categories can be elaborated from an endless multiplication of sites and flows. This understanding still assumes that as sites emerge they may do so in "redundant orders and practices," [110] but without the scaffolding of nested scales sustaining an analysis *a priori*, the researcher's exercise becomes identifying the sites that interact and fold upon each other at a given spatial configuration. Through this form of thinking, tracing entanglements becomes a practice that is directly spatial and even architectural, since it is through "follow[ing] interactive practices through their localized connections" that this identification takes place.[111]

I have attempted to study the Rio Doce valley by associating events of different durations and animating those connections. I have also tried to conceive of the design and to present it through sequences and episodes that may pertain to sites of vastly different sizes, in a way that is much less hierarchical than the usual movement from global context to architectural detail. Finally, I tried to displace the building from the center of horizontal nested scales, giving equal attention to other agents of change on site and understanding the architecture as one of many intra-acting parts that will facilitate the emergence of a new activity hub by the river.

The Rio Doce valley and the iron square are sites of dispute between two different approaches to reality: on the one hand there are beliefs that purity exists, it can be achieved, impurity can be exorcised, nothing will remain hidden and no problem will remain unsolved, sensors can see everything, everything is cognizable, everything can be found, anything can be controlled, anything can be separated, everything can be classified, everything can be ordered. On the other hand there is an understanding that complexity is irreducible, some things are spectral, confusing, blurred, repetitious, wrong, follow no causal order, have no higher motive, contradict each other, lead nowhere, do not fit neatly into a larger narrative. The ghost remains frightful because it is elusive. We cannot see it fully, we must learn to live with this estrangement and uncanniness.

I believe this dispute does not concern the usual binary of universal versus particular. Even if Haraway equates a situated view with a partial one, a flat theory of space is one where every space is a site, a part of a site and a site for other sites and is thus situated. Every view is partial, so this category as the opposite to the transcendentally universal, —which does not exist—has no more use.

Haraway also equates the view from nowhere to a view from simplicity, which can then be placed in opposition to complexity. The two disputing approaches are in fact one where it is assumed that objective languages and formats will protect us from being blindsided by reality and one where we assume that the infinite complexity that makes up our constantly changing world can at best be observed from a couple of angles, and much care should go into who and what inhabits those points of view and how they are legitimized. As much as possible, I have attempted to side with the latter approach during this project.

106. Ibid, 421.

107. Ibid, 427.

108. Ibid, 422.

109. Ibid.

110. Ibid.

111. Ibid, 425.

Krenak—*Sites of attempted ongoingness*
Minas—*Lines of solidification*
Event—*Disaster in its different durations*
Washing—*Purity as toxicity and*
Extinction—*Constrictions of future*
Entanglement map

The hauntological investigation in architecture

When starting a project, the architect usually gathers knowledge on a place during what is commonly called site analysis, in which discrete information is inscribed and later shown in a logical order, following thematic axes and standard methodological approaches. The working hypothesis, in the case of this project, is that archive manipulation with a focus on animating connections between images, stories, lives, places and events would be a more response-able way of approaching the ghosts that unfolded in time and space towards and since the disaster in 2015. The montage techniques that inspired Benjamin and Gordon all rely on the broad principle that when separate, not only the images but what they represent act as standalone *things* with a set of potential significations, and when hinged together, so placed in a specific succession in time or on a specific spatial configuration, they can produce entirely new meaning.

This process involved compiling sources, building a multimedia archive, making maps, diagrams and writing texts in order to somehow inscribe the connections to be animated. I consulted a vast gamut of sources, including news, official reports and laws, scientific articles, books, historical documents, maps and drawings, and geo-referenced data. The complete list is at the end of this report. I also visited the site on January of 2022, traveling along the river and stopping at several towns still dealing with the disaster. This embodied experience allowed me to apprehend the site in a deeper way, beyond the limitations of the un-situated view exercised through maps and diagrams.

The exercise of electing seemingly distinct entities and tracing their entanglements across the planet is not new. Some known examples and references of this project are Cooking Sections' *Salmon: a Red Herring*, an in-depth analysis of the color salmon in all its manifestations, and Anna Lowenhaupt Tsing's *The Mushroom at the End of the World*, which follows the complex movements of the Matsutake mushroom as a commodity and its points of friction with other sites, lives and stories. In terms of format more than procedure, a strong reference is Counterspace's *Ingesting Architectures: On Atmospheric Violences*, which takes the format of a video essay overlaying images, video and sound narration relating to dust production and ingestion in vulnerable parts of Johannesburg. Forensic Architecture's *Oil and Gas Pollution in Vaca Muerta* and Paulo Tavares' *Trees, Vines, Palms and Other Architectural Monuments* associate remote sensing technology and multimedia archive research in order to defend the memory, land and rights of traditional communities. Office for Political Innovation's *Being Silica* exposes the connection between the use of ultraclear glass and gas heating in buildings in New York and the environmental conditions of areas affected by drilling and fracking, including risks of cancer and silicosis due to silica extraction.

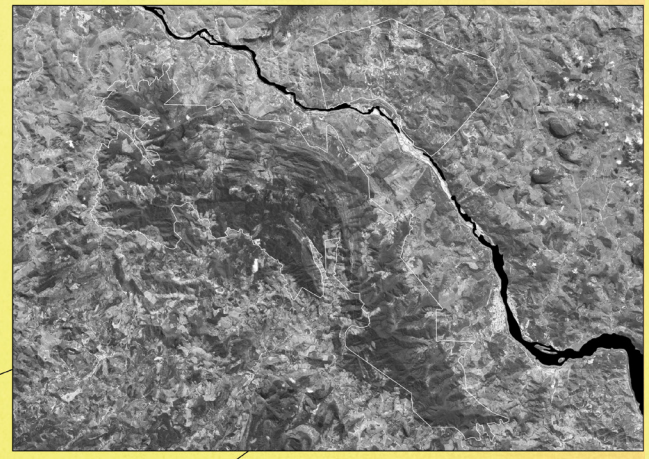
The connections I identified were translated into an entanglement map, a large textile made to be manipulated. As a malleable space on which the entanglements are visible, it has a physical texture and presence, and it does not need to be presented at any fixed position or orientation. The main inspiration for this format was Counterspace's *Material Histories: Sands, soils, recipes and other archives*, made for the 2020 Istanbul Biennale, which mapped out different recipes from the African continent, regarding them as mobile archives of knowledge that intersect issues of migration, extraction, heritage and changing cultures. The research is laid out on large sheets of paper and the connections are themselves an *action* that takes place when the user folds the paper, bringing together two areas with different information. This is the same goal of the entanglement map, with the added quality of the fabric, which does not crease and allow for an even larger multiplicity of folds and unexpected approximations.

The information on the map is clustered around five areas that infiltrate each other as they all constitute the same event. **Krenak—Sites of attempted ongoingness** tells the story of the Krenak, settled by the Rio Doce, who have dealt with consecutive ends of their life-worlds. It moves across the arrival of the colonizers, the Krenak genocide during the military dictatorship, its relationship to their resistance to the developmentalist-extractive project, and the destruction of their connection to the river after 2015. The images and text represent different sites, with different extensions and durations, in which the Krenak have tried to sustain their existence against the forces of territorial domination. **Minas—Lines of solidification** traces the origins of mineral extraction and discusses how Minas has become embroiled in a self-perpetuating fate, as the region's economy is apparently irreversibly dependent on mining. This is a story of colonization, socioeconomic inequalities, the slave trade and environmental racism. The map shows how the lines of settlement across the territory, such as the railroad and the military occupation in the 19th century, are still visible in the built environment. **Washing—Purity as toxicity and vice-versa** focuses on the current state of the Rio Doce and on forms of contamination caused by the disaster. It questions the notions of cleaning and purity, and how attempts to clean and dividuate matter are what produces the most toxicity. **Extinction—Constrictions of future** deals with the ways in which the disaster led to disentanglements between people and their surroundings and communities, with a focus on losses (of home, occupation, family and friends) and also on interruptions of the future. This interruption happens at two levels, as the self-perpetuating fate of the mining economy leads to a constriction of possible futures and the violent nature of the disaster causes individual losses of projected futures. **Event—Disaster in its different durations** discusses the ways in which the event is constantly re-actualized and ongoing, mapping out the duration of the initial sediment wave but also understanding how the event is perpetuated and made visible in the places, lives and routines that remain.

Gruta dos Sete Salões, 3D scan by Paulo Rodrigo Simões, 2020

2013: FUNAI kickstarts the process for identifying the Sete Salões state park as part of Krenak indigenous land. The park is the home of the Sete Salões grotto, a place with cultural and ceremonial relevance for the Krenak.

Krenak: Sobreviventes do Vale, documentary by Andrea Pilar Marranquiel, 2019



Perimeter of the Krenak indigenous land (North of the river) and the Sete Salões state park (South of the river), map by the author

2000: Official demarcation of the Indigenous Land Krenak with the outlines it has now.

Krenak: Sobreviventes do Vale, documentary by Andrea Pilar Marranquiel , 2019

2015: After the death of the river, the their access to clean water, to the fi their subsistence or artisanal activi the shores that they used for health swaths of land and water that they ation and excercise.

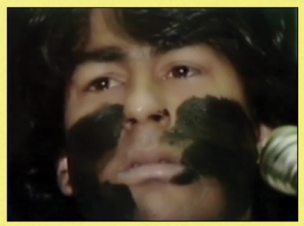
Krenak: Sobreviventes do Vale, doc drea Pilar Marranquiel, 2019

Krenak: Sobreviventes do Vale, documentary by Andrea Pilar Marranquiel, 2019

Botocudos, 1909, Walter Garbe, available via Biblioteca Nacional

Botocudos, Johann Moritz Ru das, 1835, available via Coleçã Brasiliana

Krenak—*Sites of attempted ongoingness*



Índio Cidadão?, directed by Rodrigo Siqueira, 2014, Available via Câmara dos Deputados

1987: 36 year old Ailton Krenak gives a speech at the Constituent Assembly about the rights of the indigenous peoples of Brazil.

October 27 1831: The Regency revokes the Carta Régia of 1808, officially ceasing fire and forbidding the enslavement of Botocudos.

2009: In an interview, Ailton Krenak is asked about the end of the war on the botocudos in the 19th century. He answers that from oral tradition he knows the war never ended, it just slowly died out because one of the sides had no more people to fight.

Ailton Krenak, Genocídio e resgate dos "Botocudo," interview by Marco Antônio Tavares Coelho

1808: The Rio Doce Military Divisions are estblished as a part of the war against the botocudos. Barracks are distributed throughout the river basin. The villages of Governador Valadares, Barra do Cuieté, Aimorés, Baguari, Naque, Cachoeira Escura and Belo Oriente, located directly on the river valley, will develop from these military settlements.

The buildings are precarious and not made to last, done with pau-a-pique, a type of earth construction, and wood shingle roofs.

Haruf Salmen Espindola, interview by the author

E eu espero não agredir, com a minha manifestação, o protocolo dessa Casa, mas eu acredito que os senhores não poderão ficar omissos, os senhores não terão como ficar alheios a mais essa agressão movida pelo poder econômico, pela ganância, pela ignorância do que significa ser um povo indígena. O povo indígena tem um jeito de pensar, tem um jeito de viver, tem condições fundamentais para a sua existência, para a manifestação da sua tradição, da sua vida, da sua cultura, que não colocam em risco e nunca colocaram a existência sequer dos animais que vivem ao redor das áreas indígenas, quanto mais de outros seres humanos. Eu creio que nenhum dos senhores poderia nunca apontar atos, atitude da gente indígena do Brasil que colocou em risco seja a vida, seja o patrimônio de qualquer pessoa, de qualquer grupo humano nesse país. E hoje nós somos o alvo de uma agressão que pretende atingir na essência a nossa fé, a nossa confiança de que ainda existe dignidade, de que ainda é possível construir uma sociedade que sabe respeitar os mais fracos, que sabe respeitar aqueles que não têm o dinheiro para manter uma campanha incessante de difamação, que saiba respeitar um povo que sempre viveu à revelia de todas as riquezas. Um povo que habita casas cobertas de palha, que dorme em esteiras no chão, não deve ser identificado de jeito nenh um como um povo que é o inimigo dos interesses do Brasil, inimigo dos interesses da nação, e que coloca em risco qualquer desenvolvimento. O povo indígena tem regado com sangue cada hectare dos oito milhões de quilômetros quadrados do Brasil. Os senhores são testemunha disso.

I hope not to attack, with my manifestation, the protocol in this House, but I believe that you, sirs, cannot stay silent, you cannot remove yourselves from another attack moved by economic power, by greed, by the ignorance of what it means to be an indigenous people. The indigenous people has a way to think, has a way to live, has fundamental conditions for its existence, for the manifestation of its tradition, its life, its culture, that do not put in risk and never did the existence of even the animals that live around indigenous lands, let alone other human beings. I believe that none of you sirs could never point out acts, attitudes from the indigenous peoples of Brazil that ever put in risk the life, the property of any person, of any human group in this country. And today we are the target of an aggression that intends to strike the essence of our faith, our trust that there is still dignity, that it is still possible to build a society that knows how to respect its weak, that knows how to respect those that have no money to sustain an incessant campain for defamation, that knows how to respect a people that always lived in the absence of all riches. A people that lives in houses with straw roofs, that sleeps on mats on the floor, should not be identified in any way as a people that is the enemy of the interests of Brazil, enemy of the interests of the nation, and that puts in risk any progress. The indigenous people have drenched with blood each hectar of the eight million square kilometers of Brazil. You are all a witness to that.

Ailton Krenak, speech at the Constituent Assembly of 1987

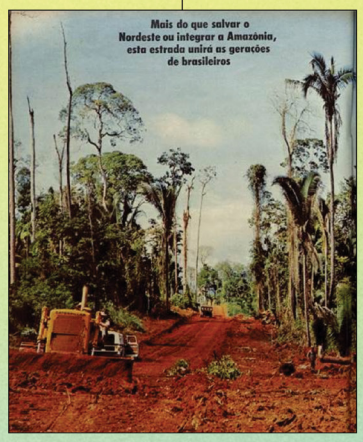
Art. 50. A educação do índio será orientada para a integração na comunhão nacional mediante processo de gradativa compreensão dos problemas gerais e valores da sociedade nacional, bem como do aproveitamento das suas aptidões individuais.

Art. 50. The education of the indian will be oriented towards the integration into national communion by means of a process of a gradual understanding of the general problems and values of national society, as well as the best use of their individual aptitudes.

Lei nº 6.001, de 19 de Dezembro de 1973

December 19, 1973: Military president Emílio Medici signs the Indigenous Statute, guaranteing certain basic rights of indigenous people but also grounding the policy on the notion of the full integration of indigenous individual into "common society."

June 16, 1970: The military government signs a decree that inaugurates the Program for National Integration (PIN), based on the construction of highways across the Amazon and what the decree describes as the "colonization" of non-urban areas.



"More than saving the Northeast or integrating the Amazon, this road will unite generations of Brazilians," Revista Manchete, 1970, number 954

1969: At the height of the military regime, the newly formed National Indian Foundation (FUNAI) opts to establish a reformatory for "deviant indians" inside the Krenak Indigenous land, at the time called Guido Marlière Indigenous Reservation (PIGM). Anything can be considered deviancy: prostitution, criminal activity, alcoholism, creating any sort of trouble, disrespecting the police. Inside, "rehabilitation" is also evaluated by arbitrary measures. The Krenak are forced to work in the reformatory as well. Practicing any rituals or speaking languages other than Portuguese is forbidden. At the same time, the state of Minas Gerais establishes the Rural Indigenous Guard, a policing branch formed exclusively by indigenous people responsible for making the arrests and supervising the reformatory.

Gustavo Araújo Simi, "And Then Everything Turns White"

1972: The prisoners and all of the Krenak are transferred to Fazenda Guarany, away from the river.

Gustavo Araújo Simi, "And Then Everything Turns White"

1979: During a period of high tide of the river, the Krenak return to their land. It had been legally theirs since 1971.

Krenak: Sobreviventes do Vale, documentary by Andrea Pilar Marranquiel, 2019

Índio Cidadão?, directed by Rodrigo Siqueira, 2014, Available via Câmara dos Deputados

1987: 36 year old Ailton Krenak gives a speech at the Constituent Assembly about the rights of the indigenous peoples of Brazil.

E eu espero não agredir, com a minha manifestação, o protocolo dessa Casa, mas eu acredito que os senhores não poderão

I hope not to attack, with my manifestation, the protocol in this House, but I believe that you, sirs, cannot stay silent, you cannot

Sendo-me as graves queixas da Capitania de Minas Geraes têm subido á minha real presença, sobre as invasões que diaria-

Being tha have come

1987: 36 year old Ailton Krenak gives a speech at the Constituent Assembly about the rights of the indigenous peoples of Brazil.

Haruf Salmen Espindola, interview by the author

Índio Cidadão?, directed by Rodrigo Siqueira, 2014, Available via Câmara dos Deputados

1987: 36 year old Ailton Krenak gives a speech at the Constituent Assembly about the rights of the indigenous peoples of Brazil.

October 27 1831: The Regency revokes the Carta Régia of 1808, officially ceasing fire and forbidding the enslavement of Botocudos.

2009: In an interview, Ailton Krenak is asked about the end of the war on the botocudos in the 19th century. He answers that from oral tradition he knows the war never ended, it just slowly died out because one of the sides had no more people to fight.

Ailton Krenak, Genocídio e resgate dos "Botocudo," interview by Marco Antônio Tavares Coelho

1808: The Rio Doce Military Divisions are estblished as a part of the war against the botocudos. Barracks are distributed throughout the river basin. The villages of Governador Valadares, Barra do Cuieté, Aimorés, Baguari, Naque, Cachoeira Escura and Belo Oriente, located directly on the river valley, will develop from these military settlements.

The buildings are precarious and not made to last, done with pau-a-pique, a type of earth construction, and wood shingle roofs.

Haruf Salmen Espindola, interview by the author

E eu espero não agredir, com a minha manifestação, o protocolo dessa Casa, mas eu acredito que os senhores não poderão ficar omissos, os senhores não terão como ficar alheios a mais essa agressão movida pelo poder econômico, pela ganância, pela ignorância do que significa ser um povo indígena. O povo indígena tem um jeito de pensar, tem um jeito de viver, tem condições fundamentais para a sua existência, para a manifestação da sua tradição, da sua vida, da sua cultura, que não colocam em risco e nunca colocaram a existência sequer dos animais que vivem ao redor das áreas indígenas, quanto mais de outros seres humanos. Eu creio que nenhum dos senhores poderia nunca apontar atos, atitude da gente indígena do Brasil que colocou em risco seja a vida, seja o patrimônio de qualquer pessoa, de qualquer grupo humano nesse país. E hoje nós somos o alvo de uma agressão que pretende atingir na essência a nossa fé, a nossa confiança de que ainda existe dignidade, de que ainda é possível construir uma sociedade que sabe respeitar os mais fracos, que sabe respeitar aqueles que não têm o dinheiro para manter uma campanha incessante de difamação, que saiba respeitar um povo que sempre viveu à revelia de todas as riquezas. Um povo que habita casas cobertas de palha, que dorme em esteiras no chão, não deve ser identificado de jeito nenh um como um povo que é o inimigo dos interesses do Brasil, inimigo dos interesses da nação, e que coloca em risco qualquer desenvolvimento. O povo indígena tem regado com sangue cada hectare dos oito milhões de quilômetros quadrados do Brasil. Os senhores são testemunha disso.

I hope not to attack, with my manifestation, the protocol in this House, but I believe that you, sirs, cannot stay silent, you cannot remove yourselves from another attack moved by economic power, by greed, by the ignorance of what it means to be an indigenous people. The indigenous people has a way to think, has a way to live, has fundamental conditions for its existence, for the manifestation of its tradition, its life, its culture, that do not put in risk and never did the existence of even the animals that live around indigenous lands, let alone other human beings. I believe that none of you sirs could never point out acts, attitudes from the indigenous peoples of Brazil that ever put in risk the life, the property of any person, of any human group in this country. And today we are the target of an aggression that intends to strike the essence of our faith, our trust that there is still dignity, that it is still possible to build a society that knows how to respect its weak, that knows how to respect those that have no money to sustain an incessant campain for defamation, that knows how to respect a people that always lived in the absence of all riches. A people that lives in houses with straw roofs, that sleeps on mats on the floor, should not be identified in any way as a people that is the enemy of the interests of Brazil, enemy of the interests of the nation, and that puts in risk any progress. The indigenous people have drenched with blood each hectar of the eight million square kilometers of Brazil. You are all a witness to that.

Ailton Krenak, speech at the Constituent Assembly of 1987

Art. 50. A educação do índio será orientada para a integração na comunhão nacional mediante processo de gradativa compreensão dos problemas gerais e valores da sociedade nacional, bem como do aproveitamento das suas aptidões individuais.

Art. 50. The education of the indian will be oriented towards the integration into national communion by means of a process of a gradual understanding of the general problems and values of national society, as well as the best use of their individual aptitudes.

Lei nº 6.001, de 19 de Dezembro de 1973

Sendo-me as graves queixas da Capitania de Minas Geraes têm subido á minha real presença, sobre as invasões que diariamente estão praticando os indios Botocudos, antropophagos, em diversas e muito distantes partes da mesma Capitania, particularmente sobre as margens do Rio Doce e rios que no mesmo desaguam e onde não só devastam todas as fazendas sitas naquellas visinhanças e tem até forçado muitos proprietarios a abandonal-as com grave prejuizo seu e da minha Real Coroa, mas passam a praticar as mais horriveis e atrozes scenas da mais barbara antropophagia, ora assassinando os Portuguezes e os indios mansos por meio de feridas, de que servem depois o sangue, ora dilacerando os corpos e comendo seus tristes restos; tendo-se verificado na minha real presença a inutilidade de todos os meios humanos, pelos quaes tenho mandado que se tente a sua civilisação e o reduzil-os a aldear-se e a gozarem dos bens permanentes de uma sociedade pacifica e doce, debaixo das justas e humanas Leis que regem os meus povos; ... sou servido por estes e outros justos motivos que ora fazem suspender os effeitos de humanidade que com elles tinha mandado praticar, ordenar-vos, em primeiro logar: Que desde o momento, em que receberdes esta minha Carta Regia, deveis considerar como principiada contra estes indios antropophagos uma guerra offensiva que continuareis sempre em todos os annos nas estações seccas e que não terá fim, senão quando tiverdes a felicidade de vos senhorear de suas habitações e de os capacitar da superioridade das minhas reaes armas de maneira tal que movidos do justo terror das mesmas, peçam a paz e sujeitando-se ao doce jugo das leis e promettendo viver em sociedade, possam vir a ser vassallos uteis, como ja o são as immensas variedades de Indios que nestes meus vastos Estados do Brazil se acham aldeados ...

Haruf Salmen Espindola, interview by the author

Civilized [sic] indians [sic] fighting Botocudos in Mogi das C 1834-1839

Graduation Ceremony of the Rural Indigenous G no author provided, 1970, available via Hemerot Biblioteca Nacional

Individual file from the reformatory, no author p ed, 1970, available via Museu do Índio

Bento Rodrigues from 2013 to 2021, Google

"COLONIAL"—GOLD RUSH—ESTRADA REAL

-20.37665,-43.4136628

-20.237512,-43.4177173

-20.3775822,-43.4177374

-20.2341966,-43.4177994

-20.2348143,-43.4179614

-20.2357436,-43.4177584

POPULAR BRAZILIAN-20TH CENTURY SETTLEMENTS—RAILWAY

-19.5770556,-42.4690405

-19.5769346,-42.4686716

-19.5768492,-42.4683764

-19.5769545,-42.4663339

-20.2835981,-43.0423914

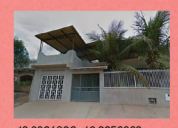
-20.2836154,-43.0433356

-19.5345848,-40.6231976

-19.4691054,-42.5583814

-19.3096148,-42.3740429

-19.1753608,-41.4737105

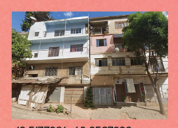

-19.2264806,-42.3356363

-19.1566653,-42.2377002

-20.3758373,-43.413675

-18.8564382,-41.9519225

-19.4979655,-41.0649119

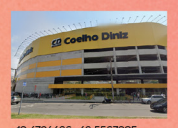

-19.5177081,-40.6567203

-19.1730295,-41.4737083

-20.2372449,-43.4176518

-20.2828486,-43.041744

-20.2447475,-42.8957804



-19.4724436,-42.5567985

-19.4044444,-40.0615839

-20.2880171,-43.0560379

-20.2844628,-43.0419067

-18.8640797,-41.941312

-19.413479,-42.413705

-19.413479,-42.413705

-19.4747798,-42.5557256

-18.8525232,-41.9474031

-19.4761804,-42.553771

-20.287809,-43.0564111

-19.4165071,-42.4138671

-19.469533,-42.5588126

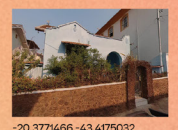
-19.4736081,-42.5522671

-20.2830323,-43.0429183

-19.5759699,-42.4661037

-18.8917574,-41.972803

-20.2833417,-43.0444735


-20.3771466,-43.4175032

Minas—*Lines of solidification*

nomy has slowly waned. So far, Rio Doce has been strictly pro- ld and diamond smuggling. Now, n is interested in turning the Doce the ports. The ban is lifted.

ndola, A navegação do Rio Doce:

1702: After the discovery of massive gold deposits in the region where now Minas Gerais is, the Portuguese Crown publishes the **Mineral Regiment**, laying out the rules for gold extraction in the area.

Between 1702 and 1822, several letters and regiments would be published concerning the occupation of the territory.

The set of official paths where gold is allowed to circulate is called Estrada Real. The rest of the region comes to be known as sertão, generally devoid of any non-native occupation until the 19th century.

Revista do Archivo Publico Mineiro, year 1, volume 4, 1896

Image of Estrada Real totem in Bento Rodriges, Marcelo Nava, 2016

Map of the EFVM (Vitóri

EARLY MODERN/POPUL

COLATINA

vitor

RESPLENDOR

Anton

CONSELHEIRO PENA

José

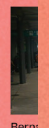
TUMIRITINGA

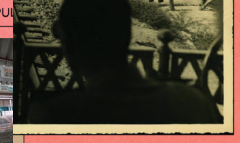
Elder

PEDRA CORRIDA

Jonil

IPATINGA


Berna


r provided, 1947

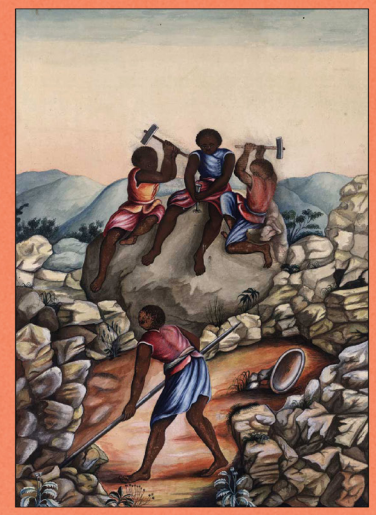
Rio de Janeiro is born and grows as the port for the mines. Rio Grande do Sul and even Argentina, mule breeders, are tied to Minas, as well as the patronage and a large deal of the slaves from the Northeast. All of that made Minas the knot that tied Brazil together and made it one single thing.
... There, in Ouro Preto and surroundings, when the gold was not as bountiful anymore, the highest expression of Brazilian civilization came to flourish.

Darcy Ribeiro, O Povo brasileiro: A formação e o sentido do Brasil, 143

Villa Rica (now Ouro Preto), Thomas Ender, 1827

Elmina castle today, Francisco Anzola, 2009

Diamantenwaescherey Curralinho, E. Meyer, 1781-1826


Slaves crushing stones for diamond extraction, Carlos Julião, no date provided

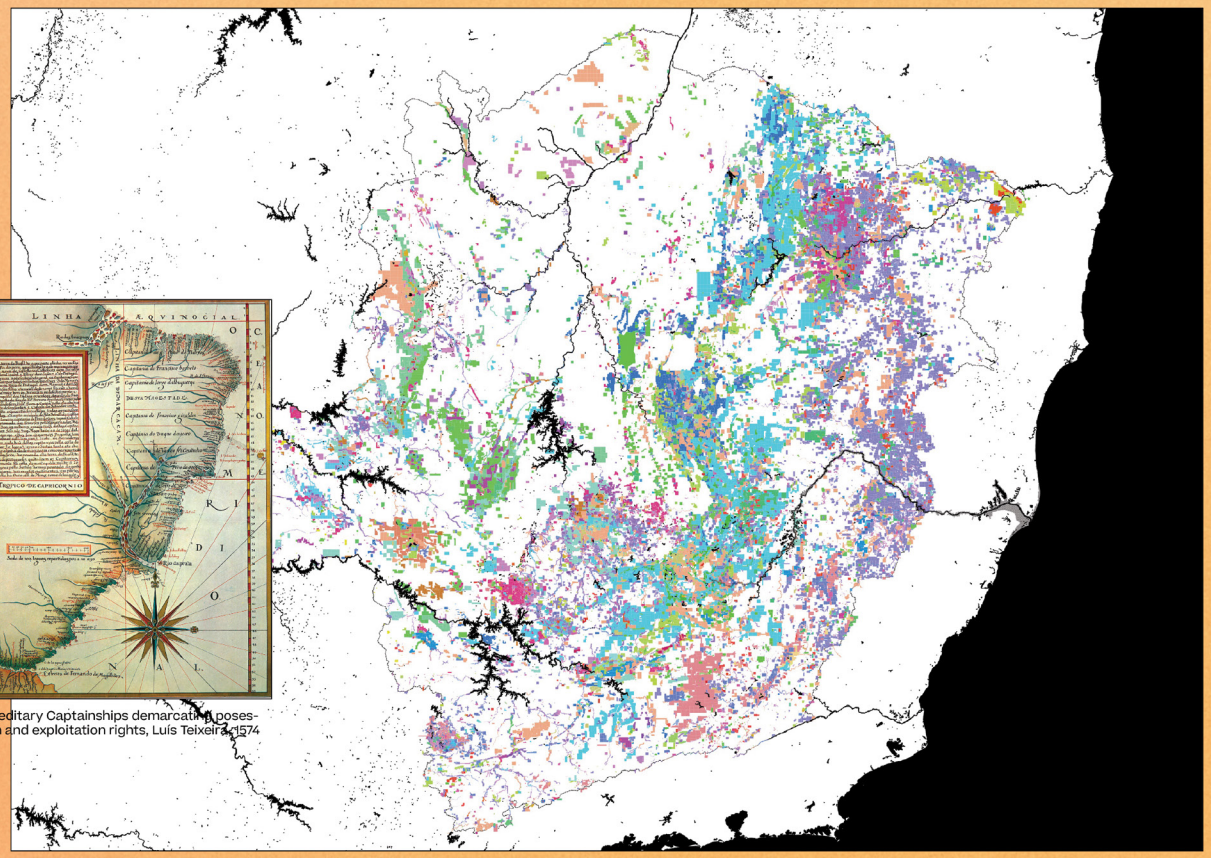
Gravel washing done by slaves, Carlos Julião, no date provided

Exploitation d'un Lavage d'Or à Villa Rica, E. Lejeune, 19th c

Lavage de l'or, Marc Ferrez, ca. 1880

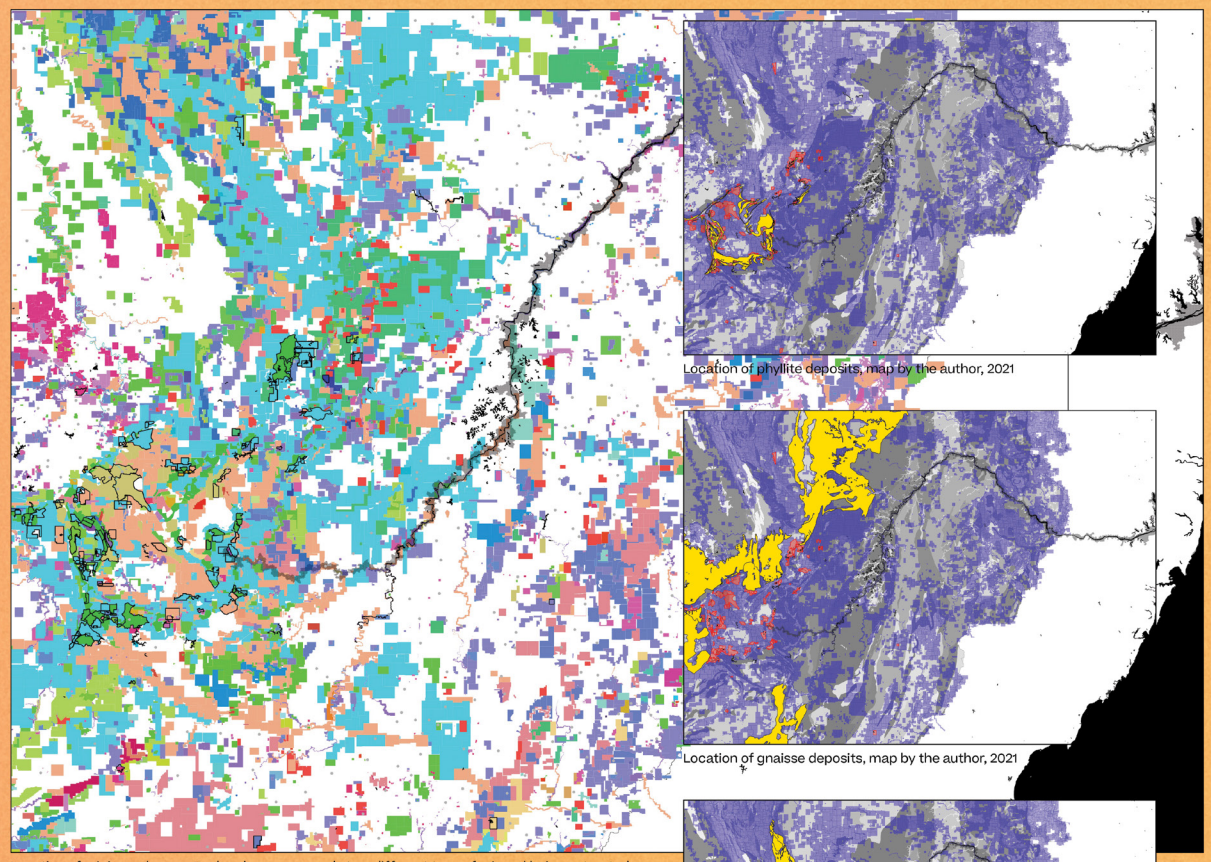
A apuração nas bateias inicia-se logo após à lavagem das mesas.
Quanto mais grosso for o ouro, como, por exemplo, o das grupiaras e dos rios, tanto menores serão as dificuldades da apuração. O trabalho torna-se, ao contrário, mais difícil quando o ouro se encontra na mistura mas finamente granulado.
Para a apuração do ouro grosso utiliza-se de qualquer poça d'água. Quando não se consegue uma delas, cava-se uma fossa à margem do rio, ou se adotam grandes tinas.
O apurador se coloca na fossa, com água até os joelhos, e, tendo posto na bateia alguns punhados do material ... começa por ajuntar-lhe um pouco dágua e a amassá-lo com as mãos, de modo a reduzi-lo a uma polpa muito fina. Em seguida, depois de nova adição de água, movimenta a bateia, de maneira a imprimir, pouco a pouco, um movimento circular a toda massa. As partes mais leves ficam em suspensão na água, enquanto as mais pesadas se acumulam com o ouro no fundo da bateia. Enquanto a água se mantiver turva, o apurador faz escorrer um pouco dela, acentuando o movimento de maneira a arrastar, tam- bém, as partes leves. Colhe de novo mais água na fossa, repetindo esta dupla operação até que a água da bateia se torne limpida.
O material da lavagem reduz-se, pois, a pequena quantidade, constituída quase só de esmeril e de ouro.
Daí por diante, ele deve imprimir rotação à bateia com mais cuidado e agilidade, a fim de que o ouro possa separar-se das diversas partes pesadas. Para isto, imprime uma rotação mais viva à bateia, para manter em suspensão na água essas partículas pesadas. Em seguida, diminuindo um pouco o movimento logo que julga estar o ouro depositado no fundo, inclina viva-

The cleaning on the bateias begins right after the washing of t
The thicker the gold, for example, the one from grupiaras and the smaller the difficulties for the cleaning. The work becomes, contrary, harder when the gold is more finely granulated in t ture.
For the cleaning of thick gold one can use any puddle of water they are not available, one digs a ditch by the river, or big vat used.
The cleaner places themselves in the ditch, with water up to th and, having put on the bateia a couple handfuls of the materi begins to add to it some water and to squeeze it with the hand reduced to a very fine pulp. Following that, after the addition they move the bateia, making the entire mass move in a circu ion, little by little. The lighter parts stay suspended in the wate the heavier ones accumulate with the gold at the bottom of the As long as the water is turbid, the cleaner drains it a little, a ating the movement so it also drags away the lighter parts. Th again more water, repeating this double operation until the w bateia is clear.
The material from the washing is reduced, then, to a small qu emery and gold.
From then on, they should rotate the bateia with more care a so that the gold can be separated from the heavier parts. For t rotate the bateia in a more lively manner, in order to keep the particles suspended in the water. Following that, as soon as th



Location of mining polygons in the entire state of Minas Gerais. The polygons correspond not to property, but to the right to develop mining activities, granted by the state government, map by the author, 2021

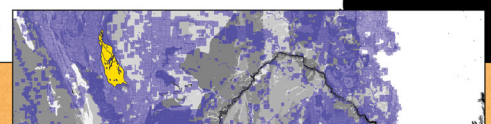
Hereditary Captainships demarcation, posession and exploitation rights, Luís Teixeira, 1574



Location of mining polygons. Each color corresponds to a different type of mineral being extracted. Blue and green correspond to iron ore or an association of other minerals with iron ore, beige and orange correspond to gold or an association of other minerals with gold. Outlined polygons have by-product dams within them, map by the author, 2021

Location of phyllite deposits, map by the author, 2021

Location of gnaisse deposits, map by the author, 2021



PEDRA CORRIDA

Jonilson Fraga, 2019

Jonilson Fraga, 2019

Franciano Calmon, 2018

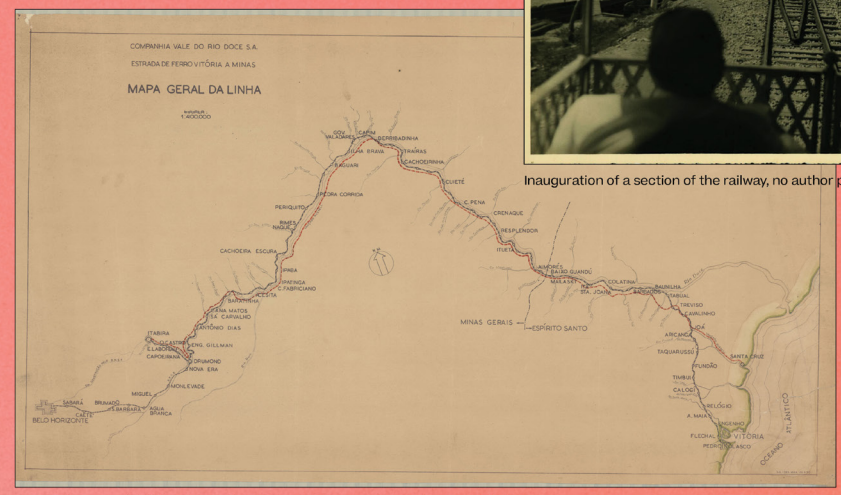
IPATINGA

Bernardo Damião, 2014

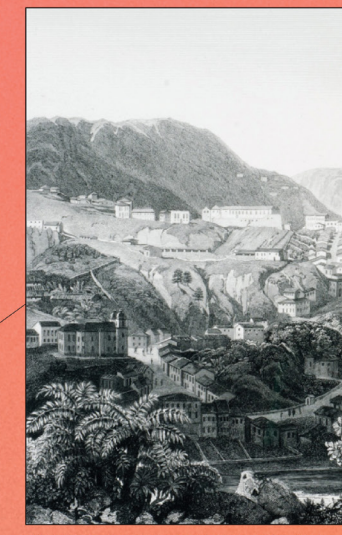
Antônio Barreira, 2014

EFVM: Conversas de Beira de Linha, interview with Haruf S. Espindola

Inauguration of a section of the railway, no author provided, 1947



Map of the EFVM (Vitória-Minas railroad), no author provided, no date provided



Villa Rica (now Ouro Preto), Thomas Ender, 1827

Map of the official path from Rio de Janeiro to Villa Rica (Ouro Preto), no author provided, 18th century

Diamantenwaescherey Curralinho, E. Meyer, 17

wave reaches the
Some of the residents
ony for the river.

da, Revista Piauí, 2016

November 19, 2015: Samarco places buoys used in oil spillages on the river to try to stop the sediments from reaching the ocean. They do not work.

Consuelo Dieguez, A Onda, Revista Piauí, 2016

November 20, 2015: The sediments reach Linhares.

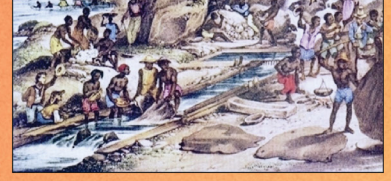
Consuelo Dieguez, A Onda, Revista Piauí, 2016

Washing—*Purity as toxicity and vice-versa*

A apuração nas bateias inicia-se logo após à lavagem das mesas.
Quanto mais grosso for o ouro, como, por exemplo, o das grupiaras e dos rios, tanto menores serão as dificuldades da apuração. O trabalho torna-se, ao contrário, mais difícil quando o ouro se encontra na mistura mas finamente granulado.
Para a apuração do ouro grosso utiliza-se de qualquer poça d'água. Quando não se consegue uma delas, cava-se uma fossa à margem do rio, ou se adotam grandes tinas.
O apurador se coloca na fossa, com água até os joelhos, e, tendo posto na bateia alguns punhados do material ... começa por ajuntar-lhe um pouco dágua e a amassá-lo com as mãos, de modo a reduzi-lo a uma polpa muito fina. Em seguida, depois de nova adição de água, movimenta a bateia, de maneira a imprimir, pouco a pouco, um movimento circular a toda massa. As partes mais leves ficam em suspensão na água, enquanto as mais pesadas se acumulam com o ouro no fundo da bateia.
Enquanto a água se mantiver turva, o apurador faz escorrer um pouco dela, acentuando o movimento de maneira a arrastar, tam- bém, as partes leves. Colhe de novo mais água na fossa, repetindo esta dupla operação até que a água da bateia se torne límpida.
O material da lavagem reduz-se, pois, a pequena quantidade, constituída quase só de esmeril e de ouro.
Daí por diante, ele deve imprimir rotação à bateia com mais cuidado e agilidade, a fim de que o ouro possa separar-se das diversas partes pesadas. Para isto, imprime uma rotação mais viva à bateia, para manter em suspensão na água essas parcelas pesadas. Em seguida, diminuindo um pouco o movimento logo que julga estar o ouro depositado no fundo, inclina vivamente a bateia, de modo a escorrer toda a água e a es- tender a massa lavada, as partes mais leves se localizando nas bordas. Mantendo a bateia inclinada com a mão esquerda, com a direita, em concha, tira um pouco de água da fossa e lava o material acumulado na borda, até não encontrar mais nenhuma partícula de ouro visível. O estéril é então lançado fora. A esta operação os lavradores denominam cortar. É repetida até que o ouro depositado no fundo da bateia se destaque como o sol entre as nuvens escuras.

The cleaning on the bateias begins right after the washing of the tables.
The thicker the gold, for example, the one from grupiaras and rivers, the smaller the difficulties for the cleaning. The work becomes, on the contrary, harder when the gold is more finely granulated in the mixture.
For the cleaning of thick gold one can use any puddle of water. When they are not available, one digs a ditch by the river, or big vats are used.
The cleaner places themselves in the ditch, with water up to their knees, and, having put on the bateia a couple handfuls of the material ... begins to add to it some water and to squeeze it with the hands, so it is reduced to a very fine pulp. Following that, after the addition of water, they move the bateia, making the entire mass move in a circular fashion, little by little. The lighter parts stay suspended in the water, while the heavier ones accumulate with the gold at the bottom of the bateia.
As long as the water is turbid, the cleaner drains it a little, accentuating the movement so it also drags away the lighter parts. They collect again more water, repeating this double operation until the water in the bateia is clear.
The material from the washing is reduced, then, to a small quantity of emery and gold.
From then on, they should rotate the bateia with more care and agility, so that the gold can be separated from the heavier parts. For that, they rotate the bateia in a more lively manner, in order to keep these heavier particles suspended in the water. Following that, as soon as they judge the gold to be deposited at the bottom, they incline the bateia starkly, so that all the water drains out and the washed mass spreads around, the lighter parts reaching close to the edge.
Keeping the bateia inclined with the left hand, one cups the right hand, gets some water from the ditch and washes the material accumulated at the edge, until no particles of gold are visible. The sterile material is then thrown away. The workers call this operation cutting. It is repeated until the gold deposited at the bottom of the bateia appears like the sun between dark clouds.

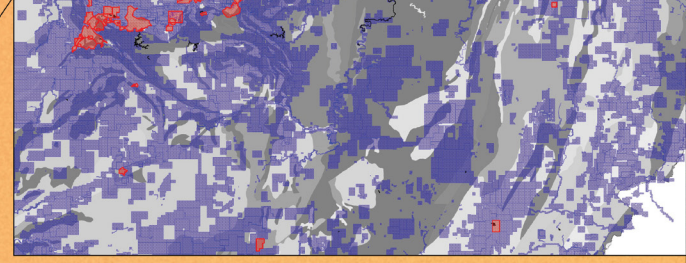
W. L. Von Eschwege, *Pluto brasiliensis*, 280



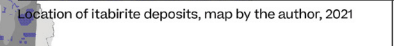
Gold washing near Itacolomi mountain (possibly Villa Rica), Rugendas, ca. 1820-1825

2021: Companies can apply for the right to exploit the mineral resources within a mining polygon. There are thousands of companies acting in the state, each color corresponds to a different type of product mined. The polygons with a black outline are the ones where a **purification process** is needed, so the mineral extracted is washed and the operation must contain a tailings dam to store the byproduct.

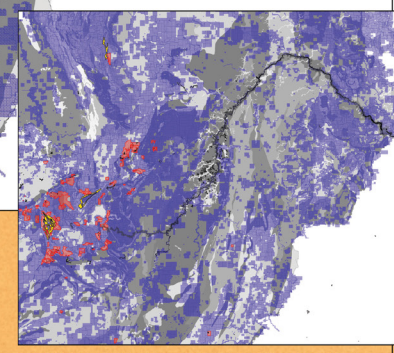
The two main materials obtained through purification or washing processes in the region closest to where the Rio Doce begins are iron and gold. Other materials that are cleaned are dolomite and topaz—Minas is one of the world's largerst exporters of precious stones.



Location of mining polygons with byproduct dams, in red, against the other mining polygons, in blue. On the background, the areas of different mineral deposits, map by the author, 2021



Location of itabirite deposits, map by the author, 2021



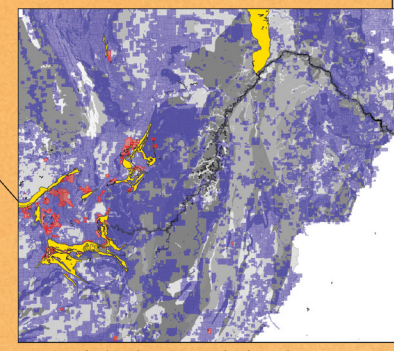
Location of quartzite deposits, map by the author, 2021

3,2 to 2,8 billion years ago: formation of granites and gnaisses, nowadays used as construction aggregate and for decoration

2,8 to 2,68 billion years ago: formation of schists and phyllite, nowadays used as construction material and for the mining of gold

2,6 to 2,0 billion years ago: formation of itabirites, nowadays mined for iron ore

2,5 to 1,6 million years ago: formation of quartzites, used for decoration and in the construction industry



Location of schist deposits, map by the author, 2021

Mining polygons with tailings dams are located on specific types of soil—in the case of the Minas Southeast, mostly schists and phyllite, which can be mined for gold, and itabirite, which can be mined for iron ore.

Processo de Britagem Primaria, video by Farley Fonseca, 2012

2015: As the sediment wave enters the Rio Doce, the Risoleta Neves hydreletric power plant closes its floodgates. This decision will stop an additional 960 thousand cubic meters of sediment from moving along the river, but the plant will hold the material in its reservoir and stay out of operation until it is removed.

Entenda como está sendo feita a limpeza da Usina Hidrelétrica Risoleta Neves, video by Fundação Renova, 2019

Risoleta Neves hydroelectric power plant, Felipe Werneck, 2016

1986: The Fernandinho tailings dam ruptures near Itabirito. Seven people die.

2001: A tailings dam managed by Rio Verde, now Vale, ruptures in Macacos. Five people die.

2007: A tailings dam managed by Rio Pomba Cataguases ruptures and floods the towns of Miraí and Muriaé.

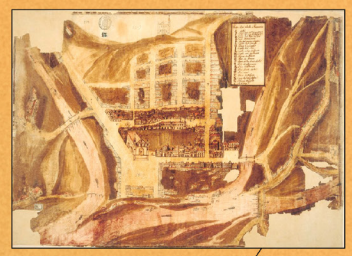
2008: A tailings dam from a gold mining plant ruptures in Itabira.

2014: A tailings dam managed by Herculano Mineração ruptures near Itabirito, killing employees that worked nearby.

2015: A tailings dam managed by Samarco ruptures near Bento Rodrigues.

2019: A tailings dam managed by Vale ruptures near Brumadinho, killing 270 people.

Minas já sofreu com outros rompimentos de barragens, Barragens de rejeito já causaram diversas tragédias em Minas Gerais; relembre, Antes fosse mais leve a carga: Reflexões sobre o desastre da Samarco/Vale/BHP Billiton

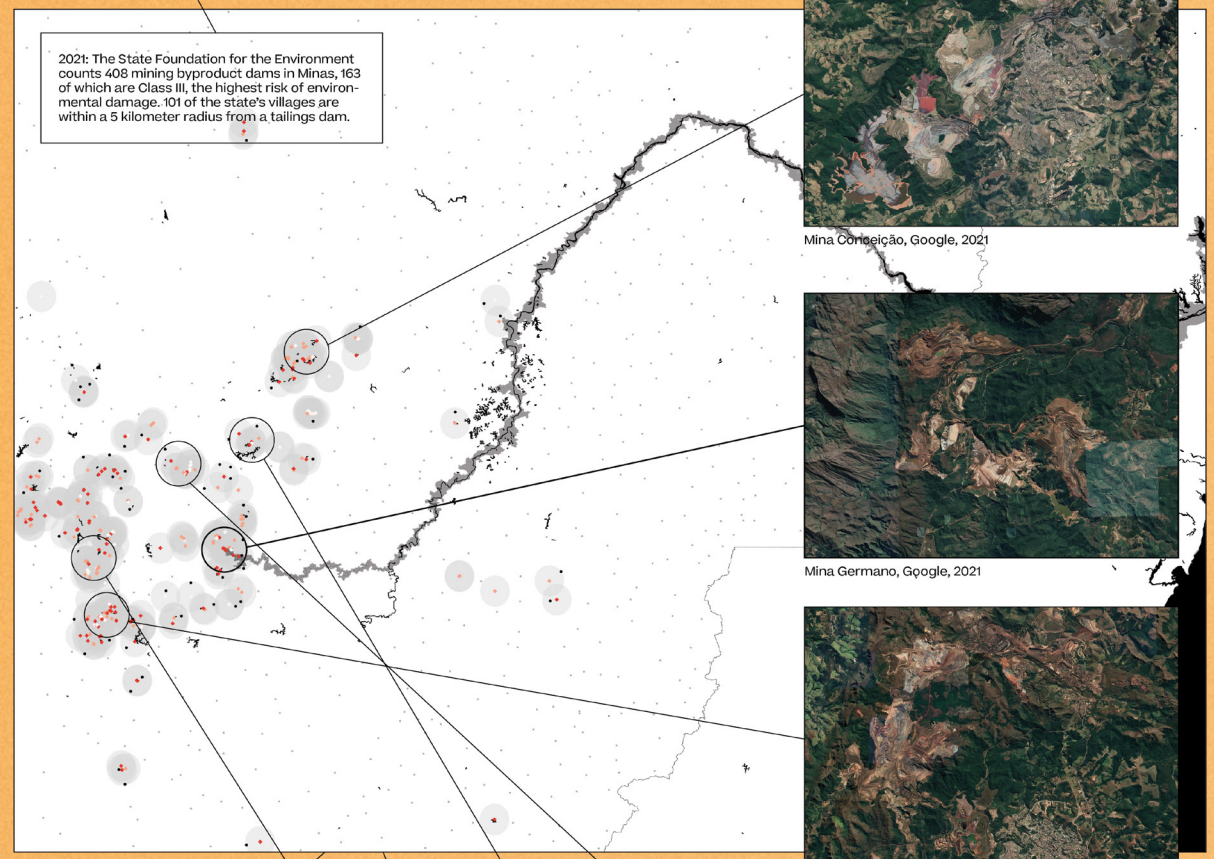


Drawing depicting a flood due to gold mining in Mariana, no author provided, ca. 18th century

1743: The Mariana Council Chamber accuses two gold miners of being responsible for the floods affecting the town. The Portuguese king intervenes in favor of the miners and they are allowed to continue their activities.

Mining and Environmental Destruction in Minas Gerais: A Historical Comparison

2021: The State Foundation for the Environment counts 408 mining byproduct dams in Minas, 163 of which are Class III, the highest risk of environmental damage. 101 of the state's villages are within a 5 kilometer radius from a tailings dam.



Byproduct dams from pink to red, according to risk level. Dots in black are villages within a 5 kilometer radius from the dams, map by the author, 2021

Mina Conceição, Google, 2021

Mina Germano, Google, 2021

Mina Casa de Pedra, Google, 2021

ideo taken right after the dam rupture, Arthur RILOS, 2015

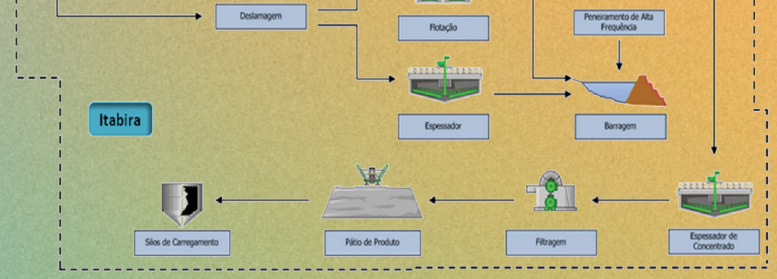


Diagram of the iron ore purification process, Galery, Perez, 2016

1986: The Fernandinho tailings dam ruptures near Itabirito. Seven people die.

2001: A tailings dam managed by Rio Verde, now Vale, ruptures in Macacos. Five people die.

2007: A tailings dam managed by Rio Pomba Cataguases ruptures and floods the towns of Miraí and Muriaé.

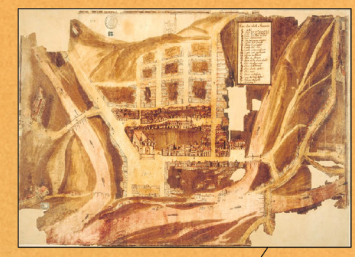
2008: A tailings dam from a gold mining plant ruptures in Itabira.

2014: A tailings dam managed by Herculano Mineração ruptures near Itabirito, killing employees that worked nearby.

2015: A tailings dam managed by Samarco ruptures near Bento Rodrigues.

2019: A tailings dam managed by Vale ruptures near Brumadinho, killing 270 people.

Minas já sofreu com outros rompimentos de barragens, Barragens de rejeito já causaram diversas tragédias em Minas Gerais; relembre, Antes fosse mais leve a carga: Reflexões sobre o desastre da Samarco/Vale/BHP Billiton



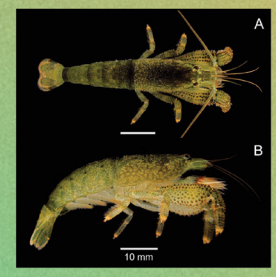
Drawing depicting a flood due to gold mining in Mariana, no author provided, ca. 18th century

1743: The Mariana Council Chamber accuses two gold miners of being responsible for the floods affecting the town. The Portuguese king intervenes in favor of the miners and they are allowed to continue their activities.

Mining and Environmental Destruction in Minas Gerais: A Historical Comparison

2015: Minerals such as itabirite and dolomite undergo a process of beneficiation where iron ore is separated from the soil. The steps in the beneficiation process in the Samarco mine are crushing, grinding, mud removal, flotation and re-grinding. The byproducts of the process are directed by gravitational pull to tailings dams.

Extinction—*Constrictions of future*

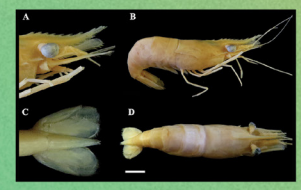


Atya scabra, Alves, DFR, 2021

Ucides cordatus, Leoadec, 2011

2015: Once the mud wave reaches the river, the aquatic life, including fish, crustaceans, plants, amphibians and others, dies from either becoming buried and trapped in the sediments or from a lack of oxygen.

Denúncia



Macrobrachium acanthurus, Laira Lianos et al., 2018

Megalops atlanticus, Kris Mikael Krister, 2016

2021: Researchers publish a detailed list of endangered species in the Rio Doce basin.

They identify 13 endangered or almost endangered species in the river basin whose distribution was directly impacted by the presence of sediments in the river. Those are *Cardisoma guanhumi*, *Minuca victoriana*, *Ucides cordatus*, *Epinephelus itajara*, *Megalops atlanticus*, *Atya scabra*, *Macrobrachium acanthurus*, *Macrobrachium carcinus*, *Macrobrachium olfersii*, *Palaemon pandaliformis*, *Potimirim potimirim*, *Ulmeritoides tamoio* and *Paramaka convexa*.

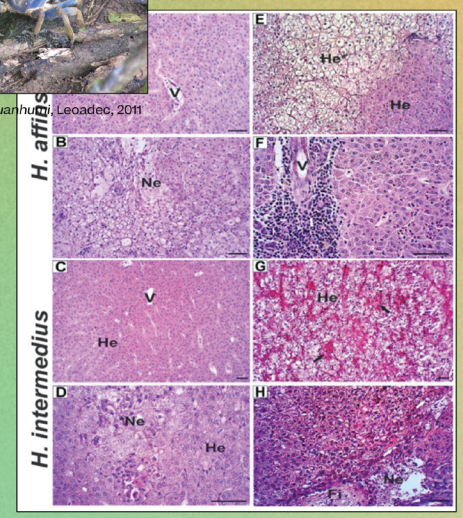
Livro Vermelho da biota aquática do Rio Doce ameaçada de extinção pós rompimento da barragem de Fundão: Mariana, Minas Gerais

Ulmeritoides tamoio, Frederico Salles, 2021

Paramaka convexa, Frederico Salles, 2021

Minuca victoriana, Luis Ernesto Arruda, 2021

Cardisoma guanhumi, Leoadec, 2011



Fish liver tissue samples. A and C are normal tissue collected at a different location. B, D and H shows nechrosis. E and H show diverse cellular pathologies. F shows inflammation. G shows blood vessels with excess blood. A. A. Weber et al., 2020.

2015: Minerals such as itabirite and dolomite undergo a process of beneficiation where iron ore is separated from the soil. The steps in the beneficiation process in the Samarco mine are crushing, grinding, mud removal, flotation and re-grinding. The byproducts of the process are directed by gravitational pull to tailings dams.

2015: The Investigative Police finds and identifies 18 bodies in the aftermath of the event. They belonged to Waldemir Aparecido Leandro, Samuel Vieira Albino, Sileno Narkievicius de Lima, Emanuelle Vitória Fernandes Izabel, Marcos Roberto Xavier, Edinaldo Oliveira de Assis, Thiago Damasceno Santos, Marcos Aurélio Pereira de Moura, Claudemir Elias dos Santos, Pedro Paulino Lopes, Daniel Altamiro de Carvalho, Maria Eliza Lucas, Maria das Graças Celestino da Silva, Mateus Márcio Fernandes, Antônio Prisco de Souza, Vando Maurílio dos Santos, Cláudio Fiuza da Silva and Ailton Martins dos Santos. The body of a 19th man, Edmirson José Pessoa, was never found.

Some bodies were missing limbs. Many had no clothes on. The bodies were scattered within a 110 kilometer range. Different remains from one of the bodies were found 70 kilometers apart.

Denúncia

Palaemon pandaliformis, Laura Flamme, no dare provided

Macrobrachium olfersii, Laira Lianos et al., 2018

2019: Researchers analyze the data from public health services from 45 towns and villages along the river and notice an expressive increase in health complaints and outpatient care if compared with the years preceding 2015. They preemptively associate the large increase in contagious and parasitic diseases to a rupture of the ecological balance of the area.

The main registered causes of complaint with increased numbers are congenital toxoplasmosis and other gestation-affecting protozoaria, Creutzfeld-Jakob disease, disease caused by the Chikungunya virus, acute respiratory syndrome, disease caused by the Zika virus, influenza, yellow fever, acoute tegumentary leishmaniasis, domestic violence, mental disorders, congenital syphilis and syphilis during pregnancy.

The main reasons for outpatient care with increased numbers are dengue, fever due to Zika virus, Chikungunya fever, yellow fever, malaria, cutaneous leishmaniasis, diarrhea, use of psychotropics such as alcohol, mental disorders, suicide, bronchitis, pneumonia, dermatitis, and abortions.

Rejeitos: Vidas Marcadas Pela Lama

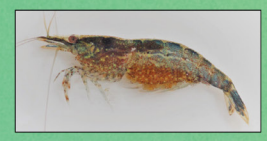
2021: Joelma, from Governador Valadares, is pressured into joining Fundação Renova's new financial aid format, where instead of receiving a single deposit and will agree to no longer pursue legal action for damages against Samarco. She has her farm on an island in the middle of the river. With no other option to water the plants, she continues to use the water which may be contaminated. She estimates her income decreased to a third of what she made before 2015.

Maria Célia de Andrade and her family, from Conselheiro Pena, used to plant coconut and guava by the river. After the sediment wave made the river flood over her farm, she lost both crops. The cows that were left suffer from frequent miscarriages.

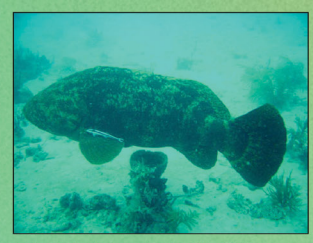
Fundação Renova impõe sistema de indenização criado por juiz em toda a bacia do Rio Doce

2015: Besides killing the aquatic and semi-aquatic fauna, the wave kills slow moving animals such as reptiles, amphibians, smaller mammals, cubs, insects, arachnids and birds and domestic animals such as oxen, horses, pigs, birds, cats and dogs.

Denúncia



Potimirim potimirim, Patricia Souza dos Santos, 2021



Epinephelus itajara, Joe Contillo, 2002

2016: An unnamed former resident of Paracatu de Baixo chooses to reside in Furquim, away from Mariana, where the rest of her family was housed after the mud destroyed their village. She thought she could not adapt to urban life, so now they live apart.

Suely, a fisherwoman from Urussuquara, Espírito Santo, is no longer able to buy meat to eat after she lost her income from fishing. She has difficulties feeding her children properly.

Thalena, a resident from Regência, Espírito Santo, tells in an interview how she thought the increasing recognition of surf as a sport would lead her village into a higher prosperity in 2016. "That year was supposed to be the year."

Several fishermen in the coast of Espírito Santo speak of a decrease of more than half in their monthly income, even with the monthly financial aid provided by Samarco.

Rejeitos: Vidas Marcadas Pela Lama

2017: The Minas Gerais State Forest Institute forbids all fishing throughout the Rio Doce with the exception of invasive species. The ban has no date to end.

Portaria Nº 40, de 11 de maio de 2017

lama da barragem em mariana matou todos os peixes do rio doce, video by samuca 50, 2015

Macrobrachium carcinus, Clinton & Charles Robertson, 2009

2016: An Espírito Santo federal judge forbids fishing in the Rio Doce from Aracruz to Linhares and at the sea from Aracruz to Degredo. The ban has no expiry date.

Justiça Federal de Linhares proíbe pesca em trecho do Rio Doce

2015: The sediment wave reaches the river during the piracema, the spawning season. Several eggs are killed by anoxia.

Os pescadores da bacia do Rio Doce: subsídios para a mitigação dos impactos socioambientais do desastre da Samarco em Mariana, Minas Gerais

e superiority of my royal weapons in such a way
terror for them, they ask for peace and subjecting
enjoyment of the laws and promising to live in
to be useful servants, as already are immense
t in my vast States of Brazil find themselves in

available at Revista do Archivo Publico Minei-
896

e Debret,

18:00, November 5, 2015: After joining in the Gualaxo do Norte river, the mud begins to flood the village of Paracatu de Baixo, followed by Gesteira, Moinhos, Barretos, Barra Longa, Vista Alegre and Corvina.

Consuelo Dieguez, A Onda, Revista Piauí, 2016

Arrival of the mud near Regência, Espírito Santo, Leandro Couri, 2015

15:30, November 5, 2015: The Fundão dam bursts.

Consuelo Dieguez, A Onda, Revista Piauí, 2016

7:00, November 6, 2015: The wave reaches the hydroelectric power plant Risoleta Neves, also known as Candonga, flooding its lake with sediments.

Consuelo Dieguez, A Onda, Revista Piauí, 2016

16:00, November 5, 2015: The sediment wave arrives at Bento Rodrigues, engulfing the lower part of the village.

Consuelo Dieguez, A Onda, Revista Piauí, 2016

Early morning, November 6, 2015: After crossing the Gualaxo do Norte, Carmo and Piranga, the mud enters the Rio Doce.

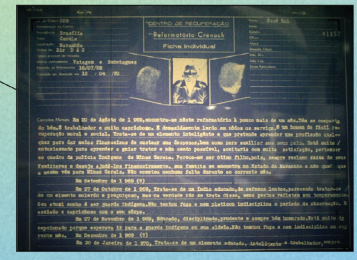
Consuelo Dieguez, A Onda, Revista Piauí, 2016

November 12,
Krenak indige
stage a mourn

Consuelo Dieg

re than saving the Northeast or integrating the
azon, this road will unite generations of Brazilians,"
sta Manchete, 1970, number 954

Krenak: Sobreviventes do Vale, documentary by Andrea Pilar Marranquiel, 2019



Individual file from the reformatory, no author provided, 1970, available via Museu do Índio

o Rodrigues from 2013 to 2021, Google

11 | 05—2013 | 08—2014 | 07—2015 | 11—2015 | 12—2015 | 04—2016 | 05—

017 | 06—2017 | 07—2017 | 08—2017 | 05—2018 | 09—2018 | 03—2019 | 07—

eira from 2015 to 2021, Google

015 | 11—2015 | 04—2016 | 07—2016 | 08—2016 | 04—2017 | 06—2017 | 08—

2021: As Fundação Renova continues t
reparation works along the Rio Doce v
identifying the improvements, Renova
temporary offices in rented commerc
construction sites and Renova cars ar
become an ubiquitous and visible pres
Mariana to Linhares.

atu from 2014 to 2021, Google

014 | 06—2015 | 11—2015 | 04—2016 | 07—2016 | 08—2016 | 04—2017 | 06—

Longa Barra Longa from 2013 to 2021, Google

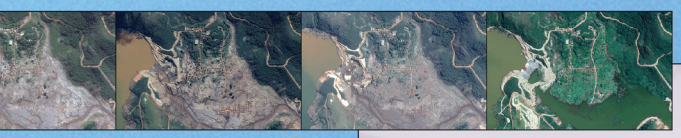
013 | 06—2014 | 11—2015 | 04—2016 | 07—2016 | 10—2016 | 03—2017 | 08—

Event—*Disaster in its different durations*

2016: The Governor of Minas Gerais passes an emergency authorization for Samarco to build dike S4, a water filtration and containment structure that will contain the leakages of mud from the ruptured dam but will in turn leave a part of Bento Rodrigues permanently flooded. The dike must be decommissioned by 2019.

November 2019: Samarco fails to meet the deadline to decommission the dike. When asked, a representative tells a news agency that the state government and the company are discussing the situation.

Dique construído pela Samarco para conter lama extrapola prazo



06—2016 | 07—2016 | 04—2017

04—2020 | 06—2020 | 06—2021

11—2019

View of a flooded section of Bento Rodrigues, image by author, 2022

2006: Samarco begins the project o
other containment dam in the Germ
mining complex. They opt to build a
stream elevation dam, where the dr
iment is shaped into steps making u
containment wall, which is sloped in

Denúncia

2014: An inspection team identifies
at the top and at the foot of the dar
structure, characterizing them as a
of pre-rupture. The head engineer o
series of recommendations to cont
situation. A later report on the same
would point to insufficient draining

2020: The president signs a law that forbids the construction of upstream elevation

97: Army official Bento Rodrigues finds
ld deposits in the southeast of Minas
erais by the Carmo river and decides to
ttle there, giving the village his name.

31: The national census identifies 318 free
en residing in Bento Rodrigues.

enúncia

2015: As the sediment wave moves downstream towards the river, it engulfs the village of Bento Rodrigues, destroying its buildings. It then moves towards Paracatu de Baixo, Gesteira and Barra Longa, flooding the houses and streets, before sliding into the Rio Doce.

Denúncia

2020: Fundação Renova signs the first contracts within the family resettlement modality, in which the family waivers the rights to a house in the new village and is instead offered one at a third location of their preference, effectively moving out of the community.

Fundação Renova atende famílias de Gesteira e fecha acordos para restituir moradia

Bento Rodrigues after the disaster, Mídia Ninja, 2016

Bento Rodrigues after the disaster, Mídia Ninja, 2016

Bento Rodrigues after the disaster, Rogério Alves/ Senado Federal, 2015

Institutional and personal limitations to alternative practices —a reflection

From the beginning, this project was framed as an inquiry into the practice of architecture as response-ability. This involved approaching the site in a less conventional manner, with a focus on archival manipulation and establishing unexpected connections between a variety of objects researched; and an attempt to design with very specific goals in mind, the main ones being that the architecture became a point of reorientation of existing entanglements in the area and that it helped provide a form of hauntological justice to vulnerable populations in the aftermath of disaster.

Having stated these goals, I feel that it was easier to achieve the ones pertaining to the research phase. I have, however, identified one main underdeveloped aspect, which is the critical contextualization of both the media and data I have come across and used in this exercise, such as maps, datasets about health and the economy in towns along the Rio Doce, drawings made by scientists hired by the former colony, anthropological photographs and models and images that result from technologies of remote sensing. These were all fundamental in my research, yet they are tools originally developed for approaches that are anything but hauntological, guided by an idea of science as an ever-expanding ability to know, see and decodify everything. I believe a better understanding of the origins and development of certain media could have helped me in applying them in a more conscious manner.

Concerning the design phase, I was certainly met with personal limitations when it came to my capabilities. This means feeling limited regarding the complexity of the built structures I could conceive and translate, but also what design methods and technical skills I was able to employ. I worked mostly with what was familiar to me: digital modeling, where I still have some shortcomings; hand drawn sketches and visualizations, which greatly helped in translating the feeling and general appearance of the project to the tutors; and digital 2D drafting, which is the method I find easiest.

There have also been a series of institutional limitations to the development of the project to its full potential. Although Explore Lab provides students with more freedom than other studios, the entire graduation process is still subjected to the outlines presented in the graduation manual, which was drafted according to a very narrow framing of the architectural practice. There are also very strict disciplinary borders between, for example, architecture, landscape design and urbanism. This results in having to retroactively establish the design, beginning with a given: a built structure is what would better engage the problems or situations identified. Only from that do we move backwards to justifying this new presence on the site.

I believe I was partially able to apply a hauntological approach to the design process, that is, to design in a way that still allows for the non-hierarchical, the fragmentary, contradictory, non-causal, non-sequential, or even, in some cases, unexplainable. I believe this was due to two main reasons: the first was that a majority of the concerns raised by tutors still framed architecture as a tool for problem solving, where the quality of the solution is fundamentally determined by a rationalized and economical application of resources, a taxonomy and reorganization of flows and uses, and a general avoidance of friction or conflict. From my side, the becoming-with the site during this year-long process did make me wary of any proposed intervention that was not absolutely grounded on the spaces, lives and movements as they are configured along the Rio Doce valley at this moment. I was not able to dissociate the design from the emergency of the problems in the region, such as a lack of work, poor physical and mental health, the need for clean soil and water, and the broader need to divest from the extractive economy. This feeling of emergency can lead, however, to conceptualizing a design that is more strategic than radically or fundamentally alternative, unwittingly returning to the same precepts of economy and rationalization.

With these first remarks made, I can identify two ways in which the design and research were related. First, the research was fundamental in becoming acquainted with concepts that guided how the design was conceived. I believe the architecture expresses a willingness to enmesh itself within existing spacetimematter entanglements, that it results from tracing and redirecting flows of material and people, that it is co-constituted with its situation, that it animates connections and makes them visible, especially when it comes to the operation of the structure along the central axis, and that it can positively intra-act with events with different extensions along space and time. In that sense, all of the main ideas discussed in the research texts are present in the design. Second, the research led to a wealth of knowledge specific to the site that I was only able to access because of the method (or non-method) applied, with a multimedia focus, no restriction on the type of sources, and a focus on establishing connections between apparently disassociated events.

I see the main disconnection between research and design at the level of method, where the freedom to envision and conduct the research process contrasted with a linear and conventional process of arriving at an architectural design. As I already mentioned, I designed through digital modeling, drawing and sketching, beginning with sketch models and progressively

detailing it further until arriving at the 1:5 scale. In contrast to the research, I would not classify the design process as experimental. It is important to note, however, that conducting experiments during the design process was not a goal that I listed either in the graduation or research plan. Nevertheless, I believe the final product would have benefited from a less conventional creative process.

It is also difficult to precise my growth in terms of personal and skill development. I do not feel like I have learned more than I would when developing a project in a professional context, but that is also due to the fact that I have already worked as an architect, researcher, writer and curatorial assistant prior to my Master studies. As with any other project, I certainly learned more about certain softwares, improved my time management skills and got to come in contact with new literature and new references. However, I would say there were other moments in my formation as an architect where I felt like the learning curve was more expressive.

In terms of how the project relates to the studio and the curriculum, it is clear to me that the results so far were only possible due to the existence of Explore Lab. Along with a friend, I made a presentation during the Architecture Department Research Day about diversity and inclusion in the faculty. This ended up leading to a discussion about education as the process of supporting students in achieving self actualization. The freedom to express ideas and experiment with methods is fundamental in this process, and a studio that allows for these things is absolutely necessary. An attendant added that Explore Lab could be considered a feminist or decolonial studio in the sense that it encourages difference beyond the highly abstract and non-situated category of "student" through which it becomes possible to assign 40 or 50 different people a design on the same location, following the same methodology, with no concern to how these fit their process of self-discovery and development.

In terms of my contributions to the discipline, I believe this has been an innovative project in the sense of threading together conventional forms of knowledge with some that are still under-appreciated in academia, providing an alternative to the idea of method and methodology, bringing forth a site and situation not commonly discussed in this school, and folding research from other fields into the project in a very transdisciplinary manner. It is difficult to simply establish whether this approach "worked" or not, but I believe much of its value lies on being an attempt at more carefully approaching a complex and large site that is home to several vulnerable communities. Instead of presenting a universally transferable methodology, which is precisely one of the objects of criticism of this work, it proposes a position to be cultivated through being open to becoming-haunted by sites of disaster or disputed sites and allowing their entanglements to emerge as they are navigated.

Literature

Literature for the report

Adams, Tim. "Félix Guattari: Architectural Enunciation." *Interstices: Journal of Architecture and Related Arts* 6 (September 2005): 119-125.

Al-Saji, Alia. "The memory of another past: Bergson, Deleuze and a new theory of time." *Continental Philosophy Review* 37 (June 2004): 203–239.

Barad, Karen. "Quantum Entanglements and Hauntological Relations of Inheritance: Dis/continuities, SpaceTime Enfoldings, and Justice-to-Come." *Derrida Today* 3, no. 2 (2010): 240–268. DOI: 10.3366/E1754850010000813.

Barad, Karen. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham and London: Duke University Press, 2007.

Barad, Karen. "Troubling time/s and ecologies of nothingness: re-turning, re-membering, and facing the incalculable." *new formations: a journal of culture/theory/politics* 92 (2018): 56-86. muse.jhu.edu/article/689858.

Brand, Dionne. *A Map to the Door of No Return: Notes to Belonging*. Toronto: Vintage Canada, 2001.

Castro-Gomez, Santiago. *La hybris del punto cero: ciencia, raza e ilustración en la Nueva Granada (1750-1816)*. Bogotá: Pontificia Universidad Javeriana, 2005.

Deleuze, Gilles. "Desert Islands." In *Desert Islands and Other Texts 1953-1974*, edited by David Lapoujade, 9-14. New York: Semiotext(e), 2004.

Derrida, Jacques. "Force of Law: The "Mystical Foundation of Authority."" In *Deconstruction and the Possibility of Justice*, edited by Drucilla Cornell, Michel Rosenfeld and David Gray Carlson, 3-67. New York, London: Routledge, 1992.

Derrida, Jacques. *Specters of Marx: The State of Debt, the Work of Mourning and the New International*. Translated by Peggy Kamuf. New York: Routledge Classics, 1994.

Dorrian, Mark. "On Google Earth." In *Seeing from Above: the Aerial View in Visual Culture*, edited by Mark Dorrian and Frédéric Pousin, 290-307. London: I.B. Tauris, 2013.

Ferreira da Silva, Denise. "On Difference Without Separability." In *Catalogue of the 32nd São Paulo Art Biennial, "Incerteza viva" (Living Uncertainty)*, curated by Jochen Volz, Gabi Ngcobo, Júlia Rebouças, Lars Bang Larsen and Sofía Olascoaga, 57-65. São Paulo: Bienal de São Paulo, 2016.

Ferreira da Silva, Denise. "Speculations on a Transformative Theory of Justice." *Hearings: The Online Journal of Contour Biennale* (April 2017). http://hearings.contour8.be/2017/04/11/speculations-transformative-theory-justice/

Ferreira da Silva, Denise. "To Be Announced: Radical Praxis or Knowing (at) the Limits of Justice." *Social Text* 114-31, no. 1 (Spring 2013): 43-62. DOI 10.1215/01642472-1958890

Ferreira da Silva, Denise. "Unpayable Debt: Reading Scenes of Value against the Arrow of Time." In *The documenta 14 Reader*, edited by Quinn Latimer and Adam Szymczyk, 81-112. Munich: Prestel, 2017.

Fyfe, Jessie, Maximilian Sternberg. "Unsettled landscapes: traumatic memory in a Croatian hinterland." *Space and Polity* 23, no. 3 (2019): 299-318, https://doi.org/10.1080/13562576.2019.1695113

Gordon, Avery. *Ghostly Matters: Haunting and the Sociological Imagination*. Minneapolis: University of Minnesota Press, 2008.
Haraway, Donna. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective." *Feminist Studies* 14, no. 3 (Autumn 1988): 575-599. http://www.jstor.org/stable/3178066
Haraway, Donna. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham and London: Duke University Press, 2016.
Hecht, Gabrielle. "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence." *Cultural Anthropology* 33, no. 1 (2018): 109-141. DOI: 10.14506/ca33.1.05
Loewenson, Thandi. "To get lost in mysterious mist." *e-flux Journal: Survivance* (2021). https://www.e-flux.com/architecture/survivance/387184/to-get-lost-in-mysterious-mist/
Maldonado-Torres, Nelson. "On the Coloniality of Being: Contributions to the development of a concept." *Cultural Studies* 21, no. 23 (March/May 2007): 240-270. DOI: 10.1080/09502380601162548
Marston, Sallie A, John Paul Jones III and Keith Woodward. "Human geography without scale." *Transactions of the Institute of British Geographers New Series* 30, no. 4 (December 2005): 416-432. https://www.jstor.org/stable/3804505
Meillassoux, Quentin. "Subtraction and Contraction: Deleuze, Immanence, and *Matter and Memory*." In *Collapse Volume III*, edited by Robin Mackay, 63-107. London: Urbanomic, 2007.
Ministério Público Federal. *Denúncia*. José Adércio Leite Sampaio, Gustavo Henrique Oliveira, Jorge Munhós de Souza, Eduardo Henrique de Almeida Aguiar, Eduardo Santos de Oliveira. Minas Gerais e Espírito Santo: Ministério Público Federal, 2016.
Morrison, Toni. *Beloved*. New York: Vintage International, 2004.
Önal, Gökce. "Media Ecologies of the 'Extractive View': Image Operations of Material Exchange." *Footprint 27: Conflict Mediations* 14, no. 2 (Autumn/Winter 2020): 31-48. https://doi.org/10.7480/footprint.14.2.4694
Povinelli, Elizabeth A. "Horizons and Frontiers, Late Liberal Territoriality, and Toxic Habitats." *e-flux Journal* 90 (2018). https://www.e-flux.com/journal/90/191186/horizons-and-frontiers-late-liberal-territoriality-and-toxic-habitats/
Purbrick, Louise. "Nitrate ruins: the photography of mining in the Atacama Desert, Chile." *Journal of Latin American Cultural Studies* 26, no. 2 (2017): 253-278. http://dx.doi.org/10.1080/13569325.2017.1313205
Rodrigues, Carla, Rafael Haddock-Lobo and Marcelo José Derzi Moraes. "Specters of Colonialidade: A Forum on Jacques Derrida's *Specters of Marx* after 25 Years, Part V." *Contexto Internacional* 42, no. 1 (Jan/Apr 2020): 149-171. http://dx.doi.org/10.1590/S0102-8529.2019420100007
Sauvagnargues, Anne. *Artmachines: Deleuze, Guattari, Simondon*. Edinburgh: Edinburgh University Press, 2016.
Sharpe, Christina. *Monstrous Intimacies: Making Post-slavery Subjects*. Durham and London: Duke University Press, 2010.
Shotwell, Alexis. *Against Purity: Living Ethically in Compromised Times*. Minneapolis: University of Minnesota Press, 2016.
Spuybroek, Lars. *Grace and Gravity: Architectures of the Figure*. London: Bloomsbury, 2020.
Vally, Sumayya. "Ingesting architectures: the violence of breathing in parts of Joburg." *The Architectural Review*, June 8, 2021. https://www.architectural-review.com/places/south-africa/ingesting-architectures-the-violence-of-breathing-in-parts-of-joburg
Weigel, Sigrid. "The Flash of Knowledge and the Temporality of Images: Walter Benjamin's Image-Based Epistemology and Its Preconditions in Visual Arts and Media History." *Critical Inquiry* 41, no. 2 (Winter 2015): 344-366. https://www.jstor.org/stable/10.1086/679079
Weizman, Eyal. *Forensic architecture: violence at the threshold of detectability*. New York: Zone Books, 2017.
Yusoff, Kathryn. *A Billion Black Anthropocenes or None*. Minneapolis: University of Minnesota Press, 2018.
Yusoff, Kathryn. "Mine as Paradigm." *e-flux Journal: Survivance* (2021). https://www.e-flux.com/architecture/survivance/381867/mine-as-paradigm/
Zonta, Márcio, Charles Trocate (organizers). *Antes fosse mais leve a carga: reflexões sobre o desastre da Samarco/Vale/BHP Billiton*. Marabá: iGuana, 2016.

Sources consulted for the entanglement map

Agência Estado. "Juíza condena Funai, União e MG por 'campo de concentração' Krenak na ditadura." *Correio Braziliense*, November 16, 2021. https://www.correiobraziliense.com.br/brasil/2021/09/4949862-juiza-condena-funai-uniao-e-mg-por-campo-de-concentracao-krenak-na-ditadura.html
Agência Nacional de Vigilância Sanitária. *Nota Técnica No 8/2019/SEI/GEARE/GGALI/DIRE2/ANVISA*. Carolina Araujo Vieira. Process no. 25351.918291/2019-53. Brasília: ANVISA, 2019.
Ailton Krenak. "Genocídio e Resgate dos "Botocudo,"" interview by Marco Antônio Tavares Coelho. *Estudos Avançados* 23, no. 65 (2009): 193-204.
Alkmim, Fernando F. "História geológica de Minas Gerais." In *Recursos minerais de Minas Gerais*, coordinated by Antônio Carlos Pedrosa-Soares, Eliane Voll, and Edson Campos Cunha. Belo Horizonte: CODEMGE, 2018.
Angelo, Maurício. "Fundação Renova impõe sistema de indenização criado por juiz em toda a bacia do Rio Doce." *Observatório da Mineração*, August 12, 2021. https://observatoriodamineracao.com.br/fundacao-renova-impoe-sistema-de-indenizacao-criado-por-juiz-em-toda-a-bacia-do-rio-doce/
"Animais atingidos pela lama de Mariana ainda sofrem." *Jornalistas Livres*, March 13, 2021. https://jornalistaslivres.org/animais-atingidos-pela-lama-de-mariana-ainda-sofrem/
Assessoria de Comunicação Social do Ministério Público Federal em Minas Gerais. "Caso Samarco: MPF pede que Juízo Federal de Ponte Nova (MG) retome andamento da ação penal." *MPF-MG*, February 9, 2021. http://www.mpf.mp.br/mg/sala-de-imprensa/noticias-mg/caso-samarco-mpf-pede-que-juizo-federal-de-ponte-nova-mg-retome-andamento-da-acao-penal
Augusto, Leonardo. "Justiça inglesa reabre ação contra BHP por desastre de Mariana (MG)." *Folha de São Paulo*, July 27, 2021. https://www1.folha.uol.com.br/cotidiano/2021/07/justica-inglesa-reabre-acao-contra-bhp-por-desastre-de-mariana-mg.shtml
Bernardino, Angelo F., Fabiano S. Pais, Louisi S. Oliveira, Fabricio A. Gabriel, Tiago O. Ferreira, Hermano M. Queiroz and Ana Carolina A. Mazzuco. "Chronic trace metals effects of mine tailings on estuarine assemblages

revealed by environmental DNA." *PeerJ* 7, e8042 (2019): 1-18. DOI 10.7717/peerj.8042

Bowker, Lindsay Newland, and David M. Chambers. *The Risk, Public Liability, & Economics of Tailings Storage Facility Failures*. Stonington, Bozeman: Bowker Associates Science & Research In The Public Interest, Center For Science In Public Participation, 2015.

Brasil, Luana Melody, and Victor Pires Ferreira Corrêa. *Rejeitos: Vidas marcadas pela lama*. Curitiba: Appris, 2021.

Canofre, Fernanda. "'A vida das famílias foi atropelada há cinco anos', diz Ailton Krenak sobre desastre no rio Doce." *Folha de São Paulo*, October 10, 2020. https://www1.folha.uol.com.br/cotidiano/2020/10/a-vida-das-familias-foi-atropelada-ha-cinco-anos-diz-ailton-krenak-sobre-desastre-no-rio-doce.shtml

Capanema, Carolina. "Mining and Environmental Destruction in Minas Gerais: A Historical Comparison." *Arcadia* 6 (Spring 2021). Rachel Carson Center for Environment and Society. doi:10.5282/rcc/9217.

Carlos, Euzeneia, Luiz Gustavo Gabler, and Tania Maria Silveira. *Boletim Técnico sobre Trabalho, Renda e Infraestrutura*. São Paulo: ComRioComMar Opinião Popular, 2020.

Carta Régia de 13 de Maio de 1808. Brasília: Câmara dos Deputados. Digitized version, https://www2.camara.leg.br/legin/fed/carreg_sn/anterioresa1824/cartaregia-40169-13-maio-1808-572129-publicacaooriginal-95256-pe.html

Carvalho, Érika. "Pescadores do ES cobram reparações 4 anos após desastre ambiental no Rio Doce." *G1*, November 5, 2019. https://g1.globo.com/es/espirito-santo/noticia/2019/11/05/pescadores-do-es-cobram-reparacoes-4-anos-apos-desastre-ambiental-no-rio-doce.ghtml

Caxito, Fabrício, and Tatiana Gonçalves Dias. "Ferro." In *Recursos minerais de Minas Gerais*, coordinated by Antônio Carlos Pedrosa-Soares, Eliane Voll, and Edson Campos Cunha. Belo Horizonte: CODEMGE, 2018.

"Comunidades da foz do Rio Doce vão receber projeto de aquaponia." *Fundação Renova*, June 14, 2019. https://www.fundacaorenova.org/noticia/comunidades-da-foz-do-rio-doce-vao-receber-projeto-de-aquaponia/

Conselho Nacional dos Direitos Humanos. *Relatório sobre o rompimento da barragem de rejeitos da mineradora Samarco e seus efeitos sobre o Vale do Rio Doce*. CNDH. Brasília: CNDH, 2017.

Corrêa, Rogério. "Reformatório Krenak (2016)." YouTube video, 18:06. November 8, 2016. https://youtu.be/Qpx8nKVXOAo

Costa, Adivane Teresinha, Hermínio Arias Nalini Jr., Jorge Carvalho de Lena, Margarete Mages, and Kurt Friese. "Surface Water Quality Parameters in an Iron Mine Region, Quadrilátero Ferrífero, Minas Gerais, Brazil." Paper presented at the International Mine Water Association Symposium, Belo Horizonte, 24-28 April 2001.

Couzemenco, Fernanda. "Renova executou apenas 17% das ações previstas, avalia rede de pesquisadores." *Século Diário*, September 27, 2020. https://www.seculodiario.com.br/meio-ambiente/renova-executou-apenas-17-das-acoes-previstas-avalia-rede-de-pesquisadores

Delarge, Raquel Gotardelo Audebert. *Estrada de Ferro Vitória a Minas: Conversas de Beira de Linha*. Master Thesis, Universidade Presbiteriana Mackenzie, 2011.

Decreto-lei No 1.106, de 16 de Junho de 1970. Brasília: Presidência da República: Casa Civil. Digitized version, http://www.planalto.gov.br/ccivil_03/decreto-lei/1965-1988/del1106.htm

Decreto-lei Nº 4.352, de 1º de Junho de 1942. Brasília: Câmara dos Deputados. Digitized version, https://www2.camara.leg.br/legin/fed/declei/1940-1949/decreto-lei-4352-1-junho-1942-414669-republicacao-68227-pe.html

Dotta, Rafaella. "Demora de reassentamentos é vista como estratégia de separação de comunidades de Mariana (MG)." *Brasil de Fato*, November 4, 2021. https://www.brasildefatomg.com.br/2021/11/04/demora-de-reassentamentos-e-vista-como-estrategia-de-separacao-de-comunidades-de-mariana-mg

Dowbor, Monika, Ana Paula Galdeano, Helder Boza, and Luciana Oliveira. *Boletim Técnico sobre Saúde*. São Paulo: ComRioComMar Opinião Popular, 2020.

Drummond, Gláucia Moreira, Rosana Junqueira Subirá, and Cássio Soares Martins. *Livro Vermelho da biota aquática do Rio Doce ameaçada de extinção pós rompimento da barragem de Fundão: Mariana, Minas Gerais: crustáceos, efemerópteros, odonatas e peixes*. Belo Horizonte: Fundação Biodiversitas, 2021.

Von Eschwege, Wilhem Ludwig. *Pluto brasiliensis*. Translated by Domício de Figueiredo Murta. Brasília: Edições do Senado Federal, 2011.

Espindola, Haruf Salmen. "A navegação do Rio Doce: 1800-1850." *Navigator* 3, no. 5 (2007): 50-72.

Espindola, Haruf Salmen. Unpublished interview conducted by the author in December 2021.

Espindola, Haruf Salmen. "Território e Geopolítica nas Minas Gerais do Século XIX." *Cadernos da Escola do Legislativo* 11, no. 16 (January-June 2009): 71-88.

Faria, Marcelo. "Barragens de rejeito já causaram diversas tragédias em Minas Gerais; relembre." *Estado de Minas*, November 5, 2015. https://www.em.com.br/app/noticia/gerais/2015/11/05/interna_gerais,705019/barragens-de-rejeito-ja-causaram-diversas-tragedias-em-minas-gerais-r.shtml

Flach, Natália. "Nos enrolaram e fomos esquecidos, diz prefeito de Mariana sobre desastre." *Exame*, February 2, 2019. https://exame.com/brasil/nos-enrolaram-e-fomos-esquecidos-diz-prefeito-de-mariana-sobre-desastre/

Ferreira, Pedro. "Atingidos por Barragens percorrem caminho inverso ao da lama da Samarco." *Estado de Minas*, October 31, 2016. https://www.em.com.br/app/noticia/gerais/2016/10/31/interna_gerais,819888/atingidos-por-barragens-percorrem-o-caminho-inverso-da-lama-da-samarco.shtml

Freitas, Raquel. "Com perda de atividade, atingidos pelo rompimento da barragem da Samarco se reinventam." *G1*, November 8, 2018. https://g1.globo.com/mg/minas-gerais/noticia/2018/11/08/com-perda-de-atividade-atingidos-pelo-rompimento-da-barragem-da-samarco-se-reinventam.ghtml

Freitas, Raquel. "Tragédia de Mariana: em 5 anos, apenas 10% dos rejeitos retidos na usina de Candonga são retirados." *G1*, October 9, 2020. https://g1.globo.com/mg/minas-gerais/noticia/2020/10/09/tragedia-de-mariana-em-5-anos-apenas-10percent-dos-rejeitos-retidos-na-usina-de-candonga-sao-retirados.ghtml

Fundação Getúlio Vargas. *Reparação Individual nos Territórios de Rio Doce, Santa Cruz do Escalvado e Chopotó: Uma Análise do Desenho, Procedimentos e da Cobertura do Cadastro, do Programa de Indenização Mediada e do Auxílio Financeiro Emergencial da Fundação Renova*. Rio de Janeiro,

São Paulo: FGV, 2020.
Fundação Renova. *Matriz de Danos 2019*, 2019. https://www.fundacaorenova.org/wp-content/uploads/2018/09/matrizdedanos20190703.pdf
"Fundação Renova atende famílias de Gesteira e fecha acordos para restituir moradia." *Fundação Renova*, October 29, 2020. https://www.fundacaorenova.org/noticia/fundacao-renova-atende-familias-de-gesteira-e-fecha-acordos-para-restituir-moradias/
G1 ES. "Contaminação no Rio Doce e Regência está maior que no auge do desastre no ES." *G1*, November 30, 2019. https://g1.globo.com/es/espirito-santo/noticia/2019/10/30/contaminacao-no-rio-doce-e-regencia-esta-maior-que-no-auge-do-desastre-no-es.ghtml
Gabriel, Fabrício Â., Rachel Ann Hauser-Davis, Lorena Soares, Ana Carolina A. Mazzuco, Rafael Christian Chavez Rocha, Tatiana D. Saint Pierre, Enrico Saggioro, Fabio Verissimo Correia, Tiago O. Ferreira and Angelo F. Bernardino. "Contamination and oxidative stress biomarkers in estuarine fish following a mine tailing disaster." *PeerJ* 8, e10266 (2020): 1-25. DOI 10.7717/peerj.10266
Guimarães, Heron, Lúcia Castro. "Um Adeus ao Rio Doce." *O Tempo*, no date provided. https://www.otempo.com.br/polopoly_fs/1.1180473.1449081357!/index.html
Instituto Estadual de Florestas. Portaria Nº 40. João Paulo Mello Rodrigues Sarmento. *Diário do Executivo Minas Gerais*. Belo Horizonte: IEF, 2017.
Instituto de Pesquisa Econômica Aplicada. *Os pescadores da bacia do Rio Doce: subsídios para a mitigação dos impactos socioambientais do desastre da Samarco em Mariana, Minas Gerais*. João Paulo Viana. Brasília: IPEA, 2016.
Junior, Edmundo Antonio Dias Netto. "Opinião: por que a Fundação Renova não funciona?" *Jornal A Sirene*, September 18, 2019. https://jornalasirene.com.br/opiniao/2019/09/18/opiniao-por-que-a-fundacao-renova-nao-funciona
"Justiça Federal de Linhares proíbe pesca em trecho do Rio Doce." *Núcleo de Comunicação Social e Relações Públicas da Justiça Federal do Espírito Santo*, February 22, 2016.
Lei No 14.066, de 30 de Setembro de 2020. Brasília: Diário Oficial da União, section 1, page 3. Digitized version, https://www.in.gov.br/en/web/dou/-/lei-n-14.066-de-30-de-setembro-de-2020-280529982
Lei de 27 de Outubro de 1831. Brasília: Câmara dos Deputados. Digitized version, https://www2.camara.leg.br/legin/fed/lei_sn/1824-1899/lei-37625-27-outubro-1831-564675-publicacaooriginal-88614-pl.html
Lei No 6.001, de 19 de Dezembro de 1973. Brasília: Presidência da República: Casa Civil. Digitized version, http://www.planalto.gov.br/ccivil_03/leis/l6001.htm
Lima, Déborah. "Prefeito de Mariana declara calamidade financeira e culpa a Vale." *Estado de Minas*, March 25, 2019. https://www.em.com.br/app/noticia/gerais/2019/03/25/interna_gerais,1040890/prefeito-de-mariana-declara-calamidade-financeira-e-culpa-a-vale.shtml
Marranquiel, Andrea Pilar. *Krenak, sobreviventes do Vale*. Directed by Andrea Pilar Marranquiel. 2019; Rio de Janeiro, RJ: Canal Futura, 2019. https://canaisglobo.globo.com/assistir/futura/krenak-sobreviventes-do-vale/v/7484834/
Oliveira, Natália. "Minas já sofreu com outros rompimentos de barragens." *O Tempo*, November 5, 2015. https://www.otempo.com.br/cidades/minas-ja-sofreu-com-outros-rompimentos-de-barragens-1.1159501
Oliveira, Wallace. ""A Justiça deixa a desejar para os atingidos", denuncia vítima do crime da Samarco." *Brasil de Fato*, October 30, 2020. https://www.brasildefatomg.com.br/2020/10/30/em-cinco-anos-historia-do-crime-da-samarco-e-marcada-pela-injustica
Oliveira, Wallace, Larissa Costa, and Raíssa Lopes. *Especial Brasil de Fato - 5 anos sem reparação*. Belo Horizonte: Brasil de Fato, 2020.
Oliveira, Wallace. "Produtores rurais de Mariana reclamam que Renova não garante a criação de animais." *Brasil de Fato*, September 13, 2021. https://www.brasildefatomg.com.br/2021/09/13/produtores-rurais-de-mariana-reclamam-que-renova-nao-garante-a-criacao-de-animais
Paiva, Eduardo França. "Bateias, carumbés, tabuleiros: mineração africana e metiçagem no Novo Mundo." In *O trabalho mestiço; maneiras de pensar e formas de viver – séculos XVI a XIX*, organized by Eduardo França Paiva and Carla Maria Junho Anastasia, 187-207. São Paulo, Belo Horizonte: Annablume/PPGH-UFMG, 2002.
Parreiras, Mateus. "Tragédia em Mariana: pescadores do Rio Doce aguardam julgamento na Inglaterra." *Estado de Minas*, July 21, 2020. https://www.em.com.br/app/noticia/gerais/2020/07/31/interna_gerais,1171931/tragedia-mariana-pescadores-rio-doce-aguardam-julgamento-inglaterra.shtml
Parreiras, Mateus. "Tragédia Mariana: município busca R$ 1,2 bilhão de indenização pelo rompimento." *Estado de Minas*, July 29, 2020. https://www.em.com.br/app/noticia/gerais/2020/07/29/interna_gerais,1171159/tragedia-mariana-municipio-busca-r-1-2-bilhao-de-indenizacao-pelo-ro.shtml
Peres Rodrigues, Fernando, Luciana A. Martins de Souza, Rosinei Ronconi Vieiras, and Dayane Santos de Souza. *Boletim Técnico sobre Água e Meio Ambiente*. São Paulo: ComRioComMar Opinião Popular, 2020.
"Projeto da nova sede da AHOBERO é aprovado." *Voz da Comunidade*, June 2021. Fundação Renova.
Queiroz, Hermano M., Gabriel N. Nóbrega, Tiago O. Ferreira, Leandro S. Almeida, Thais B. Romero, Sandra T. Santaella, Angelo F. Bernardino, and Xosé L. Otero. "The Samarco mine tailing disaster: A possible time-bomb for heavy metals contamination?" *Science of the Total Environment* 637-638 (2018): 498-506. https://doi.org/10.1016/j.scitotenv.2018.04.370
Reuters. "Samarco retoma atividades após 5 anos da tragédia de Mariana." *CNN Brasil*, December 23, 2020. https://www.cnnbrasil.com.br/business/samarco-retoma-atividades-apos-5-anos-da-tragedia-de-mariana/
Ribeiro, Bruno, Márcio Fernandes. "Lama faz índios Krenak depender de água mineral." *O Estado de S. Paulo*, November 4, 2016. https://g1.globo.com/mg/minas-gerais/noticia/2018/11/08/com-perda-de-atividade-atingidos-pelo-rompimento-da-barragem-da-samarco-se-reinventam.ghtml
Ribeiro, Darcy. *O povo brasileiro: A formação e o sentido do Brasil*. São Paulo: Global Editora, 2014.
Rodrigues, Léo. "Dique construído pela Samarco para conter lama extrapola prazo." *Agência Brasil*, November 6, 2019. https://agenciabrasil.ebc.com.br/geral/noticia/2019-11/dique-construido-pela-samarco-para-conter-lama-extrapola-prazo
SAMARCO. *Relatório da Administração e Demonstrações Financeiras*. Belo Horizonte: SAMARCO, 2014.
Dos Santos, Monica. "5 anos do Desastre da Barragem do Rio Doce. Entrevista com Monica dos Santos, atingida de Bento Rodrigues, Mariana, pelo

rompimento da barragem de rejeitos do Fundão." Interview by Cáritas Minas Gerais. Cáritas, October 13, 2020.
Secretaria de Estado de Desenvolvimento Regional, Política Urbana e Gestão Metropolitana. *Relatório: Avaliação dos efeitos e desdobramentos do rompimento da Barragem de Fundão em Mariana-MG*. Grupo da Força-Tarefa. Belo Horizonte: Secretaria de Estado de Desenvolvimento Regional, Política Urbana e Gestão Metropolitana, 2016.
Siqueira, Rodrigo. *Índio Cidadão?* Directed by Rodrigo Siqueira. April 19, 2014; São Paulo, SP: 7G Documenta. https://www.camara.leg.br/tv/432678-indio-cidadao/
Da Silva, Alexandre Pessoa (coordinator). *Estudo de avaliação de risco à saúde humana em localidades atingidas pelo rompimento da barragem do Fundão - MG*. São Paulo: AMBIOS Engenharia e Processos LTDA, 2019.
Silva, André Fabrício, Priscila Faulhaber. "Bento Rodrigues e a memória que a lama não apagou: o despertar para o patrimônio na (re)construção da identidade no contexto pós-desastre." *Boletim do Museu Paraense Emílio Goeldi*. Ciências Humanas 15, no. 1, e20200126 (2020): 1-15. doi 10.1590/2178-2547-BGOELDI-2019-0126.
Silva, Gessica, Diego Boava and Fernanda Macedo. 2016. "Refugiados de Bento Rodrigues: estudo fenomenológico sobre o desastre de Mariana, MG." Paper presented at IV Congresso Brasileiro de Estudos Organizacionais, Porto Alegre, 19 to 21 October 2016.
Silva, Gilson Pereira, Maurício Paulo Ferreira Fontes, Liovando Marciano da Costa, and Nairam Félix de Barros. "Caracterização física, química e mineralógica de estéreis e rejeito da mineração de ferro da Mina de Alegria, Mariana-MG." *Pesquisa Agropecuária Tropical* 36, no. 1 (2016): 45-52.
Simi, Gustavo Araújo. ""And Then Everything Turns White": Indigenous Peoples' Experience of Militarization and Control During the Dictatorship." *ArteMemoria* 2 (2018).
De Souza Lima, Thalita Antony, Carolina Araujo Vieira, and Ligia Lindner Schreiner. *Nota Técnica No 8/2019/SEI/GEARE/GGALI/DIRE2/ANVISA*. Brasília: Agência Nacional de Vigilância Sanitária, 2019.
Stropasolas, Pedro. "'É um tribunal do crime', diz vítima da Samarco após pedido de extinção da Renova." *Brasil de Fato*, March 5, 2021. https://www.brasildefato.com.br/2021/03/05/e-um-tribunal-do-crime-diz-vitima-da-samarco-apos-pedido-de-extincao-da-renova
Stropasolas, Pedro. "Em Barra Longa (MG), 6 das 11 pessoas diagnosticadas com metais pesados no sangue morreram." *Brasil de Fato*, November 8, 2021. https://www.brasildefatomg.com.br/2021/11/08/em-barra-longa-mg-6-das-11-pessoas-diagnosticadas-com-metais-pesados-no-sangue-morreram
Stropasolas, Pedro. "Mariana, 6 anos de um crime impune: "A justiça tem atuado como jagunço das mineradoras."" *Brasil de Fato*, November 5, 2021. https://www.brasildefato.com.br/2021/11/05/mariana-6-anos-de-um-crime-impune-a-justica-tem-atuado-como-jagunco-das-mineradoras
Stropasolas, Pedro. "Reféns da Samarco, famílias lutam para reconstruir comunidades destruídas pela lama." *Brasil de Fato*, November 4, 2020. https://www.brasildefato.com.br/2020/11/04/refens-da-samarco-familias-lutam-para-reconstruir-comunidades-destruidas-pela-lama
Stropasolas, Pedro. "Samarco retoma atividades em Mariana sem dar conta do legado de destruição." *Brasil de Fato*, November 5, 2020. https://www.brasildefato.com.br/2020/11/05/samarco-retoma-atividades-em-mariana-sem-dar-conta-do-legado-de-destruicao
Stropasolas, Pedro. "Vítimas da Samarco: os esquecidos de Barra Longa e a reparação que nunca existiu." *Brasil de Fato*, November 5, 2020. https://www.brasildefato.com.br/2020/11/05/vitimas-da-samarco-os-esquecidos-de-barra-longa-e-a-reparacao-que-nunca-existiu
Struchiner, Claudio José, Eduardo Massad, Flavio Coelho Codeço, Francisco Bezerra Coutinho, and Rita Daniela Fernández Medina. *Análise de Agravos Notificados às Bases do DATASUS – Parte 1*. São Paulo: Fundação Getúlio Vargas, 2019.
Tan, Su-Lin. "Brazil mining giant Vale agrees deal with China port to expand iron ore handling capacity." *Yahoo! News/South China Morning Post*, October 13, 2020. https://sg.news.yahoo.com/brazil-mining-giant-vale-agrees-023727488.html
"Terras Mineraes: Relação das ordens sobre terras mineraes, que, por copia, foi enviada ao Conselho Geral da Provincia de Minas Geraes." *Revista do Archivo Publico Mineiro* 4 (1896): 673-734.
"Você sabe como o nosso minério de ferro chega até nossos clientes?" *Vale*, December 18, 2015. http://www.vale.com/brasil/pt/aboutvale/news/paginas/voce-sabe-como-nosso-minerio-ferro-chega-nossos-clientes.aspx
Varella, Marcelo. "Tragédia em Mariana: produção agropecuária em áreas atingidas está comprometida." *Embrapa*, December 17, 2015. https://www.embrapa.br/busca-de-noticias/-/noticia/8410974/tragedia-em-mariana-producao-agropecuaria-em-areas-atingidas-esta-comprometida
Vormittag, Evangelina da Motta Pacheco Alves de Araujo, Maria Aparecida de Oliveira, Cristina Guimarães Rodrigues, Josué Souza Gleriano. *Avaliação dos riscos em saúde da população afetada pelo desastre de Mariana*. São Paulo: Instituto Saúde & Sustentabilidade, Greenpeace, no date provided.
Weber, André Alberto, Camila Ferreira Sales, Francisco de Souza Faria, Rafael Magno Costa Melo, Nilo Bazzoli, and Elizete Rizzo. "Effects of metal contamination on liver in two fish species from a highly impacted neotropical river: A case study of the Fundão dam, Brazil." *Ecotoxicology and Environmental Safety* 190 (March 2020). https://doi.org/10.1016/j.ecoenv.2020.110165
Zonta, Márcio, Charles Trocate (organizers). *Antes fosse mais leve a carga: reflexões sobre o desastre da Samarco/Vale/BHP Billiton*. Marabá: iGuana, 2016.
Zonta, Márcio. "Passar "dez anos sem férias" é condição comum na mineração brasileira, diz sindicato." *Brasil de Fato*, July 4, 2016. https://www.brasildefato.com.br/2016/07/04/passar-dez-anos-sem-ferias-e-condicao-comum-na-mineracao-brasileira-diz-sindicato/
Zorzal e Silva, Marta, and Monnique G. Malta Cardoso (coordinators). *Boletim Técnico Temático: Reconhecimento e Indenizações*. São Paulo: ComRioComMar Opinião Popular, 2020.

DAY 1 — SAMARCO MINE, BENTO RODRIGUES, NOVA BENTO, GESTEIRA AND BARRA LONGA ♦ We started our day trying to get to Bento Rodrigues from Mariana, which took some work. We only managed to get there on our third try. We had to stop a couple of times to ask for information and everyone was consistently friendly and helpful. At the end, we had to go around the entire mine, through Santa Rita Durão, which took over one hour. There had been heavy rains in the region (the North of Minas Gerais is in a state of calamity, with floods in several cities) and it was visible both in flooded sections along the dirt roads and in how green and luscious the vegetation was. We had to dodge the outcomes of landslides and fallen trees the entire day. Once we started approaching the mine, we could see signs marking the evacuation routes and a large suspended mineroduct. It feels like they design the roads purposefully to make it impossible to see the mine properly but we managed to park the car at a high point and take some photos of it. We also saw the Alegria mine, managed by Vale, which was more visible. From there we had to take a long and bumpy dirt road into Bento Rodrigues. Many times it felt like we wouldn't make it. There is a security checkpoint at the entrance of Bento Rodrigues with a single guard. He was friendly and calm but he explained that the area is now managed by the Civil Defense (a disaster-only type of defense corps) and we could drive along the main road, but we could not step out of the car or we could be arrested for trespassing. I asked if it was ok to drive very slowly and take photos and he just repeated what he said before verbatim. He took my first name and we went in. As it turns out, they closed off all other roads with barbed wire and there is not much to see on the main road. Generally the place felt strangely peaceful and still. There were some cows and horses grazing about. All of

the salvageable fixtures of the houses such as doors and windows have been taken away so the site is mostly walls with various levels of damage surrounded by overgrown vegetation. The lower part of the village was flooded due to dike S4 and now it looks like a shallow lake, also very still. The vegetation was lush and looked healthy. There was another security checkpoint on the other end of the road. He just asked for our first names again.

We kept on driving for around 3 kilometers and arrived at the higher part of Nova Bento. We think we probably took a wrong exit somewhere because we had to drive through the construction site and all of the workers looked at us as if it was very odd that we were there. Once again we had to drive through dirt roads mostly used by trucks and many times it felt like we might break the car. We managed to take some photos of the areas under construction. The houses look spacious in general and everything looks almost ready. There was a lot of activity and it is visibly a large operation, with the laying out of all the urban infrastructure needed for a new village.

We had to drive back into Mariana in order to go to Gesteira, which also flooded in 2015, albeit not entirely. At this point it had become clear how ubiquitous the presence of Fundação Renova, the NGO set up by Samarco, is. They have numerous sites of intervention at every town between Mariana and Barra Longa. There are agents walking around, signs identifying where Renova vehicles should go and tents and rented commercial spaces working as offices for communication with residents.

The drive to Gesteira was strikingly beautiful. The landscape is continuously impressive, with bright green rolling hills and picturesque farms and villages nested at the valleys, with white cows dotting the landscape. We drove along the Gualaxo do Norte river and all of the bridges were the same type, built by Renova, since the sediment wave destroyed the original ones.

When we arrived at Gesteira, a small rural town, nothing seemed different. The effects of the flood can only be seen at the old church, which is closed off with the same aluminum barriers of every work managed by Renova. The hard line marking the height of the sediment wave is still visible. There is a smaller construction next to the church which is now half sunken into the ground. The entire building is stained with the orange from the mud.

From Gesteira we drove to Barra Longa. It has two very distinct sections which are now separated by a large construction site managed by Renova. It will become an exhibition park, for fairs and large events. There had been landslides at the sides of some of the hills the day prior and as a result the facades of some houses were completely dirty. We drove into the center of the town and there were cars and pickups from Renova entering the parking lot of the city council building. There is a large construction site right next to the main church, with a tent with Renova agents sitting next to it. There was also military police driving up and down the main road with the car windows open and rifles pointing out, so I did not feel comfortable taking photos. We went back to our hotel after that.

BENTO RODRIGUES

BEM-VINDO AO REASSENTAMENTO
DE BENTO RODRIGUES
ESTE LUGAR JÁ FAZ PARTE DO SEU FUTURO
FUNDAÇÃO renova

ROTA DE FUGA
Em caso de Emergência ligue para:
Defesa Civil 199
Polícia Militar 190
ESTA ÁREA É ATENDIDA PELO PLANO DE ATENDIMENTO DE EMERGÊNCIAS DE BARRAGENS DA MINERAÇÃO

ATENÇÃO
AREA INDUSTRIAL DA
SAMARCO
ENTRADA PROIBIDA

ROTA DE FUGA

CAPELA DE NOSSA SENHORA
DA CONCEIÇÃO

GARAGEM

DAY 2 — UHE RISOLETA NEVES, IPATINGA AND A LOT OF DRIVING ♦ This was not a particularly lucky day. We started off driving towards the hydroelectric power plant, which can only be accessed through a sinuous dirt road. At some point we got our first sighting of the Rio Doce, which had a bright orange color from all the earth carried over due to the heavy rains. Our goal was to first drive into the power plant itself. There is work being done for kilometers around the power plant, all related to the cleaning efforts. It was much busier than I expected, with several signs placed along the road and large trucks running up and down. The total area of the operation is massive. We drove past a point where buses carrying workers all stop for the day, and from there they are picked up by smaller vans and taken to their work stations. All of the signs along the road had the Samarco brand, instead of Renova.

We drove past the entrance gate of the power plant, but a couple meters ahead there was a sign saying that area was employee only. Two workers were walking towards our car, so I talked to them and asked if we could get to Santana do Deserto, further along the river, if we kept on driving. They were also very friendly but told us we had to turn around and take a left after the gate. I only managed to take some photos of the plant when we were still far from it, but it was also much larger than I expected from the satellite images.

We drove past Fazenda Floresta on our way to Santana do Deserto. That is where they are piling up the sediment after they take it out of the lake of the power plant and separate it from the water. Once again, we could not see much from the outside, only a very understated entrance area.

There is a very small village around the church. We arrived there at lunch time. One of the buildings was a corporate restaurant, meaning it already served the workers of the power plant before Samarco started the cleaning operation. In any case, it was jarring to see several vans, one after another, stopping at the minuscule restaurant and dropping off a stream of Samarco workers for their lunch.

We went inside the church and took some photos. We then walked towards the possible site for my project, looking down on it from the road. It is beautiful and green, and it is quite clear it is a part of the floodplain of the river, so that will have to be taken into consideration for the design. We walked a little further and took photos of a farm that was further away and on higher ground, possibly a more appropriate site.

We drove back the same way and stopped for lunch at a very cheap restaurant at the town of Rio Doce: 16 Reais (EUR 2,60), all you can eat. When we were paying we noticed there were several lists all over the counter with company names where employees could mark down their lunch. There are indeed many companies all over the region, from Mariana to Rio Doce. Samarco and Renova outsource most of their operation, so you will find one company runs the employee transport, the other one the management of the parking areas, another one provides the trucks and machinery, another one does surveying, or environmental services, etc. All of the companies use the same white pickup trucks provided by Samarco or Renova, with the only difference being their logo, which is usually stamped on the back. The pickups and trucks have large square tags with a specific code: the first three letters are the ID of the company, and then there are three numbers which serve as the ID of the vehicle.

From Rio Doce we had our longest drive yet, to Ipatinga. We tried to get closer to the industrial sheds of Usiminas, a massive steel factory that has direct access to the Vale railway. The plant is so

large it has its own inner streets. Soon we reached a control gate and had to turn back. We then drove to the passenger station of the railway, which was also closed, as all the trains for the day had already passed. I managed to take some photos of the outside and also of a train carrying iron ore.

Ipatinga felt like a large and bustling city with its own complex dynamics. Since it already sits outside the area with iron deposits, there was no sign of the white pickups and mining trucks that were so present up to Rio Doce. Usiminas is certainly a presence of import, however, both from its sheer size and the fact that it has its offices in the city center and three cultural initiatives around the city: a large cultural center with a theater, which we tried to enter but only had its main lobby open for visitation, a memory center which holds the archive of the company, including important works of art acquired as company assets throughout time, and the original train station of Ipatinga, the preservation of which is managed by Usiminas itself. It was not open on the day of our visit.

Our plan after that was to take the main road to Governador Valadares and stop at Periquito to take a look at the train station and get closer to the river, however there was an accident with a truck carrying fuel which caused the traffic to stop completely. We later found out that the road we tried to take is famously known as the Highway of Death. Since all traffic had stopped, the workers of Usiminas that were taking company buses back home stepped out and started taking walks up and down the highway and climbing the trees in order to get fresh fruit to eat. We were at a standstill for two hours before we decided to take an alternate route. At the end, we arrived at Governador Valadares at 10:30 pm.

ATENÇÃO
ENTRADA
E SAÍDA DE
CAMINHÕES
PESADOS A
50m

ATENÇÃO
ENTRADA
E SAÍDA DE
CAMINHÕES
PESADOS A
50m

SANTUÁRIO DE
SANT'ANA DO DESERTO

VALE
ESTAÇÃO DE
INTENDENTE
CÂMARA

BARRACA DO PAULISTA
BEBIDAS E SALGADOS EM GERAL

DAY 3 — GOVERNADOR VALADARES, TUMIRITINGA, SÃO TOMÉ DO RIO DOCE, BARRA DO CUIETÉ, CONSELHEIRO PENA, KRENAK, RESPLENDOR ♦ We started our day at the Governador Valadares train station. It was relatively busy and most people were buying tickets for the coming days, not for the day itself. The ticket prices vary according to how long the trip is. From what I heard, people were going to many different destinations. I asked at the ticket counter when the next train was going to come (there are only two per day) and she said the first one comes at 1pm.

After that we went to Ilha Dos Araújos, an island on the river between the east and west banks. We decided to go there after I asked our hotel clerk if it was safe to walk around the riverfront everywhere with the camera and he suggested we walk only on the island.

There is only one bridge that connects it to the center, with car and bike lanes. The river was still very muddy and smelled strongly of sewage. We walked on a boulevard that circumvents the entire island; there were many other people doing walks and jogging. There is also another small island, still very green, between Ilha dos Araujos and the mainland. Some people live there and have the point of access to their homes still within Ilha dos Araujos, sometimes with a parking space associated to it. Each house has their own boat or equivalent with which they make the crossing from one island to the other.

We also noticed there were manned rafts bringing people back and forth between our island and the mainland, so we asked one of the men to do one round on the raft we could photograph the river better. The way they move is very ingenious, as they have no motor and are attached by two cables to another cable that runs the river transversally. The sailor has a lever which moves a paddle underwater and that is how he orients the boat. They are square

and once they reach the middle point of the river, in front of the second island, the sailor turns the raft the other way and it slowly starts moving towards the other bank. I asked him why so many people took them and he explained that was an easier connection between the poor neighborhoods south of the center and the island, since otherwise they would have to walk all the way to the bridge.

After Governador Valadares we drove to Tumiritinga, which is known for having a river beach with kiosks and an open stage for events. Although the day was very warm, the beach was empty. There were signs with grey paint over them, but we could still read the messages underneath warning that the water was not proper for swimming. We went for lunch at the center of the village and I noticed there were the same white pickups with square tags from Fundação Renova. They also had the company stickers, in this case Progen, a big contractor and engineering company from São Paulo that my former employer actually worked for, so I used that to strike a conversation with the restaurant owner and ask why they were there. He told me they were doing work with the rural communities and were coming there once a week for a year now. That is in fact one of the lines of reparations that Renova undertakes, the support and repair of agricultural activities. We also stopped by the Tumiritinga train station, which still has the original building.

From there we started driving along a long dirt road that runs between the river and the train station. We could not get a view of the river at all times, since there were small farms and dense vegetation between us and the water. The communities we passed were very small and could only be reached through this road. We stopped at the station of São Tomé do Rio Doce, which is a new construction and does not have a ticket office, and Barra do Cuieté, which seemed to be a slightly older building, with toilets that were locked shut and a worn out ceramic tile floor. It had a high metal ceiling and although it is a very simple construction it was very pleasant and spacious, with many birds flying perching up on the handrails and their chirping echoing through the hall.

Our next stop was Conselheiro Pena, which is one of the larger towns along the route. It also had the original station building, with interesting details in bended iron on one of the doors. With Tumiritinga and, further, Resplendor, the three larger settlements we visited on that day were also the ones with the older stations.

We then drove to the Krenak stop, which is across the river from the indigenous land and by far the smallest one. There were two Vale employees painting the handrails yellow and they invited me to go up the platform to take some photos. Coincidentally, as soon as I reached the platform we heard the train horn and started seeing its lights from far away. I asked if it was the passenger train but they answered it would not come for another hour, so it should be an iron ore train. That was indeed the case, and the train was extremely long, as it took over three minutes to pass completely. One of the employees took that time to rest and sat down on the bench, watching the train.

Our final stop in Minas Gerais was Resplendor, which is connected to a highway. As we were arriving, we noticed there were white water trucks with the Renova ID tag filling up next to a water pump. That is also in line with the fact that not only Resplendor but several towns along the Rio Doce have not yet gone back to using the river for water provision. The station was the only one that did not have the official Vale colors, instead being a light blue with the roof elements in red. There were also older buildings in the station surroundings. This was also the case in Conselheiro Pena and Tumiritinga, where

buildings with characteristic elements from the 1940s and 1950s were identifiable. It was also in Resplendor that we crossed the river and started driving on the highway along its northern edge.

We crossed the border into Espírito Santo and as we moved further towards the coast the hills became rounder and lower. The river valley became wider and the contiguous areas were formed by either open plains with tall grass or banana plantations. We traveled until Linhares.

1477

ATENÇÃO!
ÁREA TEMPORARIAMENTE
IMPRÓPRIA PARA BANHO

BEBIDAS

TUMIRITINGA

Parada
BARRA DO CUIETÉ
20

20

ACESSO
AUDITÓRIO

CESSO
DITÓRIO

PARE

Parada
CRENAC

CONSTELLATION
CSR-063
RMZ1G63

RESPLENDOR
C77
42

INÍCIO

DAY 4 — REGÊNCIA AND PORT OF TUBARÃO ♦ Linhares is located by the Doce, but the entire shore was incorporated into private lots, so we could not visit the river in the city. Our plan at first was to take a dirt road that goes from Linhares to Regência and follows the river. It had once again rained in the night and morning and quickly after entering the dirt road our car got mired in the mud. After several attempts to take it out, I had to walk to a farm to ask for help. The farmer told us it was not unusual for cars to get mired around there. He brought a shovel to dig out some of the mud but that was not enough. He then went back to fill a wheelbarrow with gravel so he could throw it around the wheels. At that point, a driver taking a different road saw us at a distance and took a detour to come and help us. He knew the region well and both men agreed it was a ludicrous idea to try to take that road after it had rained. The man who was driving the car had a rope in his trunk and the farmer brought out a metal cable he kept hidden in a bush nearby to help with mired cars. After they threw the gravel around the wheels and tied the cars to each other, we were finally able to reverse back into dry land.

We drove through another dirt road which was further from the river and finally arrived at Regencia, at the corner between the Doce and the sea. We stopped for lunch at a restaurant very close to the beach. The clouds were still very dark and a faint rain was coming and going. We sat outside to eat and from there we could see a darker and lower mass of clouds moving over the river toward the sea. The clouds reflected the bright orange of the river and in turn the sky itself was red. I asked the server if that was a common sight, and she answered they had not seen it this red for a while, but 'when the mud arrived,' that is, in 2015, all of the clouds had a bright red hue that lasted for months.

We walked to the beach and at the entrance a sign stated that the water was improper for swimming. Nevertheless, during our lunch we saw a few families leaving the beach having clearly been in the water. The mouth of the river is an area with many sea turtle nests, and the summer is indeed nesting season. Projeto Tamar, an NGO for the protection of sea turtles, has a work base in Regencia. They marked the nests with a circle made on the sand, along which they stuck small branches and a white pole with an identification number for each. There were several nests between the village and the river.

The sea water was also very brown/orange for as far as we could see. We walked along the shore for about ten minutes until we arrived at the river proper. The sand extends into a small bank that forms a hook, meaning you can stand there and see the river to one side and the sea to the other. The vegetation on the river side is typical for mangroves, with small trees with aerial roots along the shore. There was a couple bathing in the river with small fishing cages propped up which they were checking sporadically. We did not enter the water. The river itself is very wide at the mouth, so we could see only some islands at a distance going inland, but not the other shore, where the village of Povoação is located.

We walked back to Regência and then drove to Vitória, the capital of Espírito Santo, where the port of Tubarão, the final stop of the Vale railway, is located. The port consists of a single large wharf with several docking sites and plants for the pelleting of the iron ore before it is shipped. Between the city and the wharf there is a plant run by Arcelor Mittal larger than the port itself which also processes the iron ore. Once the train tracks reach the port area, they split into different, small-

er tracks that lead to these processing plants. The last thing we saw on our trip were tens of buses full of workers leaving Arcelor Mittal at the end of the workday. They all had the same sticker on the back, advertising a salt water filtration plant set up by the company in Vitoria, which they claimed helped ensure a better and more sustainable future for the city.

933
VLI

Minas, as in Mines — or the Practice of Architecture as Re-sponse-ability

Itabirite is a mineral found in the state of Minas Gerais. It has this name because it was first identified in the town of Itabira. Iron square is the name given to the area of Minas Gerais with the most Itabirite deposits. Itabirite has iron in its composition — usually between 15 and 60% — and thus can be mined for iron ore.

Iron ore mining is done in open air pits. Itabirite is composed of iron, but it also as silica and a variety of metals in smaller concentrations. Therefore, after extraction, the itabirite must be cleaned.

To the geographer Kathryn Yusoff, modern life is structured by a grammar of geology that classifies every material according to charted properties. The absolute standardization of these properties is what allows materials to be transformed and reshaped through industrial fabrication, regardless of their source or initial state.

Minas has this name because it has been mined since the seventeenth century. The first modern cities of the country emerged there, near bountiful gold and diamond deposits that stimulated the rush for large profits, population growth and strong government presence. Gold and diamond also have to be cleaned, or washed. This process used to be executed by a combination of the in-humanized black body and instruments such as a bateia—in part technologies developed and perfected by mining cultures from what is nowadays the country of Ghana. Today, this cleaning it takes place through infrastructural systems with several steps, large sites of accumulation and movement and dedicated machinery.

The process of purification is a process of separation. Itabirite must become two things: product (iron) and byproduct (tailings). These tailings are sent to dams.

Both the mines and the dams are massive, larger than entire towns that sometimes are their neighbors by only a few hundred meters. They belong, in fact, to the category of megamines, a product of evolving technologies that make it possible to obtain “clean” metals from soils with increasingly lower grades of the desired product.

After disasters involving tailings dams in 1986, 2001, 2007, 2008, 2014, 2015 and 2019, the National Mining Agency passed a resolution forbidding the construction of dams of the upstream elevation kind—the cheapest, fastest and also most prone to rupture. Besides that, all existing upstream elevation dams must be de-characterized by 2027. De-characterization can occur either by leaving the sediments on the site, removing the extractive structures and monitoring the material, or by progressively removing the accumulated tailings and applying them to other uses. This project is predicated on most of the de-characterizations being of the second kind.

A batch of tailings is stacked at the Conceição mine, in Itabira, which is undergoing de-characterization. In its composition, among other things, are silica, water, sodium hydroxide, iron and other trace metals in smaller percentages.

This batch is excavated and put on a train car. This train, which moves material (mostly) and people (marginally) travels along the Vitória-Minas Railway.

This structure was first conceived in 1901, following several failed attempts to make the Rio Doce navigable. It runs parallel to the river and was built in order to connect the iron ore deposits in the iron square to the port of Vitória, in the state of Espírito Santo.

At the train station in João Monlevade, this batch is transferred to the trunk of a truck. The truck travels along the highways MG-123 and MG-120. The truck arrives to the town of Rio Doce.

The town of Rio Doce sits very close to the origin of the river Rio Doce, at the meeting of Carmo and Piranga. It is also the site of the Risoleta Neves hydroelectric power plant, which is out of operation since November of 2015.

November 5, 2015, is the date of the rupture of a tailings dam in the Germano complex, in the municipality of Mariana.

November 7, 2015 is the date that the sediment wave enters the river, after having partially or completely destroyed the villages closest to the mine. The aquatic and terrestrial living beings that come in direct contact with the sediments die quickly from asphyxiation.

In order to present the transformations to the river valley after this moment, I take inspiration from Karen Barad’s theory of the undoing of linear time on the face of disaster and interpret every moment connected to the core event—the dam rupture—as the ongoingness of the same event, instead of a set of sequentially ordained “consequences” of an episode that is fully past.

This means the event of disaster is the same when the dam ruptures, when a living being dies buried in the mud, when a fisherman loses their lifelong occupation, when the same fisherman gets a monthly stipend, their only income, as a part of the reparations administered by the mining company, when plants do not grow by the river anymore, when the numbers of parasitic diseases explode in a village because there are no more animals to control the reproduction of mosquitoes. It is the same event every day that a woman waits for her new house to be delivered after the first one was destroyed by the wave, when a fish is already born sick, when a train loaded with iron ore arrives at the port in Vitória, when excavation for a new mine begins.

The truck exits the road and stops by the edge of a large pit. There, it dumps the batch of tailings in its trunk over a large heap of sediment. An excavator moves the batch along the pit. It is picked up by a hook with a bucket that moves it up the track. Its contents are deposited on a conveyor belt that leads to the silos. The material is dispensed from the silos in precisely established quantities in order to be used in the fabrication of geopolymer concrete.

The Rio Doce geopolymer concrete mixture* is a combination of several elements. Blast furnace slag, a byproduct of the steel industry, comes from large steel manufacturing plants located along the Vitória-Minas railway. It is used as an aluminosilicate precursor that is high in calcium, which has been found to increase the resistance of such materials.

The slag is mixed with a commercial alkali, such as sodium silicate and sodium hydroxide.

In most geopolymer compositions, the alkali is added to the mixture as a liquid solution. This brings considerable risks to the safety of those involved in its production.

The Rio Doce geopolymer concrete, however, is based off a one-part geopolymer mix developed experimentally by Brazilian researchers using iron ore tailings from the iron square in Minas. “One-part,” here, means the product is achieved by adding water to a completely dry mix of solid alkali and precursor.

The combination of water, alkali and blast furnace slag initiates the geopolymerization process. The tailings are then added to the mixture, on a proportion of up to 60% of the final product. They serve as fillers, increasing the volume of the batch.

Coarser pieces of tailings are added as aggregates. This completes the composition of the Rio Doce geopolymer concrete.

Commercial concretes made from Portland cement are completely standardized products. Their fabrication follows thorough international standards.

The Rio Doce geopolymer concrete is made from byproducts of the steel and mining industry with compositions that can vary greatly depending on the source. Every time a new batch of tailings arrives to the site of fabrication, it must be graded separately in order to define in what proportion it will be applied to the end material. Different batches lead to variations in color, texture, porosity and performance. This variation is constitutive to the system. Complete standardization is impossible and unwanted.

Geopolymer concretes are already better suited for prefabrication due to their high alkalinity and viscosity. With the added context of the impossibility of standardization, the concrete production in Rio Doce takes place on a project by project basis.

The laboratory located right next to the fabrication site is manned by residents of Rio Doce. There, they examine and grade new batches of material and design and protoype new pieces according to the needs of each project.

After the geopolymer concrete is mixed, it is poured into the formwork. The piece is de-moulded and left to cure for several days. A mobile crane lifts up the piece and brings it for pickup by a hook. As the hook moves down the track and over the road, the cars and trucks stop and wait. The piece is dropped off at the site of a new construction. It will be used to build a restaurant.

The transformations in this area begin with the arrival of the central line: a series of steel A-frames holding a truss beam along which five electrified cars move independently.

These cars are equipped with interchangeable ends such as hooks and buckets. The structure is positioned at an incline, so the bottom band of the beam is adapted for the cars to move with cogwheels. They receive their energy through a conductor bar feeding system which allows for there to be more than one car on the same track.

At the same time the track is installed, trees and plants are brought to the site in order to begin the composition of the new forest by the edge of the river. As soon as this process begins, the people of Rio Doce can already participate in it by visiting the trees, receiving training in the maintenance and observation of the forest and learning about the river and its plant and animal inhabitants.

The cycles of succession for the forest will unfold through time. The trees populating the site are not all native but are known, through experimentation, to lead to a diversification of plant and animal species.

These trees act as a barrier for silting—something of fundamental importance given the Doce is already shallow—and their fallen leaves, branches, flowers and fruits are deposited at the bottom of the river, increasing the amount of organic and decomposing matter at the benthos, its lowermost layer which has become particularly barren since the tailings have settled and compacted at the bottom.

Barad and Alexis Shotwell, among others, inform my understanding of the river not as a discrete element but as an impermanently defined entity of complex constitution. Recognizing this state of becoming is especially relevant when discussing how to deal with the river, or how to recuperate it in the aftermath of disaster. There is simply no easy path to “recovery”—because of the anthropogenic polution not related to mining, because of the characteristics of all of the branching, communicating water bodies in the entire river basin, and because of the varying ways that different animal populations have been reacting to the excess minerals and metals in the water.

Instead of “cleaning” the river, this and other forests allow for terrestrial animals to return to the margins where they now find shelter and food, for the critters to repopulate the bottom layer of the Doce and for generations of fish, shrimp, crabs and insects to succeed each other.

After the track is installed and the forest begins to grow, the structure that will house the geopolymer production is built.

This is a medium-sized fabrication site where the residents of Rio Doce and other nearby villages work; making the building elements and learning about making them.

The walk from the center of Rio Doce to the project site takes ten minutes.

MG-120 runs between the town and the fabrication site, connecting them to the Vitória-Minas railway, to the north, and to the state of Rio de Janeiro, to the south. That way, the pieces made in Rio Doce can be moved easily along the infrastructural basis of the system I call the line of gift.

The line of gift essentially hacks into the existing extractive infrastructure, especially the railway, in order to diversify the movement of people and material along the river valley. In 2015, after the dam ruptured, the earth, liquified, traveled from the mountains in the West to the sea in the East. Not coincidentally, this is the same route that the other part of this earth—the purified iron ore—makes every day, inside train cars and underground mineroducts. The line of gift is an appropriation of the large

processes of material extraction and separation, of the sites of movement and the sites of accumulation, in order to cause a diversion of flows and a diversion of purpose, so some of the material, knowledge and technology can be retained in the area, in contrast to the complete exhaustion it is usually subjected to.

When it comes to disaster, a yearning for some form of justice is very present, and it can often be conflated with the idea of reparations, something that also happened in the case of the Rio Doce.

Instead of repairing, cleaning or setting things right, I choose to work under the framework of justice as gift. The gift is not an object or an event. It should better be called a cycle, or a culture. It does not mean the introduction of something completely new to movements that are already in place, but the actualization of futures that are the result of pasts that are already latent and already possible, as they are the ones that correspond to our desires and to our aspirations.

Once fabrication is set up, the project site can expand in terms of uses and built structures, depending on budget, demand and material availability.

The construction of these buildings follows generally the same set of steps.

First, a soil compactor is used to make a flat surface on the ground.

Then, it is excavated for the placement of the rainwater channels on the perimeter of the new construction and stones and boulders collected during the land operations, which will serve as footings for the loads of the roof.

The boulders have slots which fit anchors, and, over the anchors, the columns are placed. A layer of grout increases the surface for the distribution of loads between column and footing.

Then, the floor slab is cast on site. Anything that is within the bounds of the rainwater channels works not only as a floor slab but also as a mat footing, which redistributes the loads from the walls.

Once the floor is dry, the roof beams are put in place with the help of a small crane.

The gutters and slab tiles are placed over the beams.

Then, the walls, made of geopolymer concrete cinderblocks, are built. The door frames and lintels are installed at the same time.

Finally, the doors and window sheets, gutter grates and beam caps are put into place.

The paths surrounding the buildings and connecting different areas of the site consolidate over time. Coarse tailings not used as aggregate in the geopolymer production can be used as gravel and distributed along the paths most used.

The shape and modular disposition of the roof elements are fixed, but the columns, door and window frames, gutter grates and beam caps can be freely designed and prototyped by the geopolymer fabricators. The shapes and ornaments can reflect the references of a particular person, a plant or animal from the region, or a decorative pattern with meaning to a certain group of people. Designing, producing and building on site allows for this type of autonomy over an otherwise fully standardized system.

One of the first constructions is the entrance building, where visitors are welcomed and directed to other parts of the complex. This site is enmeshed with cycles of care and community already present throughout the river. The booths form an open market where groups that exercise alternatives to the extractive economy can showcase, exchange or sell their products, either on a daily basis or during special events.

This is where a group of residents of Resplendor find themselves, for a four-day workshop on the exchange of knowledge on beekeeping. They leave their home and board on the Vitória-Minas train. They get off and take the bus at the station of João Monlevade. They get off again, at the bus stop in front of the entrance building. They arrive at the reception counter. They are directed to the workshop building.

With some time to spare, they walk up the stairs. They walk along the observation platform to look at the heaps of tailings being moved by an excavator.

They go to the square, which serves as a product pickup point and open air exhibit for geopolymer pieces. They look at the columns, touch them, comment on their appearance.

At the ceramics workshop, finer batches of tailings are used in the production of decoration pieces, tiles, tableware and other objects.

At the building for the other workshops, visitors can use the four open meeting areas to exchange knowledge. There is space for setting up tables for teaching and learning skills such as embroidery, weaving and painting. Under the same roof, there is a distillation lab, for activities such as honey extraction and essential oil production, and an experimental kitchen for the production of preserves, sauces, bread and other types of food.

This space works in close connection with the vegetable garden and orchard where material for the food products and essential oils is grown. There are also beehives and hydroponics stations which are cared for by the residents of Rio Doce.

Generally, but not forcibly, the people that work daily on the site come from the towns closest to it. As we look further along the river, visitors can take 5 or 10 hours by a combination of train and bus to reach the site, so it is expected that they will be present for a specific event, workshop or training program, and will need to spend one or more nights in Rio Doce.

The animals and plants in the forest, garden and orchard cannot come in contact with the river water as it is, so they are irrigated through a system based on rainwater collection. The rain that hits the roofs of the buildings is directed to a gutter that sticks out of the roof, moves down to open channels on the floor, and from there is directed to the center axis, running down with gravity, which allows for it to pass through a succession of filtering elements, and to be stored in cisterns for further use.

At the water and forest observation lab, which sits very close to the river, information collected at different points along the Rio Doce is archived and interpreted. The technicians, who are also locals that underwent special training, visually monitor the conditions of the water and the growth of the forest and give workshops to visitors about the local biota. Researchers from educational institutions also use the space to con-

duct their own inquiries.

After its construction is finished, the restaurant opens. It is very busy at lunch time, with daily workers, visitors and Rio Doce residents congregating to eat the most important meal of the day.

Behind the kitchen and dressing rooms, the area for child care is crowded as the parents participate in workshops throughout the day.

After spending the day collecting seeds from the aroeira tree and dropping them off at the workshop, two women walk towards the restaurant. They stop to watch as a crate loaded with vegetables is attached to a moving hook so it can be hoisted up to the patio for pick up.

They get two bottles of coke and sit on yellow plastic chairs under the cool shadow of the concrete canopy. They look at the river, their giant brother, unfurling continuously and silently towards the sea. This is a moment of respite and dignity.

In the southeast of Minas, the vulnerability of small communities is produced through their interaction with the determining presence of large scale infrastructure, mining equipment, the railway, the roads and highways full of trucks, port cranes, heaps of material, underground and overground tunnels and ducts and steel factories.

Through what I defend is a hauntological exercise of tracing the spacetimematter entanglements across the river valley (understanding that an entangled co-constitution presupposes a being and becoming that is always haunted by others and by one's surroundings) I tried to look into "minor" places and "minor" stories, but I also refused to treat the processes of large scale material movement and accumulation as too large to address or change, as if they were not somehow situated themselves and so products of genealogies and traceable interests. In that way, I have tried to conjure the ghosts, to give them a cognizable form, so we can react to them with more than an absolute surprise when they thrust themselves violently into our sight.

This is not a "clean" project. Anyone who has visited Minas knows it is impossible to keep anything clean around there, where the deep reds and oranges of the oxidized metals will find their way into every house, truck, car, road, animal, stream and river.

This is not a "clean" project. It is not exorcized from the language of land operations, stratification, buckets, pits and tracks for the accumulation and movement of material. Instead, these are all appropriated so that the processes of extraction and transformation are (1) cracked open, for everyone to see, and (2) put to use in a manner that is conducive to and affirming of life and the multiplication of life, against an overwhelming feeling of violence and violation, against the constant threat and shadow of premature death. The life I talk about is not a pure, untouched dream, but a deeply grounded, communicative, unclear and contaminated process. This irreducible complexity, full of ghosts that we must learn to live with, is the fertile ground from which radically new futures, that we cannot even imagine now, can finally sprout.

***Defining the Rio Doce valley geopolymer concrete**

Geopolymers are aluminosilicate materials, still developed mostly at an experimental level, that can possibly substitute Portland cements in the composition of concretes. They are considered a less harmful alternative to the environment in the sense that they can have large percentages of industry and mining waste in their composition.

The two essential components needed for the geopolymerization process are an aluminosilicate precursor and an alkali.[1] Differently than commercial cement, geopolymers can have different compositions, with several possibilities for each of the fundamental ingredients as long as the aluminosilicate-alkali principle is retained.[2]

A literature review conducted by Figueiredo et al. indicates that geopolymers usually behave in a more advantageous manner than Portland cement in terms of strength, shrinkage while drying, resistance to chemical attack and resistance to thermal changes.[3] A second literature review conducted by the Australian road authority, which has been closely studying the applications of geopolymers in infrastructural projects, indicates that geopolymers have higher compressive, tensile and flexural strength than commercial cement.[4] The conclusion to their review is that the specification of geopolymer concrete for structures would be very similar to how it is done with common concrete.[5]

Other conclusions were that a longer mixing time has a positive impact on the final strength of the material.[6] The ambient humidity during casting must be controlled the same way as with cements.[7] An elevated temperature when curing leads to a faster and higher gain in strength.[8,9] Large geopolymer concrete beams perform the same as Portland cement concrete ones, only with a lower ductility.[10]

The use of geopolymers is well advanced in Australia, where companies already have patented mixes produced at a commercial scale. The largest application of geopolymers in construction happened in the country, where sections of the airplane runway at the Brisbane West Wellcamp Airport were made out of a highly resistant geopolymer concrete.[11,12] Also in Brisbane, the University of Queensland Global Change Institute opened in 2013, becoming the first building with a structure designed in geopolymer concrete.

The presence of calcium greatly increases the strength of geopolymers. If the original composition is low in calcium, waste-based materials such as fly ash or blast furnace slag can be added to the mixture.[13] In the case of Minas Gerais, large steel manufacturing plants from companies such as ArcellorMittal, Gerdau, Usiminas and Vallourec have slag as a continuous by-product. These plants pose their own hazards to their surrounding communities, but at least to an immediate extent they could be the main source of calcium-rich ingredients.

There are two important differences between

1. Ricardo A.M. Figueiredo et al., "Mechanical and Chemical Analysis of One-Part Geopolymers Synthesised with Iron Ore Tailings from Brazil," Journal of Materials Research and Technology 14 (August 8, 2021): 2651, https://doi.org/10.1016/j.jmrt.2021.07.153.

2. Ahmad Shayan (org.), Specification of Geopolymer Concrete: General Guide (Sydney: Austroads, 2016), 2.

3. Figueiredo et al., "Mechanical and Chemical," 2651.

4. Shayan, Specification of Geopolymer, 13.

5. Ibid, 11.

6. Ibid, 5.

7. Ibid.

8. Ibid, 7.

9. Luukkonen et al., "One-part alkali-activated materials: A review," Cement and Concrete Research 103 (January 2018): 27, http://dx.doi.org/10.1016/j.cemconres.2017.10.001.

10. Shayan, Specification of Geopolymer, 8.

11. Ibid, 11.

12. See Glasby et al., "EFC Geopolymer Concrete Aircraft Pavements at Brisbane West Wellcamp Airport," presented at Concrete 2015 Conference, Melbourne, Australia, 2015.

13. Shayan, Specification of Geopolymer, 4.

geopolymer concretes and Portland cement concretes when it comes to everyday fabrication and handling. The first is the high viscosity of the geopolymers that makes it necessary to clean mixing vats, pipes and moulds immediately after use.[14] The second is the much higher alkalinity of the material, which can pose serious risks to people involved in the manufacturing process.[15] In order to mitigate these risks, researchers have been investigating efficient ways to produce one-part geopolymers. The more commonly studied geopolymers are considered a two-part product, in which a liquid solution of the alkali material and a solid aluminosilicate precursor are mixed with extra water. The liquid solution is considered the hazardous component in this process, as it is viscous, highly alkaline and handled in large quantities.[16] The alternative would be a one-part product: a dry mix of solid alkali and precursor to which only water would have to be added. Luukkonen et al. have conducted a review of the experiments with one-part geopolymers and have concluded that there are no obstacles to their development and application.[17]

Figueiredo et al. have successfully produced a one-part geopolymer mix using iron ore tailings from the Quadrilátero Ferrífero region in Minas Gerais. They used commercial metakaolin as the aluminosilicate precursor and sodium silicate and sodium hydroxide as the activators (another name for the alkali components). The tailings, coming from different sources and applied in different proportions to the mixture, were used as fillers.[18] The behaviour of the material was especially promising when it came to strength. Three samples reached 30.9 MPa within a day and the sample with the highest proportion of waste material (60% of the entire mix) actually reached the highest compressive strength (43.6 MPa after 14 days), thus falling within the range of high performance concrete.[19,20] For the entire experiment, the compressive strength increased in tandem with the proportion of tailings in the geopolymers.[21]

Borges et al. attempted to work with a similar mix (tailings as fillers, metakaolin as the precursor and sodium silicate and sodium hydroxide as the activators). Their results were not as promising, especially when it came to the porosity of the material.[22] They have, however, alluded to the still untested possibility of incorporating tailings even further into the geopolymer concrete production, substituting not only the cement but the large aggregates in concrete with coarser tailings.[23]

With these conclusions in mind, a geopolymer mix with readily available materials in the region of the project would consist of blast furnace slag as an aluminosilicate precursor that is already high in calcium; commercial alkali such as sodium silicate and sodium hydroxide as activators; tailings as fillers in a proportion of up to 60%; and water. If needed, sugarcane bagass could be used as an additional silica source.[24] The geopolymer concrete would be made with the addition of coarse tailings as aggregates and the use of reinforcements as with normal concrete.

14. Shayan, Specification of Geopolymer, 5.

15. Ibid, 10.

16. Luukkonen et al., “One-part alkali-activated materials: A review,” Cement and Concrete Research 103 (January 2018): 21, http://dx.doi.org/10.1016/j.cemconres.2017.10.001.

17. Ibid, 31.

18. Figueiredo et al., “Mechanical and Chemical,” 2651.

19. Ibid, 2654.

20. Ibid, 2655.

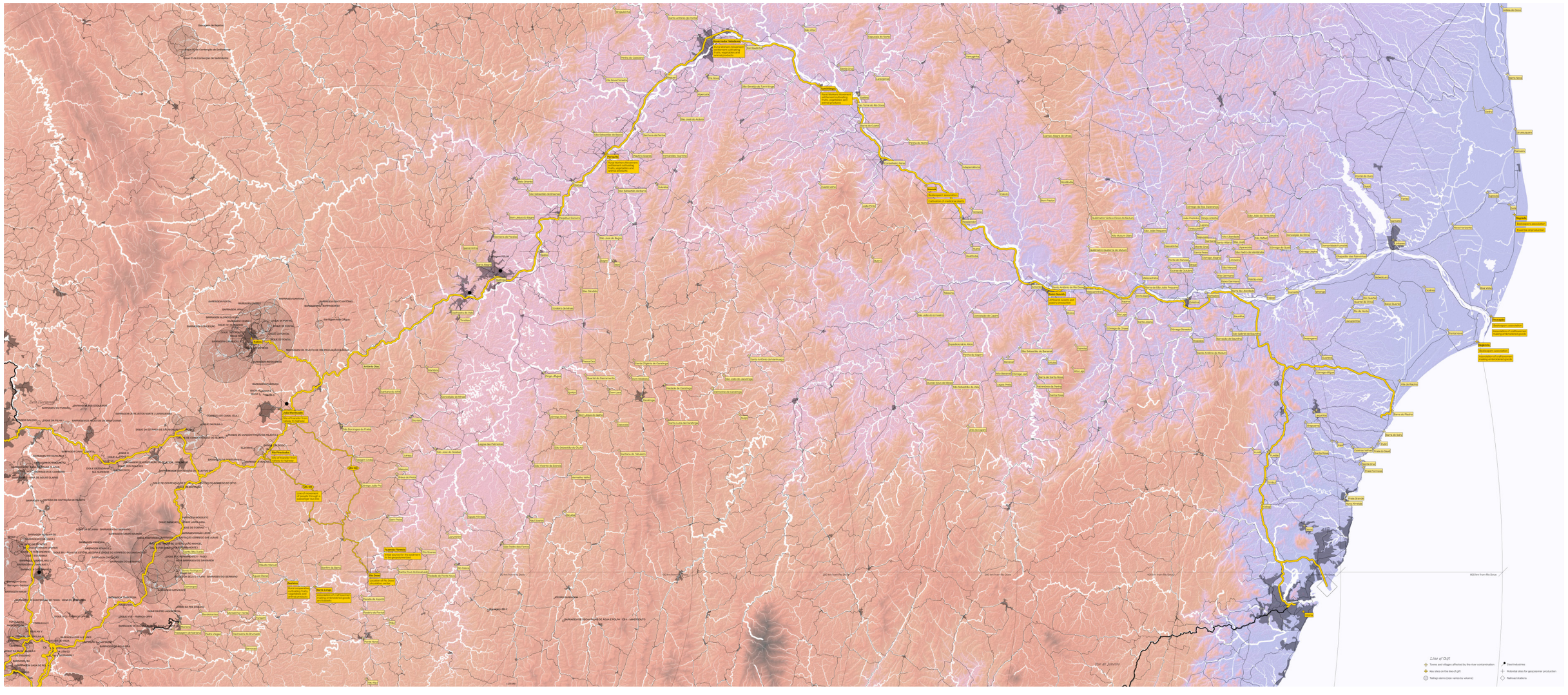
21. Ibid, 2656.

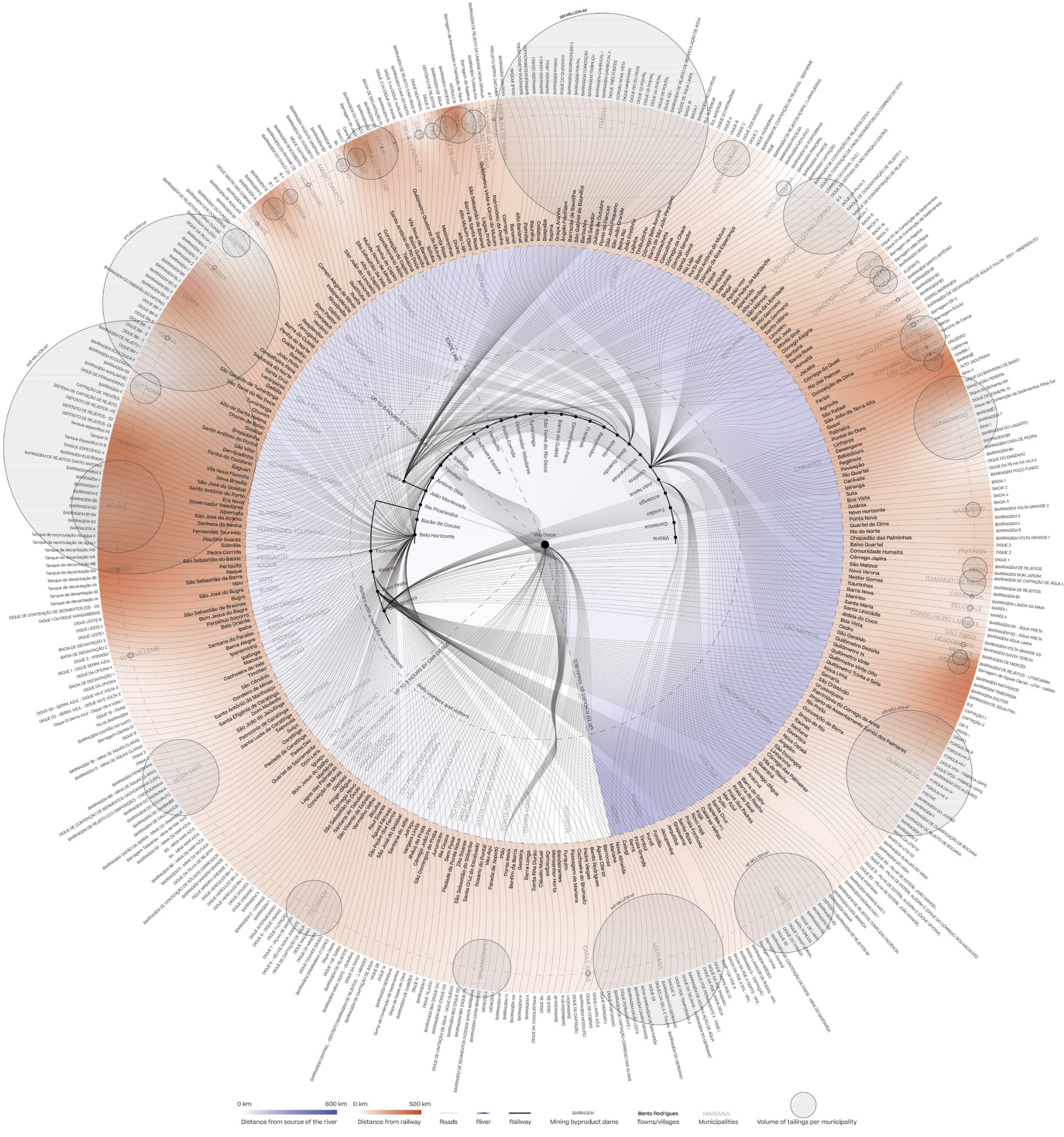
22. Borges et al., “Reuse of iron ore tailings in the production of geopolymer mortars,” REM – International Engineering Journal 72, no. 4 (October-December 2019): 586, https://doi.org/10.1590/0370-44672017720169

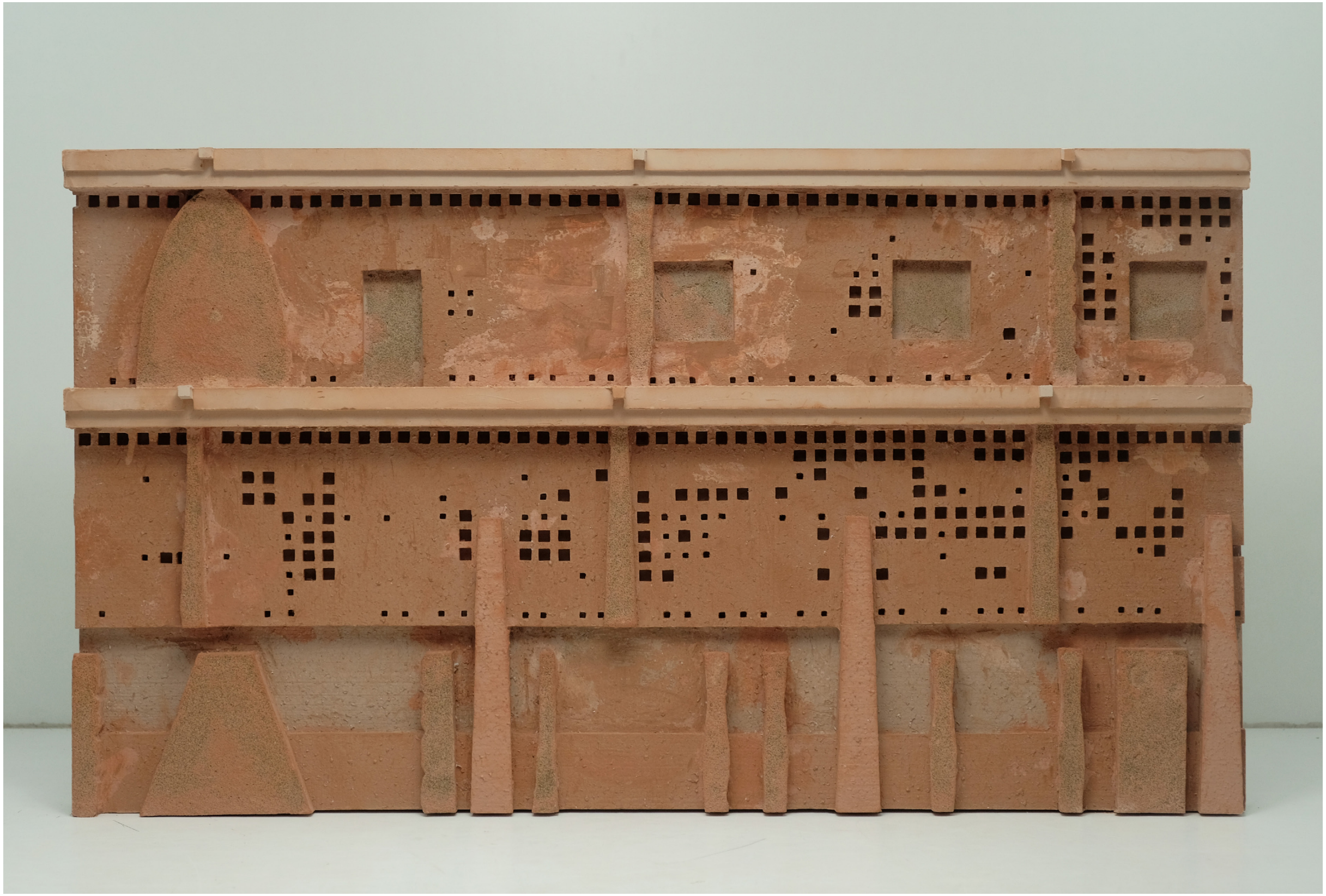
23. Ibid, 582.

24. See Norsurava et al., “Sugarcane Bagasse as a Renewable Source of Silica to Synthesize Santa Barbara Amorphous-15 (SBA-15),” Procedia Engineering 148 (2016): 839 – 846, https://doi.org/10.1016/j.proeng.2016.06.627

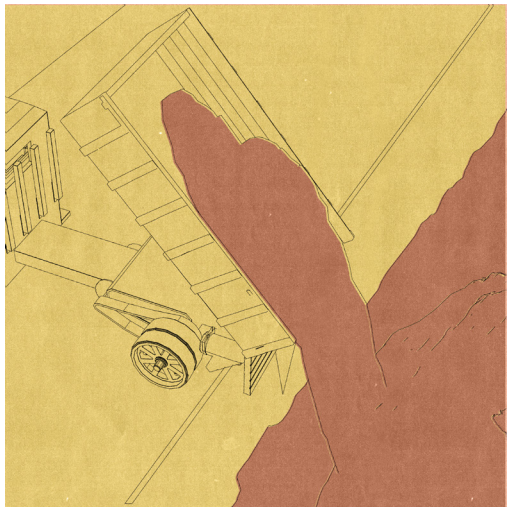
Since such a large percentage of the composition of geopolymers can come from different sources of waste material, mass production under generally established guidelines is unlikely. This means it is a material better applied on a project by project basis. Therefore, the design of pieces for each project would also be incorporated into the geopolymer lab and workshop section of the program. There is still a possibility, though, to continuously fabricate a catalogue of pieces in order to reach smaller markets such as the self-built houses that make up for most of the housing in Brazil. This could happen as long as most of the components follow a commercial structural setup, such as the combination of simple slab panels and structural concrete blocks.

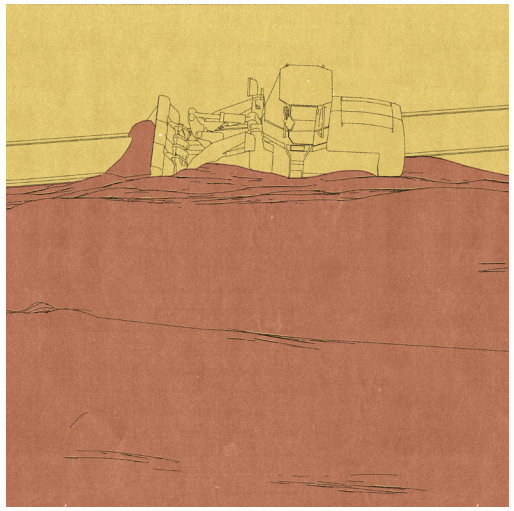

Line of Oil
Towns and villages affected by the river contamination
Key sites on the line of gift
Tailings dams (size varies by volume)
Steel industries
Potential sites for geopolymer production
Railroad stations

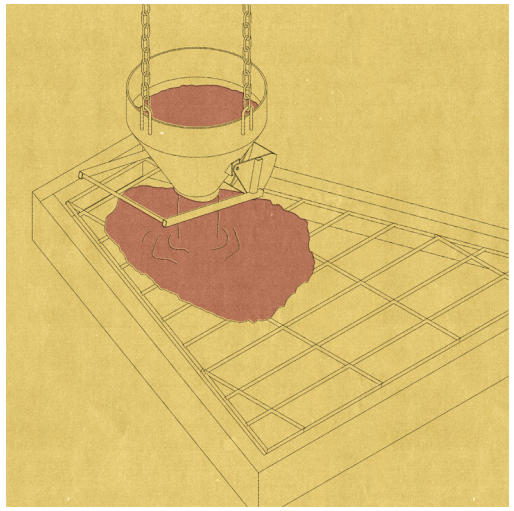

0 km
600 km
0 km
500 km
Distance from source of the river
Distance from railway
Roads
River
Railway
BARRAGEM
Mining byproduct dams
Bento Rodrigues
Towns/villages
MARIANA
Municipalities
Volume of tailings per municipality

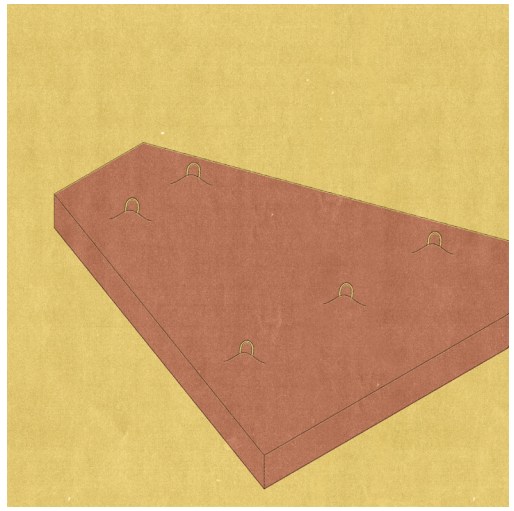


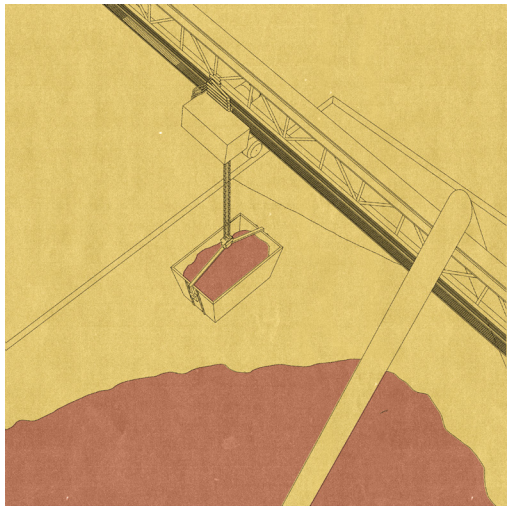
SOAPE



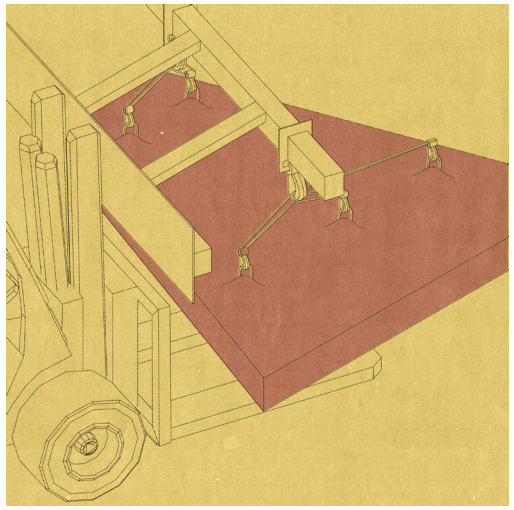




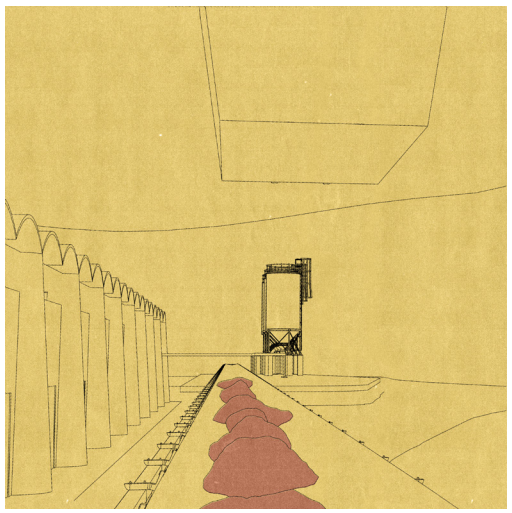


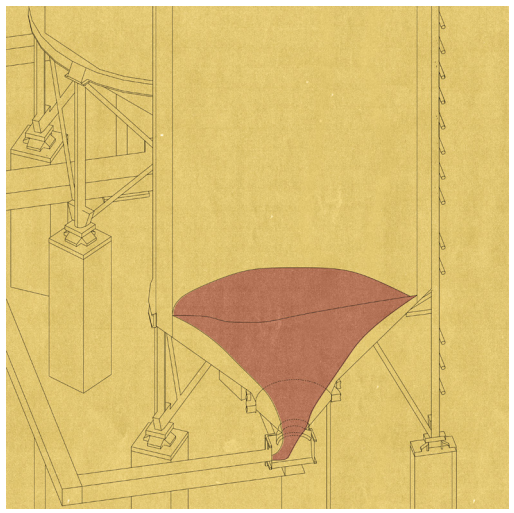


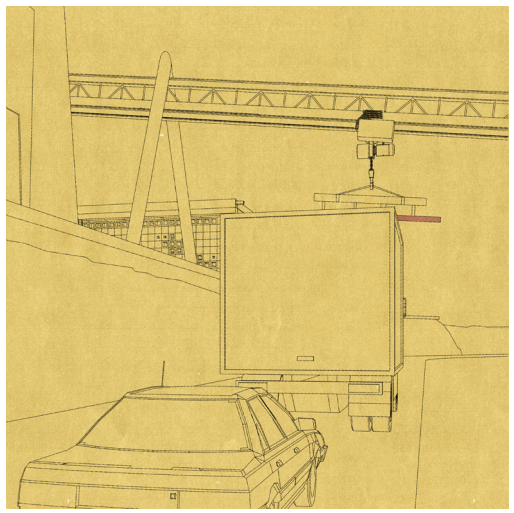
1 *Truck dumps the tailings on the heaps of sediment*
2 *Material is moved by an excavator*
3 *Material moves up the axis in a bucket*
4 *Material is carried over a conveyor belt*
5 *Material is dispensed from silos*

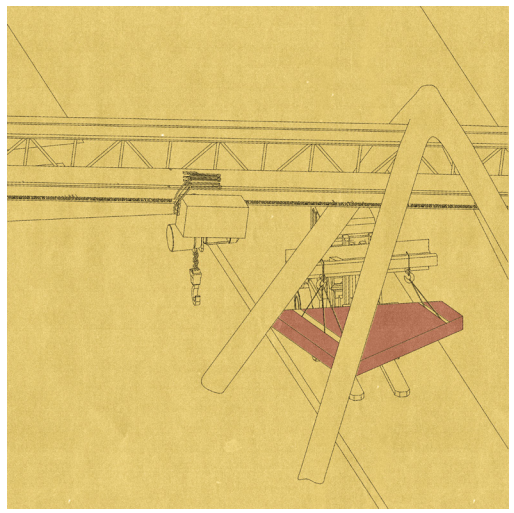


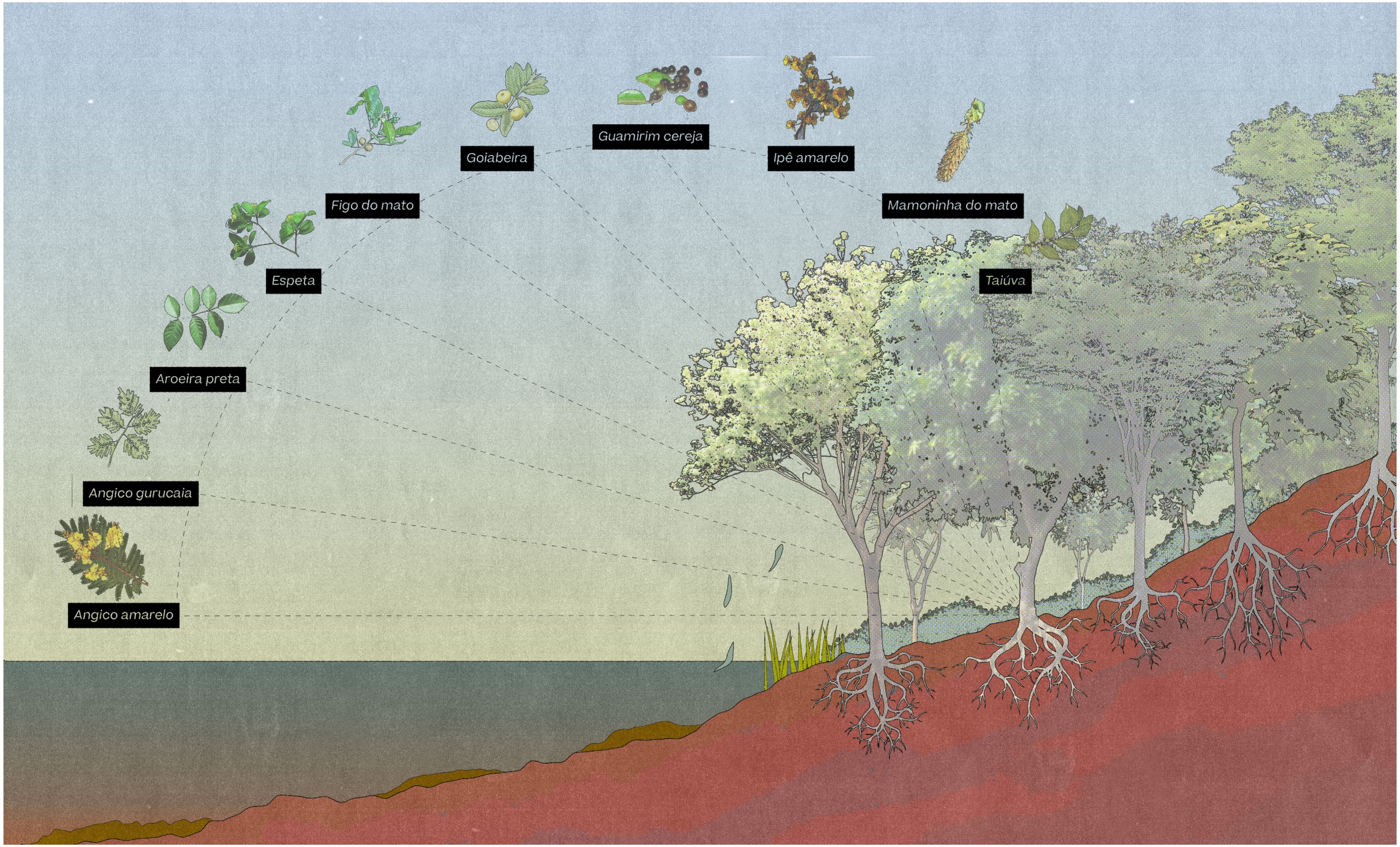
6 *Geopolymer poured into formwork*
7 *Piece is left to cure*
8 *Piece is picked up for transfer*
9 *Cars and trucks stop and wait*
10 *Piece arrives to the site of construction*

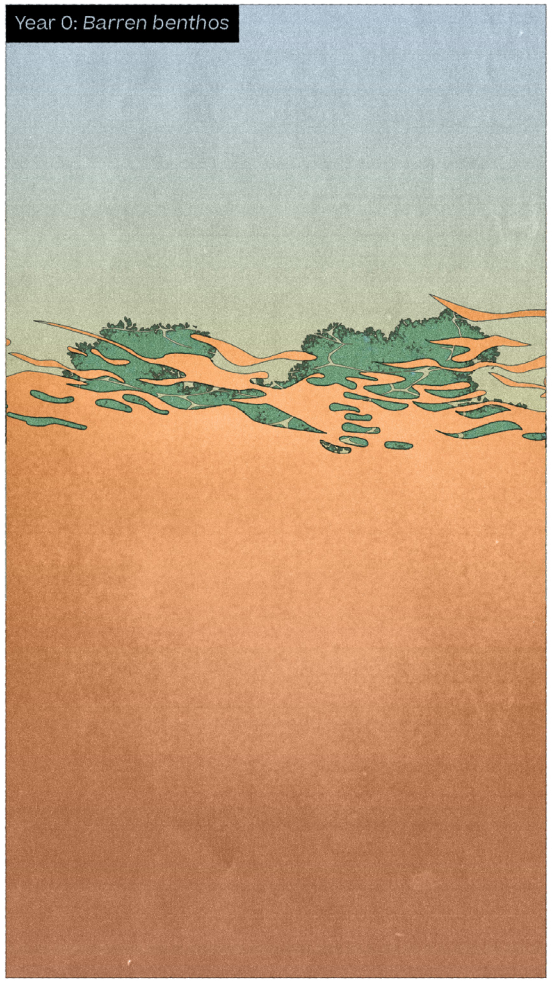






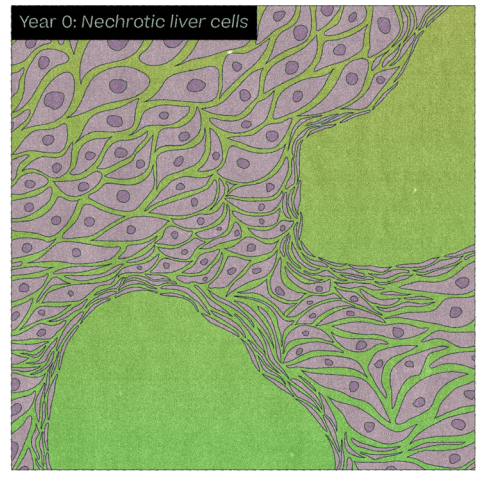


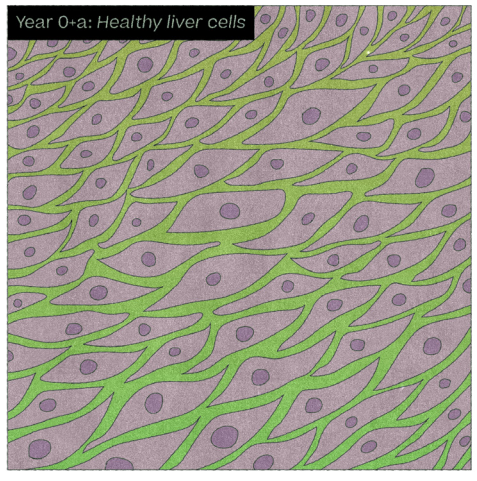

Goiabeira
Guamirim cereja
Ipê amarelo
Figo do mato
Mamoninha do mato
Espeta
Taiúva
Aroeira preta
Angico gurucaia
Angico amarelo

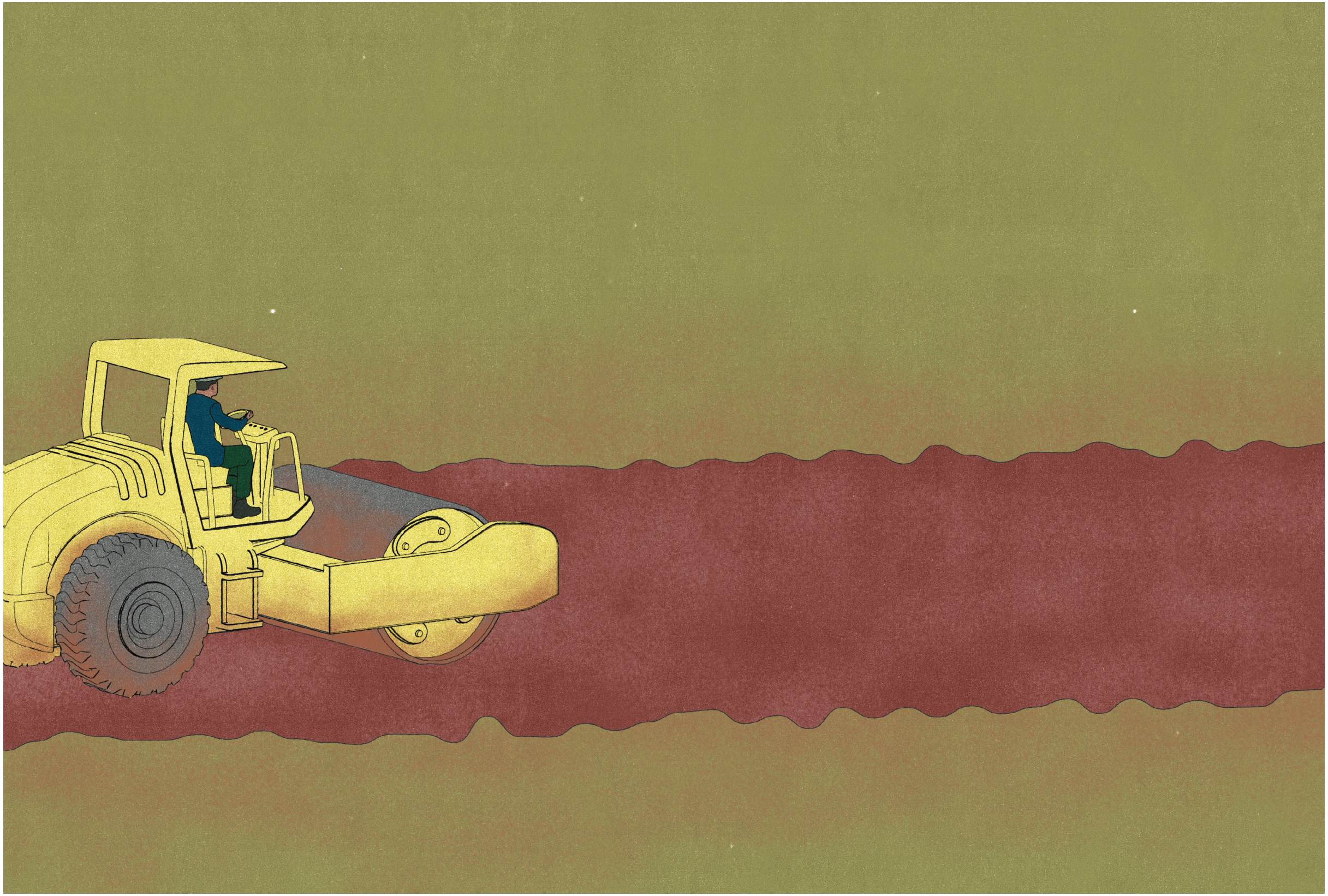

Year 0: *Barren benthos*

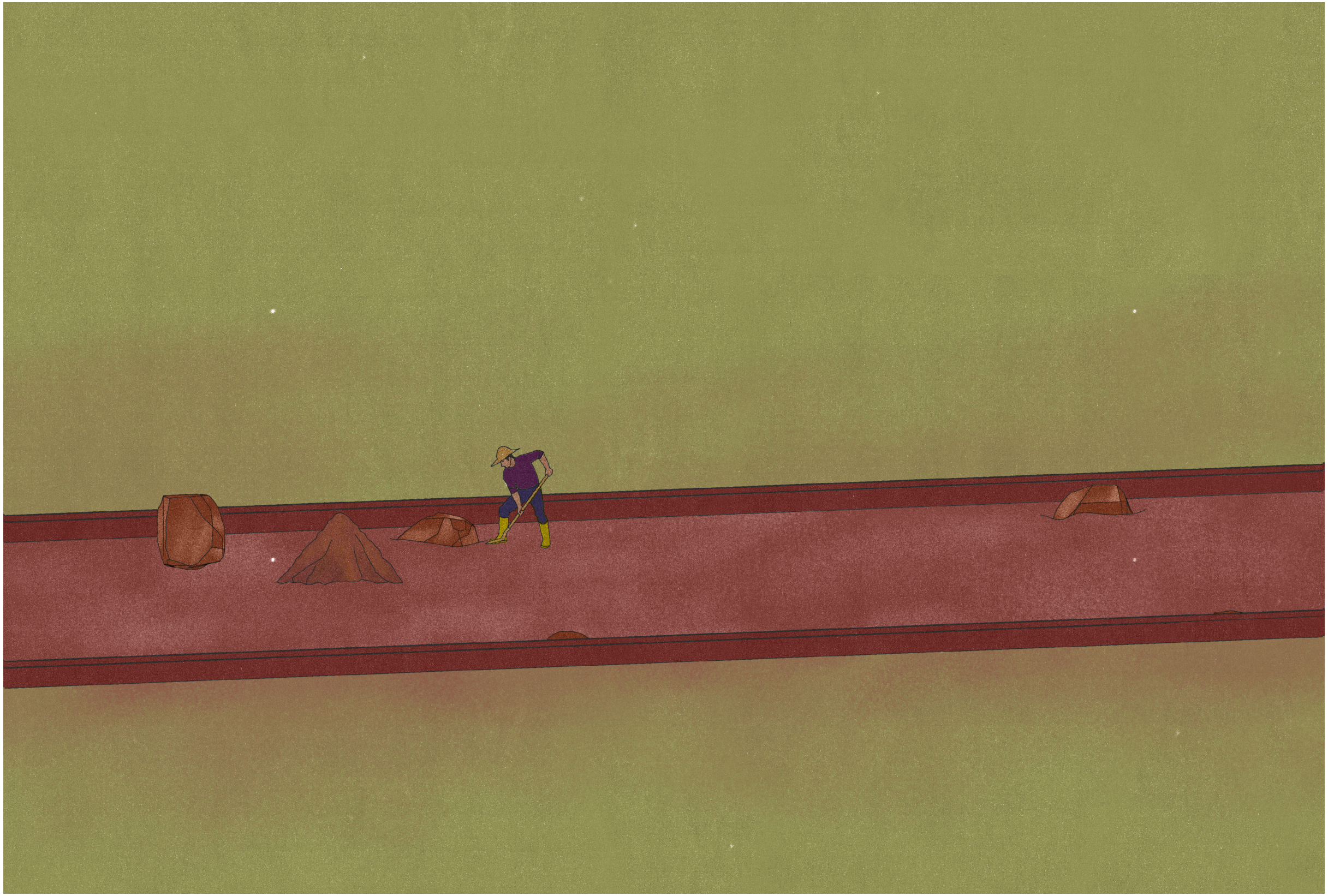
Year 0+x: *Slow repopulation*

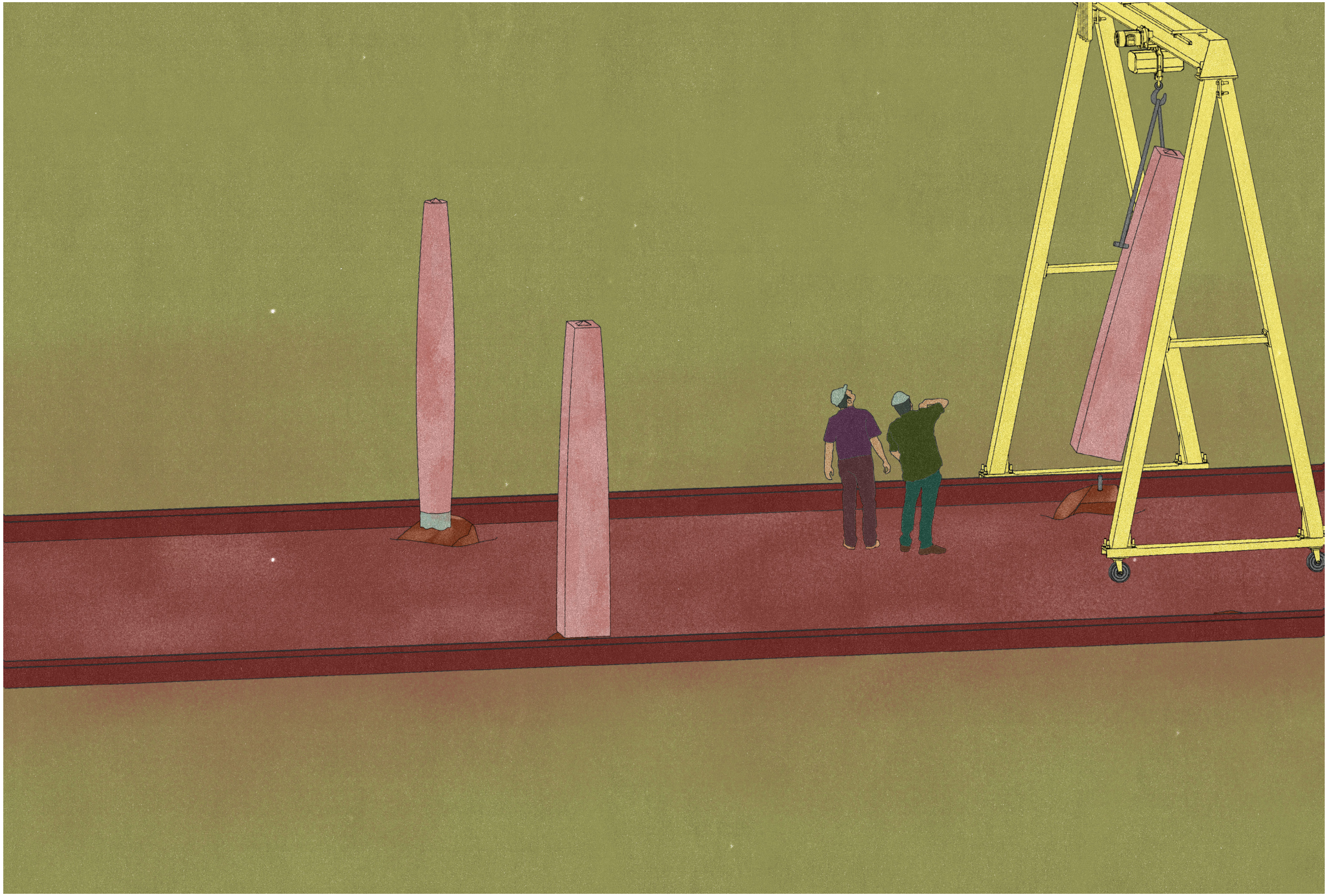
Year 0+x+y: *Thriving biota*

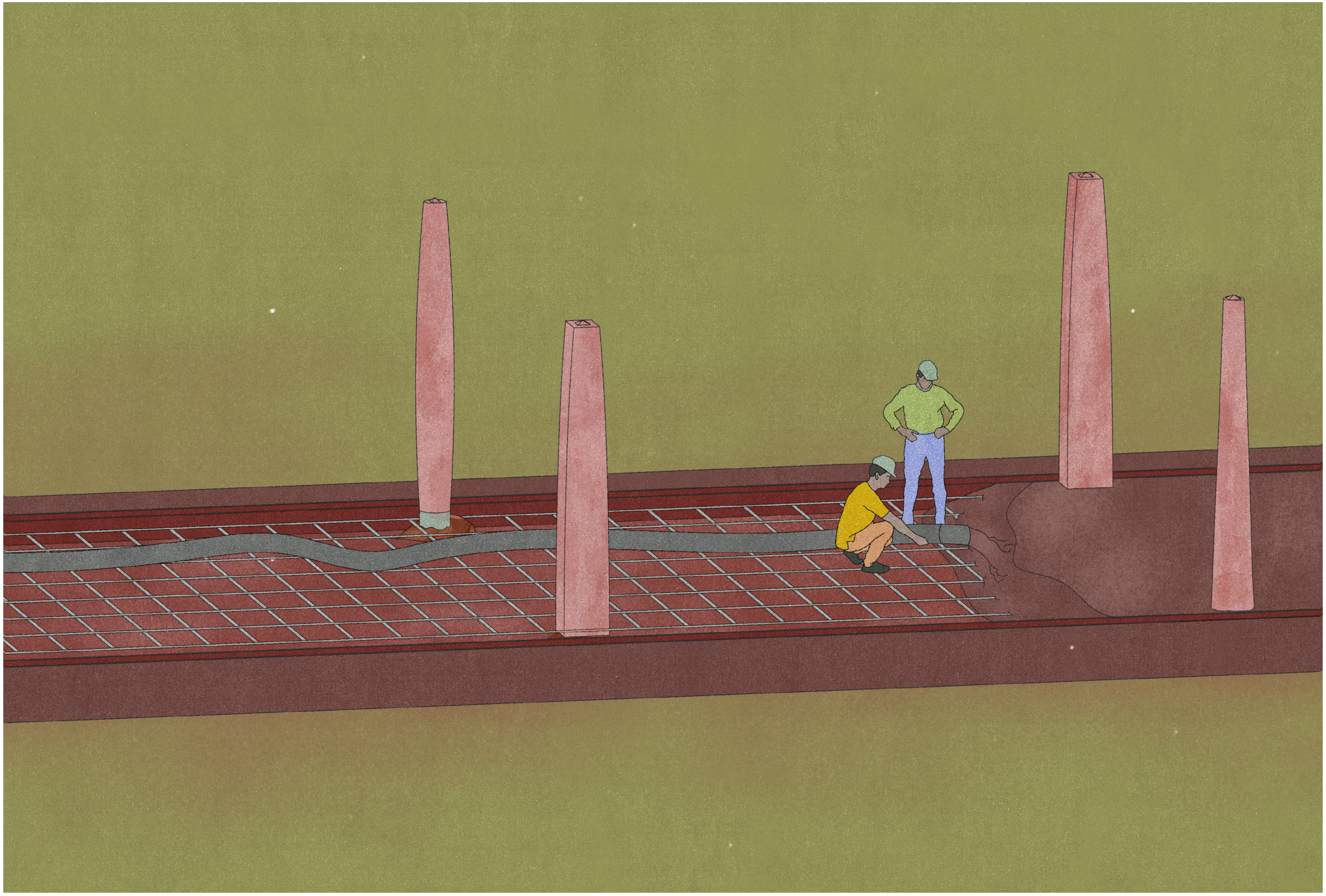

Year 0: *Nechrotic liver cells*

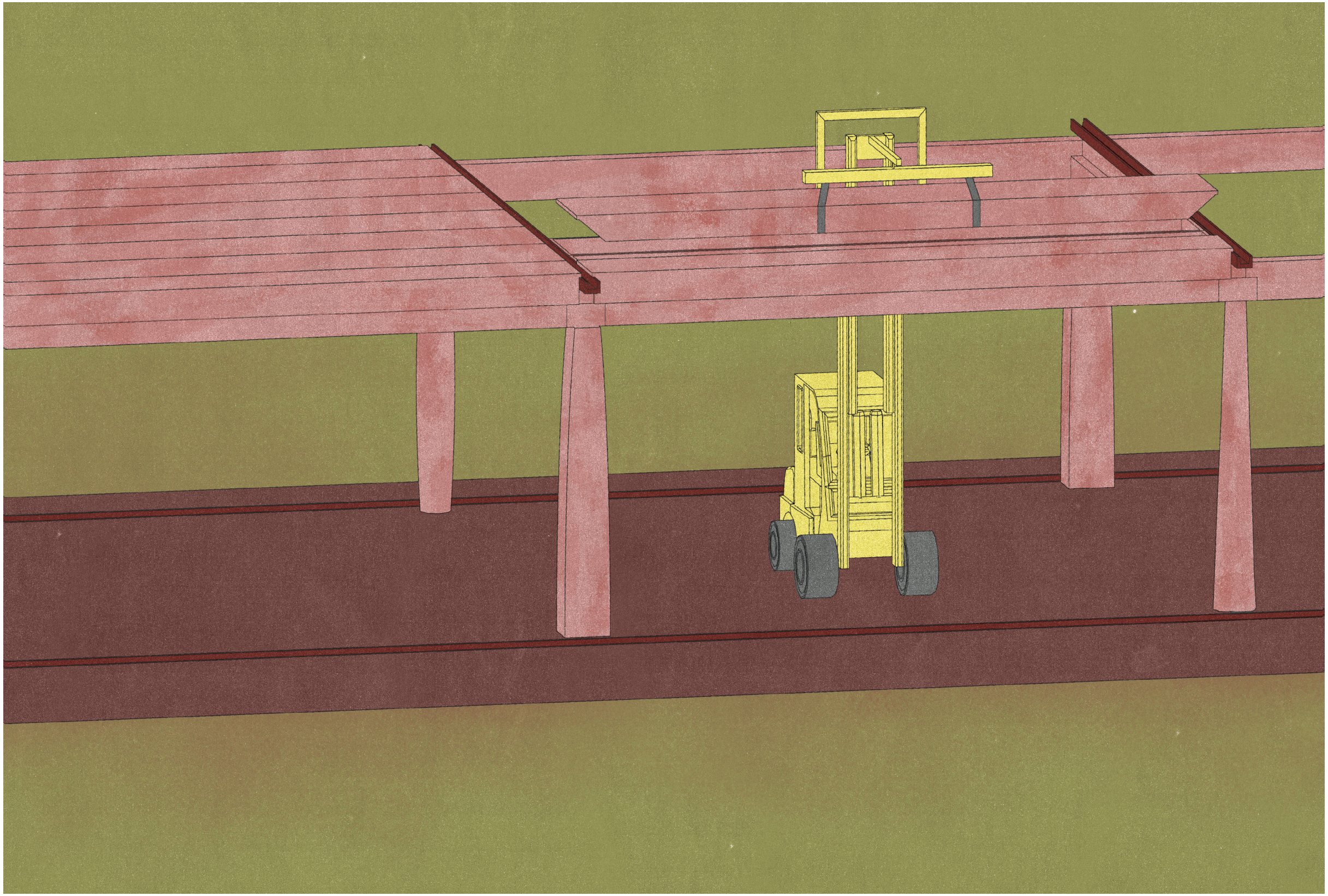

Year 0+a: *Healthy liver cells*

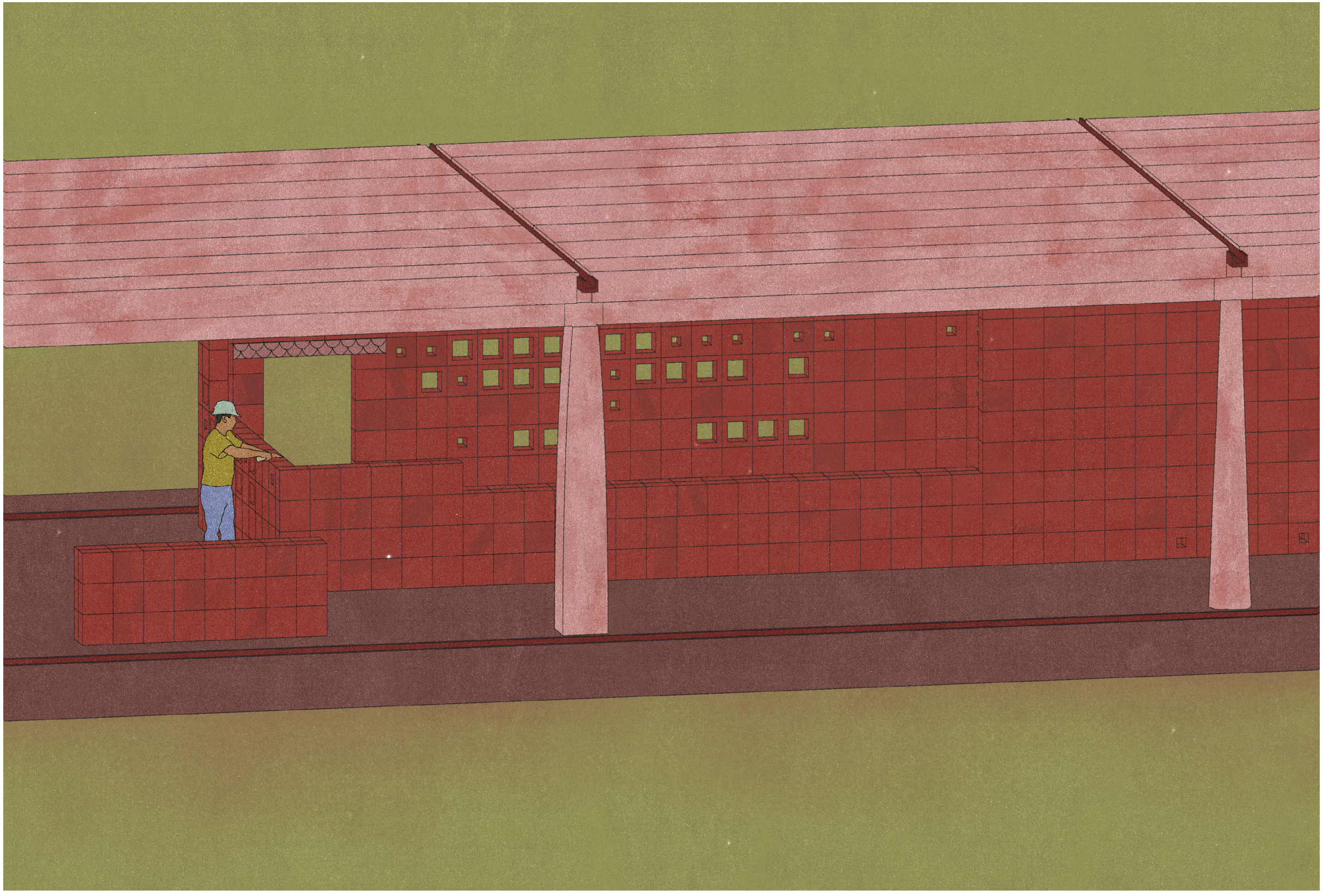


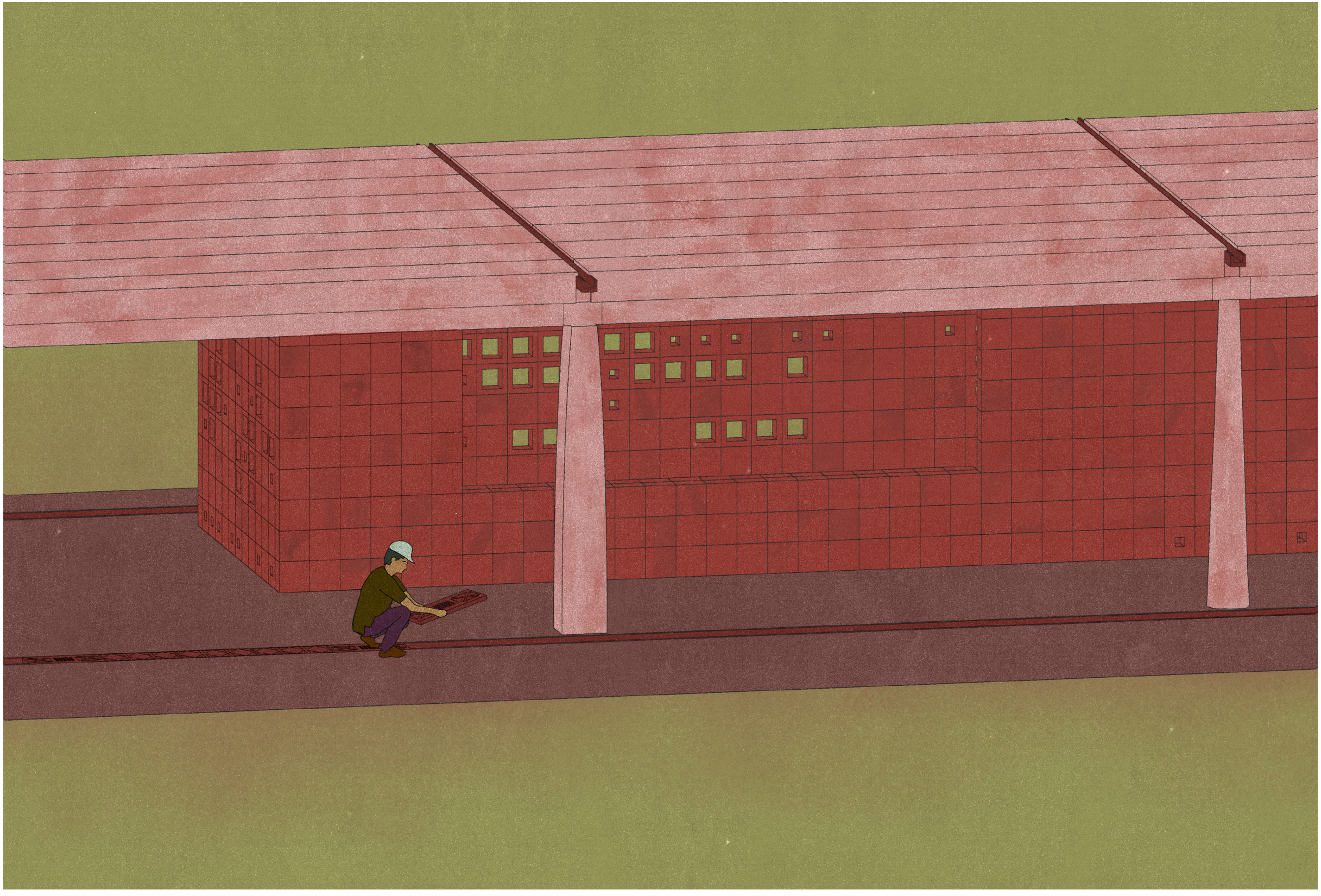


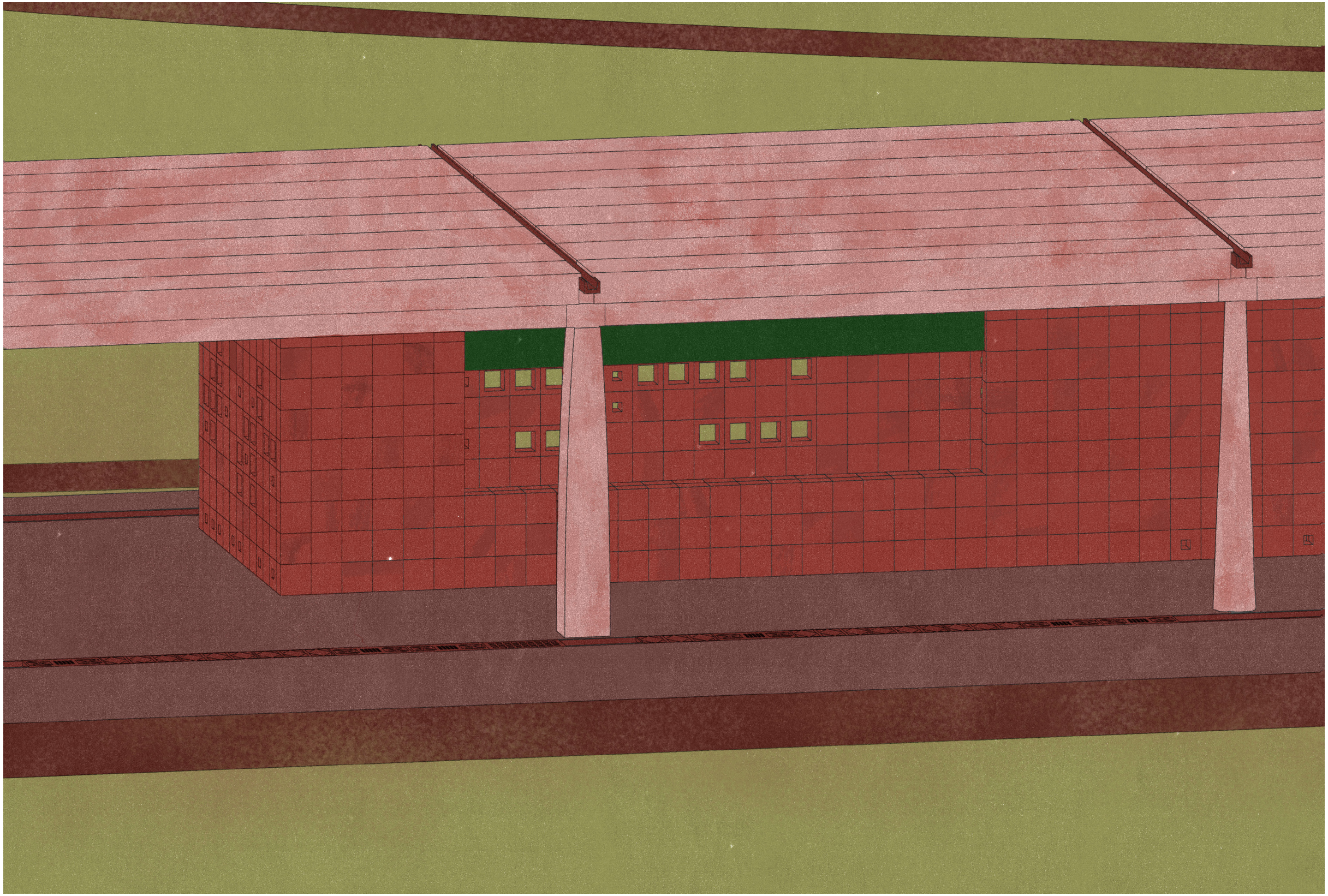


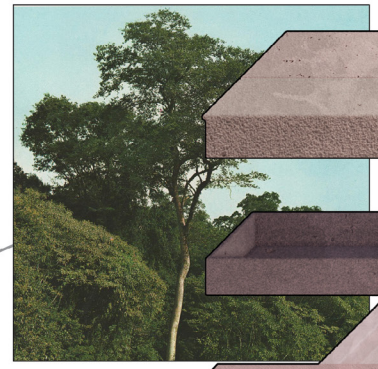


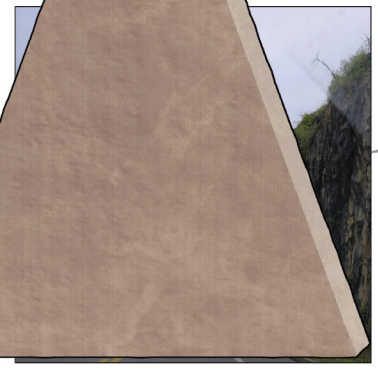




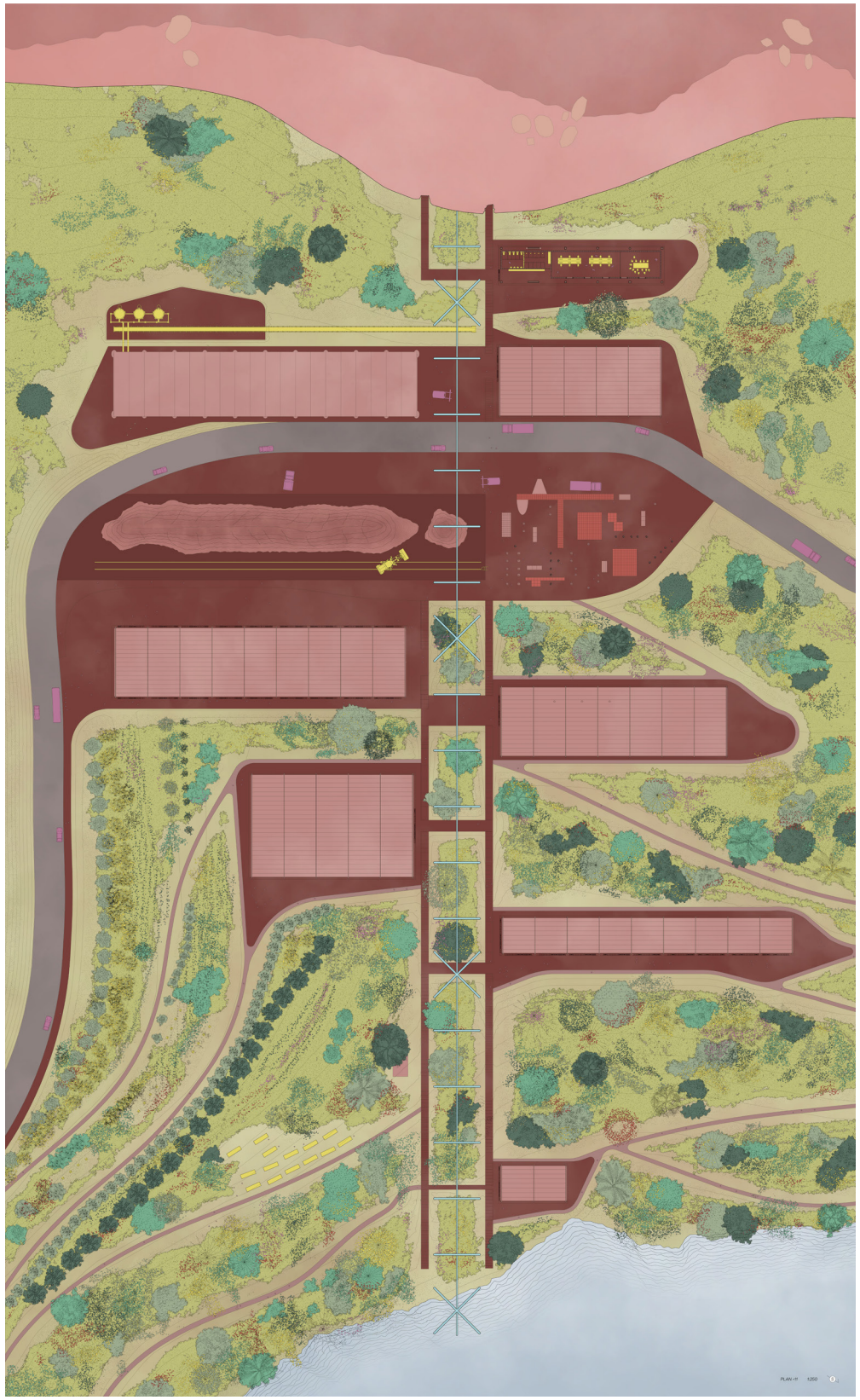


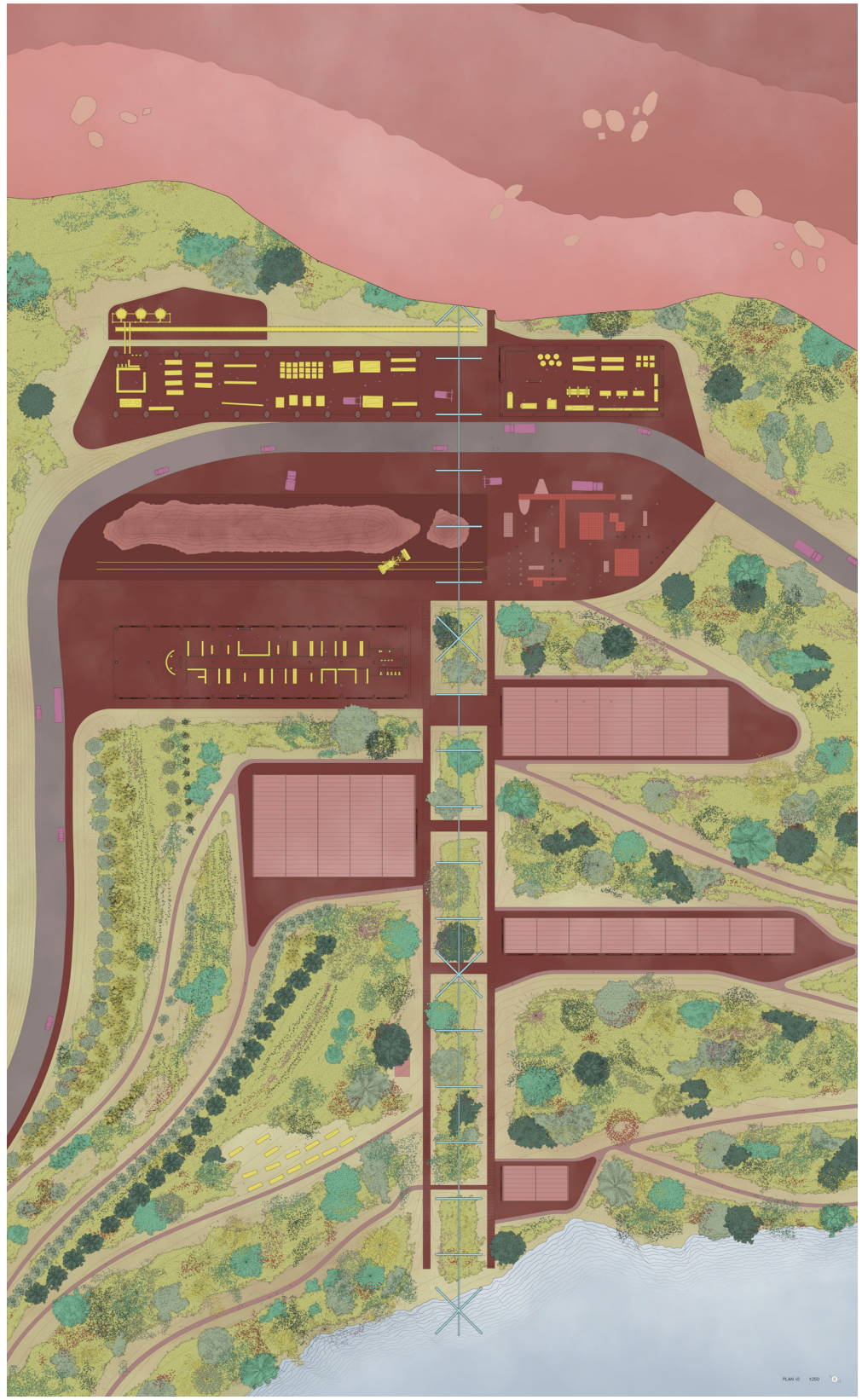


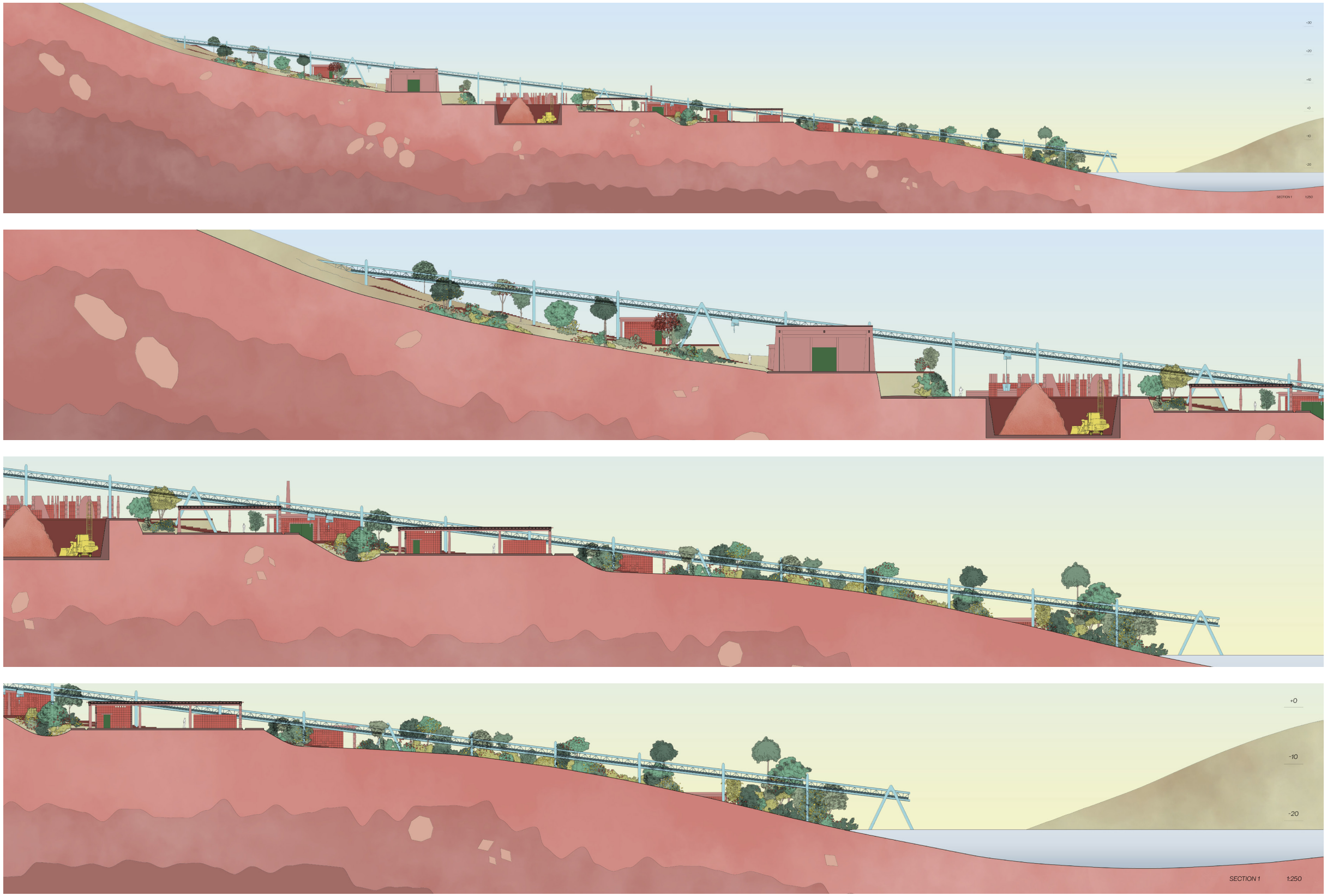




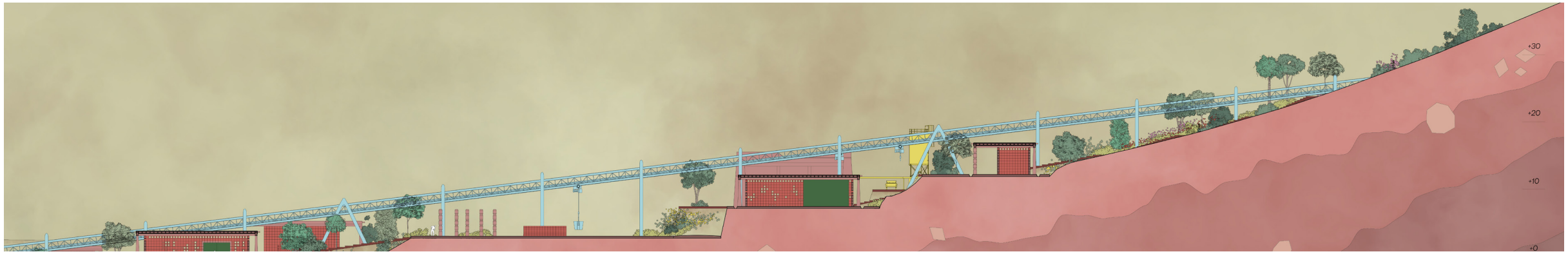
Rio Piracicaba
Joao Monlevade
Truck/passenger bus line
1km radius
~10 min. walk
New local road
Rio Doce
MG-120
Interstate
São Sebastião do Soberbo

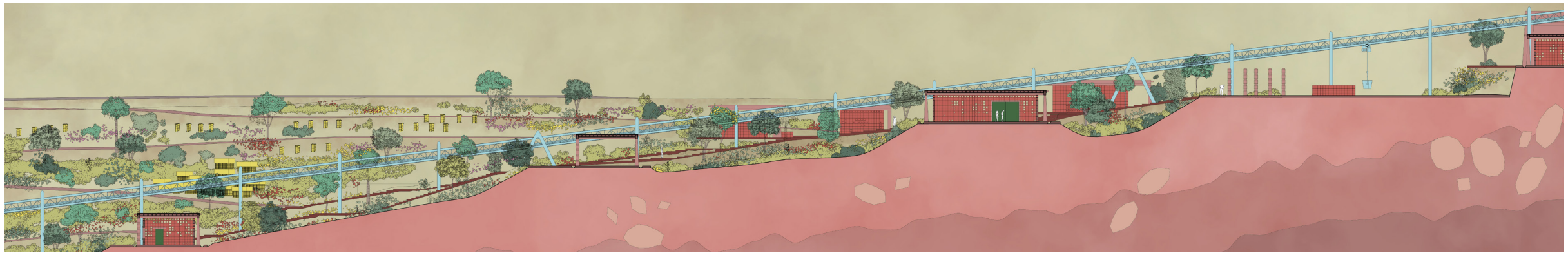


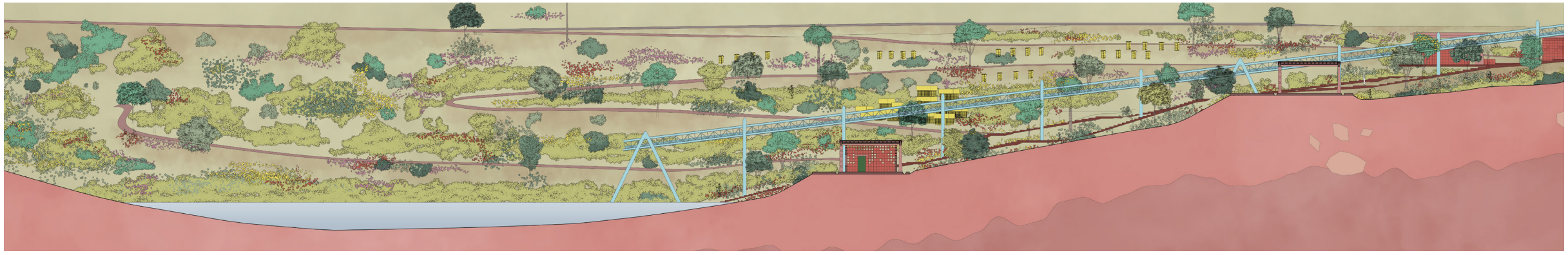


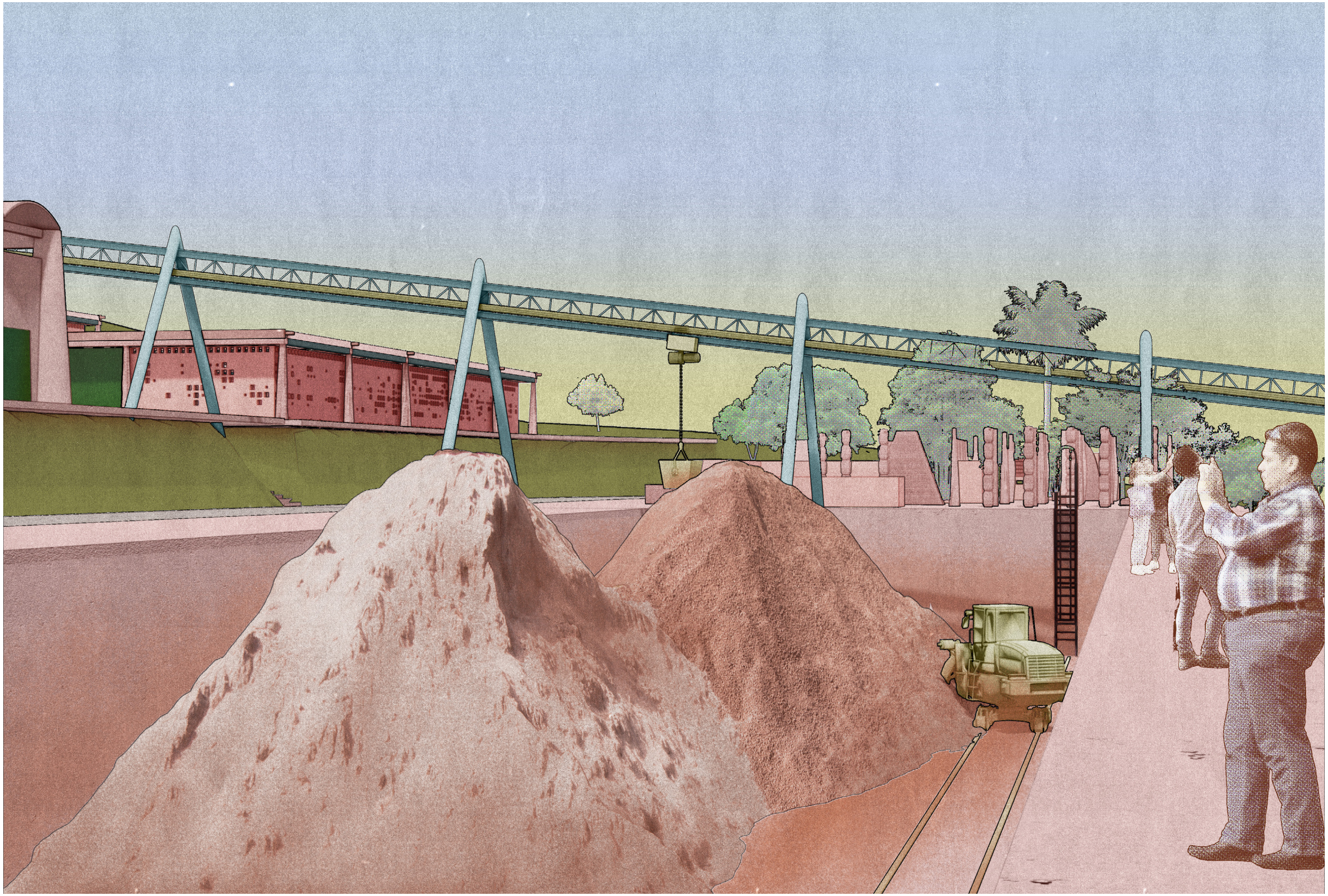

+30
+20
+10
+0
-10
-20
SECTION 1 1:250
+0
-10
-20
SECTION 1 1:250

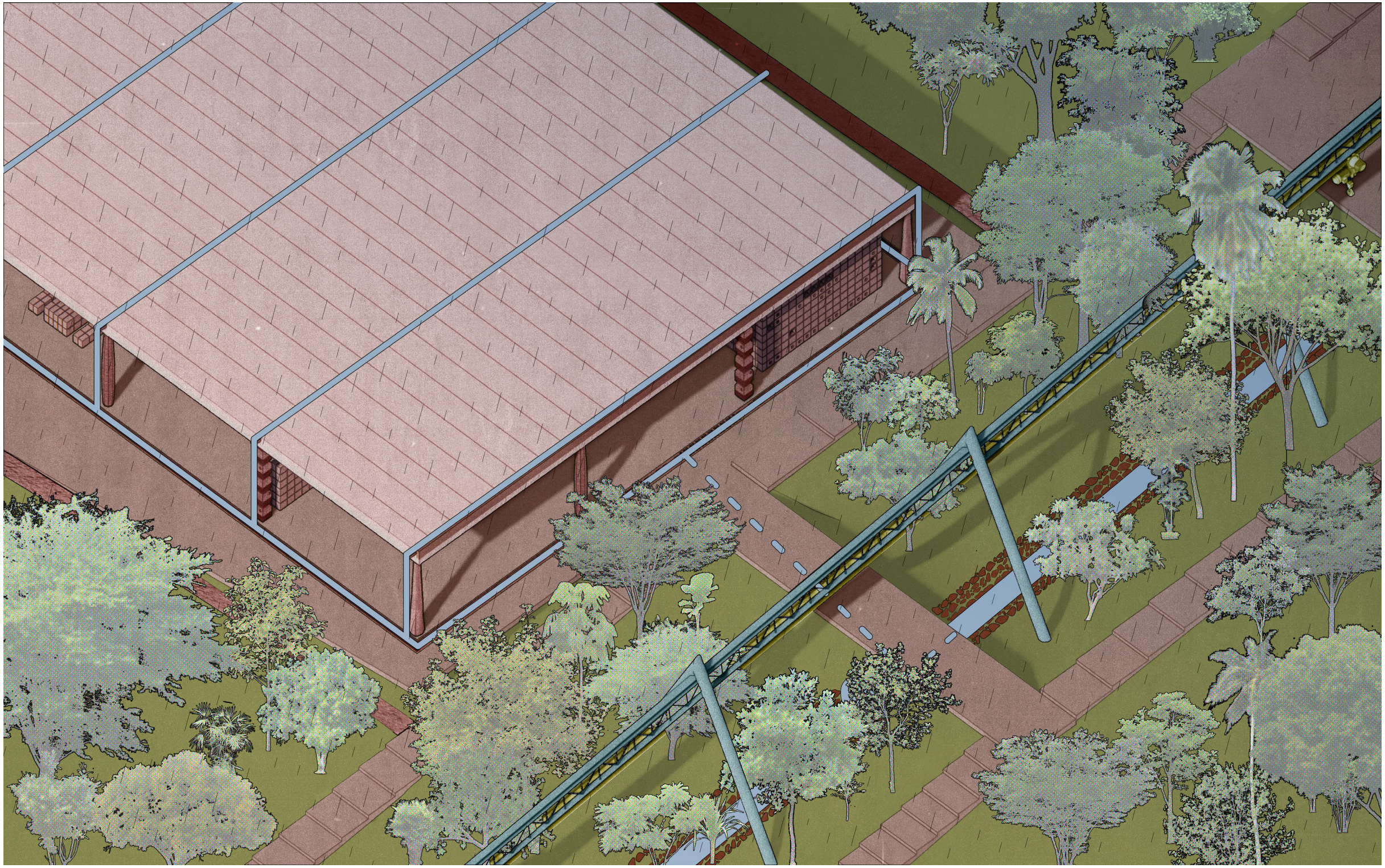
+30
+20
+10
+0
-10
-20
SECTION 2 1:250

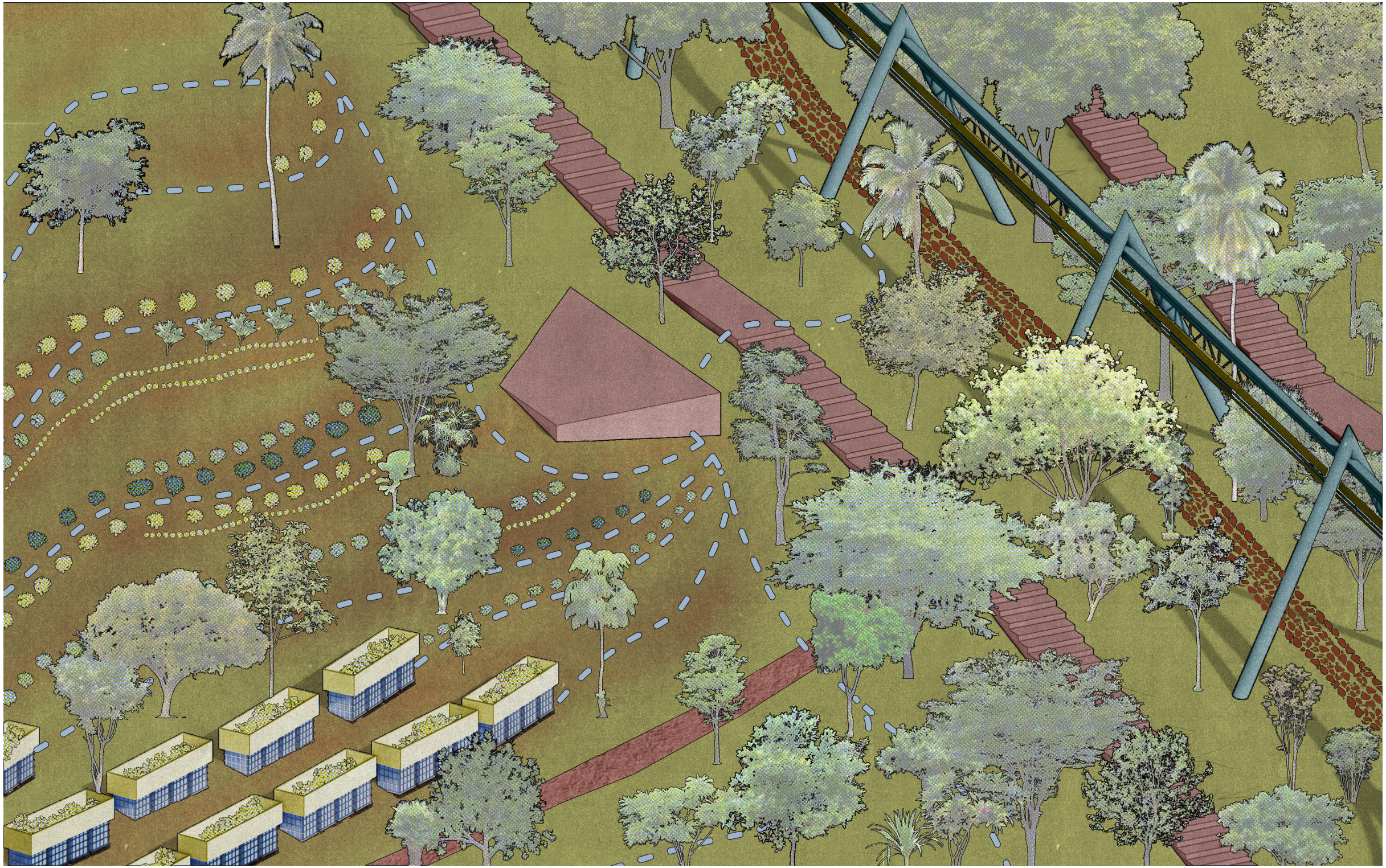

+30
+20
+10
+0











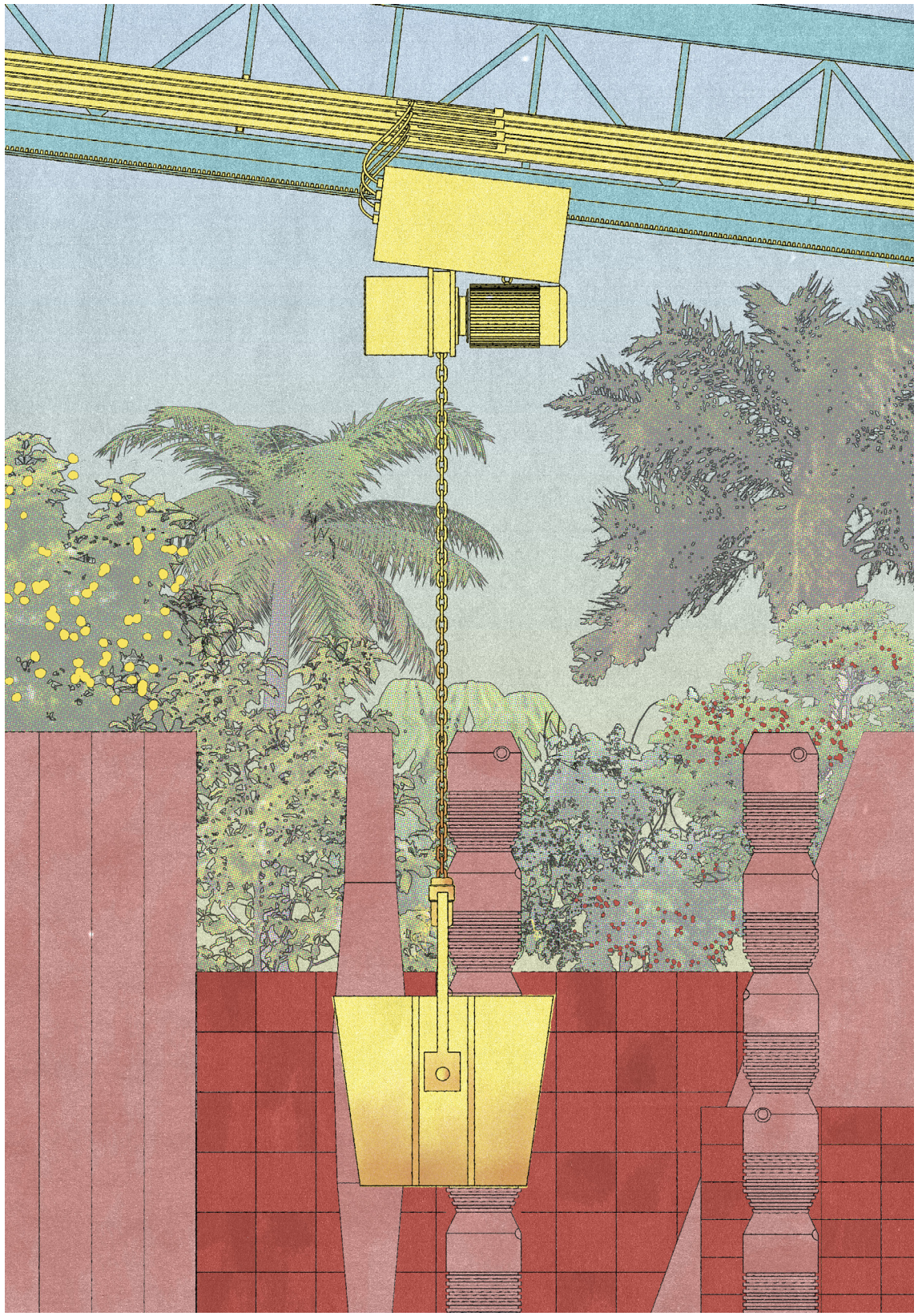
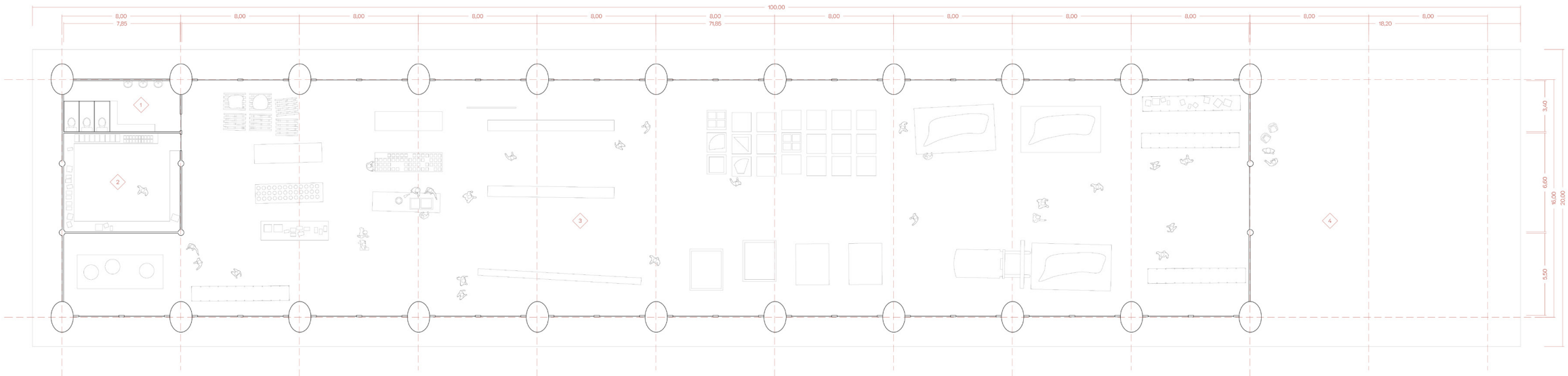


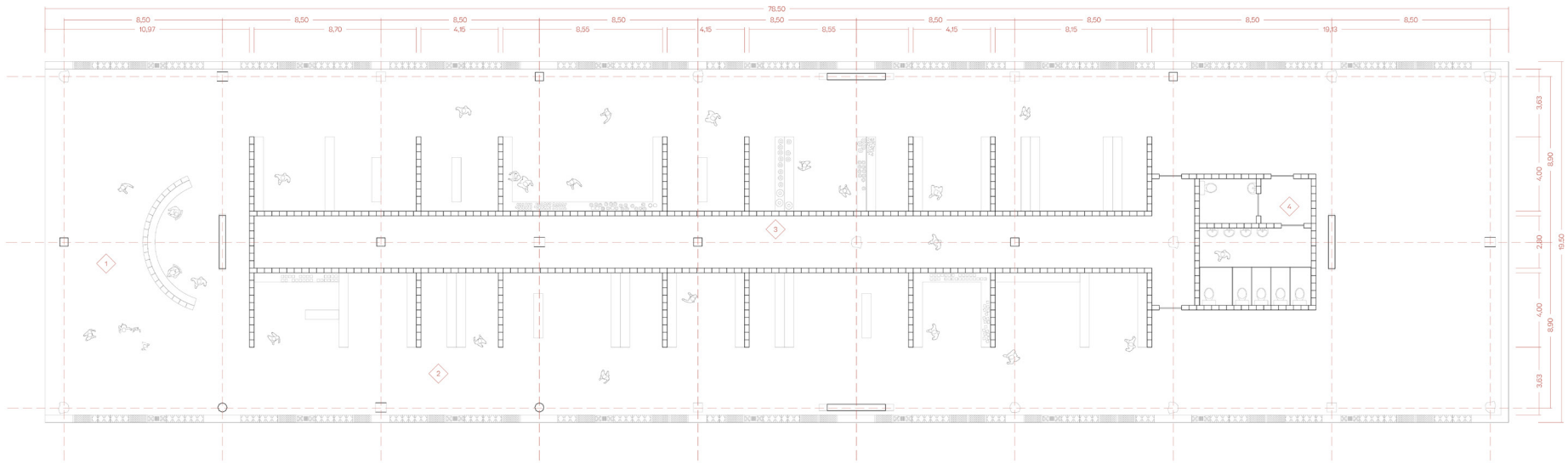
Image captions

Pages 162 - 163	Map of the Line of Gift
Pages 164 - 165	Flow matrix (infrastructure based)
Pages 166 - 167	Model representing color and texture
Pages 168 - 169	Geopolymer concrete samples
Pages 170 - 171	The center structure arrives to the site
Pages 172 - 173	Fabrication steps
Pages 174 - 175	Diagram of Forest composition
Pages 176 - 177	Changes in the river throughout time
Pages 178 - 179	The soil is compacted into a flat surface
Pages 180 - 181	The ground is excavated and stones are placed as footings
Pages 182 - 183	Columns are placed over the footings
Pages 184 - 185	The floor slab is cast on site
Pages 186 - 187	Roof beams are put in place
Pages 188 - 189	The gutters and slab tiles are placed over the beams
Pages 190 - 191	The walls are built, door frames and lintels are installed
Pages 192 - 193	Doors, window sheets, grates and beam caps are put into place
Pages 194 - 195	The paths surrounding the buildings consolidate over time
Pages 196 - 197	References for a flexible system
Pages 198 - 199	Relationship between the site and Rio Doce
Page 200	Plan + 11
Page 201	Plan + 0
Page 202	Plan - 5
Page 203	Plan - 7
Page 204	Plan - 11
Page 205	Plan - 22
Pages 206 - 207	Longitudinal Section 1
Pages 208 - 209	Longitudinal Section 2
Pages 210 - 211	Visitors looking at heaps of tailings
Pages 212 - 213	Rainwater collection on the buildings
Pages 214 - 215	Water from the cisterns being used for irrigation
Pages 216 - 217	The buildings overlook the river
Pages 218 - 219	Watching a crate being loaded on the track
Pages 220 - 221	Resting at the restaurant
Page 222	Moving car with bucket attachment



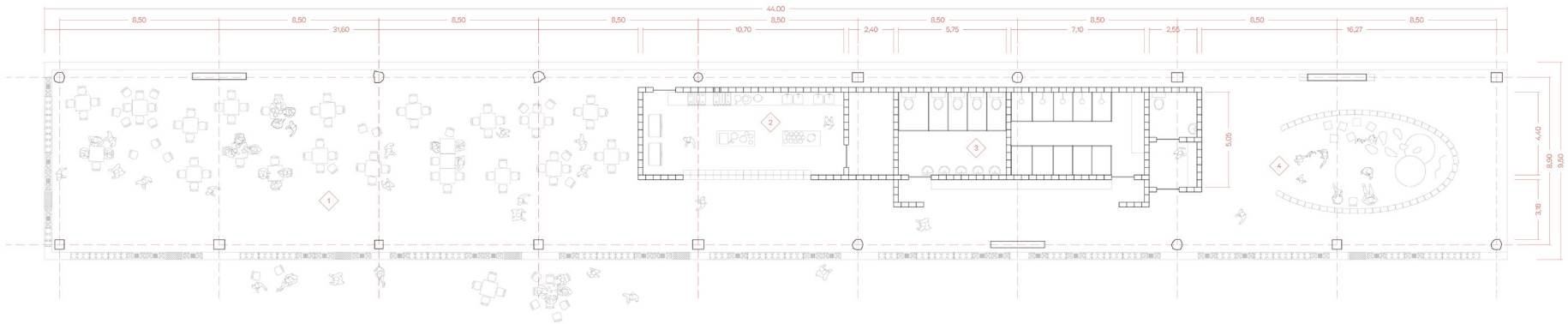
Plan - Geopolymer production area

1 - Restrooms
2 - Storage
3 - Production area
4 - Transfer yard



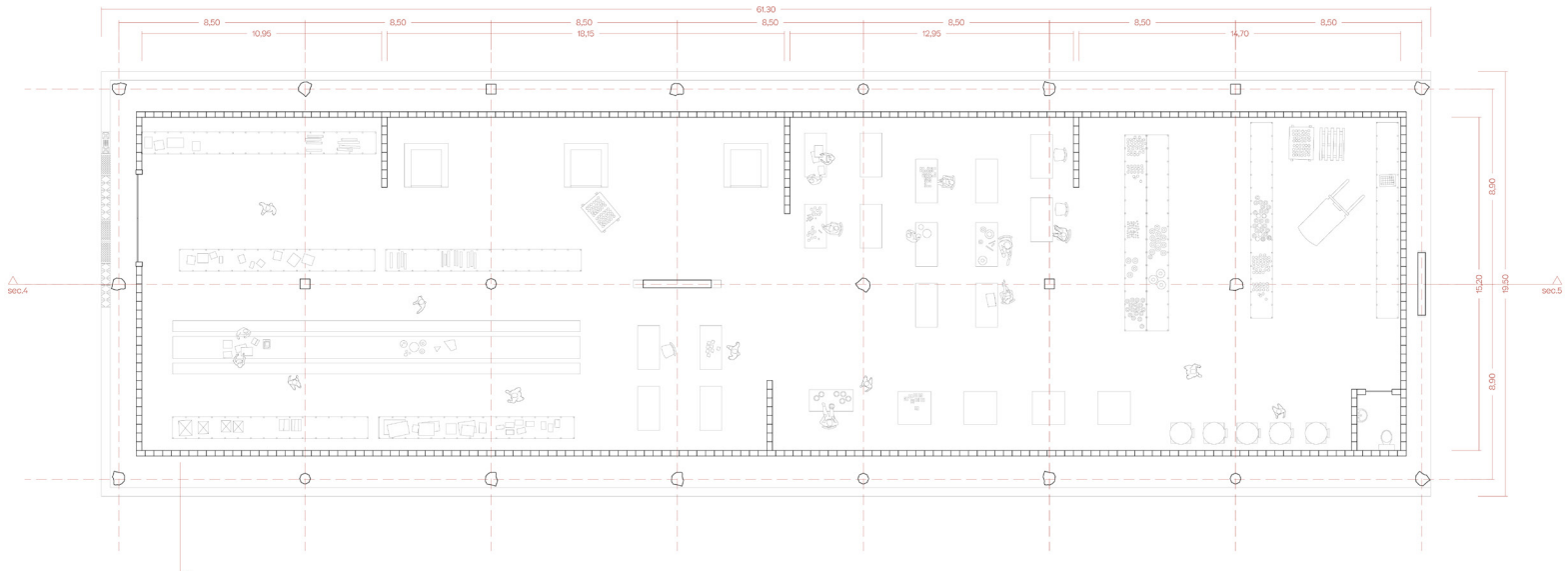
Plan - Entrance building

1 - Reception
2 - Shop
3 - Storage
4 - Restroom

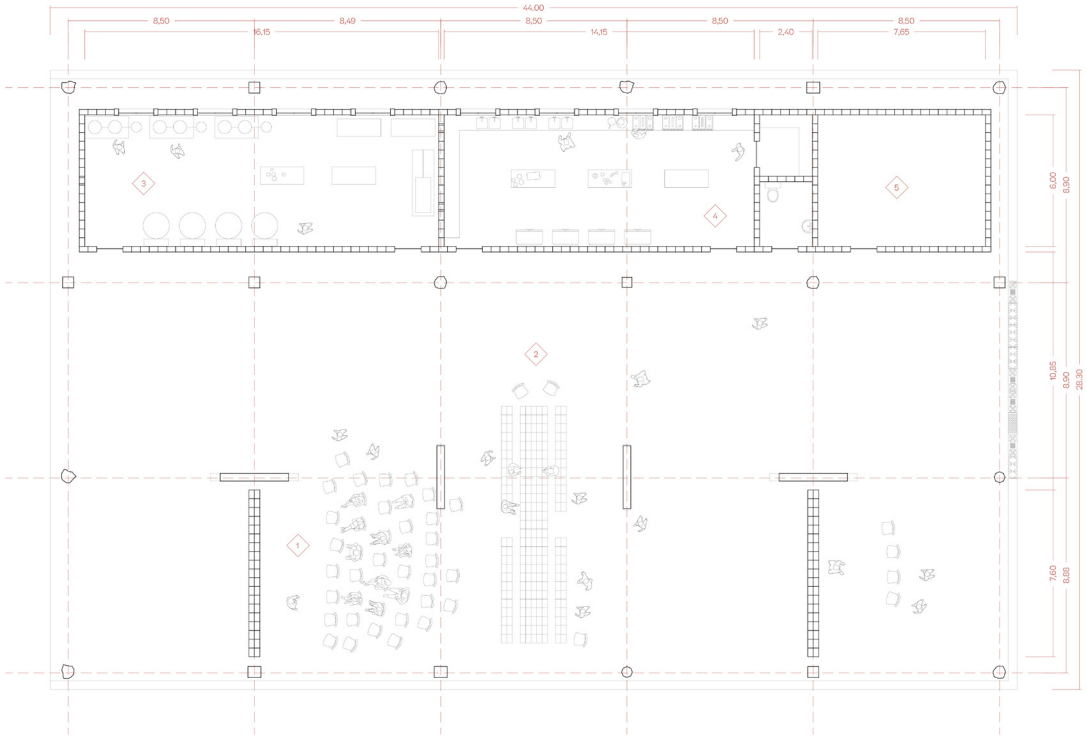


Plan - Restaurant

1 - Restaurant
2 - Kitchen
3 - Restroom
4 - Childcare

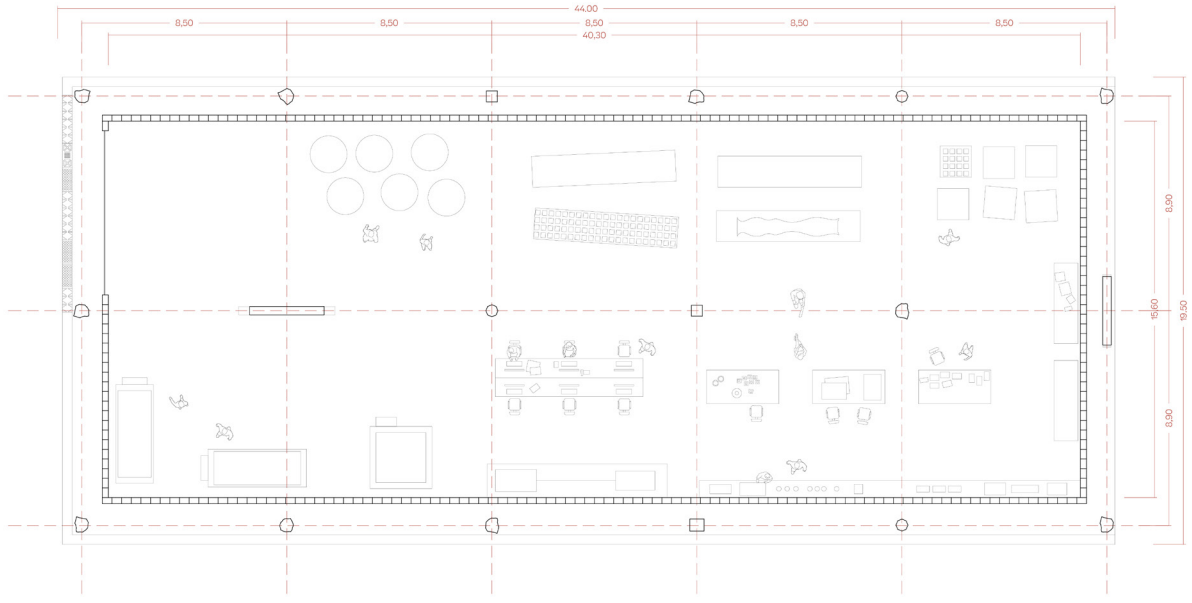


Plan - Ceramics workshop

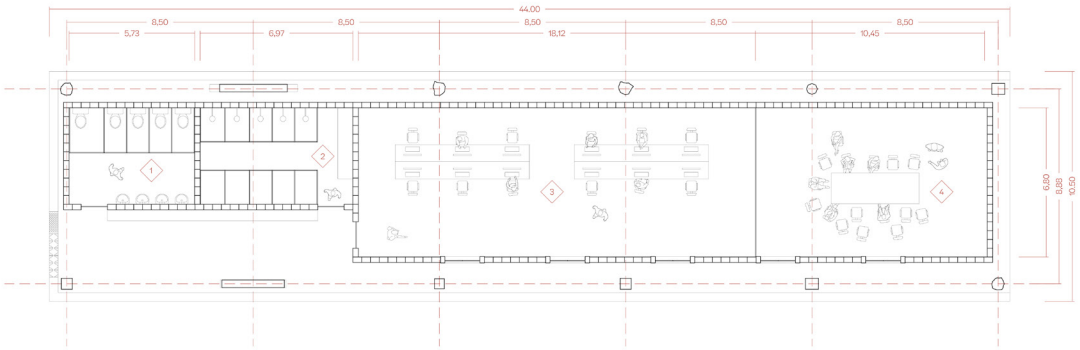


Plan - Workshops

1 - Lecture area
2 - Workshop area
3 - Distillation and bottling
4 - Experimental kitchen
5 - Deposit

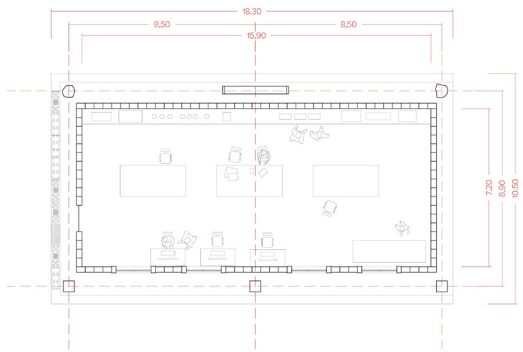


Plan - Geopolymer design lab

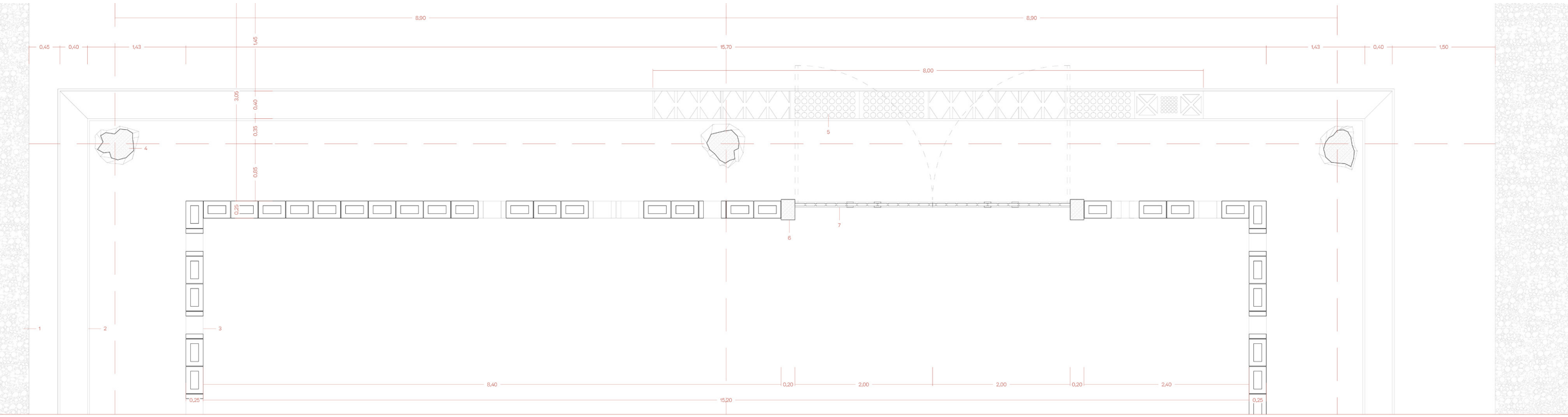


Plan - Offices

1 - Restrooms
2 - Changing rooms
3 - Offices
4 - Meeting room

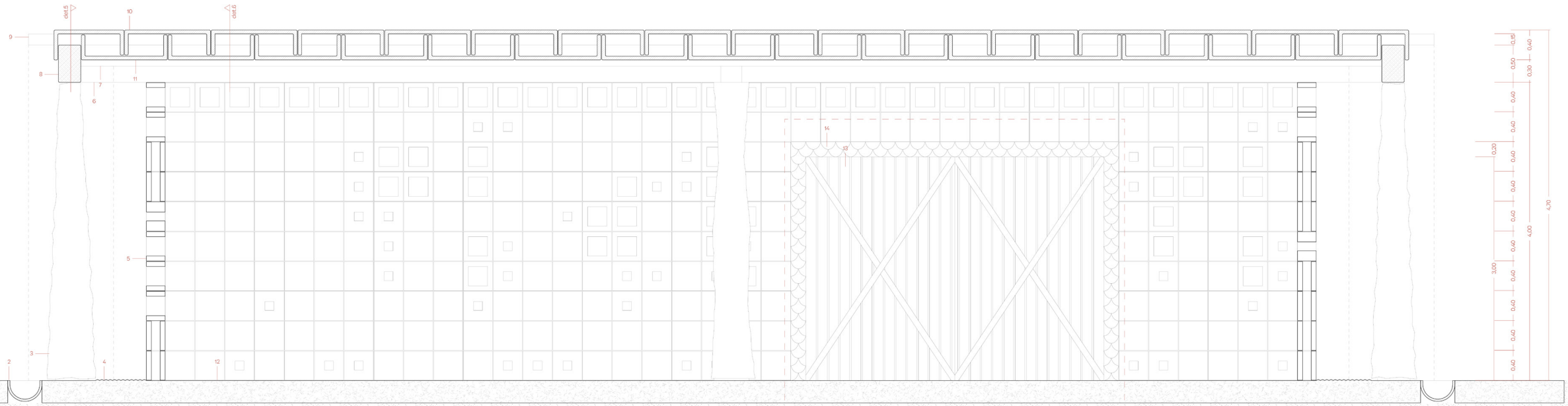


Plan - Water and forest lab



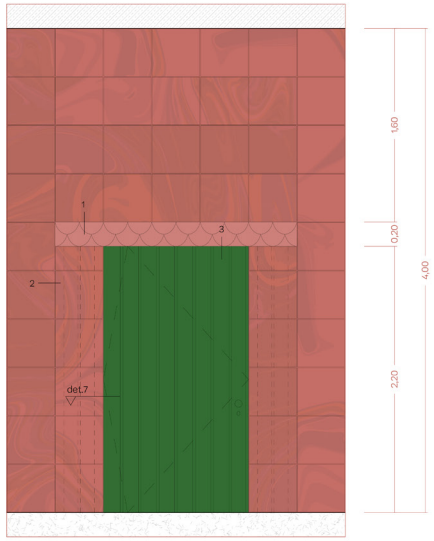
Detail 1

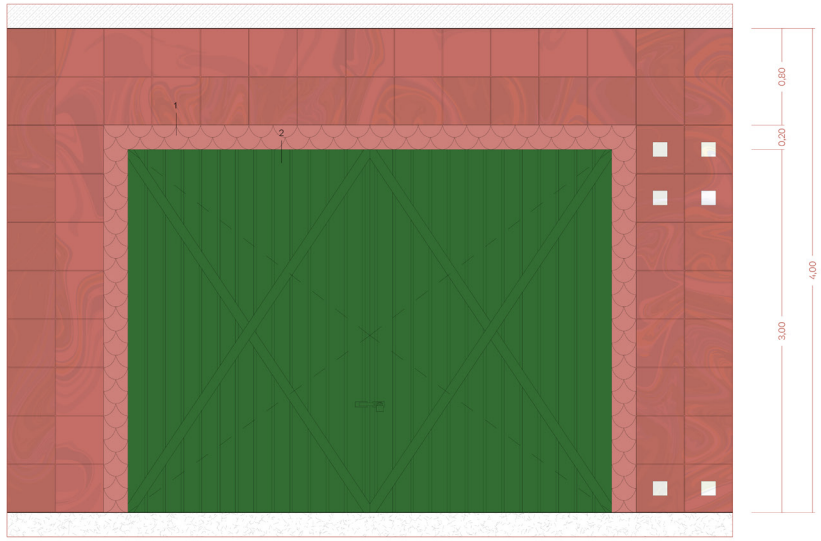
1 - Gravel path made from coarse aggregate not used in geopolymer concrete production
2 - Precast gutter in geopolymer concrete, 46x20 cm profile, length varies
3 - Precast geopolymer-based cinderblocks, 40x40x25 cm
4 - Precast column in geopolymer concrete, reinforced, 50x50x400 cm
5 - Gutter grate in geopolymer concrete, 5x40x200 cm per piece
6 - Precast door frame in geopolymer concrete, reinforced, 20x30 cm profile, overall dimensions vary according to door

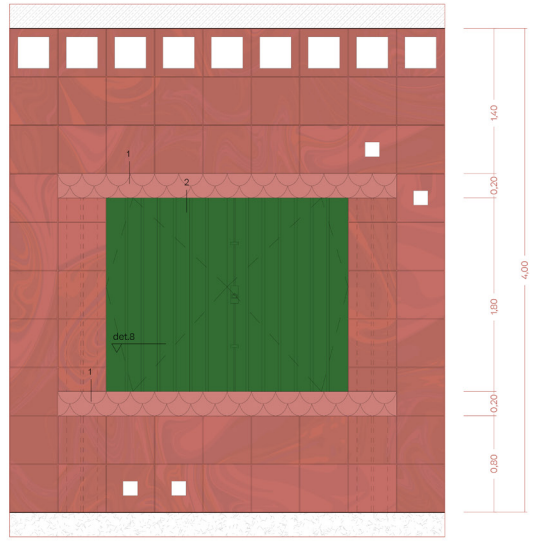


Section 3

1 - Gravel path made from coarse aggregate not used in geopolymer concrete production
2 - Precast gutter in geopolymer concrete, 46x20 cm profile, length varies
3 - Precast column in geopolymer concrete, reinforced, 50x50x400 cm
4 - Geopolymer concrete surface, sandblasted and waterproofed to receive water from secondary gutter
5 - Precast geopolymer-based cinderblocks, 40x40x25 cm
6 - Precast beam in geopolymer concrete, reinforced, 50x50x900 cm, modules joined by grouting on site
7 - Aluminum gutter, 10x8 cm, length varies
8 - Precast beam in geopolymer concrete, reinforced, 50x30x850 cm, modules joined by grouting on site
9 - Precast gutter element in geopolymer concrete, 20x15x225 cm per piece
10 - Precast slab element in geopolymer concrete, 116x35x836 cm, placed with 1 cm gap to accommodate thermal expansion
11 - Precast slab element in geopolymer concrete, 116x34x830 cm, placed with 1 cm gap to accommodate thermal expansion
12 - Geopolymer concrete mat footing and floor slab, cast on site, height to be determined by structural engineer
13 - Cedar wood door with water based enamel paint finishing in the color green, 200x300 cm each
14 - Precast door frame in geopolymer concrete, reinforced, 20x30 cm profile, overall dimensions vary according to door







Detail 2

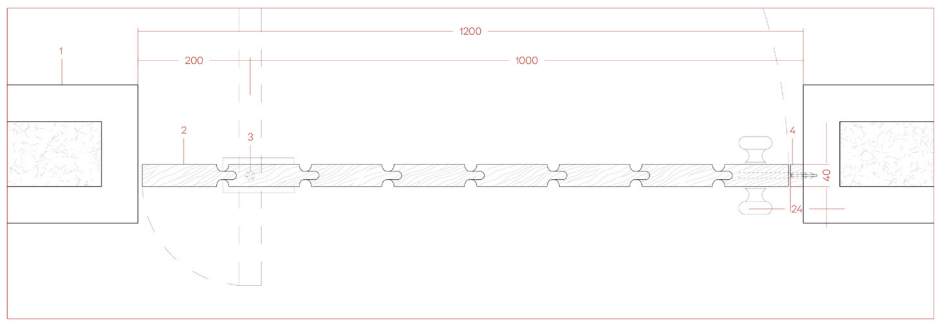
1 - Precast lintel piece in geopolymer concrete, reinforced, 20x30x200 cm
2 - Hollow cinderblock filled with grout and reinforcement bar

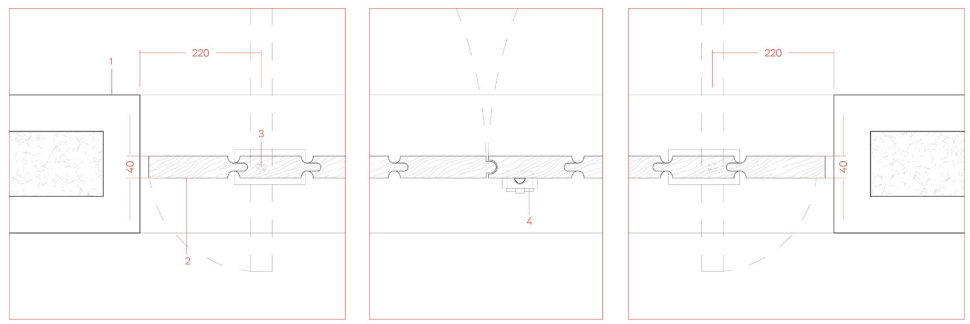
Detail 3

1 - Precast door frame in geopolymer concrete, reinforced, 20x30 cm profile, overall dimensions vary according to door
2 - Cedar wood door with water based enamel paint finishing in the color green, overall dimensions vary according to door

Detail 4

1 - Precast lintel piece in geopolymer concrete, reinforced, 20x30x280 cm
2 - Cedar wood window panel with water based enamel paint finishing in the color green, 160x80cm
3 - Cedar wood door with water based enamel paint finishing in the color green, 120x240 cm



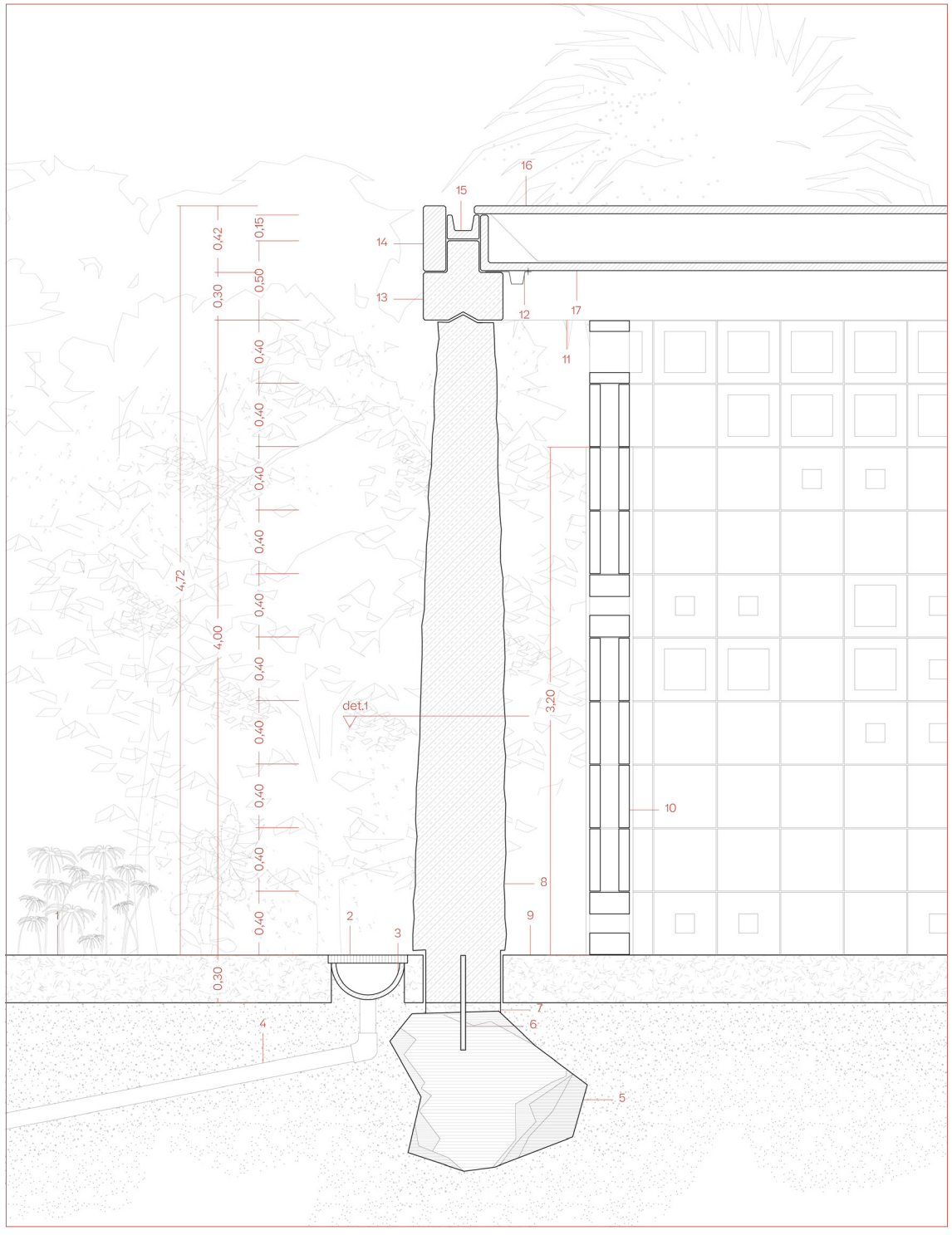


Detail 5

1 - Hollow cinderblock filled with grout and reinforcement bar
2 - Cedar wood door with water based enamel paint finishing in the color green, 120x240 cm
3 - Pivot system installed on floor and lintel
4 - Single cedar wood jamb with water based enamel paint finishing in the color green, screwed into cinderblocks and carved for deadbolt

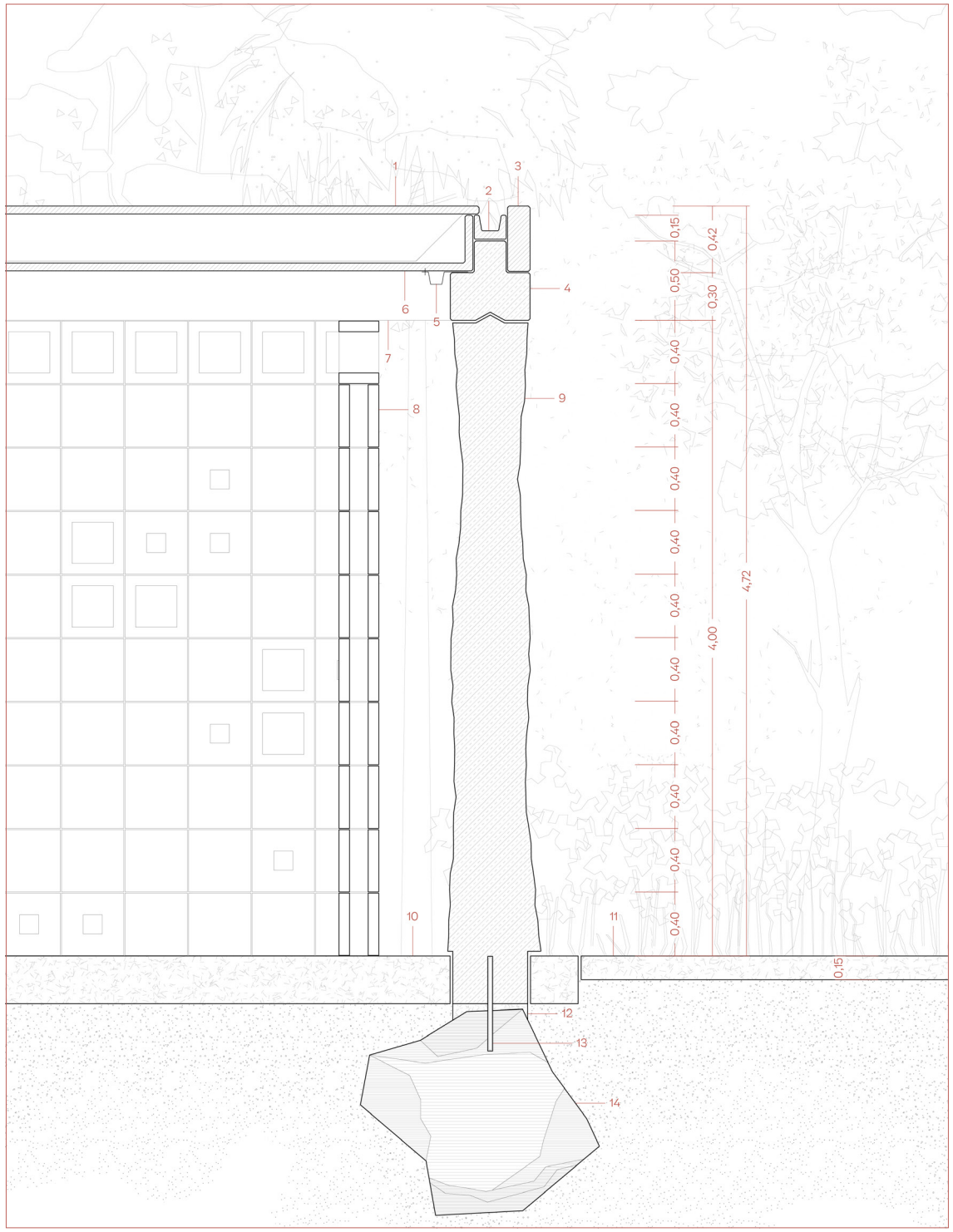
Detail 6

1 - Hollow cinderblock filled with grout and reinforcement bar Detail 8 1:5
2 - Cedar wood window panel with water based enamel paint finishing in the color green, 160x100cm
3 - Pivot system installed on bottom and top lintel
4 - Cremona-type lock with slots carved into window frame



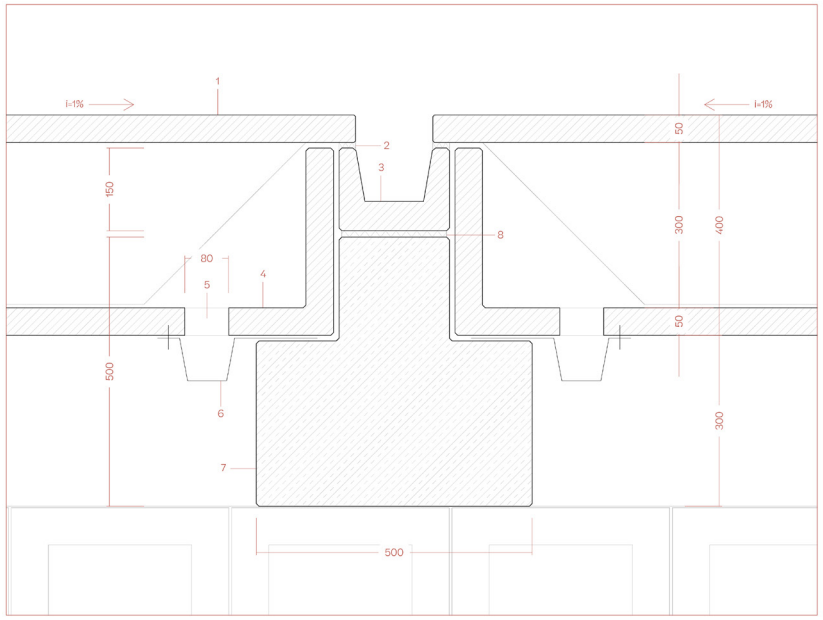
Section 4

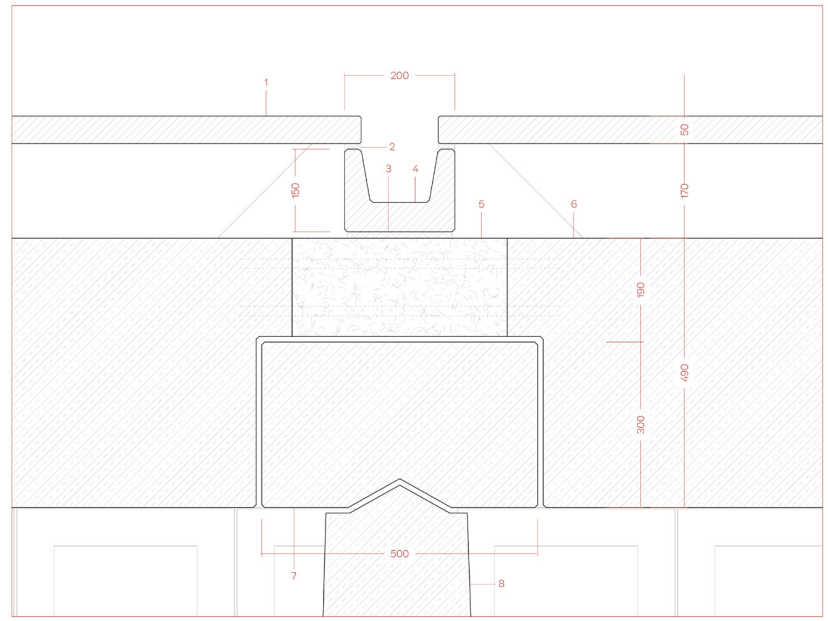
1 - Geopolymer concrete floor slab, cast on site
2 - Gutter grate in geopolymer concrete, 5x40x200 cm per piece
3 - Precast gutter in geopolymer concrete, 46x20 cm profile, length varies
4 - Rainwater drainage pipe oriented towards central axis
5 - Rock obtained on site, used as footing, drilled to receive reinforcement bar
6 - Reinforcement bar fit between rock and column
7 - Grout sleeve
8 - Precast column in geopolymer concrete, reinforced, 50x50x400 cm
9 - Geopolymer concrete mat footing and floor slab, cast on site, height to be determined by structural engineer
10 - Precast geopolymer-based cinderblocks, 40x40x25 cm
11 - Precast beam in geopolymer concrete, reinforced, 50x30x850 cm, modules joined by grouting on site
12 - Aluminum gutter, 10x8 cm, length varies
13 - Precast beam in geopolymer concrete, reinforced, 50x50x900 cm, modules joined by grouting on site
14 - Precast ornamented beam cap in geopolymer concrete, 40x15 cm, length varies
15 - Precast gutter element in geopolymer concrete, 20x15x225 cm per piece
16 - Precast slab element in geopolymer concrete, 116x35x836 cm, placed with 1 cm gap to accommodate thermal expansion
17 - Precast slab element in geopolymer concrete, 116x34x830 cm, placed with 1 cm gap to accommodate thermal expansion



Section 7

1 - Precast slab element in geopolymer concrete, 116x35x836 cm, placed with 1 cm gap to accommodate thermal expansion
2 - Precast gutter element in geopolymer concrete, 20x15x225 cm per piece
3 - Precast ornamented beam cap in geopolymer concrete, 40x15 cm, length varies
4 - Precast beam in geopolymer concrete, reinforced, 50x50x900 cm, modules joined by grouting on site
5 - Aluminum gutter, 10x8 cm, length varies
6 - Precast slab element in geopolymer concrete, 116x34x830 cm, placed with 1 cm gap to accommodate thermal expansion
7 - Precast beam in geopolymer concrete, reinforced, 50x30x850 cm, modules joined by grouting on site
8 - Precast geopolymer-based cinderblocks, 40x40x25 cm
9 - Precast column in geopolymer concrete, reinforced, 50x50x400 cm
10 - Geopolymer concrete mat footing and floor slab, cast on site, height to be determined by structural engineer
11 - Geopolymer concrete floor slab, cast on site
12 - Grout sleeve
13 - Reinforcement bar fit between rock and column
14 - Rock obtained on site, used as footing, drilled to receive reinforcement bar





Detail 8

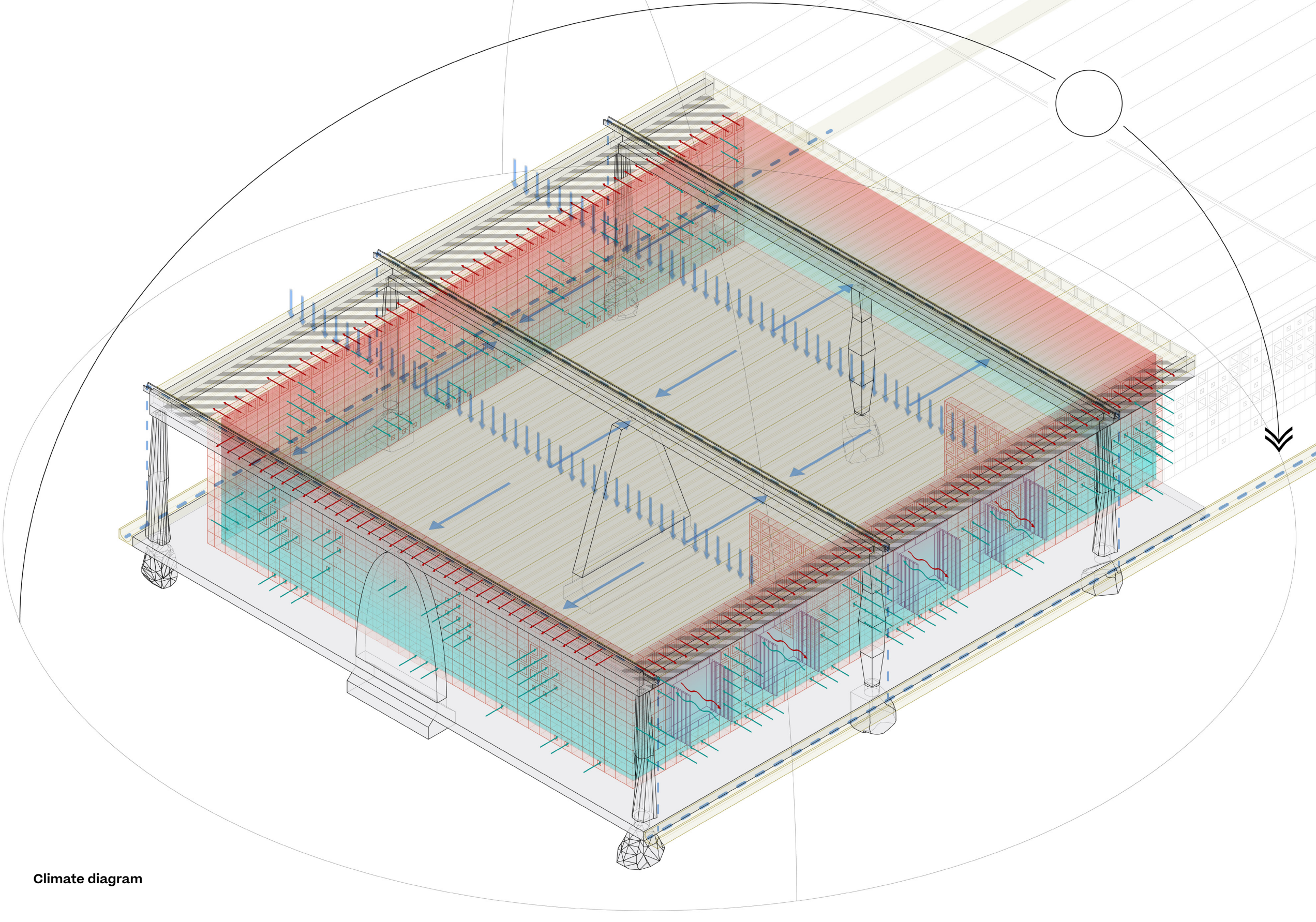
1 - Precast slab element in geopolymer concrete, 116x35x836 cm, placed with 1 cm gap to accommodate thermal expansion
2 - Clay-based waterproofing
3 - Precast gutter element in geopolymer concrete, 20x15x225 cm per piece
4 - Precast slab element in geopolymer concrete, 116x34x830 cm, placed with 1 cm gap to accommodate thermal expansion
5 - Circular hole for secondary drainage, 8cm radius, three per piece
6 - Aluminum gutter, 10x8 cm, length varies
7 - Precast beam in geopolymer concrete, reinforced, 50x50x900 cm, modules joined by grouting on site
8 - Clay-based waterproofing

Detail 9

1 - Precast slab element in geopolymer concrete, 116x35x836 cm, placed with 1 cm gap to accommodate thermal expansion
2 - Clay-based waterproofing
3 - Clay-based waterproofing
4 - Precast gutter element in geopolymer concrete, 20x15x225 cm per piece
5 - Grout sleeve, placement of reinforcement bars to be determined by structural engineer
6 - Precast beam in geopolymer concrete, reinforced, 50x30x850 cm, modules joined by grouting on site
7 - Precast beam in geopolymer concrete, reinforced, 50x50x900 cm, modules joined by grouting on site
8 - Precast column in geopolymer concrete, reinforced, 50x50x400 cm

Strcuture diagram

Static loads
Dynamic loads



Climate diagram

Acknowledgments

Collective construction of the project

Stavros Kousoulas
Vanessa Grossman
Hubert van der Meel

Direct help with production and presentations

Beatriz Paias
Guusje Enneking
Léa Alapini
Matteo Armenante
Rohan Shenoy
Sjoerd Bosch
Tim Stoop

Especially

Arthur Schoonenberg

With the support of

Carla Schoonenberg-Lems
Pieter Schoonenberg
Rosângela Paias
Fabio Paias

TU Delft
2022