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FOOTPRINT DELFT ARCHITECTURE THEORY JOURNAL
Volume 17, number 2

SITUATING MORE-THAN-HUMAN ECOLOGIES OF EXTENDED URBANISATION

AUTUMN/WINTER 2023

Contents

More-Than-Human Footprints

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Abstract

This issue of *Footprint* explores specific spatialities and materialities found across those operational landscapes of primary production that constitute the metabolic basis of urbanisation. To the extent that these landscapes are increasingly automated and digitised, production and circulation practices are becoming more capital intensive and even less labour-intensive. While amplifying the precarity of human labour, this process relies on appropriating the work of more-than-human assemblages of machines, plants, animals and microorganisms. Central to the focus of this issue is understanding the way these processes are grounded in specific architectural and landscape configurations. In this way, we also aim to complement the debates on past issues of *Footprint*, offering an investigation of the impact of technological transformations beyond the concentrated landscapes of human inhabitation.

Keywords

more-than-human city, more-than-human work, operational landscapes, automated landscapes, situated knowledge

Endless covered fields of crops lit with yellow or pink LED light, dominated with sensors and automated control systems, devoid of human presence. These are the images of contemporary Dutch greenhouses for horticultural production that are increasingly used in the media to illustrate three emergent conditions: the future of food production, human obsolescence in automated work environments, and the architecture of the so-called Post-anthropocene.[1] Most of these accounts however, ignore the fundamental labour of largely invisible, but crucial agents: pollinators.

Crops grown indoors are out of the reach of wild pollinators, a fact that could certainly impact yield and the quality of fruits. Without pollinators, tomatoes, sweet peppers and eggplants risk suboptimal development. Handheld electric vibrators or air blowers have traditionally been employed in small operations, yet their use is too labour intensive (and expensive) for bigger concerns. Therefore, hives of *bombus lapidarius,* also known as the red-tailed bumblebee, have become ubiquitous in greenhouses across the Netherlands to pollinate crops. They have many advantages over other insect pollinators: they have better sight orientation, withstand colder temperatures, target pollen directly, are less aggressive than bees (that is, better colleagues to humans), and their use is less labour intensive, and therefore cheaper.[2]

However, the reign of the bumblebee in the greenhouse might be close to its end. The reason is not just the well-known widespread global decline of pollinators, but the possibility of perfecting pollination through technology. Research groups and start-ups alike are developing autonomous micro drones able to fly like insects and use airflow to vibrate flowers for contactless pollination. This is important, because bees and bumblebees may damage flower organs when landing on them in their search for pollen or nectar; they can potentially increase the risk of disease transmission, and have an uneven performance throughout the year. In addition, a drone's eyes can track crop status and offer insights on growth parameters to managers.[3] Nobody's job is safe these days.

More-than-human, more-than-city work

Greenhouses and plants; bumblebees and drones: shifting assemblages of controlled environments and more-than-human actors in search of technonatural utopias for efficient urban metabolisms.[4] They are assemblages that can be conceived as mirror images of smart city visions that dominated technofuturist debates at the turn of the century, and still continue to emerge as responses to 'sustainable', 'equitable' and 'resilient' forms of living.[5] The recent growing diffusion of AI applications has only amplified these trajectories, weaving together speculations around promises of the applications of big data and sensorial platforms in urbanism, with broader discussions around the impact of AI on the social and spatial division of labour. With cities being infrastructural constructs based on information, but also the core of information economies, they have naturally been at the centre of these debates.[6]

But as social and environmental tensions become increasingly interwoven in the wake of the accelerating climate crisis, it becomes apparent that the battlegrounds of our technological futures might not lie at the core of human settlements – which in any case cover no more than 3 per cent of the planetary terrain.[7] They could rather unfold across the multitude of more-than-city, and largely more-than-human landscapes that operationalise in direct and indirect ways more than the 'other' 70 per cent of the earth's land surface: the landscapes of agricultural production, resource extraction, circulation and waste disposal that support city life.[8] Over the past decade, debates around the state of planetary urbanisation, unfolding around the work of Neil Brenner and Christian Schmid, have emphasised the importance of understanding the more-than-city landscapes of extended urbanisation in a dialectical relationship with the familiar agglomeration landscapes of concentrated urbanisation.[9] Both are interwoven through the geo-metabolic interdependencies linked to the spatial division of labour suggested by urbanisation: the more people, capital and economic activities concentrate in large dense settlements, the more interdependent they become with the operationalisation of a multitude of landscapes that construct their metabolic basis, and the material basis of their economies. As this urban mode of geographical organisation becomes generalised, the pressure upon primary production landscapes intensifies, in a dual search for efficiency and profit characterising the capitalist mode of production, turning them more and more into specialised, capitalised operational landscapes.[10]

These operational landscapes of planetary urbanisation reflect not only a geo-metabolic spatial division of labour, but also a shifting socio-techno-natural division of labour. More-than-city landscapes are largely operationalised through the work of more-than-human agents: from plants, animals and microbes, to machines and biotechnological agents. Processes of primary production assemble bundles of (paid or unpaid) human labour with (unpaid) more-than-human labour. These articulations shift decisively through the implementation of technological means, often reflecting the exhausted capacity of natural systems to contribute 'free labour', or their inability to keep up with increases in productivity. Through these shifts, operational landscapes weave both capitalism and urbanisation into the 'web of life' of Jason Moore's *Capitalocene*.[11]

The story of the plausible gradual expulsion of the *bombus lapidarius* from Dutch greenhouse complexes reflects exactly such a shift in the composition of ecological surplus: the greenhouse itself reflects a mode of technological substitution of otherwise free gifts of nature (favourable climatic conditions for growing plants) through capitalisation, while the substitution of the (unpaid) work of the bumblebee with the automated drone swarms seemingly leaves only plants as the last frontier of appropriated natural work in the process of agricultural production.

Towards worldly concreteness

Yet, far from being Nature, even plants have a long history as a form of 'lively capital'.[12] To serve human needs both as workers and commodities, plants have seen their traits and metabolism constantly remade, by crossbreeding and biotechnology, and their productivity further enhanced through their interaction with assemblages of AI, sensors, processors, actuators and contingent human labour in automated landscapes of production.[13] Accounting for the partial stories of bumblebees or plants, and the tangled webs that connect the non-human to one another and with human beings, is an urgent necessity. The overwhelming complexity of the landscapes of planetary urbanisation shaped by capital and technoscience, and the unintended consequences of human actions within, have destabilised humanity's capacity to imagine ways to move forward in this age of polycrises. 'That things could be different is the impulse of speculative thinking', Maria Puig de la Bellacasa argues, yet, as Rosi Braidotti points out, encountering 'too-much-ness' may mark the limits of becoming – of the potential of things being otherwise.[14] Part of the problem may be the limitations of urban theory on planetary urbanisation in accounting for partial, minor perspectives. This follows on Donna Haraway's critique of technology of vision and perspectivism, the abstraction of global datasets and cartographic representations of the planetary risks falling into the 'fallacy of misplaced concreteness', or mistaking the abstraction for the thing.[15] Deterministic explanations and views from nowhere do the 'god trick' of providing an explanation, but background those minor, subaltern voices, vernacular histories, and instances of multi-species

co-creativity within operational and automated landscapes, hampering the possibility of alternative minor theories of planetary urbanisation.[16]

Pluralising objectivity by means of partial perspectives and situated knowledge, as proposed by feminist theory, ethnographic and anthropological approaches, becomes crucial for the productive disclosure of friction between the planetary and the situated.[17] Communities and social movements in the global hinterlands, particularly indigenous movements, have spearheaded a reckoning that lies at the root of anti-extractivist ontologies, epistemologies and theories, as many groups have consistently resisted exploitation, arguably since the sixteenth century. David Graeber and David Wengrow vindicated the indigenous critique and its profound contributions to the epistemes of Western science and knowledge, as well as its political systems.[18] In the same way, Arturo Escobar's inquiry into the indigenous pluriverse and the multiple ontologies and epistemologies that populate the planet opens perspectives towards the imagination of new design stories that could afford creative transformations towards regeneration and abundance in territories of extraction.[19]

In addition, discourses that reclaim the voices and agencies of the non-human show the potential of interdisciplinary cross-pollinations and the inclusion of other forms of knowing. Political ecologists, such as geographer Susanna Hecht, have sought to interweave the findings of the social and the natural sciences into a holistic understanding of the 'social life of forests' and other ecologies.[20] Geographer Anthony Bebbington has applied this theoretical framework to study the political ecologies of the subsoil, and discusses extractivism from the perspective of the underground.[21] Overall, reading the Anthropocene, or Capitalocene, or any other -ocene, as 'patchy' or 'feral', may help tell what otherwise would be terrible stories in a different way, in turn revealing pockets of design agency, prompting calls to action and unexpected forms of 'response-ability'.[22]

Situating operationalisation

This issue of *Footprint* explores specific spatialities and materialities found across those operational landscapes of primary production that constitute the metabolic basis of urbanisation. To the extent that these landscapes are increasingly automated and digitised, production and circulation practices are becoming more capital intensive and even less labour-intensive. While amplifying the precarity of human labour, this process relies on appropriating the work of more-than-human assemblages of machines, plants, animals and microorganisms. Central to the focus of this issue is understanding the way these processes are grounded in specific architectural and landscape configurations. In this way, we also aim to complement the debates on past issues of *Footprint*, offering an investigation of the impact of technological transformations beyond the concentrated landscapes of human inhabitation.[23]

Our intention was to uncover the spatialisation of complex assemblages through which human and more-than-human agents are becoming operationalised in the making of the world ecologies of the Capitalocene. This issue reveals the social, technical and ecological tensions behind their composition, and thus revisits, from the perspective of non-city landscapes, persistent questions of cyborg urbanisation, as posed by Matthew Gandy.[24] We explore situated interpretations, building upon ethnographic and anthropological approaches to interpret the Anthropocene. Seeking to reveal how planetary-scale technological systems and flows are entangled with place-specific histories and landscapes of more-than-human ecologies, and to debunk neocybernetic fantasies of closed systems and total control, we shed light on the multiscalar dimensions of urbanisation processes. Overall, we offer a set of provocations, and call the Global North to rethink sustainability from the perspective of the urgent changes that must take place within its economy, geography, culture, and political structure, as we call into question what Vandana Shiva calls the 'monocultures of the mind', in a system of Global Cannibalism, dominated by Economic Barbarism and its irrational efficiency of eroding productivities, which include Carbon Extractivism.[25]

The contributions to this issue can be organised around three themes: 1) histories of multiscalar processes of operationalisation, revealing how the unfolding in time of political and economic imperatives ends up producing landscapes of extended urbanisation, with a focus on resource extraction, energy and data; 2) situated entanglements of technology, questioning assemblages of human and more-than-human work within particular landscapes and architectures; and 3) design investigations into automated landscapes of extended urbanisation, deciphering their physical and material configurations through mapping and visualisation exercises, and speculating on alternative futures. Below we elaborate on each of these themes and on how the different authors address them.

Stories of operationalisation

Marina Otero Verzier's essay 'Compulsive Desires: On the Entangled Realities of Lithium Extraction and the Limitless Quest for Energy' mobilises the concept of the 'Cartesian enclosure' to highlight the conditions that enable the dispossession of communities around sites of extraction for the sake of fulfilling dreams of a so-called green energy transition. Amid conflicting interests and

contradictions in landscapes of green colonialism, Otero's is a call for finding a common ground for collective action and more-than-human solidarity towards imagining a future otherwise.

In the article 'Platforms and Palimpsests: Urban Landscapes of Data in Northern Virginia', Ali Fard critically questions readings of platforms that reinforce myths of immateriality and sustainability of the digital, and scholarship confining platform urbanism to the city. His proposition to examine the operational landscapes of data production and circulation is meant to disclose the relationship between data, technology and capitalist spatial production, and to move discussions about digital platforms beyond the metaphor of the cloud.

More-than-human workplaces

Inês Vieira Rodrigues presents the results of her ethnographic and field study of cattle farming in the Azores in 'Insular Cowscapes: Technologies of Ecological Restoration'. Her work describes the operationalisation of 'cowscapes' as part of a long project of attuning the island to planetary demands for efficiency, optimisation and specialisation. With mitigation and restoration technologies appearing as fixes to support economic growth, Vieira Rodrigues argues for alternative scenarios for a post-pasture archipelago.

In 'Plantation Technologies: More-Than-Human Histories of Operationalisation in the Palm Oil Production Territories of Johor State, Malaysia', Hans Hortig investigates agro-industrial production as a process of urbanisation. Through a series of more-than-human vignettes – involving palms, weevils and owls – this article highlights plantation agriculture as a technology for the extraction of both natural resources and human and nonhuman labour, and pleads for establishing regulatory authority.

In 'Subversive Submersives: The Unseen Urbanisation of the Southern Ocean', Charity Edwards proposes to re-present this oceanspace as a way to question its mainstream perception as a remote wilderness. Employing 'wet ontologies' as a framework, Edwards's cartographic and image-making explorations bring to the fore forms of operationalisation of the ocean – for scientific research, resource extraction and surveillance – as well as the agencies and work of the wet technological bodies within.

Transformative media

The conceptual and ecological impacts of human stewardship of the environment are the focus of a review article by Katerina Labrou and Christos Montsenigos entitled 'In the Garden of Anthropos: Conservation after Artificial Intelligence'. The essay mobilises the garden metaphor as an invitation to reassess the planet's ecosystems as places of attachment and exchange between humans and non-humans. Labrou and Montsenigos argue for the formulation of a spatialised ecological intelligence to address ecological challenges and foster a new conservation culture.

Alexandra Arènes and Axelle Grégoire's visual essay entitled 'Terra Forma Speculative Mapping: Paris Watershed and Underground Environment' challenges the appropriateness of current mapping techniques to understand and respond to the environmental crisis. The result of a collective effort that brought together actors and researchers concerned with the ground, their mapping work both reveals the thickness and interactions of the critical zone, and operates as a boundary object useful to identify contradictions in urban planning processes.

Finally, in 'Walk Under the Midnight Sun: Mapping Capsicum Ecologies', Fuzzy Earth and the BÜRO imaginaire curator's collective present an unrealised project for the Hungarian Pavilion at the Venice Biennale. Carpets, an architectural element with a long history as a medium for storytelling, are used to reveal origin stories, instances of global circulation, technological environments and architectural systems in food systems. Woven of stories and pattern, their work serves as the basis to speculate on possible future capsicum ecologies.

On human and more-than-human footprints

Interrogating the spatialities of human and more-than-human interdependencies in a dialectical manner necessarily challenges their relationship with inherited spatial binaries, such as the urban and rural, the city and the countryside.[26] At a first level, the city and other agglomeration zones appear to be dominated by the concentration of human agents, capital and infrastructure, while the more-than-city, 'rural' areas are characterised by the operationalisation of more-than-human, bio-geo-technical agents. But considering them as part of a dialectical process of concentrated and extended urbanisation, city and more-than-city landscapes, human and more-than-human agents are woven together through the geo-metabolic interdependencies of urbanisation. Agricultural technologies are often developed in the innovation hubs of 'creative' agglomeration zones; genetically modified foodstuffs are primarily consumed in densely populated settlements.[27]

At the same time, the need for sustaining dense urban populations puts immense pressure on primary productive landscapes, and in turn, the urge to keep operationalising them acts as a generator for technological and capital investment at urban cores.[28] As planetary urbanisation struggles to resolve these processes through the capitalist search for profit, generative relationships in the capitalist web of life are often transformed to destructive relationships

in webs of death.[29] Pollution, environmental degradation, human and more-than-human expulsion are also operating in a dialectical relationship of mutual destruction. The typical conception of urbanisation degrading natural ecosystems through land use transformation, pollution and biodiversity loss, is only one side of the coin; on the other, the parallel intensification and operationalisation of more-than-city landscapes reflects back to the deterioration of conditions of human social reproduction in urban centres through the degradation of their base metabolic elements.

Within this context, technoscientific solutions and efficient policy-making that aim for a balanced, sustainable and equitable development of social and natural systems are being put forward to resolve these tensions.[30] Their normalisation is clear in the accelerated diffusion of nature-based-solutions paradigms, and institutionalised through the formalisation of various development trajectories in the form of Green (New) Deal(s).[31] While epistemological debates around more-than-human ontologies have foregrounded questions of inclusivity and just collaboration of human and more-than-human systems, the general tendency towards 'designing with nature' that characterises contemporary green development paradigms largely reflects an instrumental approach to more-than-human forms of existence.[32]

In that sense, technological developments are presented as ways to enhance the capacities of natural systems, through AI and biotechnological applications, or to mitigate their exhaustion and degradation, for example through various geoengineering aspirations.[33] In this way, the diffusion of technoscientific solutions across the more-than-city, more-than-human world, can be also seen as a signal of exhaustion and collapse of ecological systems, of closing frontiers of cheap natures, as more-than-human work seems unable to keep up with the accelerated pace and intensification of their operationalisation driven by the urge for endless growth. Moreover, as the application of technoscientific principles of efficiency prevails across the more-than-city, more-than-human systems, it also reduces their generative potential to the absolute envelope of the planned solutions.[34]

In a risky parallelism, it could be argued that in the same way that the generative capacity of urban environments – à la Jane Jacobs – is fuelled by the positive externalities of unplanned interactions, the simplification of the complex human and more-than-human interactions across the more-than-city world through their efficient organisation and management robs them of their unplanned, generative capacities.[35] The perils of the Plantationocene are somehow a mirror image of the perils of the monofunctional modernist zoning.[36] And yet, from precision agriculture and mining to progressive visions of circularity, the assumption of efficiency through the efficient alignment and organisation of human and more-than-human work persists.

In any case, the question around the state and performance of the emerging techno-natures that will animate the more-than-city landscapes of the twenty-first century becomes a key component of any scenario foregrounding resource efficiency – from agroecological visions to capital intensive high-tech utopias. But as long as these approaches are prescribed within the capitalist web of life (and death), prospects of technological progress and landmark goals that suggest linear advancement need to be positioned within a largely non-linear vector.[37] The articulations of human and more-than-human systems, city and more-than-city landscapes reflect an endless dance of their shifting capitalisation and appropriation in search of their more profitable bundles.[38] The bumblebees that are threatened with being replaced by the automated drones in Dutch greenhouses may very well return under conditions that increase the costs of capitalisation, while the enclosed, automated nature of the greenhouse itself might be challenged under different energy or labour regimes.

Whether dynamic or static, visions for the future of the more-than-human, more-than-city worlds that will serve as the core of any sustainable and equitable form of multispecies inhabitation of the planet, are largely lacking in major forms of practice. As several of the authors in this issue suggest, the time has come to bring to the fore alternative ways of thinking the human and more-than-human footprints, bringing Epistemologies of the South, Indigenous Knowledge Systems, and more-than-human ecologies to the forefront of a search for pathways to design otherwise, by accessing other forms of knowledge not legible by Western, Euro-centric theories and methods.

Notes

1. Frank Viviano, 'How the Netherlands Feeds the World', *National Geographic*, September 2017, https://www.nationalgeographic.com/magazine/article/holland-agriculture-sustainable-farming; Liam Young, 'Neo-machine: Architecture Without People', *Architectural Design* 89, no. 1 (2019): 6–13, http://doi.org/10.1002/ad.2381.
2. Kevin van Kester, 'How Does Pollination in Greenhouses with Bumblebees Work?', Royal Brinkman website, 18 June 2021, https://royalbrinkman.com/knowledge-center/crop-protection-disinfection/pollination-greenhouses-bumblebees; Karli Petrovic, 'Using Bees in the Greenhouse for Natural Pollination', *Greenhouse Grower*, 2 April 2017, https://www.greenhousegrower.com/production/using-bees-in-the-greenhouse-for-natural-pollination/.
3. 'Polybee: There's a New Drone in Greenhouses, and It Isn't a Bumblebee', *Hortidaily*, 16 August 2021. https://www.hortidaily.com/article/9344598/

polybee-there-s-a-new-drone-in-greenhouses-and-it-isn-t-a-bumblebee/; Patrick Williams, 'The Drones Are Close: Unmanned Aerial Vehicles Have Their Coordinates Set on the Greenhouse Industry', *Gardencenter*, August 2018, https://www.gardencentermag.com/article/drones-for-greenhouse-pollination-pollinators/.

4. Damian White and Chris Wilbert, 'Introduction: Technonatural
5. Time-Spaces', *Science as Culture* 15, no. 2 (2006): 95–104, http://doi.org/10.1080/09505430600707921.
6. Over more than three decades, the growing literature on what can broadly be referred to as 'smart cities' has been exploring and speculating on the transformative effect of technological applications in city development, with the majority of studies suggesting a solutionist approach to core urban problems, from mobility to sustainability. Among the vast and diverse literature on the topic, see for an overview: Anthony M. Townsend, *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia* (New York: WW Norton & Company, 2013); for a critical appraisal, see: Antoine Picon, *Smart Cities: A Spatialised Intelligence* (New York: John Wiley & Sons, 2015).
7. For recent reviews among the growing literature on cities and AI, see: Michael Batty, 'Artificial Intelligence and Smart Cities', *Environment and Planning B: Urban Analytics and City Science* 45, no. 1 (2018): 3–6; Zaheer Allam and Zaynah A. Dhunny, 'On Big Data, Artificial Intelligence and Smart Cities', *Cities* 89 (2019): 80–91.
8. The important and disproportionate role of cities in transforming the planetary environment beyond their footprint has been widely recognised, as reflected in the UN's recurring note that cities cover around 3 per cent of the earth's surface, yet account for 60–80 per cent of energy consumption and 75 per cent of carbon emissions, which underlines both the discussion on Sustainable Development Goals (SDGs), and the UN Habitat agenda. However, until recently, little attention has been paid on the role of more-than-human agents and the conditions across more-than-human environments constituting this 'external' domain beyond the 3 per cent. See, for example, the discussion about SDG 11 on the United Nations' Sustainable Development Goals website, https://www.un.org/sustainabledevelopment/cities/; more specifically on the energy and resource question, see the United Nations Energy Programme, *Cities: Investing in Energy and Resource Efficiency,* 2011. For an overview of global calculations and datasets of city and more-than-city landscapes of urbanisation, see: Nikos Katsikis, 'Visualizing the Planetary Urban', in *Doing Global Urban Research,* ed. John Harrison and Michael Hoyler (London: SAGE, 2018), 12–33.
9. Initially introduced by Henri Lefebvre in his *Urban Revolution*, the question of planetary urbanisation has seen a resurgence through the work of Neil Brenner, Christian Schmid and a growing body of literature around it. See: Henri Lefebvre, *The Urban after Revolution,* trans. Robert Bononno (Minneapolis: University of Minnesota Press, 2003 [1970]). Core literature on the topic by Brenner and Schmid includes Neil Brenner and Christian Schmid, 'Towards a New Epistemology of the Urban?' *City* 19, no. 2–3 (2015): 151–82; Neil Brenner and Christian Schmid, 'Planetary Urbanization', in *Urban Constellations*, ed. Matthew Gandy (Berlin: Jovis, 2011), 10–13; Neil Brenner, *Implosions/Explosions: Towards a Study of Planetary Urbanization* (Berlin: Jovis, 2014); and Neil Brenner, 'Theses on Urbanization', *Public Culture* 25, no. 1 (2013): 85–114.
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11. Jason W. Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (London: Verso Books, 2015).
12. Donna J. Haraway, *When Species Meet* (Minneapolis: University of Minnesota Press, 2008), 46.
13. Susan Schrepfer and Philip Scranton, eds., *Industrializing Organisms: Introducing Evolutionary History* (New York: Routledge, 2003); Marion Ernwein, Franklin Ginn and James Palmer, eds., *The Work That Plants Do: Life, Labour and the Future of Vegetal Economies* (Bielefeld: transcript Verlag, 2021); Víctor Muñoz Sanz, 'Best Supporting Characters', in *Automated Landscapes*, ed. Merve Bedir et al. (Rotterdam: Het Nieuwe Instituut, 2023), 149–59.
14. Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: University of Minnesota Press, 2017), 110; Rosi Braidotti, *Transpositions: On Nomadic Ethics* (Cambridge: Polity Press, 2006), 214.
15. Alfred North Whitehead (1948), as quoted in Donna J. Hawaray, *Modest_Witness@Second_Millennium. FemaleMan_Meets_OncoMouse: Feminism and Technoscience* (New York and London: Routledge, 1997), 146.
16. Donna J. Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective', *Feminist Studies* 14, no. 3 (1988): 575–99, 584, http://doi.org/10.2307/3178066; Building on Deleuze and Guattari, Cindy Katz defines minor theory as that which accounts for the 'material conditions under which knowledge is produced and shared' and is 'streaked with the peculiar temporality and spatiality of everyday life' (p. 488) in contrast to totalising theories. Set in a relation and not in opposition with the major, the 'alternative subjectivities, spatialities, and temporalities' (p. 490) of the minor speak about impossibility, about provoking a 'line of escape' in the major toward doings things otherwise (p. 489). Cindy Katz, 'Towards Minor Theory', *Environment and Planning D: Society and Space* 14, no. 4 (1996): 487–99, http://doi.org/10.1068/d140487.
17. For more on the concept of friction, see: Anna Lowenhaupt Tsing, *Friction: An Ethnography of Global Connection* (Princeton: Princeton University Press, 2005).
18. David Graeber and David Wengrow, *The Dawn of Everything: A New History of Humanity* (London: Allen Lane, 2021).

19. Arturo Escobar, *Territories of Difference: Place, Movements, Life, Redes* (Durham, NC: Duke University Press, 2008); Arturo Escobar, *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds* (Durham, NC: Duke University Press, 2018).
20. Susanna B. Hecht, Kathleen D. Morrison and Christine Padoch, eds., *The Social Lives of Forests: Past, Present, and Future of Woodland Resurgence* (Chicago: University of Chicago Press, 2014).
21. Anthony Bebbington and Jeffrey Bury, eds., *Subterranean Struggles: New Dynamics of Mining, Oil, and Gas in Latin America* (Austin: University of Texas Press, 2013).
22. Anna Lowenhaupt Tsing, Andrew S. Mathews and Nils Bubandt, 'Patchy Anthropocene: Landscape Structure, Multispecies History, and the Retooling of Anthropology', *Current Anthropology* 60, supplement 20 (2019): 186–97, http://doi.org/10.1086/703391; Anna Lowenhaupt Tsing et al., eds., *Feral Atlas: The More-Than-Human Anthropocene* (Redwood City: Stanford University Press, 2021), http://doi.org/10.21627/2020fa. For Haraway, response-ability is about 'learning to be "polite" in responsible relation[ality]' when 'looking back at each other'. Haraway, *When Species Meet.*
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24. Matthew Gandy, 'Cyborg Urbanization: Complexity and Monstrosity in the Contemporary City', *International Journal of Urban and Regional Research* 29, no. 1 (2005): 26–49.
25. Vandana Shiva, *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology* (London: Zed Books, 1993); Haroldo de Campos, 'The Rule of Anthropophagy: Europe under the Sign of Devoration', in *Baroque New Worlds: Representation, Transculturation, Counterconquest*, ed. Lois Parkinson Zamora and Monika Kaup (Durham, NC: Duke University Press, 2010), 319–40; David S. Peña, *Economic Barbarism and Managerialism* (Westport, CT: Greenwood Press, 2001).
26. Studies in urban political ecology have invested significant work in overcoming these binaries. See, for example: Yannis Tzaninis et al., 'Moving Urban Political Ecology Beyond the "Urbanization Of Nature"', *Progress in Human Geography* 45, no. 2 (2021): 229–52; Hillary Angelo and David Wachsmuth, 'Urbanizing Urban Political Ecology: A Critique of Methodological Cityism', *International Journal of Urban and Regional Research* 39, no. 1 (2015): 16–27.
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28. Stephen G. Bunker and Paul S. Ciccantell, 'Generative Sectors and the New Historical Materialism: Economic Ascent and the Cumulatively Sequential Restructuring of the World Economy', *Studies in Comparative International Development* 37 (2003): 3–30.
29. Erik Swyngedouw and Henrik Ernstson, 'Interrupting the Anthropo-obScene: Immuno-biopolitics and depoliticizing ontologies in the Anthropocene', *Theory, Culture & Society* 35, no. 6 (2018): 3–30.
30. For critical reviews see: T. J. Demos, 'To Save a World: Geoengineering, Conflictual Futurisms, and the Unthinkable', *E-flux journal* 94 (2018); Hira Sheikh, Peta Mitchell and Marcus Foth. 'More-Than-Human Smart Urban Governance: A Research Agenda', *Digital Geography and Society* 4 (2023); Jennifer Gabrys et al., *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet* (Minneapolis: University of Minnesota Press, 2016).
31. Billy Fleming, 'Design and the Green New Deal', *Places Journal* (April 2019), https://doi.org/10.22269/190416.
32. See, for example: Michael U. Hensel, 'The Rights to Ground: Integrating Human and Non-Human Perspectives in an Inclusive Approach to Sustainability', *Sustainable Development* 27, no. 2 (2019): 245–51.
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36. Donna J. Haraway, 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin', *Environmental Humanities* 6, no. 1 (2015): 159–65.
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38. Raj Patel and Jason W. Moore, *A History of the World in Seven Cheap Things: A Guide to Capitalism, Nature, and the Future of the Planet* (Oakland: University of California Press, 2017).

Biography

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Compulsive Desires: On the Entangled Realities of Lithium Extraction and the Limitless Quest for Energy

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Abstract
In this essay I analyse how energy dreams and epistemologies, constructed on cravings for productivity and profit, connect the spaces that epitomise the 'Cartesian enclosure' with the technologies and spaces of everyday life. I examine how destructive habits of extracting, procuring and consuming energy follow predictions that assume the inevitability of growth. Estimates that, even in the face of climate catastrophe, render the need for more energy inevitable and rely on finding new fixes rather than embracing other forms of living. Focusing on the case of lithium extraction in Atacama, I address the struggles sustained by indigenous communities for their lives, sovereignty and rights. Battles that emphasise how, in what has been described as 'green colonialism', the development of the 'green energy futures' too often is to the detriment of indigenous peoples.

Keywords
Cartesian grid, data infrastructures, green colonialism, extractivism, indigenous rights, lithium

In this essay I mobilise the work of philosopher Michael Marder on ecological thought, political theory and phenomenology to discuss the implications of current habits of extracting, procuring and consuming energy.[1] The battles around lithium extraction in Chile serve as a primary case to unpack how cravings for energy and profit cause the instrumentalisation of the planet and transform spaces such as the Atacama Desert into resources to be extracted. I refer to Atacama's indigenous communities and their struggles against extractivism resulting from growing dependence on lithium batteries for the so-called energy transition. Their battles emphasise how the development of 'green energy futures' too often comes at the expense of indigenous peoples.

To understand the categorisation conditions that historically enabled the subjugation and exploitation of indigenous and subaltern bodies and the destruction of their environments in the name of progress, I undertake a critical analysis of Cartesianism.[2] By reflecting on Cartesian imperatives, theories and spaces and zooming out from the Atacama to the global lithium supply chain, I put forward the notion of 'Cartesian enclosure', that is, an epistemic and spatial border that facilitates exploitative practices and maximises production and corporate turnover. The critique of Cartesianism follows ruminations on race and enclosure by philosopher Achille Mbembe and the work of decolonial thinkers.[3] Their theories and strategies offer important avenues for venturing beyond Cartesian logics, categories and spaces and advancing alternative energy epistemologies.

Finally, I compare the extractive relations defined by the territories of lithium extraction against the architectures of more-than-human ancestral solidarity in the ayllus (a traditional Andean social unit) of San Pedro de Atacama.[4] To do so, I build upon Marisol de la Cadena's theories of indigenous political strategies. De la Cadena's work questions modernity and pleads for a halt to the world's Cartesian categorisation, compartmentalisation and exploitation to a halt.[5]

Transitions

In January 2022, the companies BYD Chile SpA and Servicios y Operaciones Mineras del Norte SA won contracts to extract up to 80 000 tons of metallic lithium in Chile. Organised by Chile's Ministry of Mining under president Sebastián Piñera's right-wing government, the tender aimed to increase lithium production to meet 'the growing global demand generated by the development of areas such as electromobility'.[6] As the world strives to meet net-zero carbon emission targets, green electricity is poised to replace fossil fuels in domestic and industrial uses, while electric and hybrid vehicles substitute those using petrol. Lithium is often presented as a key element for this energy transition.

Critical for the storage of renewable energy, a fundamental component of mobile phones, electric vehicles, data centre batteries and an enabler of 'smart city' development, lithium exists in high concentration in only a few places on earth. The Atacama Desert is one of them. Containing the largest brine-based mines on the planet, Atacama's *salares* make Chile the second-largest producer of lithium globally. Not without struggle. Having been a site of human, animal, vegetal and microbial entanglement for thousands of years, the salares are now portrayed as a strategic resource deposit crucial for society's green, low latency futures.

Mining operators use extraction wells to pump brine (salty, underground water) into large human-made ponds where, aided by Atacama's sun and arid conditions, water evaporates for twelve to eighteen months, forming an agglomerate of borax, magnesium, potassium and lithium salts.[7] The salts are then routed through ponds until the lithium concentration turns into lithium carbonate, lithium hydroxide or lithium chloride. To produce one ton of lithium, mining companies use 2 800 cubic metres of water (a ton of copper requires seventy cubic metres).[8] The scale of the operations, with millions of litres of water evaporated every day, puts the salares and their inhabitants at risk of disappearance.[9]

The tender process, failing to include provisions for the safeguard of the salares and to consult with the indigenous communities who have been their stewards for generations, triggered widespread calls for its cancellation. Yet, facing growing opposition, it was carried out in the last months of Piñera's government and before the new administration, led by left-wing politician Gabriel Boric, took over. Boric, whose term started on 11 March 2022, had included in his programme the founding of a national lithium company that would facilitate debate regarding this strategic national asset. Whereas his government was legally bound to the tender's outcome, it publicly supported the legal actions of the regional governor of Atacama and Atacameño indigenous communities from Camar and Coyo attempting to suspend the process. 'They want to produce more and more lithium, but we're the ones who pay the price,' said Lady Sandón Orellana, president of the Coyo community.[10] The Copiapó court upheld their appeal in January 2022, stating that the activities of mining companies violated constitutional guarantees and the right to live in a pollution-free environment.[11]

Despite the suspension, the far-reaching ramifications of the lithium tender process had long been shaping material realities beyond Atacama. Electric buses made by BYD (China's leading manufacturer of lithium batteries and battery-powered electric vehicles, of which BYD Chile SpA, one of the companies awarded a lithium extraction contract, is a subsidiary) filled Chilean streets months before the international lithium bid.[12] A gift from China to Piñera's government, the vehicles were clear evidence of the strategic and geopolitical importance of controlling lithium extraction from Atacama. For BYD (an abbreviation of 'build your dreams'), the contract will result in the market's dominion from mine to end product. BYD sells products that generate a demand for more of its products: electric cars and autonomous transportation require data centres to manage the real-time transfer of information to users, who in turn monitor operations from their lithium-powered smartphones, tablets and laptops. Inside the automated factory BYD in Shenzhen's Pingshan District, the promises of the smart city meet the largest lithium battery production in the world, one born from the depths and at the expense of Atacama, reminding us of what it takes to 'build our dreams'.[13]

Ground-breaking grids

We are left with the task of disentangling lithium's architectures across geographies, times and scales, an undertaking paramount for imagining 'new energy cultures that depart from an endless acceleration of energy consumption'.[14] Only by doing so, I would argue, could we unravel human energy dreams and epistemologies from the logic of growth, productivism and consumerism, a logic that, while aiming at creating future worlds is putting the only world we all inhabit at risk.[15]

Whereas global climate action advocates for the replacement of fossil-based energy sources, it also stimulates the growth of so-called clean energies, which in turn require the increase of energy storage capacity. As a result, lithium – an important component of energy-storing batteries – is experiencing a price surge. Demand, according to some estimates, could rise from approximately 500 000 metric tons in 2021 to some three million to four million metric tons in 2030.[16] Meanwhile, supply chains are not able to respond to the increase in demand,

keeping prices high. In the last year, the price of lithium increased 701 per cent, bringing benefits to the Chilean state and shareholders, who will receive more than USD 1.3 billion in dividends.[17] Such a lucrative business puts unexploited lithium reserves under pressure and often harms indigenous communities, who are forced to dedicate their lives to fighting for their rights, sovereignty and survival against the epistemic violence and extractivism carried out in the name of green, connected, datafied futures.

At the core of these struggles is what Michael Marder calls an 'unapologetically instrumental attitude that characterises the scientific paradigm'.[18] The modern scientific perspective on the earth, Marder argues, is an 'appendage to the technologies of exploitation, single-mindedly focused on the extraction of metals, precious stones and fossils'.[19] By enabling the limitless instrumentalisation of the planet, modern science has reduced the earth to 'a collection of natural resources, fertile soils, construction materials, territories to be occupied'. This perspective assumes that the earth always holds something in store to be extracted.[20]

Atacama holds resources. It is is one of the biggest repositories of lithium globally, making it a zone of interest to mining companies. To extract and seize what Atacama holds in the ground, the desert ecosystem has to be portrayed as a lifeless space and the salare's hyper-biodiverse environment ready to be sacrificed. Tamed by logistical models and a grid of mining concessions that act as blueprints for the exploitation of the ground, Atacama becomes a major economic asset. [21] [Fig. 1] The Cartesian grid laid over the territory gives a legal and spatial framework to unearthing the depths of the desert for the sake of energy dreams, the corporate cravings for productivity and profit. The grid rationalises and divides the ground by laying regular lines. It serves to calculate, optimise, standardise and ultimately to control space.[22] Its abstract aesthetic stimulates the ambitions that drove the mechanical age, colonial subjugation and the formation of capitalism and that instigated economic efficacy at the expense of ethical and ecological awareness.[23]

The grid is, above all, a conceptual speculation, writes Rem Koolhaas in *Delirious New York*; 'in its indifference to topography, to what exists, it claims the superiority of mental construction over reality… it announces that the subjugation, if not obliteration, of nature is its true ambition'.[24] In Atacama the Cartesian grid organises the world's driest desert in ponds, where millions of litres of water are evaporated every day in the name of development. The grid disregards the indigenous cosmic vision, the Andean *Pachamama* and reveals the conflicting understandings of land by the Atacameño communities (focused on stewardship practices), by the mining companies and by the Chilean State. It constructs distinctions and categories that delineate what is alive and what is lifeless; where there is matter, it sees commodities and in the place of living ecosystems, it sees nonlife. When it visually manifests in the sublime brine ponds, the aesthetic experience of the grid conceals the destruction it unleashes.

Grids are not always discernible on the ground. They operate by extending an epistemic system shaped by patriarchal and colonial rationales that epitomise the 'Cartesian enclosure', a system that legitimised Western man's domination of landscape, resources and other beings.[25] It is a system entangled with the sites of resource extraction, contemporary infrastructures and the daily technologies, rhythms and spaces whose functioning depends on the maximisation on the ground's productivity, increasing energy consumption and CO_2 emissions.[26] A mental construction, the grid promises to facilitate a perfect accommodation of the human in the environment by setting the human and its compulsive tendencies over and against the environment. It sells illusion of order and legibility, an ontological version of the world so perfected that it seems inevitable. The gird is 'antinatural, antimimetic, antireal', writes Rosalind Krauss in 'Grids'. The grid is 'what art looks like when it turns its back on nature. In the flatness that results from its coordinates, the grid is the means of crowding out the dimensions of the real and replacing them with the lateral spread of a single surface'.[27]

Paradoxically, the grid's capacity for objectivising the environment and asserting human power and exceptionality leads to the neglect of others, the destruction of the world, and ultimately to the impossibility of human existence.[28] Too often we forget how the smooth touch of screens, the experience of minimum latency, endless consumption and the persuasive appeal of electric cars are products of the greed for what is below and the destruction of deepest layers of the ground and living beings that exist above and around. They are products of *groundbreaking* innovations, or in Marder's words, 'the disarticulation, the shattering of one totality at the behest of another – that of capital'.[29]

Battles

Despite the grid's lines that tame, segregate and sell out their territory, the Atacameños know that the desert's ground is alive, that the minerals extracted from its deepest layers and exported to faraway territories are not lifeless matter.[30] They are not commodities. They are micro-organisms essential to the salare's ecosystem and the symbiotic relations between its inhabitants, including shrimp, flamingos, llamas and humans. Indigenous leaders like Rolando Humire have long been fighting against the drought, contamination and death resulting from the activities of the

mining industry in the region. 'Do I drink lithium? Do I eat copper?' asks a graffiti at the entrance of San Pedro de Atacama. [Fig. 2] Villages experience water shortages and nearby lagoons have dried up, affecting the population of wild flamingos that feed on them. Concerns that the damage may be irreversible have instigated demands by residents, scientists and politicians for the lithium tender process to be cancelled.

Recently the Atacameños had reasons to celebrate. On 1 June 2022, after upholding the appeals by the indigenous communities of Camar and Coyo, the Third Chamber of the Chilean Supreme Court confirmed that any intervention on ancestral territories or that may affect indigenous communities requires consultation in accordance with Convention 169 in Article 5 of Chile's constitution. As the consultation hadn't taken place, the court annulled the bidding process for lithium exploitation.[31] The next day, the government announced the constitution of a state lithium company and a lithium institute – a proposal already included in Boric's electoral programme – with the mandate to publicly discuss the future management of lithium reserves and to guarantee the dialogue with the indigenous peoples.[32] Gabriel Muñoz, the lawyer representing the Atacameño community of Coyo, celebrated the outcome, declaring:

> It is a historic fact, unprecedented from the judicial point of view and from the perspective of the defence of the ancestral rights of the Atacameño communities that the Supreme Court accepts these appeals, defends these communities, gives value to their ancestral and territorial rights and in the defence of the Salar de Atacama and, therefore, suspends the contracts, the bidding and the awarding.[33]

This episode echoes other struggles sustained by indigenous communities for their lives, sovereignty and rights, across territories. Battles that emphasise how, in what has been described as green colonialism, the development of the 'green energy futures' is too often to the detriment of indigenous peoples. In the Nordic countries the thriving data centre industry supported by renewable energy initiatives has catastrophic effects on Sami communities. Wind turbines invade grazing lands and displace reindeer, putting the protected practice of traditional herding, essential to Sami identity, at risk.[34] As in the case of Chile, some judges make a difference, and in October 2021, the Norwegian Supreme Court ruled in favour of Sami communities and against the largest onshore windfarm in Europe. The court referred to Article 27 of the UN international covenant on civil and political rights, which protects minority ethnic people from being denied 'the right, in community with the other members of their group, to enjoy their own culture.[35]

The Norwegian and the Chilean cases emphasise the need for governments and companies working on decarbonisation to acknowledge and consult with indigenous communities to ensure climate justice. Yet, the reality of indigenous populations around the world is more often characterised by conflicts with governments and private corporations for the control of what markets describe as fundamental economic assets. Besides facing local challenges, indigenous communities also have to deal with broader geopolitical issues such as foreign intervention in the form of economic pressure, misinformation campaigns and destabilisation practices. Recently, the *Wall Street Journal* published an article in response to the Chilean Supreme Court's cancellation of the lithium contract with BYD. The paper, with ties to powerful political and economic lobbies (it is owned by Rupert Murdoch's News Corp), accused left wing governments of 'blowing the electric-car revolution'.[36] Emphasising the increasing global demand and dependence on lithium, the article blamed left-wing leaders in Latin America, and the governments of Chile and Bolivia in particular, of becoming a 'major bottleneck for growth in electric vehicles'.[37]

Long exposed to the ills of extractivism and its impact on economic, social and political life, Latin American countries recently introduced strategic changes to the mining model. In 2017, Bolivia created the state company Yacimientos de Litio Bolivianos Corporación (YLB).[38] Mexico followed by officially nationalising its lithium industry.[39] Chile is also moving towards strengthening the state's role in the management of its lithium reserves, prioritising environmental rules and indigenous rights over mining. Had it been approved (it was rejected in a national Constitutional Plebiscite held on 4 September 2022), Chile's new constitution would have strengthened the regulation of mining and would have granted rights to nature and animals, required mining companies to pay royalties of up to 40 per cent to the government, to provide up to 25 per cent of their production to local businesses at a low market price, and to give part of the sales to indigenous communities as restitution.[40] In parallel, Argentina, Bolivia and Chile are discussing lithium production under a joint governance strategy that addresses environmental and social issues associated with extraction, as well as methods to add value in the form of associated industries.[41]

To the *Wall Street Journal*, these policies, advocating greater control of national resources and aligning with the local communities, 'risks derailing lithium production' and creating battery shortages precisely at a moment of exploding demand, rising prices and the readiness of all the major car makers to shift to electric vehicles.[42] The article appears to demonstrate neocolonial biases by presenting a perspective that assumes a future mismanagement

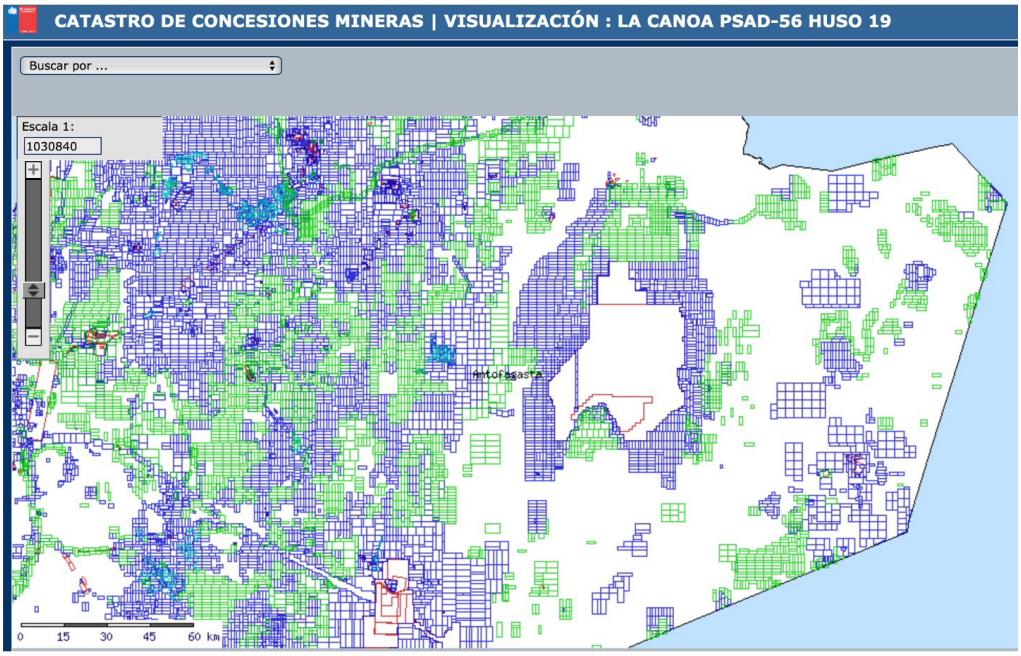

Fig. 1: Mining concessions in the salar de Atacama. Screenshot from the Catastro de Concesiones Mineras, 2022.

Fig. 2: Anti-Extractivist banner, San Pedro de Atacama, Chile, 2022. Photo: author.

of the resources due to the region's 'corruption and nepotism' and its 'lack of know-how and technology'. By contrast, it acknowledges Argentina's efforts to provide tax agreements and ease currency controls for companies, which is expected to incentivise a boom in mining investments from companies such miners Rio Tinto PLC, battery maker Ganfeng Lithium Co., and deals with Toyota, Ford and BMW.[43] Concomitantly, London-based consulting firms sketch a scenario in which Argentina moves from two to nineteen lithium mines by 2031 and increases its lithium annual production sixfold.[44] As Albemarle Corp country manager in Chile, Ignacio Mehech, explains, 'we have to be able to produce the lithium that the world needs'.[45]

The world's projected lithium needs might be miscalculated, based on the predictions that assume the inevitability of growth in vehicle production and corporate profit. Estimates that, even in the face of climate catastrophe, render the need for more energy inevitable and rely on finding new fixes (and old habits of extracting and consuming energy) rather than embracing other forms of living.[46] After all, as Cara New Daggett claims, the problem of energy is intertwined with the politics of work and leisure and 'in order to live appropriately on the Earth', humans need to contest the 'consumerist life of high energy consumption with an alternative political vision of pleasure'. [47] [Fig. 3]

In this context, the role of the state in the extractive sector and increasing nationalisation of lithium extraction by progressive countries in Latin America demands further scrutiny. As Alberto Acosta and Eduardo Gudynas have argued, state intervention and control over natural resources could prevent foreign corporations from profiteering at the expense of the country and their people.[48] This, in turn, could allow for greater regulation and oversight of extractive activities. However, in what has been defined as neo-extractivism, increased state control does not necessarily lead to social and environmental responsibility. Many progressive governments rely on extractivist activities as a means of financing social programmes that give them political legitimacy, thus prioritising economic growth over environmental protection and social justice. Through this lens, neo-extractivism reinforces a modernist idea of progress based on the exploitation of nature through technological means, which perpetuates environmental destruction, social conflict and economic dependency. As Gudynas reminds us, progressive governments in South America have yet to develop an alternative vision; to them, economic growth equals development. Gudynas explains that, even if Bolivian and Ecuadorian discussions on 'good living' have that potential to bring alternatives to life, a broader transformation in the relations between state actors, local communities and the environment is necessary to disentangle the human dreams from the workings of the extractivist economies, and stop the acceptance of environmental destruction as the inevitable cost of progress.

Paradoxes

Not far from the colourful lithium pools where mining companies extract almost two thousand litres of water per second from the ground's deepest layers, the Atacameño communities subsist through architectures of solidarity.[49] Traditional architecture in the villages of San Pedro de Atacama, some dating back 12 000 years, are attuned to all the beings in *ayllu*. [Fig. 4] Vernacular houses are oriented towards Licancabur, the volcano, which reveals the sunrise every morning and marks the start of the day and the start of life.[50] Seeking equilibrium with the land, a guide and expert on the infra-world ('what is under') indicates the best place to settle.[51] Not all sites are appropriate for construction. The ground is alive and ancestors become one with the earth. 'Every time you step on a path, you are stepping on people,' says Rolando Humire.[52] Before laying the foundations, Atacameños make an offering to the land, ask permission and express gratitude to the spirits, the ancestors and Mother Earth, '*Patta Hoiri*'. [53] Their architectural practices transcend the Cartesian divide and question modern ways of knowing and describing the world; they challenge the idea that someone can actually 'own' a place or its resources and export them in exchange for profit. 'We don't own anything. We are part of everything', Humire explains.[54] The activities of the Atacameño community are not only based on taking, but primarily on caring and giving back. [Fig. 5]

Yet, the Atacameños don't live in a vacuum and the sustained dispossession they have faced has made it inevitable that they mediate the space between indigenous cosmovision, the state's legal framework and the omnipresent grid. Safeguarding their environment and livelihood from actors who aim to control land and resources often means, for numerous communities, recognising and securing land rights, as well as strengthening property rights. In Atacama, such processes are currently fulfilled by the National Indigenous Development Corporation through the mechanism of land purchase and transfer.[55] It is necessary to notice the discrepancy between the indigenous ontologies of land and the fragmented outcomes that result from the technocratic process of land titling. As Penelope Anthias contends, land tilting programmes and processes connected to contemporary indigenous territorial claims in Latin America have helped to make visible the communities that the cadastral maps had previously invisibilised.[56] They clarify and formalise land tenure arrangements, particularly if conducted through decision-making processes involving the community and guaranteeing the recognition

Fig. 3: Pipes connecting to the lithium evaporation ponds in the SQM plant in Atacama, Chile, 2022. Photo: author.

Fig. 4: Bosque Viejo, Toconao, San Pedro de Atacama, Chile, 2022. Photographer: author.

and respect of customary land tenure systems, which are often based on communal ownership and use rather than individual property rights.[57]

At the same time, as critical academic accounts have pointed out, many of these processes impose modern forms of cartography, territory and property that perpetuate essentialist understandings of identity and insert indigenous territories within state and capitalist grids of legibility and control.[58] The proliferation of internal property boundaries often results in community fragmentation and atomisation, which could be leveraged by corporations and state actors to bypass indigenous demands for consultation. In Atacama, to reconstitute and reclaim territory from outside the Cartesian enclosure is an arduous task filled with contradictions. Villages such as Toconao, a town that borders the Atacama Salt Flat with a population of 670 inhabitants, 90 per cent of whom are members of the Lickanantay people, has not yet been able to obtain ownership of their territories.

The indigenous community of Toconao has the largest territorial claim in the Atacama basin, pertaining around 400 000 hectares, of which only 25 per cent has been regularised and transferred to members of the community.[59] Had the proposal for a new Chilean constitution been approved, Toconao would have found renewed support in the regularisation of its territories. Article 79 established that the state should recognise and guarantee 'the right of indigenous peoples and nations to their lands, territories and resources' and that 'restitution constitutes a preferential mechanism for reparation, public utility and general interest'.[60]

In addition to their lands, water management in Toconao is also at the centre of conflicting yet concurring modalities of existence. Water is communal, irrigation is organised in turns and customary indigenous norms apply for its administration.[61] A system of canals and ponds serves to redistribute water, and is regularly maintained by the 'comunidad de regantes' (irrigation community). [Fig. 6] Water is treasured, and habitants don't use more water than they are entitled to, or out of turn. These water relations in ayllu manifest an ecosocial system based on relationality and forms of interdependency that is capable of instigating other imaginaries of life in common. Water relations, however, has also been an object of dispute among indigenous communities and their allies in the area. Examples of these tensions are manifold, but the transfer of part of their water rights to Sociedad Química y Minera de Chile (SQM) in 2013, turning irrigation water into mining water put the Asociación Atacameña de Regantes y Agricultores de Aguas Blancas, which represents Toconao, under scrutiny. The association sold 4752 m^3 of water per day at a rate of 55 litres per second, at USD 1.05 per m^3.[62]

Community members do not hold homogeneous positions in relation to mining companies. Employment, social corporate responsibility programmes and commercial agreements make indigenous communities into participants in the extractivist economies that have endangered their survival. Indigenous life practices are intertwined with and inevitably affected by lithium mining and the political processes it instigates. There is no respite for Atacameño communities and for many other indigenous communities inexorably linked to global markets, where corporations' externalised impacts are most noticed. They face the challenge of balancing their relationships with the state apparatus and the local economy with their right to self-determination. They must navigate the pressures of neoliberalism, which requires that they be entrepreneurial in order to survive, while maintaining a local economy of solidarity. [Fig. 7, 8]

It would be hypocritical to highlight the contradictions arising from the coexistence of indigenous communities within capitalism without considering our conflicting interests regarding green energy futures. It is crucial to acknowledge these contradictions in order not to essentialise indigenous peoples. Under no circumstances should they be burdened with the task of setting an example for Western societies on how to overcome the systems of exploitation and environmental destruction that these societies set forth. As recognised by Article 26 of the United Nations Declaration on the Rights of Indigenous Peoples, these communities have the right to own, use, develop and control the lands, territories and resources they have traditionally occupied or otherwise used or acquired.[63] The balancing act of determining priorities and strategies for improving their economic and social conditions is what allows the peoples of Toconao to reclaim local power from extractivist industries, challenging historical processes of violent appropriation and dispossession and ultimately ensuring their survival. [Fig. 9, 10, 11]

If the Cartesian grid operating in the Atacama cadastre overtakes the dimensions of the real by selling the illusion of order and legibility for the sake of energy extraction, the life in the salares reaffirms itself as contested and contingent. The grid disregards the actual relations and, using Marder's terms, levels down *what is* for the sake of *what could be*, to make the actual conform to the template of our energy dreams. It is in the messiness of *what is* where we can find common ground for broader coalitions among human and more-than-human life, from where to build collective action against extractivism and the dualism of the Cartesian enclosure.

Fig. 5: Camelid in the Bosque Viejo, Toconao, San Pedro de Atacama, Chile, 2022. Photo: author.
Fig. 6: Communication by the Asociación Atacameña de Regantes y Agricultores de Toconao (Toconao's irrigation community), 2022. Photo: author.

Fig. 7, 8: Irrigation system in Toconao, San Pedro de Atacama, Chile, 2022. Photo: author.

Fig. 9: Water infrastructure in Toconao, San Pedro de Atacama, Chile, 2022. Photo: author.

Fig. 10: Irrigation canal in Toconao, San Pedro de Atacama, Chile, 2022. Photo: author.

Fig. 11: Irrigation canal in Toconao, San Pedro de Atacama, Chile, 2022. Photo: author.

Notes

In this essay I draw on and summarise several of my previous works, including the book *Lithium: States of Exhaustion* that I co-edited.

1. Michael Marder, *Energy Dreams: Of Actuality* (New York: Columbia University Press, 2017).
2. The critical analysis of Cartesianism follows the work of Georges Canguillhem, particularly Georges Canguillhem, 'Machine and Organism', trans. Mark Cohen and Randall Cherry, in *Incorporations*, ed. Jonathan Crary and Sanford Kwinter (New York: Zone Books, 1992), 44–69. I have elaborated on these questions in previous academic articles and chapters in books.
3. Achille Mbembe, *Critique of Black Reason* (Durham, NC: Duke University Press, 2017).
4. The term ayllu is a traditional Andean social unit, often structured by family and kinship relationships.
5. Marisol de la Cadena, *Earth Beings: Ecologies of Practice across Andean Worlds* (Durham, NC: Duke University Press, 2015).
6. 'Mining Ministry notifies the awarding of a public tender to increase lithium production', in Gob.cl, the digital portal of the government of Chile, 12 January 2022, https://www.gob.cl/en/news/mining-ministry-notifies-awarding-public-tender-increase-lithium-production/.
7. 'Lithium 101: Learn more about the element Lithium', *Albemarle* website, https://www.albemarle.com/businesses/lithium/lithium-101, accessed August 23, 2022.
8. Ryan Dube, 'The Place With the Most Lithium Is Blowing the Electric-Car Revolution', *The Wall Street Journal*, 10 August 2022, https://www.wsj.com/articles/electric-cars-batteries-lithium-triangle-latin-america-11660141017.
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Biography

Dr. Marina Otero Verzier is an architect and researcher. She is Dean’s Visiting Assistant Professor at Columbia University’s GSAPP in in New York. In 2022 she received the Harvard Graduate School of Design’s Wheelwright Prize for a project on the future of data storage. From 2020–23 she was the Head of the Social Design Masters at Design Academy Eindhoven, and from 2015–22, the Director of Research at the Nieuwe Instituut, where she led initiatives focused on labour, extraction and mental health. Previously, Otero was Director of Global Network Programming at Studio-X, Columbia University. Otero was a co-curator at the Shanghai Art Biennial 2021, curator of the Dutch Pavilion at the Venice Architecture Biennale in 2018 and chief curator of the 2016 Oslo Architecture Triennale. She co-edited *Automated Landscapes* (2023), *Lithium: States of Exhaustion* (2021), *More-than-Human* (2020), *Architecture of Appropriation* (2019), *Work, Body, Leisure* (2018) and *After Belonging* (2016), among others.

Platforms and Palimpsests: Urban Landscapes of Data in Northern Virginia

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Abstract

Data platforms increasingly mediate the relationship of society to the data it produces and therefore form a critical layer of the contemporary link between data and urbanisation. However, the current discussion of the impact of data platforms on urbanisation is limited on one hand by an overly metaphoric articulation of platforms, which obscures the material geographies and infrastructural landscapes of data production; and on the other hand, by an administratively bounded reading of platforms, which confines the discussion to only their most visible impact in cities. In this article I argue that to fully capture the impact of platforms on urbanisation we need to overcome these limitations by examining the 'operational landscapes' of data production and circulation. This extended ontology of platforms positions the spatial discourse of technology in relationship with other forms of capitalist spatial production and opens up the material geographies and infrastructural landscapes of data production for critical engagement as integral parts of the sociotechnical construction of platforms. By examining the data landscapes of Northern Virginia, I illustrate how historic and contemporary forces, actor networks, and urban dynamics contribute to the construction and maintenance of the extended geography of data platforms.

Keywords

platforms, platform urbanism, data production, operational landscapes, neoliberal urbanism, Northern Virginia

The Washington and Old Dominion (W&OD) trail is a forty-five-miles (seventy-kilometres)-long multi-use trail outside of Washington DC, on the southern banks of the Potomac River. It stretches from Arlington to Purcellville, close to the Virginia-West Virginia border. If the name is not enough of a giveaway, there are plenty of clues along the length of the trail that connect it to its railroad predecessor. The entire length of the trail is converted from a series of failed railroads, the earliest of which dates back to 1859. But it is not only weekend joggers, weekday commuters and parents pushing strollers that occupy the right-of-way of the old railroad. Underground fibre optic cables share space with high voltage transmission lines above. It is estimated that around 70 per cent of global internet traffic passes through the data centres and exchange hubs of this part of Virginia.[1] This unassuming geography is an important part of the operational landscapes of data: where global data circulates, where it is exchanged and stored, and where it takes on its value. This is where data platforms assemble and expand their infrastructure and hence their territorial claim over data. Given the importance of data to all aspects of contemporary urban life, operational landscapes like those surrounding the W&OD trail, which so heavily contribute to the circulation, storage, and otherwise production of data, become potent sites for the examination of the spatial imprints and urban agency of technology platforms. The W&OD plays an unintentional but significant role in the development of the technology corridor for which it serves as the unofficial spine.

In the first quarter of the twenty-first century, advanced capitalism has been largely reoriented toward the extraction, management and operationalisation of data.[2] The platform has emerged as a new model of capitalist corporate entity in response to the ascendance of data and the long decline in the profitability of the manufacturing sector. A platform is a hybrid mix of software and hardware that enables and facilitates the data operations at the core of the contemporary information economy. While platforms often grow from the internal needs of technology companies to handle their own data, they have quickly become

an 'efficient way to monopolise, extract, analyse, and use the increasingly large amounts of data' for other companies and organisations.[3] The platforms' domination over data resources has positioned them as powerful infrastructural entities for other sectors, businesses, and organisations who depend on data but often lack the resources and capacity to handle massive amounts of data on their own.

And while platforms like Amazon and Google seem to operate outside of traditional capitalist economies, they very much depend on strategies of enclosure and expansion at the core of capitalism. So even though platforms are 'asset- and employee-light, low on liability and high on upside', they 'aspire to monopoly, often unapologetically, and have been instrumental in rehabilitating the concept'.[4] In their simultaneous capacity as 'organizational forms that are highly technical, and technical forms that provide extraordinary organizational complexity to emerge,' platforms 'take on a powerful institutional role, solidifying economies and cultures in their image over time'.[5] In their basic role as technical infrastructures, societal armatures and organisational forms, platforms prepare the ground for actions, and hence prompt conformity to their rules, limits and politics. Platforms are at once, and inherently, concentrative and expansive: they 'centralize and decentralize at once, drawing many actors into a common infrastructure'.[6]

In this article I argue that two readings within the discussion of data platforms and urbanisation have resulted in a limiting of scope within critical examination of how technology and data are transforming urban environments, their conception and their future. On one hand, metaphoric readings of technology and data have been instrumental in establishing and maintaining the sociotechnical imaginaries of platforms that propagate myths of immateriality, inherent sustainability, and ideologies of technologically driven social progress. While problematic metaphors abound in the discussion of data platforms, scratching their surface can often reveal the very systems, spaces, and politics that metaphors try to hide as they attempt to iron out the wrinkles of the messy geopolitics of technology. On the other hand, scholarship at the intersection of technology, data and urbanisation is still largely confined to the city. While recent literature, mainly from media studies, has explored the materiality of data and its infrastructure, a broader discussion of the complex relationship between global urban processes and data platforms is still lacking.[7] Examining the 'operational landscapes' of data production and circulation enables an extended reading of platforms and urbanisation that positions the spatial discourse of technology in relationship with other forms of capitalist spatial production and opens them up for critical engagement as integral parts of the sociotechnical construction of platforms.[8] While seemingly unrelated, these two readings have been essential to the conception of data platforms and their urban operations. To fully ground the spatial and material impact of technology platforms on contemporary processes of urbanisation we first need to unpack the limitations of each of these readings. This is followed by an analysis of Northern Virginia's data landscapes and their histories as an example of the specific ways in which planetary platforms and their construction are grounded within the complexity of local geopolitics.

Pushing back on metaphors

In a 2010 special report on managing information, *The Economist* outlined the ways in which cloud companies profit from internet data. Writing specifically about Google, the article details the various ways in which the company exploits the 'by-product' data generated from millions of user interactions on the web. The report calls this by-product 'data exhaust'.[9] While this may not be the first instance of the use of data exhaust to refer to the digital footprint of web activity, it is conceptually and operationally significant. First, by not granting any value to digital footprints, Google positions itself as a pioneering company that is generating value and profit out of nothing, as if by alchemy. And second, as Shoshana Zuboff elaborates, 'once the data are redefined as waste material, their extraction and eventual monetization are less likely to be contested'.[10] In a similar vein, the 'data is the new oil' metaphor argues that data has supplanted oil as the world's most valuable resource.[11] The metaphor has become commonplace not only in business and technology publications but also within the literature of global organisations such as the World Economic Forum or the International Monetary Fund.[12]

These metaphoric characterisations of data have consequences beyond buzz words. They directly contribute to the material construction of technology platforms and their operational logic. As media theorist Shannon Mattern reminds us, 'metaphors give rise to technical models, which inform design processes, which in turn shape knowledges and politics, not to mention material cities'.[13] Metaphors are in this sense instrumental in establishing and maintaining the sociotechnical imaginaries of technology platforms, which Sheila Jasanoff describes as 'collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology'.[14] While within this formulation the state is typically the main actor in the construction and expansion of sociotechnical imaginaries, in the case of contemporary data platforms it is largely technology firms that 'set the tone, enroll other actors, and weave the narratives' necessary

for their establishment and expansion.[15] Devaluing data as waste or presenting it as raw material through these metaphors has been instrumental in establishing and maintaining the sociotechnical imaginaries of platforms that in turn propagate myths of immateriality, inherent sustainability and ideologies of technologically driven societal progress.

Furthermore, as scholars of technology have long maintained, data does not exist in a raw state.[16] Hence, it cannot simply be extracted like oil. Instead, data is actively produced.[17] The production of data is always a material operation and – unlike the amorphous clouds that represent it – entails an uneven planetary geography. In a process parallel to other capitalist modes of production, the production of data and its mobility necessitate the spatial (re)production of operational landscapes of extraction, storage and processing, as well as infrastructural geographies of circulation that accommodate the continual expansion of data platforms as capitalist entities.[18] From the collection of data through smartphones and sensors, and their transmission through a global network of cables and exchange facilities, to their storage and processing in data centres and their ultimate visualisation on urban dashboards, the production of data entails a material geography that not only rivals any other economic sector, but it surpasses them in scale and importance. Once you consider the mining and extraction practices of elements critical to electronic devices and the supply chain of their delivery, the material geography of data forms a truly planetary condition. Metaphors actively obscure these material processes and the infrastructural mediations necessary to the construction and maintenance of this planetary geography. Platforms in turn leverage this same geography to wield power in cities and to dominate the production and management of the valuable data that is exchanged within them.

Urbanising platforms

In parallel to the metaphoric representations of data, the way platforms are viewed in relationship to urbanisation presents inherent spatial limitations that undermine the extended geographies of their production in favour of a more normative analysis of their transformative effects in cities. While population-based thresholds and statistic or administrative definitions of urbanisation have been questioned since the early twentieth century, the current perceptions of platforms and technological urbanism seem to suggest the resilience of the city as the dominant site of urban discourse.[19] This is particularly visible within the emerging discourse of platform urbanism. Within much of the literature platform urbanism is presented as a nascent assemblage of urban visions, ideologies, practices, and materialities largely promoted, driven and dominated by technology platforms. Partly in response to the conceptual uncertainty of smart urbanism, platform urbanism attempts to go 'beyond the smart city' by positioning itself as more of a template applicable to multiple urban conditions, and 'not primarily defined and delineated by set urban geographies, but rather by novel, digitally-enabled assemblages of technology firms, providers of goods and services, users/consumers'.[20]

But while the potential for an extended reading is introduced in the literature on platform urbanism, so far it has not been taken up as a serious component of studying the relationship between platforms and urbanisation. Much of the material on platform urbanism is still largely contained within the city and constrained by a 'methodological cityism' that has limited a broader and more complex understanding of how urban technology regimes are constructed atop globally extended material geographies with inherent political, social, and spatial intricacies.[21] Instead, the emerging literature on platform urbanism focuses on the most visible impacts of technology platforms in cities by exploring delivery and dating apps, ride-sharing platforms, or the city as a data marketplace, which are inherently administratively bounded, anthropocentric, and which further emphasise population densities as sites of analysis and platform operations.[22]

The relationship between platforms and urbanisation in these discussions is often portrayed as a one-dimensional process of data extraction and service provision. Platforms are rendered as black boxes that provide an array of services to the city and in exchange extract data from users. So while the dependency of platforms on population centres – for the cache of data that they hold – is clearly articulated, how these relationships are mediated and the extended reach of data infrastructures and their dependence on other geographic and environmental conditions are only hinted at and not fully considered. This is important as these extensions are the operational landscapes that underwrite the power platforms wield in cities, and precisely how they have positioned themselves as harbingers of new models of urbanism. Hence, the 'where' and the 'how' of platform urbanism needs to be complicated to capture the intricate relationship between cities and the operational landscapes of data production and circulation that may be found outside of the typical notions of urbanity.

Towards an extended ontology of platforms

Metaphoric representations and geographic limitations do not only hide the means of production of data, but they also tend to obscure the *longue durée* of technical landscapes and how contemporary landscapes of data have evolved in direct relationship to previous rounds of infrastructural development. By so doing they conceal the spatial dependence of data production on other infrastructural

systems and material geographies that continue to enable the ascendance of data platforms, even as the resources essential to the storing, processing and circulation of data dwindle.[23] Alternatively, conceptualising platforms through their territorial processes allows for capturing the palimpsest of dynamics that contribute to the construction and continual maintenance of technology platforms. This problematises the dominant understanding of platforms as already existing conditions, and instead positions them as evolving assemblage of processes and conditions that enable the competitive territorial expansion and enclosure of resources at the core of twenty-first-century data capitalism.[24] Rematerialising the discussion of platforms through an infrastructural perspective allows for an examination of the contours of production and circulation of data in platforms and the intricate relationships and interdependencies they create with ecological, environmental, and political conditions.

Recent debates on planetary urbanisation in urban studies and cyborg urbanisation in urban political ecology allow for the construction of a hybrid analytical framing that collapses the natural/social, human/non-human, and concentrated/extended dichotomies of urbanisation.[25] In the critical analysis of the operational landscapes of data, like those stretched along the W&OD trail in Northern Virginia, historical narratives of the forces and actors that contribute to their emergence and construction illustrate the inherent fallacy of weightlessness and sustainability that accompanies much of the sociotechnical imaginary of platforms. These narratives ultimately redraw the territorial footprint of platforms into the extended moments of urbanisation, to incorporate the human and more-than-human agencies contributing to the sociotechnical production of platforms, and to capture the full spectrum of their social, environmental and ecological impact. The case of Northern Virginia is especially interesting in this context as it captures the full range of urban landscapes that are operationalised through the process of data production. From dense population and commercial centres in Arlington and Tysons where urban data is extracted and consumed, to the pathways and corridors of data circulation along highways and trails, to the more than seventy-five data centres that store and process the massive quantities of data and that underwrite the computing power of platforms.

Decoding the palimpsest:
spatiotemporal contours of a tech corridor

The northernmost edge of Virginia, stretched along the southern banks of the Potomac River, is shaped equally by history and the future. Straddling the line between the North and the South, Northern Virginia's multilayered urban landscapes reflect a patchwork of American history. Home to over 3.2 million residents, Northern Virginia is among the fastest growing urban areas in the country. The region is also home to some of the richest counties in the United States. Loudoun County in Northern Virginia has the highest median household income in the country, followed by Falls Church City (second), Fairfax County (fifth) and Arlington County (seventh), all of which form the core of the region colloquially referred to as NOVA.[26] Urbanistically, Northern Virginia presents a dizzying array of uses and stakeholders. Federal agencies share space with current and future tech campuses; historic plantations butt up against nature reserves; airports, logistics hubs, office parks and data centres mingle with breweries, shopping centres, senior living facilities, golf courses and gated communities. A thickening infrastructural mesh connects these spaces while further fragmenting the urban landscape of a region that until fifty years ago was largely farmland. [Fig. 1]

Among technopoles in the world Northern Virginia holds an understated centrality.[27] Around 70 per cent of all global internet traffic passes through the data centres and exchange hubs that dot the region. This figure alone is significant, but all other identifying factors are also present in NOVA: an entrepreneurial attitude and the presence of venture capitalists; highly ranked research universities; a cooperative infrastructure of zoning boards, developers, marketing firms and lawyers that helps companies get established quickly and efficiently; a high quality living environment including good schools and access to parks and recreational facilities; and the presence of governmental and military institutions that provide access to federal funding.[28] This last point, the region's relationship to federal institutions, has been a constant and defining factor in the technological growth of the region and one that has influenced all other factors. However, much like its other American counterparts, Silicon Valley and Route 128 in Boston, the growth of Northern Virginia in this way has been significant but largely unplanned.[29]

As historians would remind us, the formulaic packaging of the factors that contribute to the emergence of these technological poles only makes sense in retrospect. Original technopoles were not purposefully designed or thought out along these rigid formulations. Yet within the organic nature of technological development in these regions certain forces and actors catalyse, drive or direct the growth. In Silicon Valley, for example, the role of research universities, especially Stanford, cannot be underplayed. High tech industry in Boston's Route 128 has taken over from previous rounds of industrialisation in the region.[30] In Northern Virginia, in the absence of major research universities specialising in technology and any previous industrial activity, the increasing dependency of

federal defence and intelligence agencies on technology contractors in the wake of the Cold War and the area's convenient proximity to the seat of government provided an initial and sustained spark for development. Federal decisions and actions at the local, national and international scales, coupled with a specific series of developments provide the ground for the rapid and particular growth of the region after the 1960s. Peeling back the various layers of this development as well as the forces and actors that have contributed to the build-up of the spatial palimpsest that is Northern Virginia provide insights into the current spatial characteristics of the region and how they maintain the continual production and expansion of data platforms in the area.

From coal to bits

As one of the earliest regional infrastructural developments in Northern Virginia, the Washington and Old Dominion railroad perfectly captures the unintended, yet critical, role that early infrastructural pathways and decisions play in defining and directing the future development of Northern Virginia. Established in 1855 as the Alexandria and Harper's Ferry Railroad, the railway was intended to cross the Blue Ridge Mountains to connect the port city of Alexandria to the coal fields of West Virginia. However, the railroad would face a number of financial problems and was never able to go beyond the Shenandoah River, ultimately terminating in Bluemont, VA. Instead of coal, by the early 1900s the railroad carried passengers, mail, milk and freight as an interurban trolley (tram) system between Alexandria and Western Loudoun County, where several resorts catered to vacationers and day trippers.[31] [Fig. 2] By the middle of the twentieth century and in the context of growing automobile ownership and the extension of highways and roads in the region, ridership on the W&OD dwindled significantly. As its final curtain call the W&OD would deliver aggregate for the construction of the Capital Beltway and the runways of Dulles Airport in the early 1960s, in a symbolic way helping to construct its replacements. In 1968, the W&OD ceased all rail operations. The towns and villages that were stitched together along its track were now hubs within a rapidly expanding urban region flanked by two major airports and crisscrossed by a web of interstate highways and roads.

Over the next three decades the W&OD would be transformed into a recreational and bike trail extending from Arlington to Purcellville. The W&OD regional park is now considered one of the most successful rail-to-trail projects in America. In its current incarnation as a regional trail and a linear park, the W&OD achieves something that its rail-based predecessor could not: a truly regional (even global) connective infrastructure. Sharing the trail with commuting bikers are extra high voltage transmission lines and fibre optic cables that use the right-of-way established by the nineteenth-century rail line to mediate the region's growing dependence on electricity and to bolster its position as a global node for data traffic. Like an infrastructural palimpsest, successive lines and forces have built on the trajectories and rights-of-way established by previous connective infrastructure, creating a dense network of dependencies that mediate the flows at the heart of this contemporary urban landscape. [Fig. 3]

Anchors and institutions

Northern Virginia's proximity to Washington DC and its close relationship with intelligence and federal agencies have heavily contributed to the rapid urbanisation of the region. The establishment of the Pentagon in Arlington in 1943 and of the CIA headquarters in Langley in 1961 were catalytic to the development of the region following World War II. One can draw a clear correlation between these anchor institutions and the suburban development of Northern Virginia. The historian Andrew Friedman has captured how the emerging suburban landscape of Northern Virginia provided the perfect cover for the globally extended operations of American imperial power and an 'imperial home front' for the US after the war.[32] In a way, speculative real estate and the resulting unassuming low-density urban landscapes of Northern Virginia that became home to the growing number of military personnel and intelligence officers, disrupted only by an archipelago of office parks and fragmented by regional transportation lines, provided the perfect cover for the region's many critical infrastructures and the globally extended operations of this 'covert capital'.

As new technology and scientific methods began to inform not just military operations but also other governmental activities, these institutions became the anchors from which the federal support of research was directed during the Cold War. As federal funding support grew, so did the pace of development in the region. Proximity to these institutional anchors together with the general shift of government and military institutions towards private contractors, coupled with relaxed local land use politics and the post-war movement from central cities to suburbs would heavily contribute to the rapid development of the area of Northern Virginia between the Pentagon and the CIA headquarters in the 1960s.[33]

Highways, office parks and shopping malls

It is well documented that the threat of nuclear attack after the Second World War contributed to a push towards dispersal and suburban growth. Following the destruction of Hiroshima and Nagasaki, the scientific community, whose

efforts had helped create the atomic bomb, was quick to offer solutions for the reconfiguration of cities to minimise damage to their populations or industries in the event of a nuclear attack. One such plan came from Norbert Wiener, the intellectual father of cybernetics. In a 1950 issue of *Life* magazine, under the title 'How U.S. Cities Can Prepare for Atomic War', Wiener laid out a plan to decentralise American cities.[34] Using a system of arterial roads and a beltway ten miles out from the centre of the city, the plan called for the dispersal of the functions and living environments of the city as a defensive measure against a nuclear strike, as well as to 'thwart the extreme and unhealthy internal growth' of America's large cities.[35] While other factors such as rising automobile ownership and lending policies that favoured single family homes were also significant contributors to the rise of suburbia in post-war America, for Washington DC during the Cold War the dispersal of industries, government and residences seemed like an operational necessity.

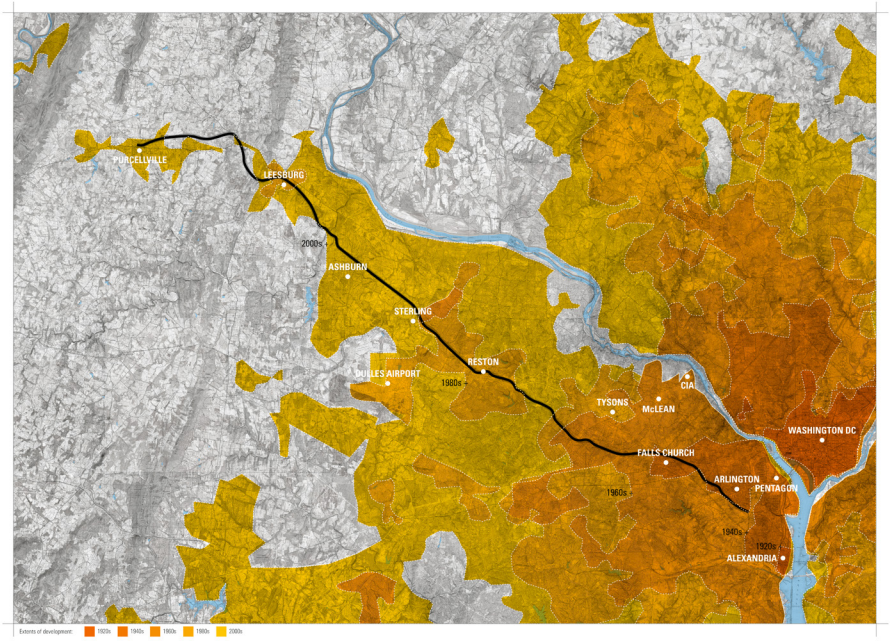
It was in this defensive climate that the idea of a series of loops around Washington was first proposed in 1950. The outermost loop – the only one to be fully completed – was proposed to be outside of a possible atomic blast zone at a ten-mile radius from the White House, matching the radius of the proposed beltway in Wiener's plan.[36] This outer loop would become the Capital Beltway, the completion of which in 1964 was essential to the urban growth of Northern Virginia, specifically that of Tysons (previously Tyson's Corner). The beltway provided a much-needed connection to Washington and Maryland on the other side of the Potomac. By the early 1960s much of the commercial and residential development outside of the district was happening in Maryland. The beltway redirected this growth towards Northern Virginia. This new connectivity, coupled with the presence of the Pentagon and the CIA headquarters in NOVA, made the region an attractive place for technology contractors, who in the wake of the Cold War were in high demand. The completion of Dulles International Airport in 1962 and the extension of the Dulles Access Road which connected to the Capital Beltway in Tysons ensured the local and international connectivity of the region.

Tysons was strategically positioned to take advantage of this new connectivity. Resident resistance to commercial development to the east of the beltway meant that most of the new development would have to extend out to the west of the beltway. The undeveloped nature of the land in Tysons and its ownership by a small number of farming families made urban development less complicated and faster than the neighbouring McLean, Falls Church or Vienna, which were at that time subdivided and dominated by low-density suburban housing. The development of Reston to the immediate west of Tysons provided an additional green buffer that enabled a density of development in Tysons that was unlike other suburban areas. Soon, the office parks and the shopping centres that were so central to Joel Garreau's conception of the 'edge city' would begin to populate this strategically located, yet unplanned, part of Northern Virginia.[37] [Fig. 4] The construction of the Tysons Corner Center in 1968 at the intersection of the Capital Beltway and Route 123 spurred a rapid rise in real estate values, prompting the construction of hotels, office buildings and residential complexes. The super-regional mall and the neighbouring Tysons Galleria, which respectively attract twenty-five million and twenty million visitors annually, would eventually anchor a surge in development in the region. These commercial centres were important in attracting the many technology contractors (and their families) working with the federal government that would define the region's urban identity for the next thirty years.[38]

Infrastructure of the information age

The growth of the internet from military foundations is well documented and a nuanced history of its development lies outside of the bounds of this study. However, it is perhaps worthwhile to examine how this part of Northern Virginia, stretching from Tysons to the west of the Dulles airport along the converted path of the W&OD railroad, became so critical to the growth of the internet, and subsequently to data platforms. By the early 1990s, with defence spending in a downturn, vacancy in the office buildings of Tysons was on the rise. These vacancies were soon to be filled by a new economic force, one built on networking and communication. The internet grew out of ARPANET, a communication network set up by the Advanced Research Projects Agency of the US Department of Defense to enable access and resource sharing to and between remote computers. The rise of the personal computer in the 1990s highlighted the commercial potential of such a network and some of the earliest commercial access providers to the network that would become the internet, like MCI, UUNet, and PSINet were based in Northern Virginia.[39]

To make the internet into a network of networks as it was first imagined, the growing number of service providers needed facilities that enabled exchange between their different networks. MAE-East was among one of the world's first internet exchange points, with facilities in Vienna, Reston and Ashburn. Its original 1992 location was in Tysons at 8100 Boone Blvd, one block south of the Tysons Corner Center.[40] This location still operates as a data centre, albeit a small one by today's standards. The presence of these early peering and exchange facilities in the region as well as the rapid growth of local internet service providers such as America Online (AOL) gave way to



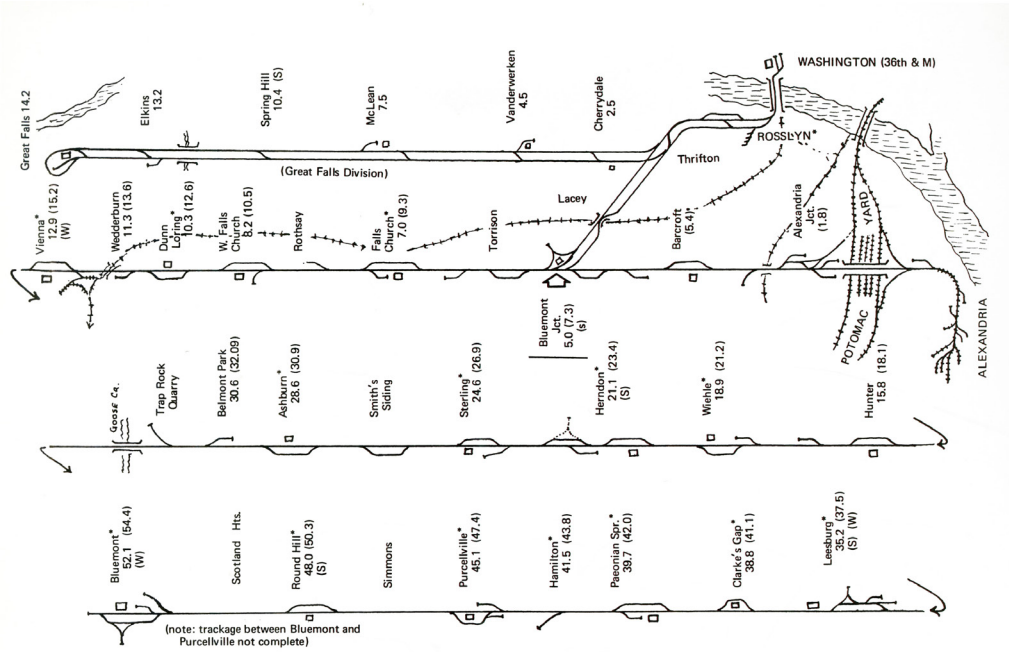


Fig. 1: The historical progression of development in NOVA in relationship to the W&OD trail, 1920s– 2010s. Drawing: author, assembled from historic topography maps from USGS's map archive.

Fig. 2: Trackage diagram of the W&OD, 1916. The flattening of the path of the railway in the diagram reshapes the surrounding territory based on the linear logic of the tracks. Source: Herbert H. Harwood, *Rails to the Blue Ridge* (Fairfax Station, VA: Northern Virginia Regional Park Authority, 2000).

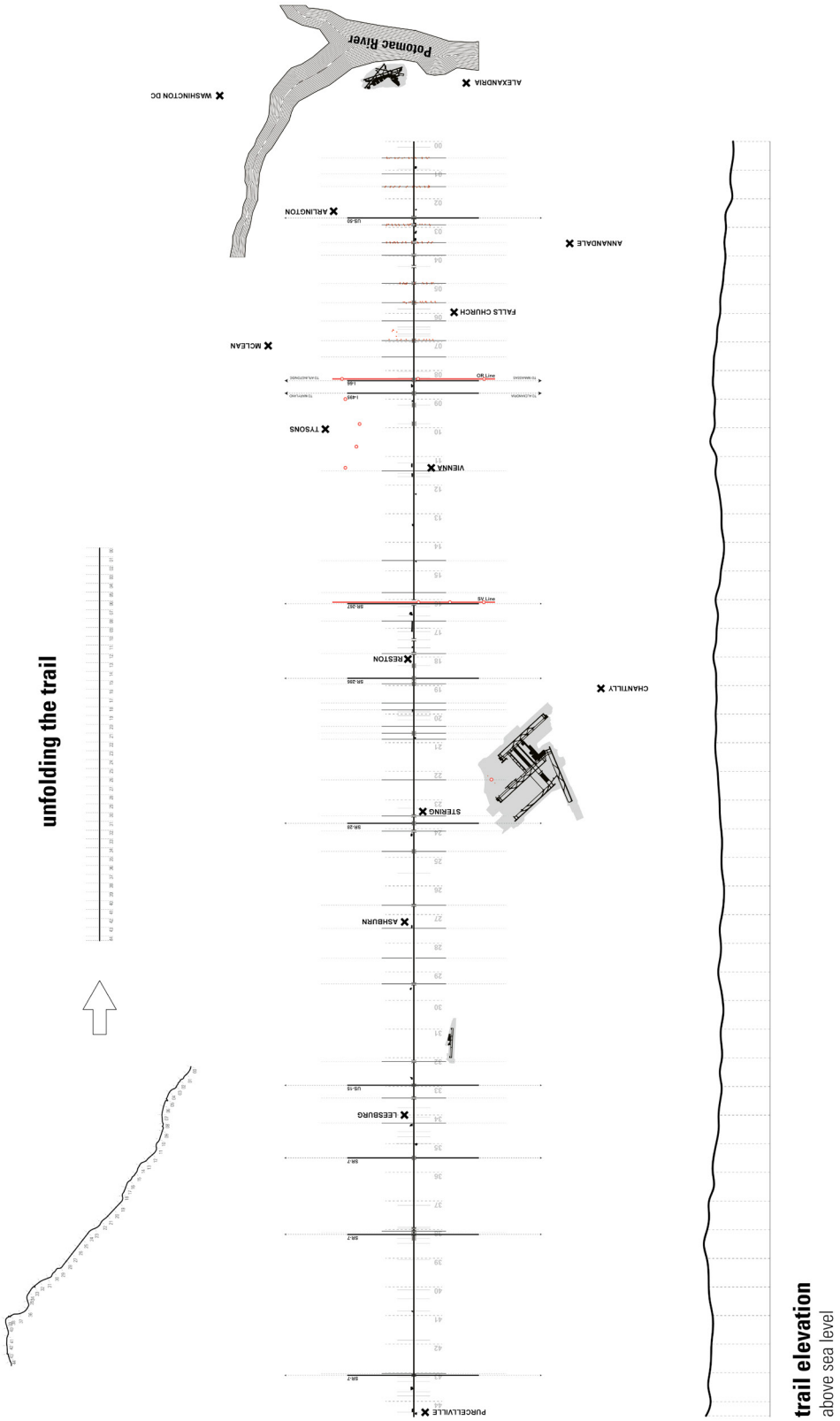


Fig. 3: The unfolded path of W&OD showing elevation, towns, airports, and all roads and highway crossings. Drawing: author.

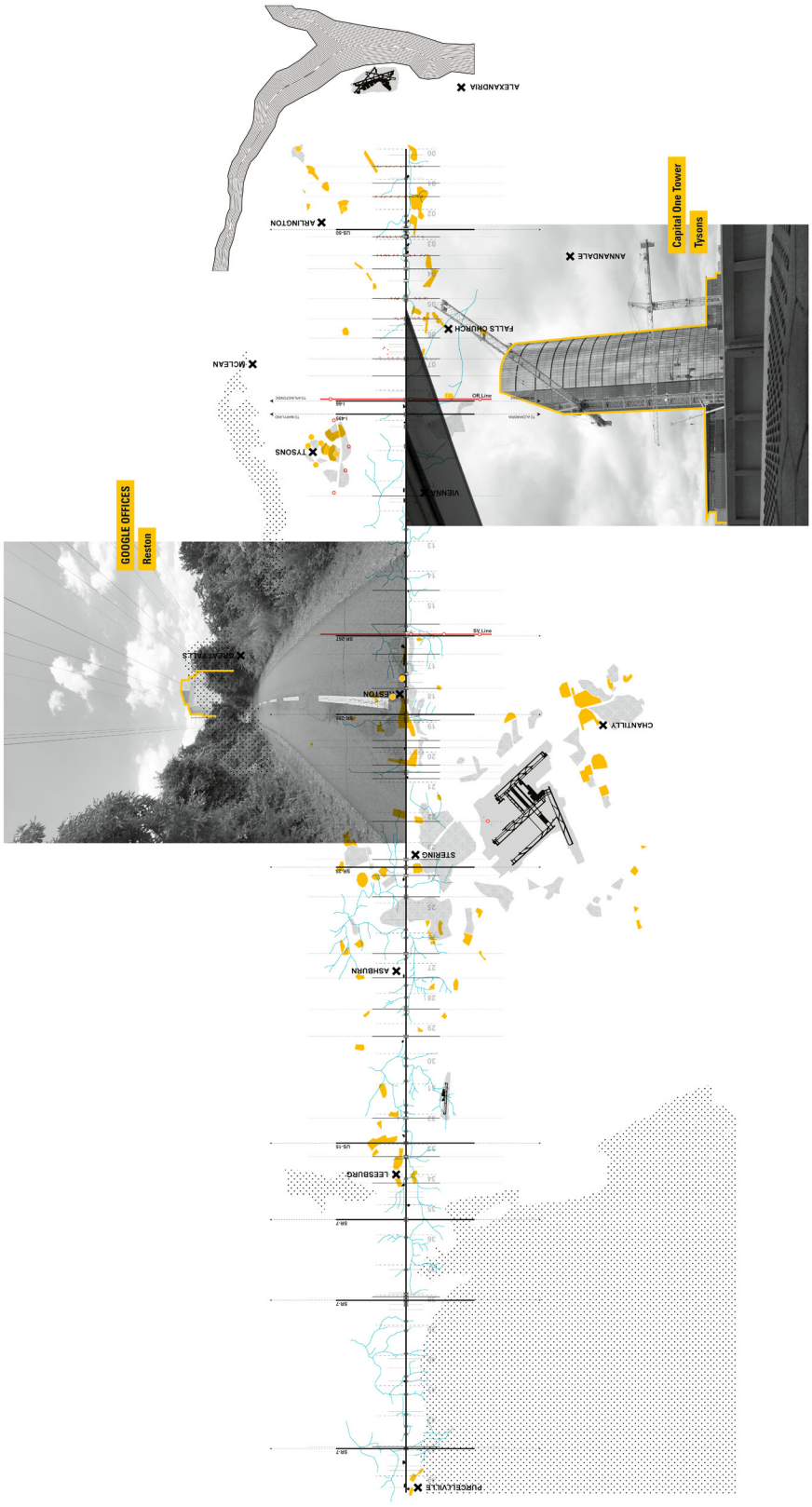


Fig. 4: Office parks and commercial spaces along the W&OD trail. Office parks and Fortune 500 companies are shown in yellow and commercial spaces including malls and shopping centres are cross-hatched in grey. Drawing: author.

a dense network of fibre optics which was laid in anticipation of the growing network demand that would accompany the rise of the internet. Northern Virginia is now home to 'the most dense fiber network anywhere in the world'.[41]

A thickening geography

It is partly due to this infrastructural capacity that the area has remained attractive to technology firms even in the aftermath of the dot-com crash of the early 2000s. However, as it did at the end of the Cold War, the region has shape-shifted. The growth of platforms is transforming the nature of computing from personal computing on individual devices to distributed computing in the cloud, and the dominant form of data networks from decentralised networks on public backbones to centralised data ecosystems on increasingly private networks.[42] This has led to the growing importance of data centres as instruments of expansion within the extended geographies of platforms. Within this expansionist logic, reliability is an important factor. Building up redundancies in the network through the creation of multiple data regions and zones is an essential part of making a data platform reliable. The regions and zones of the cloud are materialised through data centres that are in turn grounded in the specificities of geography. Over the past two decades, relying on relatively inexpensive land in the western parts of the corridor, low-cost electricity, ready access to water for cooling, a growing skilled and educated population, favourable tax incentives, and reliable and redundant infrastructural connectivity, Northern Virginia has positioned itself as the largest data centre market in the world.[43] [Fig. 5]

The positioning of Northern Virginia's technology corridor between federal agencies – a massive client base for data platforms – and the critical data infrastructures embedded in its urban fabric has been crucial in establishing its urban identity and continues to inform its future. Major technology platforms like Google and Amazon have established a significant presence in the region, both in terms of office real estate and back-of-house infrastructure critical to their operations. Amazon, whose Amazon Web Services (AWS) division counts as clients not only other technology firms but also the federal government's defence, civilian and intelligence sectors, has invested $35 billion in data centres located in Northern Virginia since 2011.[44] The company has also recently chosen a site in Arlington for its second global headquarters.[45] Called 'National Landing', the development will involve billions of public and private funding to create a new Amazon campus that will house 25 000 new employees.[46] And there is currently no sign that the buildout of the infrastructural landscapes that support the expansion of platforms will be slowing down in the region. This signals the continued importance of geography, infrastructural capacity and spatial proximities in how data platforms operate. At the same time, it is important to consider that while these factors are increasingly important to the continual urbanisation of the region, they have largely followed paths established by an interwoven web of speculation, infrastructural development and technological advancements since the middle of the nineteenth century.

The more concentrated forms of development in Tysons or Reston that have defined the urbanisation of NOVA for the past fifty years are currently under pressure by the emerging form of urbanisation driven by technology platforms. The Covid-19 pandemic has accelerated the process, driving a data centre construction boom in a region that already represents the largest data centre market in the world.[47] The contemporary urbanisation of Northern Virginia may now be closer to the 'edgeless cities' of Robert E. Lang than the 'edge cities' of Joel Garreau, as the density that was bounded within Tysons spills out and expands.[48] But whether there is an edge or not, there certainly is a spine. The converted tracks of the W&OD have unintentionally become the spine of development in NOVA. The tree-lined trail provides a cross-sectional cut across the different eras of development that have defined the urbanisation of the region over its relatively short history. [Fig. 6]

Grounding platforms and excavating palimpsests

Analytically, the forty-five miles (70 km) of the trail can be broken down to a set of distinct zones that owe their formation to the forces that have contributed to the urbanisation of the region over time. [Fig. 7] The first five miles (8 km) of the trail (Zone 1) are conditioned by the historical presence of the colonial port city of Alexandria and the density and intensity of Arlington, whose development after the arrival of the Pentagon has given direction to the entire region. Here, we find a mix of urban conditions and the highest population density in the region: from high-density office and residential towers to single-family housing that has grown in relationship to the Pentagon. The next seven miles (11 km), between mile markers 5 and 12, (Zone 2) are the commercial heart of Northern Virginia, with Tysons acting as the commercial and office centre surrounded by low-density suburban housing extending out to McLean, Vienna and Falls Church. The next nine miles (14.4 km) to the west of Vienna (Zone 3) are the living room of the region, with large tracts of low-density housing and a large number of public parks and other recreational spaces like golf courses. There is also a significant density of office buildings in Reston, along the W&OD, which has been growing over the past years as large tech companies like Google establish local offices here. The ten miles (16 km)

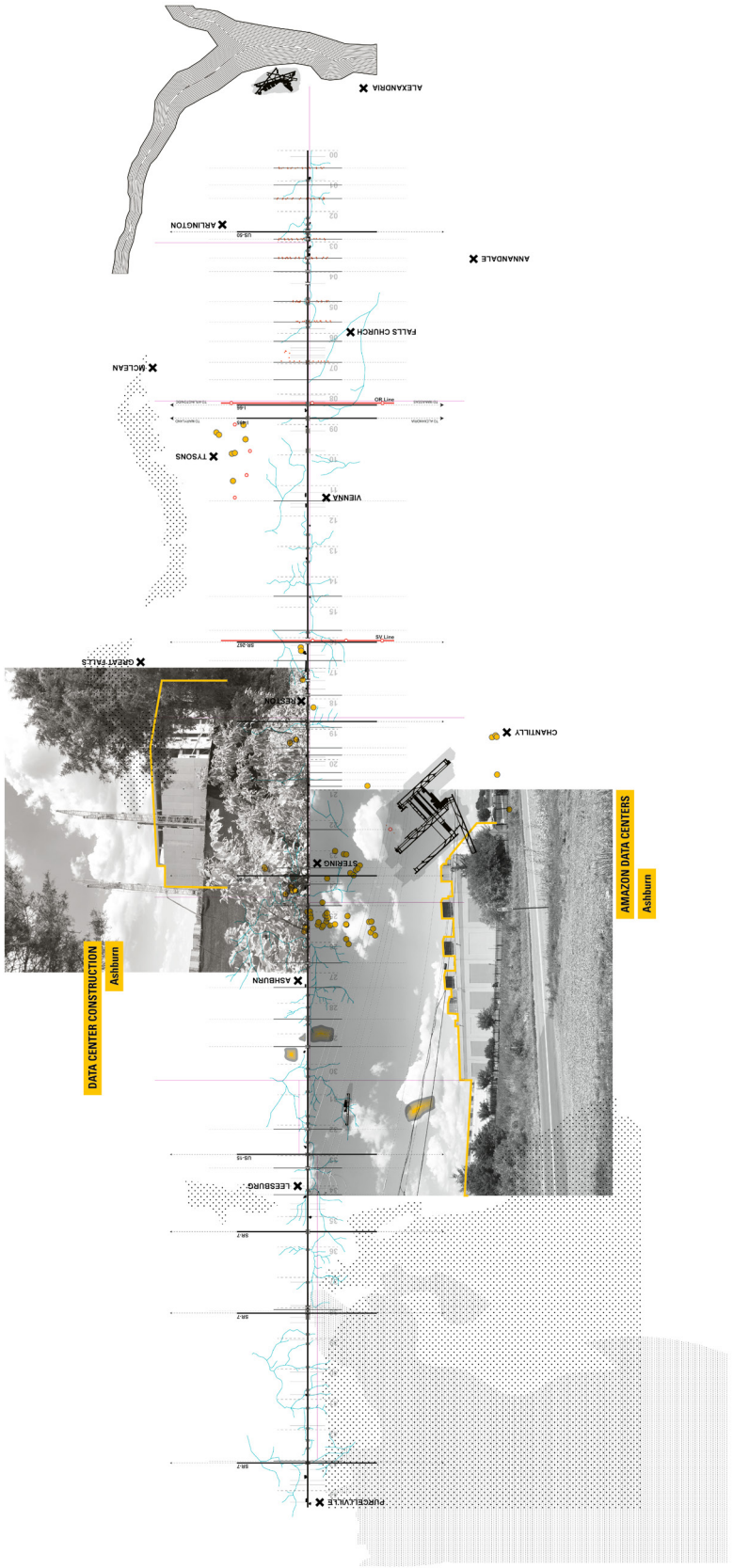


Fig. 5: The operational landscapes of data along the W&OD trail, showing data centres (yellow circles), power-lines (pink lines), quarries (grey-yellow gradient) and agricultural land (fine grey dots). Drawing: author.

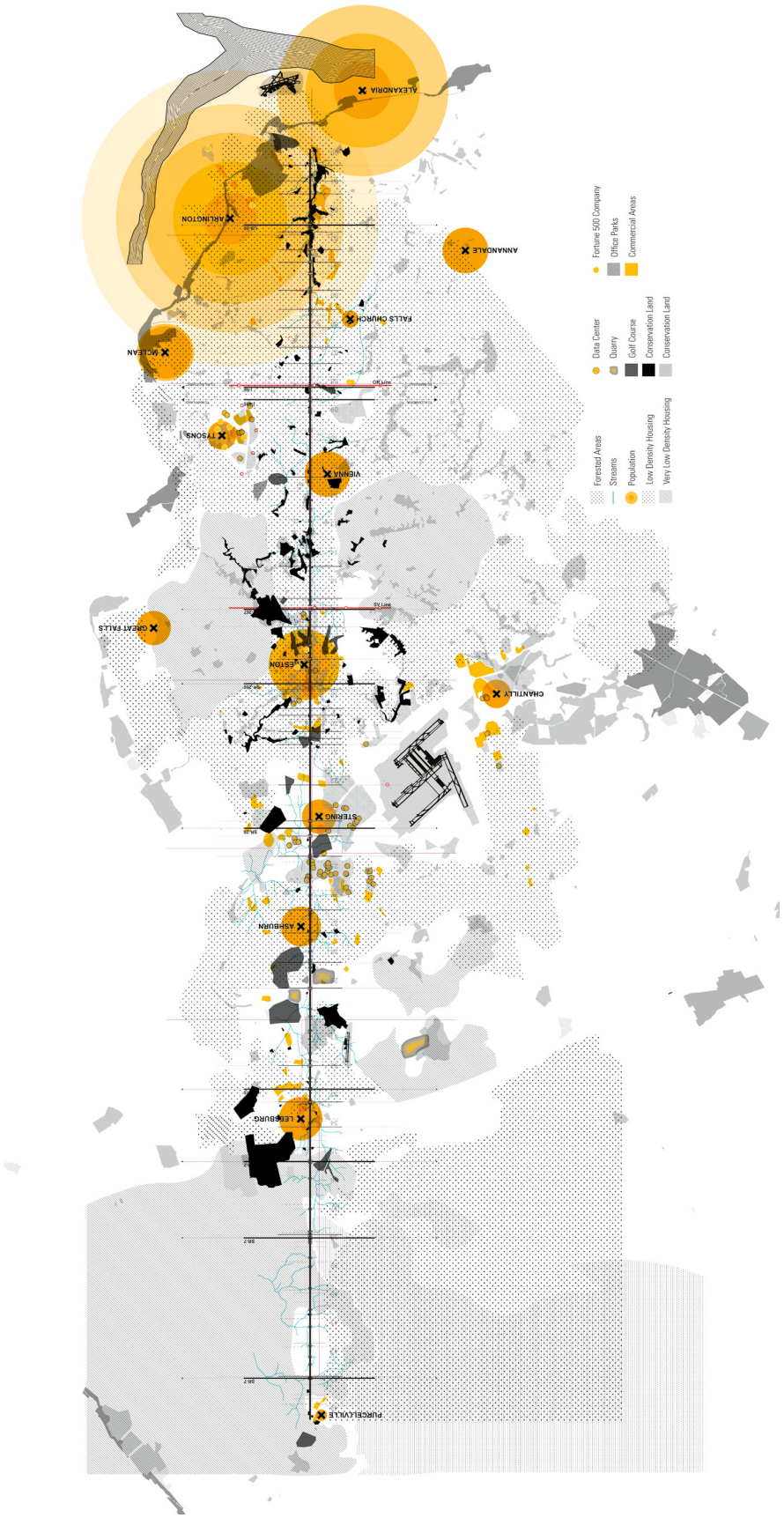


Fig. 6: Urban intensities and proximities in Northern Virginia. The drawing shows how natural geography, population densities, park lands, protected areas, residential zones, data centres and commercial spaces create a thickened urban palimpsest along the path of the W&OD. Drawing: author.

Figure 7: The urban zones of NOVA. Drawing: author.

between mile markers 21 and 31 (Zone 4) can be characterised as the operational landscape of the region. There is the usual suburban housing, but the massive clustering of data centres, coupled with the presence of the airport and surrounding logistical facilities and quarries, make this stretch the infrastructural and logistical engine of the entire tech corridor. The next five miles (8 km, Zone 5) are characterised by the centrality of Leesburg, a historic city that has transformed into a suburban bedroom community for commuters to Washington. The final nine miles (14.4 km) of the trail (Zone 6) pass through a largely agricultural landscape with some low-density housing. The stretch between Leesburg and Purcellville is the least developed portion of the trail, but given the pace and intensity of development happing to its immediate east, this zone will likely witness a radical transformation over the next decade.

Understanding the histories, systems, actors and forces that inform NOVA's urbanisation ultimately helps ground the contemporary operations and trajectories of technology platforms. Through this historical grounding the urban landscape of the region emerges as an infrastructural palimpsest that is continually built upon, tweaked and expanded. And while the contemporary condition is often dismissed as an extension of suburbanisation or sprawl, the presence of technology corporations, defence and intelligence agencies, and the density of critical infrastructural networks in the region hint at a condition that is more akin to the infrastructuralisation of urbanism outlined in Keller Easterling's conception of 'extrastatecraft'.[49] In this vein, the entire urbanisation of NOVA operates as a spatiotemporal infrastructure whose specific twists and turns directly contribute to the continual construction of one of the largest and most important operational landscapes of data in the world. Hence, when speaking about platforms, these spatial narratives and the urban dynamics that play out within them provide a fuller picture of how platforms are constructed, of their spatial dependencies, the timescales of their emergence, and the intricacy of their operation, through all of which data gains its value.

To fully capture the complexity of contemporary relationships between technology, data and urbanisation we need to move beyond the city and into the landscapes that accommodate the production and circulation of data as the lifeblood of the capitalist formation of the platform. These landscapes, which have been constructed over time, need to be historically grounded to more precisely articulate the forces, actors, systems and agencies that continue to contribute to their build-up. This deep mapping of the sociotechnical landscapes of platforms allows the narratives of their construction to move beyond the metaphoric articulations and arbitrary boundaries that typically plague discussions of technology and urbanisation. The aim, however, is not to suggest that all geographies of data production and circulation share these same characteristics. Rather, the point is to highlight the variegated conditions that emerge as we engage with these uneven geographies and the specificities of history and materiality that are embedded within them. Research on these operational landscapes can produce a much more elaborate understating of the diversity of spatial conditions, histories and material geographies that contribute to the construction and maintenance of platforms and provide a counterpoint to the myths that they spread and the 'revolutionary' urban visions they propagate.

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Biography

Ali Fard is a researcher, designer, and educator, currently an assistant professor at the University of Virginia School of Architecture. Fard’s work operates at the intersection of design and global urban processes. He is particularly interested in the spatial imprints of technology and the urban disposition of infrastructure, and how design research can help ground the operational complexity, spatial hybridity, and territorial scales of technical systems. Through writing and his design research practice AF/DR, Fard has been involved in a range of award-winning projects that reinforce design’s critical and multi-scalar role within the territorial dynamics of contemporary urbanisation.

Insular Cowscapes: Technologies of Ecological Restoration

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Abstract
The Azores is an archipelago known for its Edenic landscapes, strongly symbolised by cows grazing in vast pasturelands. These 'natural' scenarios, however, obfuscate technologies of ecological restoration resulting from cattle exploitation, which seem to be in a clear collision with the perception of the Azorean scenery as 'a good way of life'. Impelled by the focus of this *Footprint* issue, I recently visited two farms in São Miguel Island: a medium-size dairy farm and an intensive beef farm. Through this field inquiry, in this article I intend to problematise the fabrication of productive farming landscapes or, rather, the production of cowscapes. The current livestock political vision appears as twofold: a restorative ideal, promoting the 'return to' a supposed bucolic state; and the synchronization of livestock activities through the reconfiguration of the terrain, machines, animals and work. The triad efficiency-optimisation-specialisation might be symptomatic of the current path in the archipelago, within which extensive farming translates into an increased farmland footprint. After all, more efficiency requires more pastureland. Ultimately, the contemporary Azorean cowscapes perpetuate the loss of resilience in global food systems, and the island is only the beginning of the evidentiary trail.

Keywords
cowscapes, metabolic surveillance, bacterial symbiosis, efficiency, extensive farming, farmland footprint.

In this article I problematise the fabrication of productive farming landscapes, or the production of cowscapes. Through fieldwork conducted on São Miguel Island in the summer of 2022, involving an exploration of the techniques and methodologies practiced in one dairy farm and one beef farm, I intend to advance an interpretation of the current entanglement in the productive relation between cows, humans, labour, technology and land.

Rebranded territory, or cowscapes

Let us start by clarifying the 'rebrand' concept, which is here used in the sense of creating a new, competitive territorial identity, capable of being positioned in the global market flows. Indeed, the nine Azorean islands, located in the Atlantic Ocean, are known for their 'natural' landscapes and Edenic scenarios, a connotation which is the outcome of an intensive and relatively recent operation of landscape modification propelled by means of agrarian conversion. The farming modernisation project on São Miguel began in 1843 with the foundation of the first agricultural association on the island, Sociedade Promotora da Agricultura Micaelense, which implemented a system of intense land reform.[1] Prior to this event, during the eighteenth and nineteenth centuries, the biggest island of the archipelago was covered by citrus orchards, responsible for the most important economic activity at that time: the export of oranges to England as a remedy for scurvy.[2] From 1840 to 1860, a plague destroyed the stock of citrus trees, leading the farmers to find alternatives and to farm high-value crops, such as tea, tobacco and pineapple.[3] Along with it a livestock vision for the Azorean islands was slowly starting to be conceived and put in practice, following some examples observed in other European countries.[4] More than a hundred years have passed since the island was conceived as a livestock territory until its actual realisation. The post-war period saw the intensification of livestock breeding and the consequent advance of artificial pastures in the landscape, as companies from the Portuguese mainland established on the island, encouraging and financing farmers to build herds.[5] At first at

an insular scale, farming and livestock rearing ultimately became archipelagic projects.

On the one hand, the perception of these islands as bounded and isolated, with 'visible' limits, means that the main economic activity is in the primary sector, revealed through pineapple greenhouses, beet plantations, passion-fruit trees, immense tea-fields, and almost as an ever-present element, cows. On the other, in the presence of the continuous prospect of endless expansion, and still through the lens of contemporary landscapes of primary production, the island might be a productive 'figure through which a new form of universalism can be conceived.'[6] In short, this insular duality is useful for the purpose of this article: to explore beyond the evident layers of these cowscapes. In the face of climate change, and as Víctor Muñoz Sanz urges, in the following I will attempt 'to reimagine the relationships between society and nature beyond overproduction and domination'.[7]

When I moved to São Miguel Island as an eleven-year-old in 2000, I was told that there were more cattle than residents on the archipelago – a fact that remains true. According to recent data there are roughly 289 000 animals and 242 497 inhabitants.[8] Currently, the production of cow's milk and beef are the main farming activities, and the sector has been growing.[9] The Azores accounts for approximately 35 per cent of total Portuguese dairy production; additionally, 75 per cent of Azorean dairy products is exported to the Portuguese mainland, 15 per cent is distributed on the archipelago, and the remaining 10 per cent is shipped to the Madeira archipelago and to other countries.[10] Contrary to the policy of mainland Portugal, milk production on the Azores increased about 25 per cent from 2003 to 2015, from 507 000 to 629 000 tons.[11] Effectively, milk is the main agricultural product of the autonomous region.[12] [Fig. 1] As a matter of fact, if the Azores 'is one of the most suitable regions for dairy production in Portugal', I ought to add that this is because the archipelago was designed for that purpose.[13]

In 2015, dairy quotas were abolished, following a period of thirty-one years of control by the European Union. The Common Agricultural Policy instituted a different direction, 'to allow farmers the flexibility to expand their production and to profit from the growing extra-EU demand for milk products.'[14] The regional government of the Azores took advantage of the opportunity, investing in the promotion of the islands as a cow's wonderland. Indeed, Azorean tourist marketing rests upon the 'fortunate cows' narrative, formalised in the Happy Cows (*Vacas Felizes*) milk programme launched in January 2015.[15] The organisation's motto is printed on milk packaging: these are 'happy cows that live outdoors and eat fresh grass 365 days a year'.[16]

São Miguel Island has the highest rate of milk production, reaching 89 per cent of the archipelago's total output in 2017.[17] As anyone traveling on the island might notice, the mobile milking systems result from the landscape's idiosyncratic character, due to the fact that 'a typical Azorean farm comprises different plots of land of varied sizes that are rarely contiguous', resulting in a disaggregated field area, which 'creates several problems to dairy farmers that have to move their stock and equipment (milking and feeding equipment) from plot to plot across public roads and paths.'[18] [Fig. 2, 3] These movable instruments are used in the prevailing way of milking cows, entailing pasture rotation methods in conformity with the prevalence of farms with small inventories and size (twenty to a hundred animals and twenty to fifty hectares).[19] The field plot dispersion is very common; thus, only wealthy landowners can afford to have the production concentrated on a single, larger plot of land. Nonetheless, the archipelagic cowscapes have been changing, given that the number of dairy farms in the Azores has been decreasing (by 19 per cent from 2007 to 2017), even though the average number of dairy cows per farm grew by 36 per cent.[20] Apart from this portable device, the so-called traditional system of fixed milking parlours has been gaining presence in the insular landscape.[21] [Fig. 4]

Though less representative than the dairy sector, meat production is growing as well, in tandem with a significant increase in the shipment of carcasses, replacing overseas shipments of live animals.[22] Apart from São Miguel, Terceira and Graciosa islands, most of the meat produced has its origin on extensive farms (99 per cent on Corvo, 63 per cent on São Jorge, 59 per cent on Santa Maria, 58 per cent on both Flores and Pico, and 50 per cent on Faial).[23] On São Miguel Island, 67 per cent of the total meat produced comes from intensive farms, with only 6 per cent raised in extensive farms, as shown in figure 5, in the chart on the left.[24] Most of the fresh meat consumed in continental Portugal is imported from the European Union – from Spain, the Netherlands, Poland, Ireland, France and the United Kingdom.[25] Considering that the consumption of beef per capita has been increasing nationally, the regional government of the Azores has identified this as an opportunity to replace fresh meat imports to the Portuguese mainland with Azorean meat.[26]

Financial aid provided by the regional government and the European Union, directed towards production costs, has a significant impact on the net income of each farming activity, being responsible for, on average, 70 per cent of the total gross income.[27] The main portion of expenses is logistics and transport, given that production, investment, and labour costs generally tend to be low, but the need to deliver the products to the major markets on the Portuguese mainland substantially increases prices.[28]

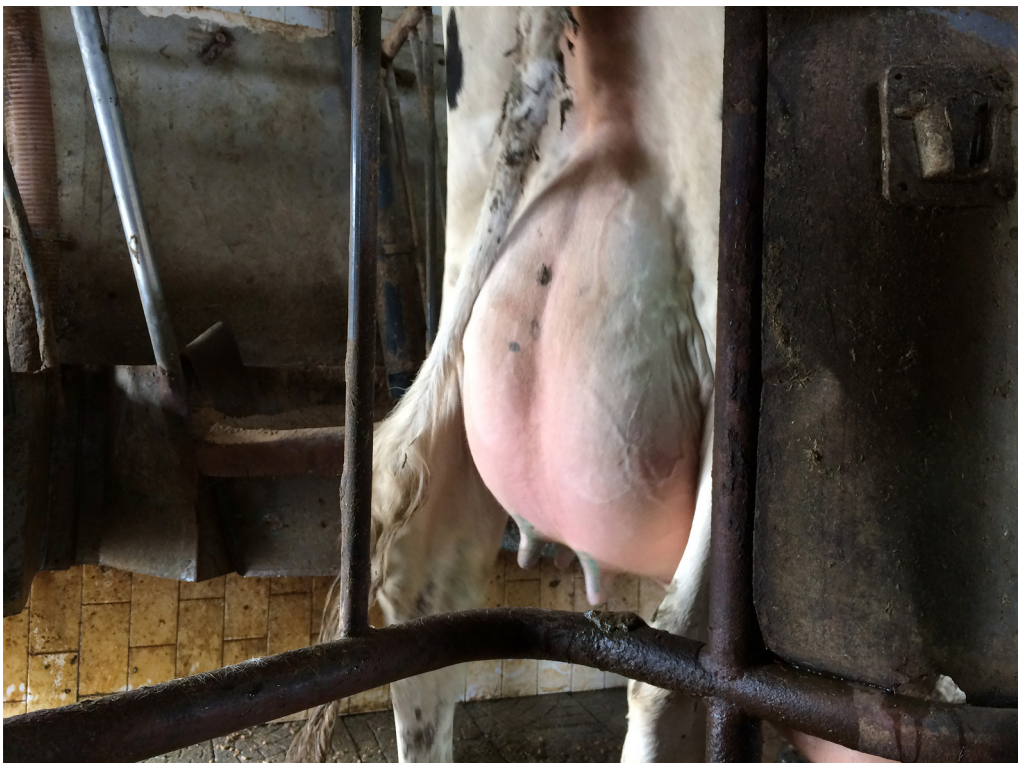
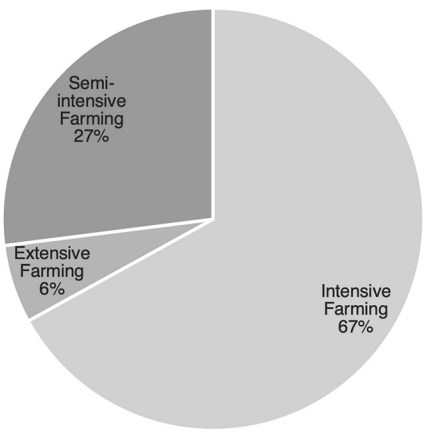


Fig. 1: Dairy cattle, São Miguel Island, 2018. Photo: João Gonçalves.

Fig. 2: Mobile milking system, São Miguel Island, 2022. Photo: Sofia Travassos.

Fig. 3: Mobile milking system, São Miguel Island, 2022. Photo: Sofia Travassos.

Fig. 4: Fixed milking parlour, São Miguel Island, 2018. Photo: João Gonçalves.



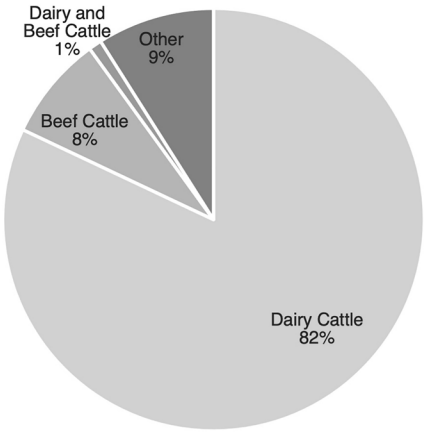


Fig. 5: Left: meat production systems in São Miguel Island. Chart: author. Source: Bisex – Consultoria, Gestão e Execução de Projetos, AgroGes – Estudos e Projetos, 'Plano Estratégico para a Fileira da Carne' (Strategic plan for the meat sector), 2021. Right: animal husbandry on São Miguel Island. Chart: author. Source: Bisex – Consultoria, Gestão e Execução de Projetos, AgroGes– Estudos e Projetos, 'Plano Estratégico para a Fileira da Carne' (Strategic plan for the meat sector), 2021.

Fig. 6: Satellite image of a dairy farm. Source: Google Earth.

According to 2019 data, there are 5 922 dairy and beef producers on the Azores, occupying a total forage area of around 101 900 hectares, corresponding to approximately 44 per cent of Azorean land (231 676 hectares).[29] In figure 5, in the chart on the right, we can clearly see that on the biggest island, dairy cattle accounts for 82 per cent of the breeding, whereas beef exploitation corresponds to 8 per cent.[30] With the aim to understanding objectively what these numbers mean, and impelled by the focus of this issue of *Footprint*, I recently visited two farms on São Miguel: a medium-size dairy farm and an intensive beef farm. Thus, I suggest that we move into these cowscapes.

Metabolic surveillance: pursuing animal performance

I arrived at Eugénio Câmara's facilities on a foggy, windy summer morning. This farm, located in the northern area of Ponta Delgada, in the civil parish of Fajã de Cima, comprises fifty-six hectares and seventy Holstein-Friesian cows, and is a certified producer in the Happy Cows programme. [Fig. 6]. The farmer-manager, who is also an engineer, manages the dairy business started by his grandfather several decades ago. Although it was only a few minutes past seven, all the work related to the first milking period of the day was done. He promptly showed me the facilities, starting with the cowshed, where I noticed a bracelet around each cow's leg. [Fig. 7]. 'That is the best investment I have ever made', Câmara said. 'I implemented this system ten years ago, around 2012, and I do not regret it at all: it is a leg sensor for cow monitoring'.[31] Perhaps he noticed my surprise, so he continued: 'this bracelet is part of a broader programme of detailed monitoring, tracking, among other things, the cows' temperature and the ideal time to inseminate them. It also warns if the cow has been lying down for too long, if it takes too few steps… it is something of an instant cow check tool'. He added: 'You will better understand once we see the milking parlour'.

Indeed, once we entered the fixed milking parlour, he pointed to the floor: 'look at the infrared sensor: it collects information on the amount of milk that is collected, and, through the use of antenna technology, which identifies each cow, registers it on a database'. Câmara continued to elaborate his thoughts on this system, saying: 'it also identifies health problems such as overcrowding, poor bedding, excess group activity, digestion problems… or any other factors that might disturb the animals' comfort and thus can have an impact on their production'. He admitted, 'it completely changed the farm work', because 'the automated system knows exactly what each cow produces, and the parameterised alerts reach us through mobile phone or computer'. [Fig. 8]

In this arrangement, computers and smartphones mediate the relationship between cows and humans, reducing the amount of time needed daily to observe the cows. When I asked Câmara if he thought that automation could ever replace human labour, he said that he does not believe so, and told me that there is a common saying among farmers: 'the cow gets fat with the owner's eye', which means that 'there is always something for the human eye to detect', even if 'dairy farms' work is today so much simpler and easier than some years ago'. And he asserted, 'the problem is to find people who want to work. Off course, when farmers deal with herds of a thousand animals… that individualised attention to cattle is not possible'.

This farm employs two other people besides Câmara. 'We are trying to employ a third, but it is being very difficult to find people nowadays', he said, because 'the schedules are tight, the first milking of the day starts at five o'clock, so two people need to arrive around four in the morning. The second milking of the day is around half past four in the afternoon'. Concerning the type of work performed by each employee, he said, 'one takes care of the cows, the other is responsible for cleaning'. He said, further, that 'each milking takes about one and a half, two hours, and each cow produces thirty to sixty litres per day', and that 'this parlour comprises sixteen milking stations, eight on each side'. Indeed, this so-called herringbone parlour (the name refers to the lay-out) enables the simultaneous milking of sixteen cows, each identified by its bracelet with a unique serial number. Câmara clarified: 'the system retracts when milking stops; it also doses the feed according to each cow. It is essential for optimising production and not wasting feed… But be aware that there are parlours much more advanced than this one! Some of them even have pivoting gates', he stressed, 'so that less time is wasted after milking'.

The bracelet system reminded me of human activity trackers and smart watches. The logic seems the same: calories for humans, calories for other-than-humans. The fitness programmes' approach appears to be extended into the cattle industry, since the well-being imaginary – be it for humans or for cows – entails the notion of efficiency of bodies. The tracking of bodily data attempts to fully operationalise beings. More data leads to more accuracy, and therefore, a greater yield. To manage human and more-than-human metabolisms is to tightly control bodies, considering that 'each body is a porous system.'[32] From this standpoint, cows have an environment related to them, which is behind the 'cowscape' notion: the contingency between the cow and the milieu. In this arrangement between animals and land, nonhumans are forced to perform in service of humans: the cow is a symbol of manipulation, a body to enhance, and a capital emblem. In fact, as Muñoz Sanz elucidates, 'cattle, etymologically, is derived, via Anglo-French, from medieval Latin capitale – property, capital – it was our value and value in exchange.'[33]

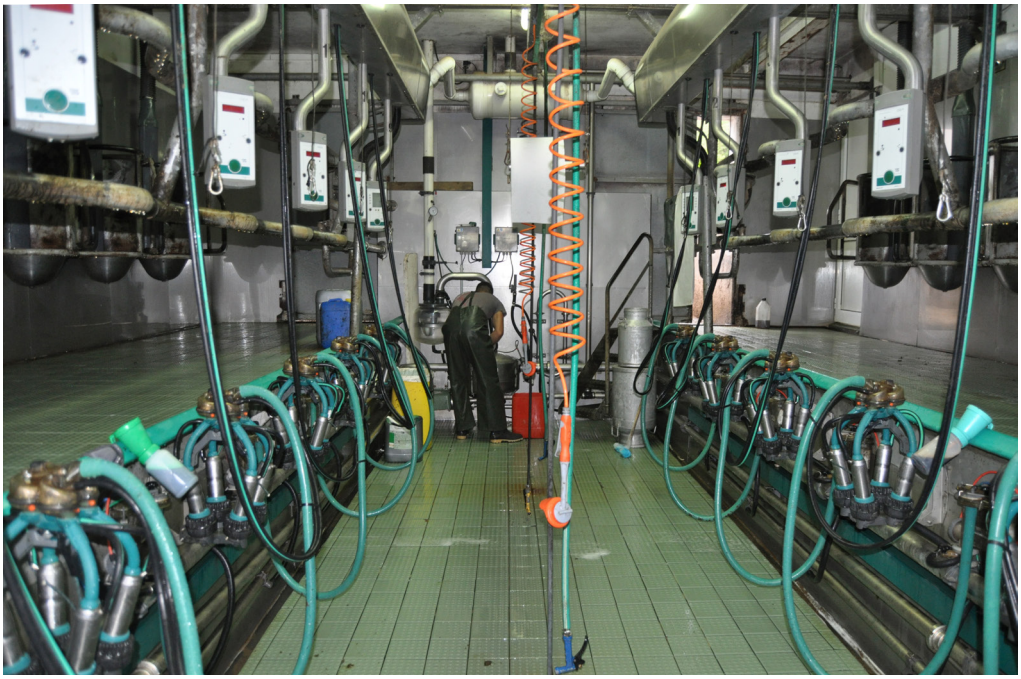


Fig. 7: Cowshed, São Miguel Island, 2022. Photo: author.

Fig. 8: Fixed milking parlour, São Miguel Island, 2022. Photo: author.

Subsequently, we must acknowledge that human beings are also shaped within this system, created by themselves, whose conditions are being reconfigured in a mutual process; mutual, not equal, and certainly not fair.[34] Animal performance and metabolic surveillance are closely linked within a system that profoundly changes human labour, and thus converts the human-animal relation into more-than-human coordinated conduct.

Bacterial symbionts, a more-than-human relation

Before entering the gate, the intense manure smell that could be sensed from some metres away already announced the presence of farm animals. Francisco Lopes, a young veterinarian, welcomed me sympathetically, telling me that he oversees and treats eight hundred animals on this five-hectare beef farm, located in Lagoa municipality, 15 kilometers from Eugénio Câmara's farm which I had visited four days earlier.[35] [Fig. 9] 'The cattle that come here are not pure… they are milk animals inseminated with meat breeds. In this case, 98 per cent of the herd is crossed with Angus, because we have a direct partnership with Pingo Doce', a supermarket franchise leader in Portugal. I then noticed some large, brightly-coloured, plastic balls (more precisely, boat fenders) that 'are included in the animal welfare procedures, for environmental enrichment… the males play with them a lot. We also have brushes, their favourite, but they do not last very long; they easily rip them apart'. [Fig. 10] Pointing to the cattle ear tag earrings, Lopes said: 'the home tag earring is yellow. The white tag was recently added, for the identification of an antibiotic-free animal. It means that after weaning, the animal has not had a millilitre of antibiotics.' He continued, 'you must have seen Pingo Doce's advertising on television... [big on] animal welfare and now antibiotic free'. Lopes further explained that 'the antibiotic protocol states that the animal cannot receive any antibiotics from the moment it stops drinking milk. If the calf gets sick, it is treated, but it is no longer part of the group of antibiotic-free animals'. When I asked if he could expand a little, he continued: 'each farm has a limit on the antibiotics it can use. We cannot exceed ours. This is different from what happens on the Portuguese mainland and even here on the Azores, on Terceira, Santa Maria and Pico islands, where the animals are in extensive farms', because 'our animals are weaned at two and a half months, at a hundred kilograms... their calves suckle until five or six months and weigh double. That means that if calves get sick before that, they are treated and still receive the antibiotic-free label'. He concluded: 'proportionally, very little antibiotics are administered here, but then this does not translate into the number of animals that are distinguished with the white label. Our average is 70 per cent of animals without antibiotics'. These plastic ear tags might be taken for 'a common biopolitical practice for monitoring cattle health'.[36]

I wanted to know more about diseases, and he answered, 'the milk phase is crucial.' As we walked towards some wood structures on the north area of the farm, he added: 'the first thing workers have to do is to give milk to the calves, around eight in the morning… Here, we keep office hours, from eight to five'. Young calves' heads started to appear in each wooden box, and Lopes said, 'they enter here at fifteen days old, and stay for two and a half months, as I said. For a month they get two doses of milk a day, around two and a half litres… then one dose a day… during the last week in the boxes, they already get used to the feed that they are going to eat afterwards'. [Fig. 11] This is a new method: 'without that transition, there were a lot of pneumonia outbreaks once the animals got together with the bigger ones; it is a time when they are under a lot of stress. It changes their routine, and believe it or not, these animals are deeply used to routine'. In these nursery structures, 'the animals must be treated like babies for the first twenty-one days… even more than that, like babies in incubators. If one has diarrhoea, the others will get it too, so they must be isolated'.

Francisco Lopes's enthusiasm was evident. 'I really like what I do and the possibility to introduce better conditions, even if slowly'. And he followed the reflection with a practical example: 'when I arrived, I had the feeling that I was going to drastically reduce pneumonia… I did not. But the introduction of a division in the bucket area, as you see... when the animal first drank water, it then turned its head and went directly to the feed bucket', which 'wet the feed. And when the food is wet it starts to ferment and they do not like it anymore. Just the fact of having the buckets separated, with this wooden division, their average daily gain has increased by five kilos. This is also welfare'.

He continued, 'cows are ruminants, with four stomachs. Milk is supposed to go to one stomach, food and water to another. The oesophageal groove opens when the calf is going to drink milk, and it closes when it drinks water… how is this muscle stimulated to open when you drink milk?' He answered: 'first, the position of the head matters, and second, the temperature of the milk and its concentration… we use powdered milk'. The problem starts when 'the milk is more diluted, and the animal thinks it is drinking water… causing food diarrhoea'. This situation can get more complicated if 'bacteria start to take advantage of it. And then bacteria start to proliferate, and the animal gets weaker… it starts with an alimentary diarrhoea and develops into a bacterial one, so the animal must be given antibiotics, serum… We all have bacteria inside us, as you know'.

A better solution would be 'to make the calves suckle the rubber teats, instead of the buckets. But it is expensive,

each teat costs five euros and it cannot be reused'. He explained that 'the teat causes them to produce saliva, making them drink the milk more slowly. In addition, saliva is an excellent buffer for diarrhoea, due to its sodium bicarbonate content, which helps in the digestion of milk'. This means that 'almost all the milk they drink is digested. It is more effective. Once again, everything that gives health, renders efficiency in productive terms'.

It was obvious to me that on this farm, the first ten weeks of each calf are crucial. 'The easiest way, whether you like it or not, is to use antibiotics. And then public opinion – which is partially right – argues that antibiotic resistance is because of animal production.' He continued, 'on a dairy farm it is easier to implement control and hygiene measures than on an intensive fattening calf farm, like this one.' As an example, 'when an animal is born on a dairy farm, we make sure that it is given the colostrum. It is fundamental, it is the main vaccine.' From then on, 'the calves will remain in the same environment,' in contrast with 'what happens here, receiving calves from one side, from another… one brings a virus, the other bacteria... one drank colostrum, the other did not… there is a mixture that is very difficult to maintain in a park. When one has pneumonia, I know the others will get it too'. Then he said something that resonated with what Câmara had said: 'we need to "go into" our own eye' (we need to trust our own eyes) when observing younger calves.

Questioned about the differences between milk and beef production, he said that 'on this island, there has been a huge conversion from milk to beef, encouraged by the regional government. However, people generally think that whoever produces milk, will easily raise beef'. This assumption is not true: 'beef infrastructure is completely different. In addition, animals are bigger and heavier here'. I had assumed that human labour was more demanding on beef farms. 'Not exactly', he answered, 'as I said, the advantage of any intensive calf farmer is the schedule. This exploitation requires three people to be present permanently, besides my daily visit and that of the engineer (the technician who services the equipment). It is easier to get workers for this kind of work', compared to dairy farms, because 'that is a very conditioned life... milking has to be done each twelve hours, and it involves a lot of procedures'. Nevertheless, he said 'it is still difficult to find reliable workers on São Miguel.'

The visit continues, accompanied by Lopes's reflections: 'animal welfare protocol is very important; however, I believe it should be adapted according to the country and the region... here the animal's bed is made out of cement, but the animals must have a proper bed, and the regulations specify one made out of straw'. He pointed to the manger and said: 'you can see where the straw is. We do not produce straw on the island, so it arrives here at the price of food, which is not viable for us'. According to the farmer, the most apt solution to the island situation is 'just like the park that we developed, on soil... the animals have better conditions, though when it rains, it gets muddy, and people who do not observe the context closely think the animals are suffering'. Moreover, 'they behave like animals on the savannah, they take advantage of water puddles to regulate their body temperature. You can see that those are the cleanest animals'. [Fig. 12]

Lopes said: 'this will change…because they [animal welfare protocols] want pasture, that is it', declaring: 'it is a fantasy. Even if it is very easy for us to open the gate and put the animals in the pasture, it only lasts two days: they eat a bit, but they waste the rest of it. Instead, with the ploughed land, it is possible to produce the equivalent of a week's food for fifty animals'. When it comes to manure management, they reuse it in the farm. 'There are rocks under that plot, look! Still, the grass grows by simply using manure… this is a rich material, we use it as fertiliser, it is part of the ecosystem'. He added that 'the price of fertiliser has doubled, as you know… and since then people have not stopped coming here to get manure.'

As my visit was approaching its end, Lopes pointed out: 'unfortunately, farming is seen as a subsidy-dependent activity... If the producers were paid what is owed to them in a fair system, subsidies would no longer be necessary'. The only way 'to compete with products from other countries is to create products with added value. Agrofood tourism, something like that... It is important to open people's eyes, they need to see if the animals are really dirty or not'. I asked him about his thoughts on the quality of the meat, and he asserted: 'there is a very strong control of quality and hygiene, the European Union does really well in that regard'. However, 'almost all of our meat is exported; we consume cheaper meat from Argentina and Brazil'.

As observed, for the purpose of complying with European regulations concerning animal welfare, labour is required to conform to increasingly stringent hygiene routines. Particularly, in dairy farms, the human workforce is increasingly required to submit to a regime of hygienisation, along with the ability to use computers or smartphones, subsequently requiring more time spent indoors. The path traced seems to rely progressively on technological systems, even if human discernment cannot be neglected.

Cattle 'cyborgisation'

On both farms, and through a proliferation of ancillary systems, disturbances to the animal's development are minimised. In this symbiotic relation, there appears to be a

Fig. 9: Satellite image of a beef farm. Source: Google Earth.

Fig. 10: Beef cattle, São Miguel Island, 2022. Photo: author.

Fig. 11: Young calves in wooden boxes, São Miguel Island, 2022. Photo: author.

Fig. 12: Cattle park, São Miguel Island, 2022. Photo: author.

more-than-human coordinated performance, which is set to restore the conditions for production. According to Scott F. Gilbert, 'the cow is an obvious example of what is called a holobiont, an organism plus its persistent communities of symbionts', consequently, what 'makes the cow possible' is the 'symbiotic community of microorganisms in her gut', which allows it to digest the grass.[37] This theory defies the established understanding of animal distinctiveness, given that 'animal-focused biologists may have struggled to see organisms as holobionts because the holobiont concept undermines the classic definitions of animal individuality', in the sense that 'animals are not monogenomic organisms.'[38] Gilbert goes further:

> We talk about the Anthropocene. We talk about the age of fishes, and we talk about the age of reptiles, and the age of mammals. No. It is the age of bacteria, always was, and always will be. We evolve as teams, as consortia – and we likely always have. It appears that there is no individuality in the classical biological sense.[39]

The evolution of organisms as consortia seems to be at the base of cattle exploitation. Both types of farms (dairy and beef production) survey the rumination or, rather, the foundational symbiotic operation of cows: in the case of the dairy farm, mainly the digital, automated system; on the beef farm, human cognition. The more-than-human arrangement is, thus, manifold, yet it converges in the same aspiration: to control and to intervene on the most profound dimension of the exploited being, its bacterial symbiosis.

One of the biggest contemporary challenges of farming is to reduce greenhouse gas emissions through the digestive process of livestock, and there is an assumption that 'the type of food given to animals can, in fact, mitigate methane emissions.'[40] Alfredo Borba, former director of the Institute for Research and Agrarian and Environmental Technologies (IITAA), says that the production of methane is a process of 'inefficiency of use', more precisely 'an inefficient digestive use'.[41] Borba adds that an improvement can be achieved through food manipulation, by means of 'treatments that increase its digestibility, or through mechanical cuts', which render smaller pieces of food.[42] In addition, there are other technical resources such as precision feeding, which consists of 'knowing the needs of an animal in any given physiological state and trying to ensure that the food covers those needs without excess', as Câmara's system already does.[43] Furthermore, IITAA researchers have been studying a method to decrease methane production through the use of chemical elements that inhibit it, such as the introduction of the incense plant (*Pittosporum undulatum*) and container plant (*Hedychium gardnerianum*) to the feed. These plants are invasive species in the Azores and they 'could be used as an alternative to fodder, such as straw'.[44] In fact, 'we are learning more and more about how microbes can be critically important in development', particularly, 'in fields such as medicine and in agriculture'.[45]

These more-than-human arrangements are in line with insights on the developmental roles of bacterial symbionts. From perspective, some cattle 'cyborgisation' is necessary for them to continue 'to operate' and 'to function' in the regional economy; their modification aims at accomplishing their 'indispensable enhancement'. Drawing upon Donna Haraway's thesis, 'cyborgs are not machines in just any sense, nor are they machine-organism hybrids. In fact, they are not hybrids at all. They are, rather, imploded entities, dense material semiotic "things"', additionally, 'cyborgs matter in terran worlding'.[46] Cattle 'become with', as 'worlding' accounts for the intertwinement between humans and nonhumans; it withdraws the barriers between environment and animals. In this enmeshed relation, cattle 'cyborgisation' matters in the archipelagic terraforming.

Modernisation as synchronisation

After these visits, it was obvious to me that some of the major problems acknowledged by the farmers derive from the island situation: the principal markets are too far, at around 1 500 km away; the same is true for feed and straw. [Fig. 13] With the aim of overcoming the geographical constraints, the Secretary of Agriculture and Rural Development of the Government of the Azores, António Ventura, recently declared: 'we have to assert ourselves as an exporting region of genetic improvement'.[47] One of the proposed methods is to 'support the use of genotyping for the selection of females with the greatest genetic potential, associated with milk or meat production objectives… as well as the use of sexed semen'.[48]

The prospect of a genetic improvement is in tandem with a project that aims at arranging the islands in a single territorial pace, the 'Azorean Agriculture Innovation and Digitalisation Programme'. It is included in the European recovery plan (The Recovery and Resilience Facility) conceived after the beginning of the Covid-19 pandemic. The report states: 'in an Ultraperipheral Region with nine realities, digital connection is essential for the empowerment strategy of farmers, regardless of the island where they live, therefore, generating territorial cohesion'.[49] It envisions each island as a monitored portion of land, where the installation of new infrastructures such as automatic weather stations and biological observation posts will enable the analysis of the water content in the soil; this information will be made available to technicians and producers.[50] In essence, the current effort might be the synchronisation of

the farming activities. Agricultural environments increasingly rely on modern technologies, and this political move goes even further in imagining the coincidence of materials, technologies, bodies, and land. The expectation arises as the fulfilment of modernisation as synchronisation, in which the global economic dimension absorbs the local or, to put it another way, the planet has priority over the island.[51]

Apart from creating new infrastructures and connected digital platforms, it seems that the prospect focuses predominantly on the 'improvement' of cattle, through the control of and interference with bacterial symbioses, rather than on the alternatives to the use of land and water. In this light, the island emerges as a mere support of the activity, even though envisioned as unified, connected, syncopated. Nevertheless, this modernisation project appears to be grounded in the very principles identified as problematic, that is, the logistics of import and export. The 'modern' is presented full of apparatuses and digital systems, although the model that sustains it does not change; the 'modern' concept is, thus, exhausted. In accordance with Yuk Hui's theory:

> If we want to surpass modernity, there is no way to simply reset it as if it were a computer or a smartphone. We must instead escape its global time-axis, escape a (trans)humanism that subordinates other beings to the terms of its own destiny, and propose a new agenda and imagination of technology that open up new forms of social, political, and aesthetic life and new relations with nonhumans, the earth, and the cosmos.[52]

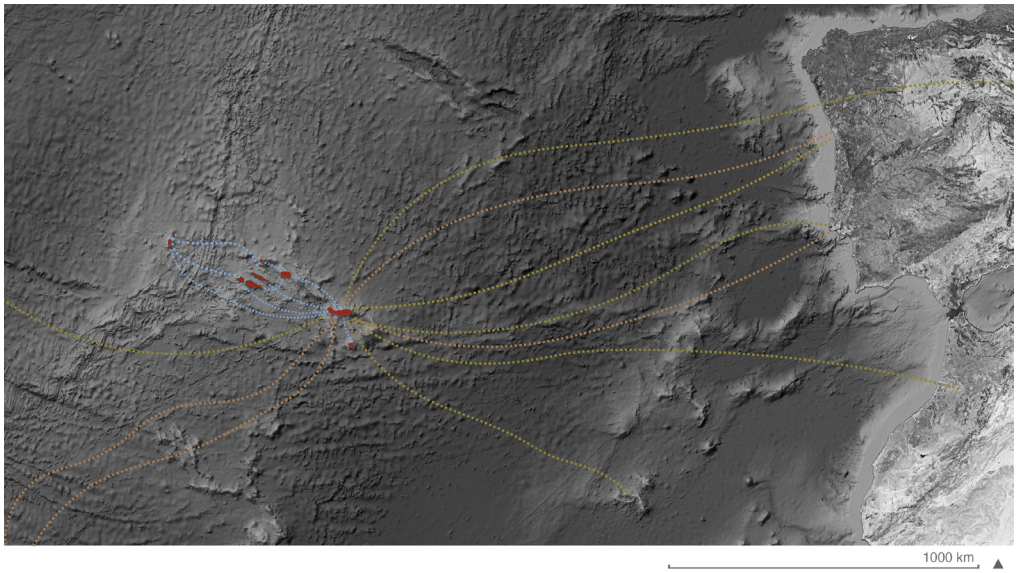
Consequently, a distinct vision of the island and the archipelago is needed. As it stands at the moment, the broader purpose seems to be to accelerate into full automation, even though we know 'that humans are now being used as a connective tissue to make those systems work.'[53] Let us recall that both Eugénio Câmara and Francisco Lopes underlined the need for human attention: the gaze, in particular, as an example of the importance of human intervention to guarantee animal welfare and production yield; it demonstrates that, in practice, 'the race toward a frictionless productive process is not without challenges or conflicts with efficiency.'[54]

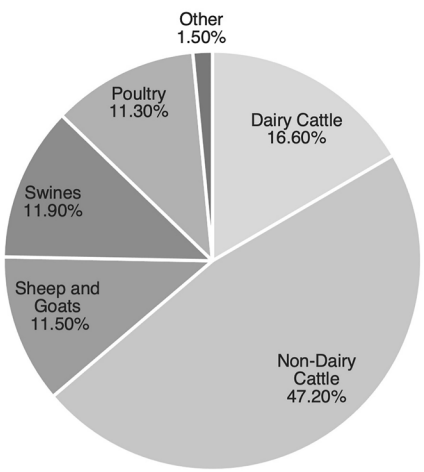
The work of pretending to be profoundly automated and digital would be extremely time-consuming, and more significantly, it would constitute a missed opportunity. In line with Holly Jean Buck's theory, it could be just another 'business as usual' case if it lacks an alternative social – and, I might add, an ecological, economic, and territorial – vision, ending up as a mere 'discursive way out for a couple of years', until its uselessness becomes evident.[55] Eventually, the expectation for change relies upon a bundle of 'sociotechnical "fixes"', which seem incapable of altering the current ecological and economic quest, since they operate 'through compensatory efforts to intensify techno-extractive logics'.[56] In this scenario, it is very hard to conceive a political shift.

The cow in the room

In recent reports on energy policy in the Azores issued by the regional government, the methane emissions originating in the digestive process of animals are scarcely discussed in the greenhouse gas emissions section, in spite of the increase of 48 per cent in methane emissions from cattle, in Portugal, between 1990 and 2017.[57] Nonetheless, there are a few instances where the reality is recognised, for example in a programme outline by the Regional Government of the Azores: 'the positive image gained by the Azores with regard to its dairy products can quickly deteriorate if Azorean producers do not take timely precautions regarding the climate impact of their production activity.'[58] In fact, according to recent data, agriculture is one of the biggest pollutants in terms of greenhouse gas emissions.[59] Furthermore, 'the major contributors to total nitrogen from livestock manure in Portugal in 2019 were non-dairy cattle and dairy cattle', which comprised 63.8 per cent of the total national emissions from manure management.[60] Likewise, in 2019, cattle contributed with about 81.3 per cent of total national methane emissions from enteric fermentation.[61] [Fig. 14] In parallel, there seems to be even less awareness of the overexploitation of water on farms, another enormous issue, while new agricultural developments are being built with the anticipation of sufficient water. In line with the current national tendency for cattle exploitation, the government of the Azores announced a major investment in slaughterhouses for 2022.[62] In the face of the climate catastrophe, the archipelago is envisioned as a strengthened livestock territory. 'The cow in the room' emerges as the cow itself. [Fig. 15]

Accordingly, the anthropogenic activities resulting from cattle exploitation seem to be in direct opposition to the perception of the Azorean 'good way of life'. Some farmland owners, producers and politicians, appear to dismiss the consequences of such practices; others recognise the need for change within the cattle industry. However, both perspectives seem to coincide in one fundamental premise – which is also problematic, as I have argued in this article: the need to continue the same economic model, simply altering the ecologies that sustain it. Cattle farming on the Azores appears as a paramount example of Erik Swyngedouw's diagnosis that 'under the banner of radical techno-managerial restructuring, the focus is squarely on how to sustain capitalist urbanity so that nothing really has to change'.[63] Or, as the French say, *plus ça change, plus c'est la même chose*.





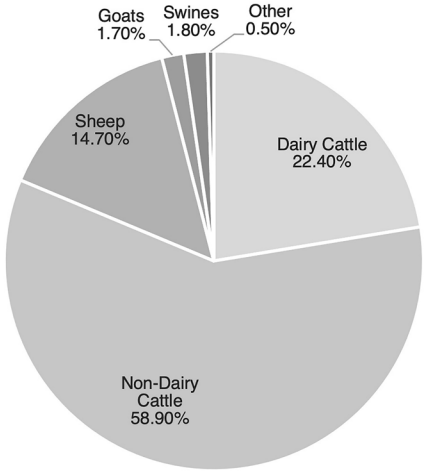


Fig. 13: Exports from São Miguel Island (yellow dots), imports to São Miguel Island (orange dots), and exports from one island to another (blue dots), in the Azores (in red). Source: Google Earth.

Fig. 14: Left: the origin of nitrogen emissions in manure produced per animal type in Portugal in 2019. Chart: author. Source: Portuguese Environment Agency. Right: methane emissions from enteric fermentation per animal species in Portugal in 2019. Chart: author. Source: Portuguese Environment Agency.

Fig. 15: The cow in the room, São Miguel Island, 2022. Photo: author.

In fact, 'ecology' was and has been an agent of the capitalisation of nature. 'Ecology' and 'economy' share the same prefix, and Emanuele Coccia reminds us that it is one of the reasons why it is impossible to think of the two concepts together; after all, it entails an epistemological contradiction.[64] As Rania Ghosn and El Hadi Jazairy put it:

> Whereas the word ecology evokes associations with environmentalism and green politics, it is also tightly entangled in a capitalist imaginary of Earth, or what we refer to as natural resources… As far as the process of resource extraction is concerned, economy and ecology are two sides of the same coin.[65]

Given this context, as already mentioned, some 'mitigation technologies' are being envisioned to pursue the model of economic achievement and, concomitantly, to abide by the environmental goals stated in international agendas.[66] From milking techniques to grazing systems to food supplements, and even to an 'agricultural digitisation', the improvement of livestock production conditions is contingent upon political will.

Meanwhile, these contemporary technologies of ecological restoration must continue to fit the 'cowscape idea' as part of the Azorean Arcadia. Both advertising companies and funding institutions work on a prospect built upon the continuous need for pastureland. Nonetheless, to rest upon this 'good cattle farming' axiom seems counterproductive if the goal is to address environmental issues, as argued by George Monbiot.[67] Throughout his splendid book, *Regenesis*, he discusses the 'efficiency paradox' according to which 'improving the efficiency of farming can cause a greater use of land'.[68] Eventually, 'we appear to be trapped between two dangerous forces: efficiency and sprawl'.[69] The aim to perform more efficiently, and throughout an increasing area, contributes to a lack of adaptability and robustness in these landscapes of primary production activities. Consequently, 'efficiency threatens resilience'.[70]

Ultimately, we seem stranded in a condition of consuming apathy that appears to accommodate a somewhat apocalyptic environment: 'This is the way the world ends / Not with a bang but with a whimper', in the words of T. S. Elliot.[71] The discrepancy can be found 'between knowledge and belief: we *know* the (ecological) catastrophe is possible, probable even, yet we do not *believe* it will really happen'.[72]

Conclusion: between efficiency and sprawl

My aim with this article has been to explore beyond the evident layers of the Azorean cowscapes. After the profound terraforming of the islands established less than two hundred years ago, motivated by agriculture, and deploying an active management of fauna and flora, the awareness of living in the Anthropocene – or perhaps in the age of bacteria, as defended by Scott F. Gilbert – compels the pursuit of alternative forms of social, spatial, and climate justice.

The association of governance and infrastructure seems to perpetuate and to accelerate the climate crisis, and there is a clear contradiction between the image of the arcadian archipelago and its operational landscape. In this sense, the pursuit of the optimisation of human labour is concomitant with cattle fertility and feed digestibility efficiency, all converging in land specialisation. The triad efficiency-optimisation-specialisation might be symptomatic of the archipelago's current course, where extensive farming translates into an increased farmland footprint. Ultimately, more efficiency requires more pastureland. The pressure on land is what makes extensive farming even more damaging than intensive farming, given that land is the crucial metric.[73]

As more is revealed about these food systems, we see that this intricate mechanism vastly exceeds the island: a major part of the meat and dairy produced is exported to the Portuguese mainland, the meat consumed on the archipelago comes mainly from South America, straw and feed are imported, and live animals are exported to other islands, or even to North Africa. It turns out to be an inefficient food production system.

I would like to advance an alternative scenario, in line with Monbiot's proposal: to refuse the current expansion within the food network, by setting up 'circuit breakers' in the arrangement.[74] The scaling up prospect of farming activities arises because, I understand, there is no imagination of a post-pastureland archipelago. On the contrary, as intended to be demonstrated throughout this article, the investment in the livestock sector has been growing. In this light, the current technologies of ecological restoration are redundant: an instrument operating within a tautological procedure. After all, things seem to change so that nothing changes: the contemporary cowscapes perpetuate the loss of resilience in global food systems, and the island is only the start of the evidentiary trail.

Notes

This research was funded by the Portuguese Foundation for Science and Technology (FCT-MCTES) through national and European funds (European Social Fund), under the scope of the PhD grant 2020.05223.BD. I would like to thank Eugénio Câmara and Francisco Lopes for their time and cooperation.

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Biography

Inês Vieira Rodrigues is an architect, an integrated researcher at the Centre for Studies in Architecture and Urbanism, and a PhD candidate at the Faculty of Architecture of the University of Porto (FAUP, Portugal). As a grantee of the Portuguese Foundation for Science and Technology (FCT-MCTES), she is working on a study of the territory of the Azores. She has previously worked as an architect in Portugal and France. Her master’s dissertation, titled *Rabo de Peixe: Society and Urban Form,* was published as a book (Caleidoscópio Editor, 2016). She was recently awarded the Fernando Távora Prise (2022).

Plantation Technologies: More-Than-Human Histories of Operationalisation in the Palm Oil Production Territories of Johor State, Malaysia

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Abstract

In this article we investigate plantation agriculture as a technology aimed at extracting natural resources, utilising unpaid labour, and installing regulatory authority. Using the oil palm plantation territories of Johor State in Malaysia – a core zone of palm oil production, manufacturing and export – as a case study, we ask how more-than-human assemblages enabled the expansion and refinement of oil palm plantations in Malaysia and contributed to the material transformation of the territory. We also explore how plantations can be mobilised as an analytical device to study the urbanisation of territory through agro-industrial production. To explore those questions, we present three episodes of more-than-human involvement in assembling oil palm plantation territories in Johor. Through the conceptual frame of the operationalisation of territory, we bring into dialogue literature on the Plantationocene with critical urban studies and the history of urbanisation.

Keywords

extended urbanisation, operationalisation, plantation, palm oil, Malaysia

Setting the scene: plantations everywhere

Compared to other vegetable oils and foodstuffs, the global production and omnipresent use of palm oil is a recent phenomenon. In less than a hundred years, a series of technological innovations, (geo)political interventions and vast socio-ecological transformations turned palm oil into the most productive and by far most used vegetable oil on the planet. Today, palm oil production is concentrated along the equatorial belt in Central Africa, South America, and Southeast Asia, with only two countries – Indonesia and Malaysia – accounting for 85 per cent of global production. Oil palm plantations in those countries cover an area of 120 000 km² – three times the size of the Netherlands or roughly the size of the American corn belt.

Southeast Asia's lead in palm oil production has been accompanied by a profound material transformation of the territory, primarily based on the logic of plantation agriculture. The plantation serves as the modus operandi of agro-industrial production, which includes the radical simplification, classification and replication of agrarian practices and social relations, steered towards an export market and governed by economies of scale. As a scalable technology, the plantation enables the expansion of agrarian production and associated forms of governance through uniform blocks – or pixels – without transforming the constituting parameters.[1] Thus, in their 'pure form', plantations work as idealised models, an operative vehicle aiming for the extraction of natural resources under capitalist modes of agrarian production driven by efficiency.[2] [Fig. 1]

In Johor, the use of oil palm as cash-crop was predated by a successive introduction of neotropical crops such as coffee, tobacco and sweet potato, and a sweeping territorial transformation based on rubber cultivation.[3] The introduction and fine-tuning of plantation agriculture, associated infrastructures, trading houses, and bureaucratic institutions based on rubber plantations set the scene for the spread of experimental oil palm plantations and the eventual expansion of the commercial production of palm oil.[4]

Today, more than 7 000 km² of Johor State are covered by oil palm plantations, accounting for three-quarters of the total land under cultivation.[5] Those palm oil territories are subject to transformative processes that drive, and in turn are driven, by rapid demographic change, economic restructuring, and large-scale land-use conversion. On the one hand, agro-industrial conglomerates focus on vertical integration and investments in the industrialisation of palm oil production through, for example, food processing and refining facilities. On the other hand, land available for large-scale oil palm cultivation is scarce, and scholars anticipate that farmers who pursue other forms of agriculture are likely to switch to oil palm cultivation in the future.[6] Simultaneously, rapid urbanisation and the expansion of urban centralities – not least driven by the proximity to Singapore – lead to the conversion of plantations into housing estates, commercial and industrial quarters. These structural changes have resulted in higher income levels and rising standards of living, leading to the disengagement of the local population from agrarian labour and growing (legal and illegal) employment of foreign workers.[7] Johor's latest demographic statistics (from 2020) classified 77 per cent of the population as living in urban areas, while agrarian indicators show that the state was in the lead in terms of agricultural gross domestic product per hectare farmland.[8] Through these statistics, Johor appears as a highly urbanised territory comprising large patches of industrialised agriculture mixed with different urban patterns that amalgamate to form the city of Johor Bahru at the southern tip of the peninsula. [Fig. 2]

In this context, historians have investigated the complex relations between colonial agrarian policies, labour regimes and capitalist modes of production that enable and reproduce plantation systems in Southeast Asia.[9] Ethnographic research has engaged with questions of labour, modes of governance and the political ecology of, and in, palm oil producing territories.[10] Additionally, scholars have challenged notions of the urban-rural divide through accounts of the urban integration of rural communities, and the growth of village populations in oil palm territories as an indirect effect of plantation agriculture.[11] The following article contributes to this body of literature by framing agro-industrial production as a process of urbanisation, highlighting the role of plantations as technological devices to commodify nature, resettle human and other-than-human labour, and install infrastructures to manage the extraction of resources.

Extended urbanisation in the Plantationocene

Urbanisation and agrarian production are often depicted as separate narratives in studies of the densification and expansion of the urban fabric and the more-or-less market-oriented extraction of resources to produce food and commodities. Different strands of research in geography, history and social science developed bridges between these separated lines of investigation by reading their simultaneity, interaction and mutual dependencies. To unpack the role of plantation agriculture in urbanisation processes, we will introduce the conceptual frameworks of extended urbanisation and the Plantationocene, which both rearticulate the relations of urbanisation and agrarian production. Then we introduce the notion of operational landscapes to frame agro-industrial production as a process of extended urbanisation, and the plantation as one of its manifestations.[12]

Since the early 1990s, a strand of research developed in critical urban studies engaged with territories of extended urbanisation aiming to investigate urbanisation processes beyond the limits of the city. Scholars analysed extended metropolitan regions, but also remote territories including forests and deserts, oceans and alpine landscapes, offering insights and methods for a structural understanding of socio-spatial and multi-scalar dimensions of urbanisation processes.[13] In this context, Brenner and Schmid have developed the conceptual triad of extended, concentrated, and differential urbanisation to define the theoretical framework of planetary urbanisation. Planetary urbanisation, they argue, 'requires new strategies of concrete research and comparative analysis that transcend the assumptions regarding the appropriate object and parameters for "urban" research that have long been entrenched and presupposed within the mainstream social sciences and planning/design disciplines'.[14] Dwelling on Henri Lefebvre's thesis on the 'complete urbanisation of society', they call for a shift in analysis from urban form to urbanisation processes.[15] While concentrated urbanisation is associated with urban agglomerations, extended urbanisation 'involves, first, the operationalisation of places, territories and landscapes, often located far beyond the dense population centres, to support the everyday activities and socioeconomic dynamics of urban life'.[16]

While Neil Brenner and Christian Schmid provide a conceptual framework to understand operationalisation as a process of extended urbanisation, Nikos Katsikis refines the concept in his study *From Hinterland to Hinterglobe*, to develop a territorial analysis of urbanisation processes on a global scale.[17] Applying Kasikis's conceptual apparatus to the case of palm oil territories, operationalisation involves the appropriation of natural resources through the alienation of land and the commodification of nature by various actors, the installation of infrastructures such as palm oil mills, refineries and shipping facilities, direct or indirect population control through resettlement schemes and urban programs, and a wide array of regulatory

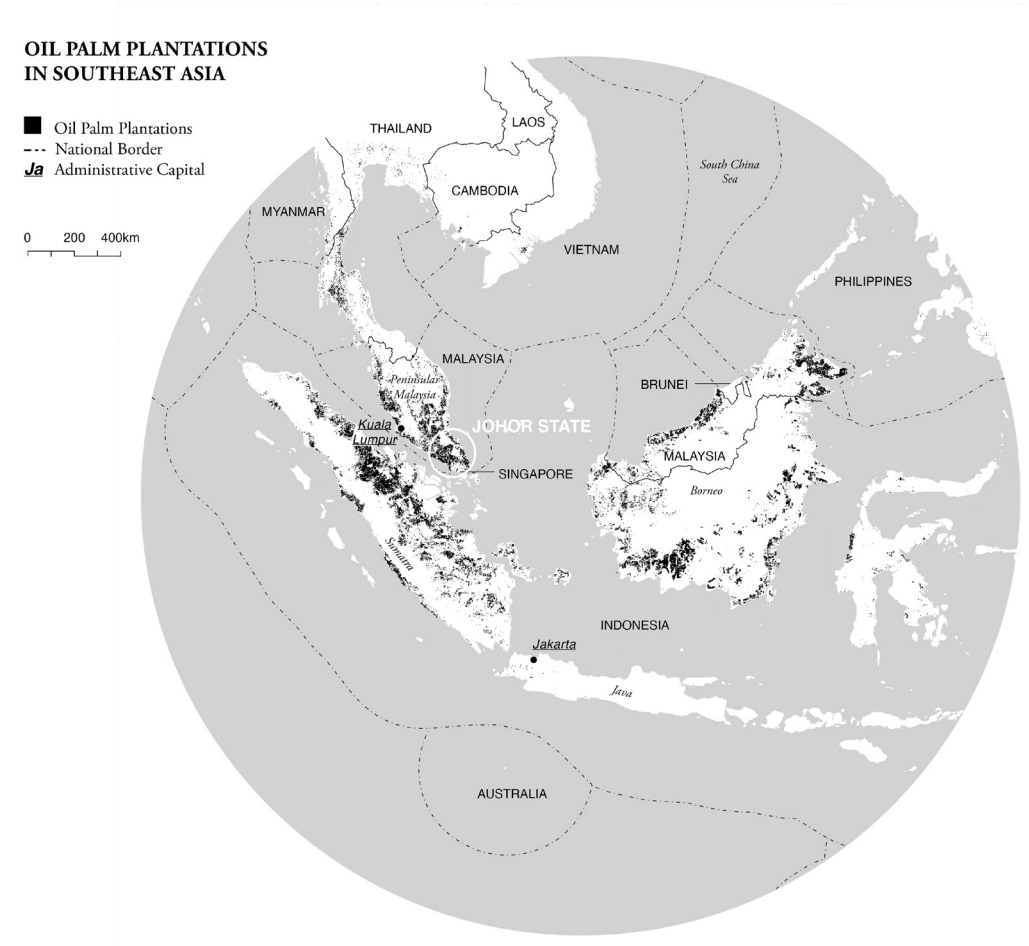

Fig. 1: Global and Southeast Asian palm oil plantations. Source: author. Data: Descals Adrià et al., high resolution global industrial and smallholder oil palm map for 2019 (version 1, 27 January 2021), *Zenodo*, doi:10.5281/zenodo.4473715.

mechanisms from state policies to international development programmes and sustainability standards. These notions of operationalisation engage with what Rania Ghosn calls the 'aesthetics of totalising abstraction' where operations dictate everyday life by sorting spaces of production through the logic of simplification, exploitation, and homogenisation.[18]

To move from the global scale of operational landscapes to the study of specific geographies of production and extraction, Rodrigo Castriota proposes to conceptualise operationalisation as an unfinished process, mediated through everyday struggles and appropriation.[19] This interpretation resonates with accounts of plantation life and everyday resistance described by Tania Li and Pujo Semedi in oil palm plantation territories in Indonesia.[20] Their work highlights that plantations are technologies for the operationalisation of territories, but that they can neither be considered independent entities without relations to the world beyond their boundaries nor are they devoid of internal modes of appropriation, sabotage or capture. Our preliminary research in Johor has revealed similar tendencies. At the first glance, different types of plantations – private estates, government-led smallholders, and individual smallholders – appear as district entities of production with their internal logics, but everyday experiences and appropriations reveal much more fluid spatial constellations. Even if power relations are centred around the milling infrastructure, everyday practices blur the boundaries between production entities and different types of plantation. What emerges are territories of palm oil production characterised by various degrees of operationalisation that are constantly negotiated, adapted, and rearticulated.

Therefore, we understand the conceptual notion of operationalisation not only in its abstract form or 'extreme degree of abstraction', but also as a set of practices deployed by a range of actors at different scales in an attempt to negotiate access to resources and extract agrarian products.[21] Even though territories of palm oil production are vast and appear monotonous, processes of operationalisation cannot be solely associated with the 'colossal' top-down management practices or state interventions.[22] The uneven and combined nature of production arrangements are always negotiated through local material practice, political claims and imaginaries.[23] As generic as operational processes appear in textbooks and managerial guidelines, the specificities of everyday life demand adaptation on the ground, rearranging agrarian routines and practices. Thus, understanding operationalisation as a process of urbanisation involves what Sandro Mezzadra and Brett Neilson describe as operations hitting the ground, unfolding 'moments in which they [operations] enter into complex relations (both generative and destructive) with different forms of life and matter.'[24]

Within the fields of political ecology and anthropology, researchers proposed to frame the current geological epoch as Plantationocene, to describe the socio-ecological consequence of agro-industrial production and account for the global prevalence of plantation monocropping.[25] While plantations have long been a subject of study in the fields of history, social science and economy,[26] a reinterpretation has developed around this conceptual notion, linking social science with ecological research in interdisciplinary discussions around the social, political, and economic workings of plantation systems.[27] The concept highlights the plantation as dominant form of agrarian production based on export crops, a model invented and developed through European colonisation and subsequently translated into various forms of contemporary capitalist agriculture.

Davis highlights the conceptual capacity of the Plantationocene to decentre Eurocentric narratives on the industrial revolution and to strengthen networked relations of social and natural entanglements. Drawing on Black geographic and ecologic literature on plantation histories, he calls for attention to the racial stratification of the plantation landscape.[28] Others have emphasised the need for both theoretical engagement with plantation systems and for grounded ethnographic research to grapple with the plantation as an analytical category and an ontic reality.[29] In addition to the racialising tendencies and ecological simplification of plantation systems, the focus of the Plantationocene discourse on a specific form of agrarian production – the plantations – calls for a spatial interpretation that has only partially entered the debate.[30] In Wendy Wolford's words, plantations 'embody both racial violence and resistance, straddling or bridging the divide between rural and urban, agriculture and industry, town and country, and local and global.'[31] Thus, plantations epitomise the dialectical relations of colony and metropolis summarised as 'synthesis of field and factory' and can be described as an example of how processes of extended urbanisation work and rework material realities on the ground.[32]

To account for a nuanced and localised reading of the Plantationocene, the role of more-than-human involvement in the histories of making and unmaking plantations has been the topic of several academic contributions.[33] Scholars draw on the work by Anna Tsing, Donna Haraway, Tim Ingold and María Puig de la Bellacasa to capture varieties of life forms associated with plantations.[34] These insights emphasise alternative cosmologies negotiated within plantations and engage with ecologies of reproduction and labour beyond the human body. The focus on seemingly marginal subjects of plantation territories questions the totalising singularity of monocropping and opens

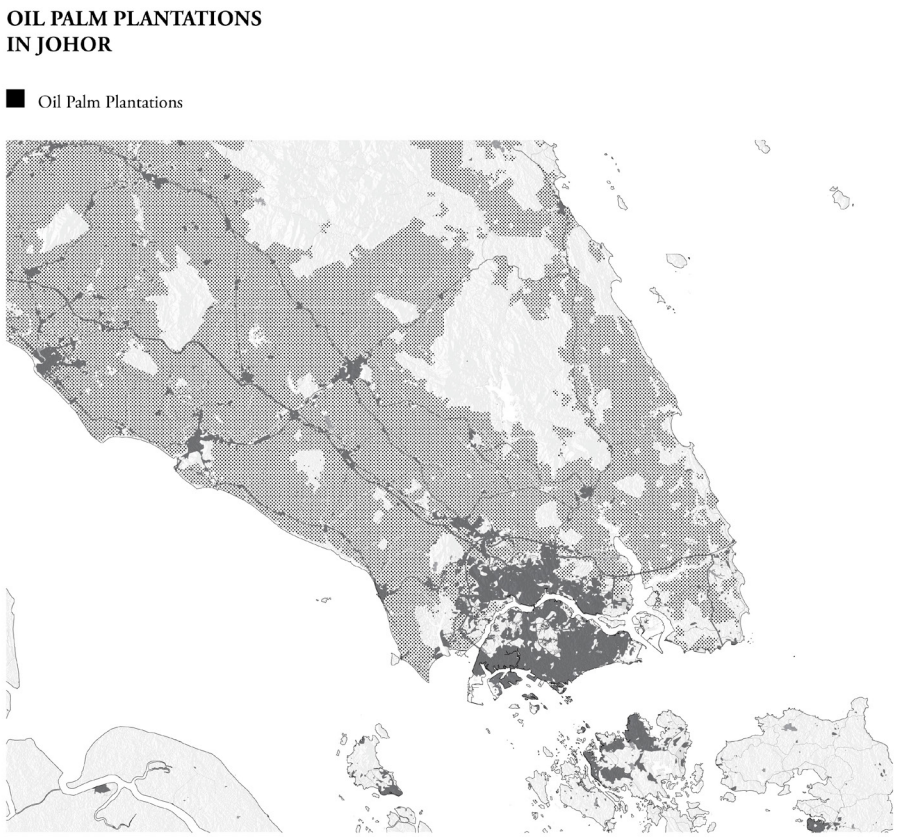

Fig. 2: Johor State palm oil plantations. Source: author. Data: Descals Adrià et al., high resolution global industrial and smallholder oil palm map for 2019 (version 1, 27 January 27 2021), ***Zenodo,*** doi:10.5281/zenodo.4473715.

a field of research engaging with specific modalities of operationalisation.[35]

Drawing on these theoretical frameworks, I refer to Jill Casid's 'Necrolandscaping, where she asks: 'If forests are flush with the chatter of humans and other species, can the plantation speak?' While Casid's reference to questions of agency and representation is evident, the aim of this article is not to shift away from anthropo-centrism by focusing on non-human lifeworlds per se, but rather to explore human and non-human relationships that led to the operationalisation of territory.[36] I follow AbdouMaliq Simone's novel approach to 'explore … what it means to inhabit the processes rather than places of urbanisation' by highlight how palms, weevils, and owls enable and contribute to the operationalisation of territories through oil palm plantations.[37]

In the following section, I investigate the spatio-temporal formation of Johor's and Southeast Asia's highly urbanised agrarian territory, and present three episodes crucial to the proliferation and solidification of oil palm plantations. The first episode on oil palms, highlights the role of botanical imperialism and the industrialisation of palm oil production, the second investigates non-human labour in enhancing the productivity of oil palm plantations through weevil pollination, and the third focuses on barn owls to highlight relations between methods of sustainable production and animal management.

Oil palm, *Elaeis guineensis*: the landscape as factory

The oil palm, *Elaeis guineensis,* can reach a height of thirty metres and an age of up to three hundred years. Fertilised female flowers produce fruits that grow and ripen over about six months. The fruits are sessile drupes borne on a large compact bunch, also called a fresh fruit bunch, with a weight ranging from 5 to 50 kg depending on the age of the palm, the genetic traits, and the environmental conditions.[38] A mature bunch contains a few hundred to a few thousand fruits which hold an average of 5 kg of crude palm oil and 0.6 kg of crude palm kernel oil.[39] [Fig. 3]

In its native environments, along the west and central coast of Africa, the oil palm provides not only edible oil, but is used as a building material, in handicrafts and to produce everyday objects such as carpets, mattresses and baskets.[40] Fresh fruit bunches have been harvested in semi-natural groves for thousands of years, and palm oil trade between Africa and Europe is documented since the sixteenth century. Traded quantities remained small until the early nineteenth century, when the British slave trade was officially abolished and traders foraged for new 'commodities' to keep their trading ships afloat. Discoveries in oil and fat chemistry opened the market for the use of palm oil in the production of soap, candles, and as a lubricant for industrial manufacturing. From the early 1800s onwards, merchants such as William Lever, the subsequent founder of Lever Brothers (which later became UniLever), sought to establish mono-crop plantations in Africa, with limited success. Political instability, internal conflict, and difficulties in obtaining land, providing transport and processing infrastructures are among the impediments cited as hindering the commercial success of large-scale oil palm plantations.[41] At the same time, oil palm seeds began to be distributed around the world by botanists who operated within colonial networks of plant collections and botanical gardens. In Southeast Asia, the botanical gardens of Bogor (on Java, within the Dutch colonial sphere) and Singapore (as a British outpost of the Royal Botanical Gardens in Kew) provided seeds to entrepreneurial planters.[42] As centres of research, propagation and economic experimentation, the botanical gardens became essential infrastructures and laboratories in the commercialisation of crops. The 'mastery of nature' through modern science in botanical gardens fostered the power and knowledge systems to expand the influence of imperial networks.[43] It is thus not surprising that one of the early descriptions of the economic properties of the oil palm circulated in Southeast Asia was published by Henry Ridley, the first director of the Singapore Botanical Gardens in 1907.[44] As part of the European imperialist project, the transplanting of plant specimens proved useful in erasing local cultural practices and cosmologies associated with their use and cultivation.[45] In colonial territories with similar environmental characteristics, plants could be turned into crops without any cultural 'ballast'.[46] This process of transplantation marked the transformation of the semi-wild harvested oil palm into a crop producing a globally traded commodity.

Contrary to most historic accounts of the distribution of oil palms in Malaysia, the first estate experimenting with large-scale cultivation was opened at Kluang, Central Johor in 1910.[47] In the 1920s, it was incorporated into the British/Singaporean Guthrie group, which was floated at the London Stock Exchange in 1924 and merged with two other conglomerates in 2007 to form the largest plantation company in the world in terms of land holdings, Sime Darby.[48] The Kluang estate remains operational today. It has gone through the fourth and fifth cycle of oil palm replanting on most of the plot. In plantation management, the 'critical age' for replanting oil palms is determined at twenty to twenty-five years, because the oil content of fresh fruit bunches begins to drop, and the harvesting of fruits above ten meters hight is not considered economically viable.[49]

Once harvested, the fresh fruit bunches need to be processed within twenty-four hours to prevent the build-up of fatty acids. Therefore, palm oil mills are crucial infrastructures dominating the production process and industrialising agrarian territories. During our fieldwork in Johor State,

Fig. 3: Plantation worker harvesting fresh fruit bunches with a 12-meter-long rod. Johor, Malaysia 2019.
Source: author.

interlocutors invariably called palm oil mills 'the factory', indicating the industrial character of palm oil production, despite the geographic location in the middle of agrarian landscapes. The 440 registered mills located in Malaysia have various production capacities from 20 to 120 metric tons per hour, and produce crude palm oil and palm kernel oil that is transported by trucks to shipping facilities or refineries. Compared to other states in Peninsular Malaysia, Johor is in the lead in terms of milling capacities and number of mills.[50] [Fig. 4]

The mill as industrial technology is a crucial element in agrarian change. Once installed, smallholders can change their cropping system and opt into the logic of plantation agriculture through out-grower schemes or by selling fresh fruit bunches to middlemen who supply the mill.[51] Even on the smallest plot of land, harvesting, maintenance, transport and processing of fruits are governed by the industrial logic of production and the rhythms of the plant's reproductive cycle.

This phenomenon can be observed in Pontian district in Johor, where a large share of individual smallholders planted oil palms during the 1980s.[52] The declining rubber prices, harsh environmental conditions for coconut production, and government subsidies for oil palm planting, together with the establishment of oil palm mills, triggered a substantial land use change.[53] Today, almost 70 per cent of the agrarian land in the district is covered by smallholder oil palm plantations.[54]

Li describes how the plantations' operational logic and infrastructural dominance spreads throughout the territory, creating 'saturated [palm oil] zones'. Plantations, she argues, expand to monopolise livelihood resources and subordinate law and governance to leave no outside for alternative forms of life.[55] Through the properties of the palm and associated milling techniques, the plantation model has been able to proliferate beyond the large scale plantation form, rooted in colonial estates, and expanded on smallholder landholdings.

Palm weevil, *Elaeidobius kamerunicus*: cheap nature

The main protagonist of the second episode is *Elaeidobius kamerunicus,* a brown to black weevil with an adult average length of around 2.5 cm. It is part of the *Curculionidae* weevil family, which is associated with a narrow range of hosts, in many cases only living on a single species.[56] The weevil is an important pollinator of the oil palm, but it is not native to Southeast Asia. Although it is tightly connected to the oil palm's reproduction, the weevil's introduction to Southeast Asia occurred much later, but had a profound impact on the production of palm oil and the plantation management.

In the early twentieth century, when commercial experiments with oil palms in Southeast Asia began to take off, human-induced artificial pollination became crucial.[57] Planters and scientists recommended assisted pollination to control fruit production and stabilise the supply of fresh fruit bunches for the mill.[58] Estate workers collected pollen from male flowers to dust receptive female flowers with it through hand puffers, or lance puffers for taller palms. The routine recommendation was for eight to ten rounds of pollination per month.[59] Assisted pollination increased yield and it was commonly assumed that oil palms were wind pollinated.

In 1976, the entomologist Rahman Syed was commissioned by Unilever to investigate the significance of weevils in pollinating oil palms. Through various experiments in Cameroon, he was able to confirm the role of weevils as important pollinators and the lack of animals in Southeast Asia as the reason for comparable low yields. He identified *Elaeidobius kamerunicus* as the most fitting species for Malaysia because it carries more pollen grains than other weevil, is adapted to wet and dry seasons, and is unable to breed on other host plants, minimising unintended environmental effects. Subsequently, the Malaysian government approved the import of an initial weevil population, which was released at the Unilever Mamor palm oil estate in central Johor on 21 February 1981. The release was celebrated in the media, and a newspaper article in the Singaporean Straits Times portrayed the weevil as potential 'labour-saving and production-improving device'.[60] The weevils personally released by Syed soon replaced assisted pollination previously performed by plantation workers. [Fig. 5]

During the early 1980s, monitoring of output performances confirmed the increasing production of fresh fruit bunches by 20 to 30 per cent.[61] While most subsequent publications focused on the productivity and environmental characteristics of the weevil population, the long-term effects on labour management and the social implications associated with the weevil's introduction were sidelined. Syed and Yusoff Hussein report an annual labour cost saving USD 60 million, since the practice of hand pollination was abandoned, while accounting for the increased yield led to an annual saving of USD 100 million.[62] The reported increase in palm oil production was found to be unevenly distributed throughout palm oil production territories. While Sabah on Borneo reported a 20 per cent increase in oil production per hectare, outputs at estates in Johor did not change due to other pollinating species and the effective human pollination which was already in place.[63] The yield per palm did not rise, because fresh fruit bunches increase in weight while the annual number of bunches decreased.[64]

Fig. 4: Video: Palm Oil Weevil release, Johor 1981. Source: https://www.youtube.com/watch?v=SpgYb44tpUM.

Fig. 5: Barn owl nesting box in an oil palm estate in Johor, Malaysia 2019. Source: author.

The introduction of the weevil had numerous effects on labour management on the plantation. It enabled the fine-tuning of fieldwork tasks that could not be mechanised, but were 'outsourced' to the pollinating insects. The workforce for hand-pollination was replaced by the 'cheap nature' of the weevil.[65] Human-assisted pollination was phased out and the reduced amount of fresh fruit bunches further diminished the labour required for harvesting. The effects of this reduction of labour inputs are not reflected in scholarly work other than the statistical accounting of the reduced labour force. Anecdotal evidence from fieldwork in Johor suggests that it was largely female casual labourers who worked in the plantations as 'pollinators' and lost their jobs. Resulting labour pools have been largely absorbed in downstream industrial facilities developed at the new Johor port. From the 1970s onwards, resource-based industrial complexes and port facilities have been developed in Pasir Gudang close to Johor Bahru.[66] The port and bulking facilities are fed by palm oil refineries, oleo chemical plants and other industrial facilities. Today, Pasir Gudang represents the largest concentration of palm oil refining industries and downstream activities in the world.[67]

The weevil as 'living technology' played a vital role in fine-tuning oil palm plantations as agro-industrial production complexes and solidified the logic of plantation agriculture in Malaysia.[68] While colonial projects of expanding agro-industrial production through plantations relied on enslaved, coerced, indentured, or otherwise exploited cheap labour, the introduction of the oil palm weevil signifies a shift towards efficiency based on the exploitation of natural resources. What was initially celebrated as a potential increase in yield, turned out to substitute labour input by operationalising 'cheap nature'.

Barn owl, *Tyto alba*: sustaining operations

The barn owl, *Tyto alba,* is one of the most widespread bird species in the world, occurring in a large variety of environments. Adult animals are thirty to forty centimetres tall, can live up to twenty years, and feeds on insects, amphibians, and rodents. As the English name suggests, barn owls are widely associated with human settlement and agrarian production. Similarly to the oil palm weevil, the barn owl was intended to work as cheap nature in the palm oil agro-industrial complex, but it gradually became a symbol for sustainable production practices.

In the 1960s, oil palm plantations started to expand significantly in Johor. The ecological simplification through monocropping triggered the spread of species that found shelter and abundant food sources in plantations. Among wild boars, snakes and squirrels, rats became a significant cause of plant and fruit 'damage' in the territories of palm oil production. For rats, oil palms are an ideal environment, as the crown can serve as a nesting site and the fruits growing there are a constant source of food. Consequently, the control of rat populations in plantations became a continual and costly operation.[69] The initial manager's response was chemical warfare: pesticides and baits were used in large quantities on oil palm estates.[70] The introduction of natural predators such as cats and snakes, as well as hunting, were among the experimental practices to keep rat populations at bay.[71]

When plantations and rats started to proliferate, the barn owl increasingly became a key species on Malaysian palm oil estates, solidifying its role as integrated pest control decades before discussions on sustainable production sparked public interest. The bird has been sighted as casual visitor in Malaysia, and the first recorded nesting was at the Fraser Estate in Johor in 1969. When it was estimated that rats make up 98 per cent of barn owls' diet on the plantation, and individual owls consume up to two thousand rats per year, the animal was rapidly incorporated into management programmes.[72] A potential limit to the growth of the population due to a lack of available nest sites triggered experiments with the design and introduction of nesting boxes from 1976 onwards.[73] The original design by Graham Lenton can still be found all over Johor and Malaysia, with slight modifications and materials variations. It consists of a basic box with a waterproof roof, an entrance and a maintenance shaft.[74] The box is mounted on a four- to five-metre-high pole to keep it safe from predators. The recommended density of nesting boxes varies from one per five hectares to one per ten hectares.

Since 1985, the Palm Oil Research Institute of Malaysia promoted barn owls as biological control agents.[75] Through breeding and research programmes the birds spread in tandem with the expansion of oil palm plantations. With a reported 20 per cent of the cost of baiting, the economic calculus enabled the incorporation of the species into the plantation system. However, the relations between rat populations and barn owls are more complicated: a minimum rat population must be maintained to feed the owls; owls' hunting grounds vary greatly, which makes accounting for their efficiency uncertain; and the specific targeting of rats might increase other rodent populations. Thus, Hereward Corley and Bernard Tinker conclude that 'the effectiveness and the economics of biological control of rats by owls remain uncertain'.[76]

A significant shift in the perception of the bird occurred during the early 2000s. The mounting pressure on the palm oil industry's environmental effects lead to the establishment of the Round Table on Sustainable Palm Oil (RSPO) in 2004. The global-scale NGO seeks to regulate the palm oil industry through auditing processes designed to guide

producers in fulfilling the principles set to achieve sustainable production. The principles are linked to specific practices and technical requirements. Criterion 7, titled 'Planet', includes Integrated Pest Management, to 'reduce pollution, minimise resource use, and optimise productivity'.[77] Through this framework of sustainable production, barn owls became part of a counter-narrative against the utilisation of the orangutan as key species of the campaigns against the palm oil industry. As natural predators of rats, owls did not only take up the work of cheap nature, but served as indicator species for integrated pest management at a time when the concept gained popularity in conventional agriculture.

The RSPO introduced a layer of techno-managerial practices to the palm oil industry by introducing global standards for the 'commodification of sustainability'.[78] Peter Vandergeest's work exposes how sustainable standards in the fishing industry assemble 'sustainable territories', deploying standards and governance structures, 'redefin[ing] bounded spaces for the purpose of controlling activities'.[79] Similarly, the RSPO legitimises territories of sustainable production through auditing practices based on plantation agriculture, which includes large estate plantations, managed smallholder schemes, or mills. While independent smallholders have been able to seek approval for their oil palm production since 2018, their participation in the market for sustainable palm oil remains marginal to this day.[80]

Despite integrated pest management practices, rodenticides continue to be used in palm oil plantations to control large rat populations, leading to the unintentional poisoning of barn owls and other non-targeted species through the consumption of contaminated rats. This was a less pressing issue until the 1980s, when warfarin-resistance was discovered in rats and a new generation of rodenticides, with more toxic ingredients, was introduced. The use of stronger poison reduced the population of barn owls at Fraser estate from forty to four in less than three years.[81] In a more recent case, barn owls were discovered being captured and traded illegally for meat consumption. In 2008, the Department of Wildlife and National Parks of Peninsular Malaysia confiscated over nine hundred frozen owls in Muar, Johor, with evidence suggesting they were collected by covering nesting boxes with nets or hunting along the edges of plantations. Prior to this uncovering of wildlife trade, owls had not been associated with illegal capture and trade.[82] It can be estimated that the seized animals covered 10 per cent of Johor's oil palm plantations, but no changes in population were reported by plantation managers.[83]

The example highlights how overreliance on barn owls as a pest control method can lead to unintended consequences, such as a breakdown of the predator-prey system or overpopulation. Brian Wood and Chung Gait Fee conclude that there is no evidence to demonstrate that the introduction of barn owls for rat control 'has any advantage over simply allowing "natural" predation to restore'.[84] Consequently, the barn owl has become a heraldic animal for integrated pest control, expanding managerial practices of population control to non-human actors rather than engaging with natural fluctuations between pests and their various predators. Questions of how to monitor and respond to fruit damage remain, and the emergence of new management systems, such as biological pest control, as well as new pests, are constantly challenging plantations' fragile ecologies.

Plantation technologies and territories of extended urbanisation

Concluding, we would like to highlight three crucial aspects of more-than-human involvement in shaping oil palm plantation as technologies of extended urbanisation in Johor and Southeast Asia. First, the oil palm's vegetal agency illustrates how temporal rhythms of production are inscribed into the landscape and social structures, leading to the urbanisation of the countryside through industrial temporalities. Contrary to other plantation crops, such as cotton, 'the factory' (mill) never left the fields. Wolford's description of the 'metabolic rift of colonial agriculture', the shift of factories towards the metropolis, did not emerge in the palm oil industry, leading to the effective industrialisation of the countryside.[85] Second, while oil palm plantations have largely resisted efforts to mechanise production until today, animals serve as alternative technologies of cheap nature. The introduction of the oil palm weevil did not increase production but reduced labour inputs, providing profits based on the exploitation of non-human labour. The available human labour was absorbed in downstream manufacturing and industrial agglomerations such as the Johor port, leading to the depopulation of the countryside. Third, the example of the barn owl highlights how market participation is substantiated through transnational governance structures for sustainable production. As an allegory of environmentally friendly management practices, the barn owl was integrated into sustainable production while the efficiency of barn owl-related rat management became side-lined.

The episodes outlined above illustrate the intricate interconnections of agro-industrial production and more-than-human life in plantation territories. The plantation as a managerial and spatial category of analysis enables us to trace the patterns and pathways of extended urbanisation in their specific spatio-temporal trajectories. On the one hand, the material transformation of the countryside through plantation agriculture highlights the interconnectedness of

colony and metropolis, or centre and periphery. It reveals the ongoing extraction and gradual exhaustion of natural resources in a continuous expansion of the frontier of commodification – from land and human labour to chemical inputs and cheap nature – and exposes the potential emergence of 'plagues of planetary urbanization', which are nourished through the simplification of agrarian territories.[86] In the case of Johor, the dialectics of extended and concentrated urbanisation manifest in the industrialisation of the countryside, the agglomeration of manufacturing and processing facilities, and associated urban development.

On the other hand, through the notion of operationalisation, it becomes apparent how the plantation as a managerial system transforms the territory beyond the estate boundaries, incorporating villages, smallholders and middleman into the logics of agro-industrial production. The more-than-human perspective allows for an understanding of operationalisation as an urbanisation process that can be established, deepened, and reoriented. Thinking with operationalisation thus involves constantly asking who operationalises what for whom and why. In this context, operationalisation does not appear as a linear process of industrialisation or mechanisation, but includes a host of actors aiming for different goals in a complex socio-ecological territory. Beyond the colossal techno-infrastructures of production and circulation, the inquiry into more-than-human entanglement enables an engagement with the background – or the 'ordinary' forms – of extended urbanisation through the specificities of palm oil production. Although scholars have long challenged the statistical representations of urbanisation in Southeast Asia, arguing that rural dwellers are by and large well-integrated into urban or 'more-than-rural' modes of living and inhabitation, Johor's agro-industrial territories of palm oil production are still described as rural, peripheral landscapes.[87] In this article, we emphasise that the operationalisation of territory through palm oil production has significantly transformed the social and environmental conditions of Peninsular Malaysia by rendering palms into factories, weevils into labour and owls into regulatory guardians of sustainable production, shaping the plantation as a technology of extended urbanisation.

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Biography

Hans Hortig is a landscape architect and researcher. He studied landscape architecture at the Technical University Berlin, the ETH Zurich and the School of Design, Mysore. Since 2013 he taught research and design studios at the *Future Cities Laboratory* in Singapore and the ETH Zurich, and guided graduation thesis at ETH Zurich and TU Berlin. He is a co-curator of the lecture series Sessions on Territory and contributed to several exhibitions such as the *Rotterdam Biennale* 2014, the *Shenzhen Biennale for Architecture/Urbanism* 2015, or *Under the Radar, SAM Basel* 2019. His scholarly work has been published in *Architheses*, *GAM Magazine* and by *ISEAS Publishers*, and he is co-editing the forthcoming book *Singapore Beyond the Border* with Milica Topalović. His current research focuses on Palm Oil Territories in Johor State, Malaysia.

Subversive Submersives: The Unseen Urbanisation of the Southern Ocean

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Abstract

The enormity of the ocean presents as an unusual physical obstacle that complicates claims for spaces being urbanised well beyond the traditional container of the city, such as the focus of this discussion: the Southern Ocean. Though commonly perceived as a pristine wilderness at the end of the earth, the ocean surrounding Antarctica has been imbricated in planetary-scale processes of urbanisation since the late eighteenth century, so the absence of this oceanic volume from twenty-first-century urban debates is troubling. Representations of the Antarctic as remote and disconnected from cities do nothing to contribute to a critical discussion of its ocean volume, technological histories or ongoing colonial settler imaginaries. Instead, attention might turn to codifying what the ocean increasingly contains by way of urban processes and, ultimately, what might be offered by confirming extended forms of urbanisation operating on and, importantly, through the Earth. In this article I re-present the Southern Ocean via comparative cartographies and critical image-making to cross-examine what its occlusion signifies for the planetary reach of urbanisation. For underneath the machinery of extraction and exploitation lie significant questions regarding representations of the urban as they manifest outside conventions that overstate 'the city' as central to urbanisation.

Keywords

planetary urbanisation, Southern Ocean, wet ontologies, technology, cartography, urban

The enormity of the ocean presents as an unusual physical obstacle that complicates claims for spaces being urbanised well beyond the traditional container of the city, such as the focus of this discussion: the Southern Ocean. Though commonly perceived as a pristine wilderness at the end of the Earth, the ocean surrounding Antarctica has been imbricated in planetary-scale processes of urbanisation since the late eighteenth century, so the absence of this oceanic volume from twenty-first-century urban debates is troubling, especially given that current discussions often universalise the premise of a 'global urban age'.[1] While the Southern Ocean is remote from most cities, this does not preclude its co-option by expanding urban processes, and though the Southern Ocean, like all oceanspace, is constituted from a materiality resistant to surveillance, it does not necessarily mean these urbanisation processes are completely hidden from view. Examining how the Southern Ocean is being urbanised re-presents foundational questions regarding space, representation and control. For instance: What environments are considered as 'appropriately' urban? Where might representations work to legitimise some spaces as somehow 'outside' of what is urban? And what emancipatory possibilities emerge from dismantling such constraints on lexicons of the urban? These concerns are not only pertinent to the field of urban studies, but also bear on the ways many scholars and practitioners across geography, architecture, art and creative practice seek to work in the world.

Henri Lefebvre's notion of physical and ideological 'blind fields' becomes critical here, as does his demand for the inclusion of methods beyond traditional urban analysis. Lefebvre urges us to interrogate spaces that limit conceptions of the urban by relinquishing prior frameworks, synthesising fragmentary information, and revealing difference: that the analysis of urban phenomena requires a 'gathering together of what gives itself as dispersed, dissociated, separated, and this in the form of simultaneity and encounters'.[2] In this article, I turn my attention to codifying what the ocean increasingly contains by way of urban processes at a planetary scale; representations of human,

more-than-human, and nonhuman encounters experienced within the urbanising Southern Ocean in particular; and, ultimately, what might be offered by confirming extended forms of urbanisation operating on and, importantly, through the earth. Representations of the Southern Ocean as remote and disconnected from cities do little to contribute to a critical discussion more generally of oceanspace, nor do they reveal the diverse ecologies, technological histories, and colonial settler imaginaries produced during the urbanisation of this space. Neither does representing the high seas as uninhabitable or distant from everyday urban life, which avoids a long history of extraction and exploitation undertaken in the Southern Ocean in the service of cities much further away. Together, this helps to externalise oceans from the co-constitution of human and nonhuman relationships across a rapidly urbanising planet. It also runs counter to a large body of creative work produced since the early 2000's by artists (such as Philip Samartzis, Janet Laurence, Nicholas Mangan and many others), filmmakers (like Allan Sekula, Noël Burch, and Harvard University's Sensory Ethnography lab), writers (including Joy McCann and Zakes Mda), spatial practitioners (for instance, 'The Forensic Oceanography Project', a subset of the Forensic Architecture research agency), and cultural organisations (like TBA21-Academy in Venice, Italy) confronting similar concerns.

For oceanspace is not just a blue-tinted blank expanse on a map, but rather an embodied volume comprising a multiplicity of processes working through experienced and materially unique territories. Acknowledging extended forms of urbanisation here transforms a conventional limit to most urban debates, which geographers Philip Steinberg and Kimberley Peters characterise as 'land-sea binaries'.[3] A landed bias in much architectural and urban theory helps support critical disregard of oceanspace, despite it connecting cities and hinterlands across the planet. I will therefore re-present the Southern Ocean to better understand what this disregard signifies for the planetary reach of urbanisation. Through comparative cartographies and critical image-making, I seek to both demonstrate how the Southern Ocean is being urbanised and resituate underwater sensing within Lefebvre's 'spaces of representation' schema, as an experienced space created by ideas, discourse, and theory that works to 'make' the world rather than 'represent space'.[4] Examining the 'disarticulated sensing apparatus' of subsurface data in particular, as gathered by ocean-going robots, satellite surveillance, and ship-based technologies, means asking seriously what contribution can be made to understanding an urbanising planet through encounters with remote worlds inhabited by drone bodies.[5] To this end, I argue that underneath the machinery of extraction and exploitation in the ocean lie significant questions regarding representations of the urban, outside conventions that overstate 'the city' as central to urbanisation.

Cities and their elsewheres

The ocean, as figure 1 illustrates, is increasingly consumed by apparatuses that reveal urban processes operating at the scale of the planet.[6] A combination of scientific endeavours and commercial speculation have laid foundations for an ocean made urban, while 'pristine' and 'wilderness' imaginaries of the Southern Ocean falter as exploitation and extraction are acknowledged as long present. Much contemporary discussion of urbanisation is declared through a rhetoric of planet-wide ecological crisis, yet it is significant that locations outside centres of this discourse – what is commonly referred to as the Global South and also, significantly, the Southern Hemisphere (though these two are sometimes assumed to overlap)[7] – seem rendered only as othered spaces within such discussions: marginalised as requiring aid and protection provided from and by those centres (typically its constructed binary, popularly known as the Global North) but without clear agency of their own. These debates originated in major British, European, and North American cities and their prestige institutions (the London School of Economics, Deutsche Bank, The Sorbonne, Harvard University, Brookings Institution, and Rockefeller Foundation among others) via a series of 'urban age' conferences and publications beginning in 2005.[8] While the issue of what exactly constitutes the urban straddles a range of disciplines, including urban theory, geography, planning, and architecture, 'the global urban age' championed today by planners, urbanists, and governments alike grew from these discussions, celebrating the 'emergence' of a dominant condition of city life around the world. However, Australian feminist geographers Ruth Fincher and Jane Jacobs highlighted a need to be wary of 'blockbuster urban commentaries' more than two decades ago, and urban sociologist Neil Brenner and others more recently called out this 'metanarrative' for continuing to privilege the container of the city over more expansive urban processes and unevenly experienced effects.[9]

The exclusion of remote spaces like the ocean and other forms of 'wilderness' – which are seen as *non-urban* – from this discourse has also been problematic.[10] Seeing the ocean only in this way neglects spatial ordering, human and non-human experience, and the continually forming relationships between our social worlds.[11] What is or is not considered appropriate as urban is still largely framed by European and North American narratives and practices projected across the planet. That will surprise few First Nations, Indigenous or Black diaspora scholars, who have

Fig. 1: The Southern Ocean. Photomontage: author.

all argued that settler colonial logics of *terra nullius* render certain environments empty and available for remaking.[12] As a non-Indigenous architect and researcher benefitting from uneven power hierarchies in the lands and waters of Naarm/Melbourne where I live and work, I am indebted to these scholars in recognising the structure of settler colonialism, which continues to authorise lexicons of the urban. I acknowledge that this article builds on their intellectual and emotional labour, and remember to also take care to resist changes in representation that simply reinscribe the colonial project facilitated by many cities and institutions of the Global North. As Timmah Ball warns, 'the growing appetite for Aboriginal culture is astounding, at times lulling us into a false sense of security where power is shifting'.[13] It remains important that spaces assumed to be outside even extended forms of urbanisation are brought to bear on questions regarding the urban at a planetary scale.

Indeed, geographer Matthew Gandy notes that cities are just one type of urbanisation rather than things isolated from larger processes, and Lefebvre also claimed 'the city' could not exist without an 'elsewhere'.[14] In the classic 1970 text, *The Urban Revolution*, he sees such spaces produced simply to create technologies, knowledges, beings, and objects in the service of the city.[15] Lefebvre later wrote that the externalisation of nature prefigured a 'planetarization of the urban' and lamented that this was routinely ignored in mainstream debates.[16] Categorical distinctions between urban and non-urban are never neutral, and the elsewhere/'nature' proposition remains an intrinsic problem for how cities are conceptualised. More recent discussions in architecture and urban theory have re-examined Lefebvre's premise: most notably in Brenner and urban geographer Christian Schmid's theorisation of 'planetary urbanisation', which sees cities constituted by socio-spatial processes that extend well beyond any city boundary, right up to the scale of the earth.[17] Although critiques regarding the erasure of Indigenous, postcolonial, feminist, queer, and rural studies scholarship already at the intersection of these concerns have been aimed at Brenner and Schmid, few argue against their conceptualisation of 'extended urbanisation.'[18] For Brenner and Schmid, the ongoing expansion of urban processes transform environments adjacent to cities into operationalised territories, which are radically reconfigured through resource extraction, agribusiness, and/or logistical enclosure to service accelerating growth. Urbanisation thus extends into hinterlands and transnational spaces through forces of capital and planning, degrading once 'wild' places well beyond the boundaries of cities.[19] Brenner and urbanist Nikos Katsikis also hold that many spaces assumed as non-urban by dominant discourses are already urbanising and have been for some time.[20]

The unseen urban ocean

I therefore start from a clear premise: that the ocean is being urbanised. Examples of this can be seen in studies of contemporary urbanisation in among the Atlantic, Pacific and Arctic Oceans, along with the Barents and South China Seas.[21] Brenner and Katsikis look at similar concerns in the Mediterranean region but only obliquely recognise that the oceanic volume co-constitutes urbanising processes. Their 2014 text, *Is the Mediterranean Urban?* seeks to dismantle a land bias common to visualisations of urban analysis by demonstrating the density of transport networks operating across oceanspace. However, the Mediterranean sea basin still figures as a surface to be traversed: most crucially in the 'Major ground and marine transportation routes around the Mediterranean' figure, which maps a flat ocean studded with infrastructural points between ports.[22] Indeed, relative few scholars have foregrounded implications of planetary urbanisation for the volume of the ocean itself (those include Nancy Couling, Milica Topalović and Ross Exo Adams; all of whom, intriguingly, trained as architects). In this article I chart instead the extension of urbanisation into oceanspace via 'wet ontologies': a conceptual framework developed by Philip Steinberg and Kimberley Peters to more rigorously explore embodied spaces of water at the scale of the planet.[23] Thinking through wetness in these ways reconfigures basic spatial categories: examining what constitutes the urban outside of cities, beyond the limits of dry land, and below the surface of water – enables recognition of extended urbanisation forms largely unseen in urban knowledges and their representations.

Siting this inquiry within the Southern Ocean is critical, due to its position as the world's newest and arguably most vulnerable ocean: host to complex and unique intersections between ice, water, land, science, geopolitics, commercial incentives, agents, and organisms. 'New' in this context refers to institutional recognition: though over thirty million years old, the Southern Ocean was only 'established' by the International Hydrographic Organisation in the year 2000 – or, more accurately 're-instated' after many nations lobbied to revoke its listing in the 1928 *Limits of Oceans and Seas*.[24] Since then, it has been fragmented into 'Southern' extensions of the Pacific, Atlantic and Indian Oceans, or known as the South Polar or Antarctic Ocean. 'Newness' is also very probably a function of a popular misconception, driven by *The National Geographic Society*'s refusal to label it an ocean until 2021.[25] The Southern Ocean is thus constructed by a variety of actors (human, non-human, and otherwise) and confirms law theorist Henry Jones's claim that meaning here is fixed through arbitrary systems

of demarcation while the ocean itself is perpetually in movement.[26] This challenges basic models of place by creating conflicts between the means of ordering space and that space as it is actually experienced.[27]

For instance, there are long histories of human occupation in the Southern Ocean. The late eighteenth century focused on heroic polar exploration and ignored rapidly industrialising marine mammal harvesting, even as commercial premises began to spread through the Southern Ocean. Factory facilities along the Antarctic coastline and sub-Antarctic islands testify to intensive exploitation of seals embedded in global financial networks and food, fuel, and clothing markets well into the nineteenth century.[28] Seal overharvesting nearly obliterated the 'productive value' of the Southern Ocean, and was remedied only by a new boom in whaling. All the while, marine mammal exploitation continued to recede behind images of heroes battling harsh elements on the Antarctic continent. Up until the twentieth century, urban processes and the Southern Ocean were considered separate although bound together through the supply of fuel and manufacturing resources. Similarly, David Harvey famously noted that nineteenth-century capitalism broke the assumed spatial boundaries of urbanisation through new technologies and their apparatuses.[29] During the mid-twentieth century, new international governance institutions for the Antarctic laid down latent principles for ordering global urbanisation. Clear lines were drawn between the prized 'wilderness' of the Southern Ocean and everywhere else on the planet (where the presence of urbanising activities were normalised) and the Antarctic region was 'restored' as remote, pristine and protected from the rest of the world.

This reminds us that the codification of the ocean is continually constructed, flattened and controlled from a distance.[30] For example, the Southern Ocean's political boundary is often taken as the Antarctic Treaty Limit of 60°S, but that rarely aligns with historical or scientific discourse. For these fields, the Southern Ocean's southern boundary is set at the Antarctic continent, but its full reach is less settled. Unlike other oceans, deep water – rather than landmass – hints at a northern edge and the strong Antarctic Circumpolar Current (ACC) is most often called upon to demarcate that boundary. These are problems with this too, as the ACC operates more like an atmospheric system: essentially a borderless phenomenon subject to other currents, gyres, eddies and seasonal air-sea fluxes, and interactions with the Pacific, Atlantic and Indian oceans.[31] Geopolitics scholar Klaus Dodds says that these 'fuzzy' delineations are open to almost-constant contestation.[32] Indeed, Australia roundly rejects the ACC boundary, arguing instead for its southern shoreline and thus including many industrial ports as ocean entry points.[33] Basic principles limit seeing the Southern Ocean as a coherent geographical entity, let alone identifying it as 'urban'.

The Southern Ocean is the only body of water on earth that is clearly and materially *planetary*, and is constituted as a global common under the 1959 *Antarctic Treaty System* (ATS).[34] The Southern Ocean is represented variously as a visual, conceptual or legal space but remains held at a distance from cities and experienced by humans almost entirely mediated by images and maps. It is, however, very much present in our world, and in relation with urban centres across the planet. As researchers at the *Antarctic Cities and the Global Commons* project attest, Southern Ocean rim cities like Hobart (Australia), Christchurch (New Zealand), Punta Arenas (Chile), Ushuaia (Argentina) and Cape Town (South Africa) cooperate as international custodians of Antarctic tourism, shipping, logistics, resource speculation and scientific research, and have long produced their city imaginaries in close association with the Southern Ocean. Arguing against seeing these cities as disparate ports, the researchers have created an 'Antarctic Connectivity Index' as evidence of governance and sustainability planning coordinated between the 'gateway cities'.[35] I must also reiterate that the Southern Ocean is governed from and in cities, albeit via multilateral treaties –including the ATS, the 1982 *United Nations Convention on the Law of the Sea* (signed into existence in Montego Bay, Jamaica), and the 1991 *Madrid Protocol on Environmental Protection to the Antarctic Treaty*; regionally-focused protections such as *Convention on the Conservation of Antarctic Marine Living Resources* (CCAMLR, with its secretariat based in Hobart); shipping bodies such as the International Maritime Organisation (IMO, headquartered in London); and ongoing negotiations for a new United Nations treaty to regulate marine biodiversity in areas beyond national jurisdiction ('BBNJ', whose secretariat is located in New York).

Southern Ocean governance may be global in structure, but it is legislated, implemented and policed through the nation-state, leading to conflicts between territorial claims, extraction opportunities, economic potential and surveillance of a vast region supposedly operating in the peaceful pursuit of scientific knowledge. While Antarctica and its surrounding ocean seem distant, uncultivated and uninhabitable, these assumptions neglect much evidence of increasingly urban processes, as figure 1 illustrates. This includes resource extraction to supply growing populations elsewhere, such as commercial harvests of krill (bound for animal pet feed and fish bait in South Korean, Norwegian, Japanese and Polish markets) and exploitation of vulnerable toothfish (also known as Chilean seabass, sold for domestic consumption in Australia, the US, China, Singapore, South Korea and Japan), an increase in adventure travel (a 32 per cent growth in tourist ship

transports was recorded in 2018–2020 alone, and there has been a significant expansion of tourism facilities over the last twenty years), and marine bioprospecting by commercial entities (for use in agriculture, food product, wine, pharmaceutical and cosmetic industries around the world).[36] Examined closely, the Southern Ocean starts to reveal so many planetary-scale interdependencies operating in long chains of historical transformation and accumulation that anthropologist Stefan Helmreich suggests more 'thinking from southern oceans' is urgently required.[37] All this suggests also, as architectural and urban theorist Ross Exo Adams says, that there is a history, logic and political character to the urban; and what is or is not acknowledged as urban may be considered an ongoing project to reorganise power in space.[38] There seems a constructed absence of the urban in the ocean, and as Lefebvre recognised, 'blind fields' are not just acts of unconscious blindness, but instead an ideological 'not-seeing' that is also a 'not-knowing'.[39]

Key to the Southern Ocean's disregard is the matter of its representation: it suffers both from remote geographical distance and normative forms of spatial ordering that support the visibility of certain conditions of urbanisation over others. For instance, commercial fishing, pharmaceutical developments, tourism and logistical support for processes supplying non-adjacent cities have been increasing within the Southern Ocean since 1995, but are typically evidenced through academic scientific publications or government environmental reports rather than urban analysis performed by the same institutions (as is the case in the Antarctic resource extraction and exploitation figures quoted in the paragraph above).[40] These impacts have been shown in decades' worth of rigorous marine science and disseminated via regular global environmental assessments but remain largely absent from urban debates.[41] Brenner and Schmid's notion of extended urbanisation can therefore be helpful in confirming that urban processes are operating through the ocean, though not as visible as other spaces on land. Central to the urbanisation of the ocean has been the working of these spaces and transforming their bodies in the service of industrial logics: what geographers Martin Arboleda and Daniel Banoub call a 'market monstrosity'.[42] Just as early sealing and whaling interests reconfigured the Southern Ocean as a lucrative hunting ground after marine mammal populations crashed elsewhere, so too contemporary efforts to dramatically expand krill harvests in the Antarctic are driven by the near-collapse of once abundant South China Sea fishing grounds and escalating protein demands from China, Australia and beyond.[43]

Rethinking wetness

The wet ontologies framework developed by geographers Steinberg and Peters demands that we reconceive the ocean as an emergent tool for thinking through space on its own terms: a clear alignment with Lefebvre, Brenner, Schmid, and others' insistence on the urban as a category of theorising rather than a physical container. Further, they reject any objectification of the ocean: thinking must be from the ocean, not about it.[44] Wet ontologies acknowledge that the ocean is not a homogeneous whole, but rather that specific physical, political, and philosophical characteristics mark its manifestation around the planet. This means that missing relations from many urban debates are within the water and include what geographer Ruth Panelli describes as 'the operationalisation of more-than-human bodies'.[45] I therefore acknowledge humans, non-humans, and 'not-quite human things' as significant assemblages within oceanic volumes shaped by ongoing social, spatial and material processes.[46] Through wet ontologies, Steinberg and Peters seek to reconfigure our planet as an interconnected series of wet volumes that decentres land bias amid norms of space and time. In this context, it is worth remembering a few statistics: approximately 71 per cent of our planet is covered by oceans; humans have explored more territory on Mars than the ocean floor; and the ocean is this planet's largest carbon sink and thus key for mediating rising global average temperatures.[47] When we avoid relations with the wetness of this planet, critical connections between ourselves, others, and the urban remain unseen, even as they all experience significant transformations together.

Wet ontologies also highlight oceanspace is conceptualised through relations to political and economic change, cultural imaginaries, and historical processes of colonisation, conquest, resource extraction and trade.[48] The bias towards land conveniently allows the disregard of a territory occupying much of the earth, and one that provides literal connections between many urban centres on this planet. By way of example, ocean-going freighters transport more than 80 per cent of all global trade (a figure sustained despite global Covid-19 disruptions since 2020), yet maritime networks are more generally understood through international law or corporate governance frameworks.[49] Large bodies of water such as the Southern Ocean are defined by a seeming lack of characteristics intrinsic to urban discourse, but wet ontologies position oceanspace as a critical lens for reflexive and relational thinking at interdependent urban, global and microscopic scales.[50] Codification of the ocean – including the Southern Ocean – is not restricted to scientific, geopolitical or legal knowledges. Numerous disciplines engage with the ocean and have implications for how the extended urbanisation of the Southern Ocean is represented. Aquatic ecologists

Airlie McCarthy, Lloyd Peck and David Aldridge discovered significant flaws identifying fishing, tourism, research and supply shipping movements across the Southern Ocean as they evaluated invasive species and other biosecurity risks borne by such vessels. Their research revealed that the Southern Ocean is overlooked within global maritime intelligence data because Antarctica has no commercial ports. To correct this flaw, they developed new methods, merging raw satellite observations, commercial ship logs and terrestrial port calls, in order to quantify the actual range and frequency of Antarctic ship traffic. The results identified a tenfold increase in known port-to-port networks connected with the Southern Ocean and unexpected links to urban centres across East Asia, North Africa, and Europe.[51]

Rethinking (wet) bodies

Not seeing the urbanisation of the Southern Ocean is also a function of how bodies that inhabit it are identified and communicated, and the significance of underwater relations between those bodies. New technologies expanding into the ocean – such as submersible robots and autonomous underwater vehicles (AUVs) used in oceanographic research and resource exploration – present unique considerations. The growth of underwater infrastructures is a surprising manifestation of urbanisation but little attention has been paid to how such technologies operate in these contexts as things with intelligence. Robot bodies move untethered through the ocean and make decisions about data, mapping environmental features while communicating with ships and orbiting satellites, and responding to encounters with others.[52] The technological development of underwater vehicles grew from military-led oceanographic exploration and commercial salvage operations after World War II, and a new awareness of the potential for rare earth mineral extraction from the deep seabed.[53] Underwater vehicles are also the producers of unique visual representations via integration with remote sensing, soundings, multibeam sonar, stereo imaging, satellite surveillance and locational technologies operating planetarily. In figure 2, we can see independent AUVs, drifting ARGO swarms, marine mammals, orbiting satellite systems, secured-in-place buoys, traversing ships, and fixed data centres back on dry land assembled under, on, over and beyond the ocean. AUVs are uncrewed submersibles fitted with thrusters, batteries, and a range of complex instruments and embedded computing power that enable collection of extremely high-resolution, accurately geo-referenced acoustic imagery, and water column data to a depth of 6 000 m, mostly in the service of national science programmes (although commercial markets are growing as demand soars for extractive exploration technologies that can operate in ever more challenging undersea environments).[54] ARGO floats, by contrast, operate as simple robotic sensing instruments drifting with ocean currents on an automated vertical dive sequence, which allows them to reach depths of up to 2 000 m, and collect water temperature, salinity and pressure information as they sink. After ten days they typically return to the surface to transmit data to communications satellites before beginning the dive loop again. More than three thousand floats operate in the ocean at any time and are usually abandoned to the seafloor when their instruments fail after five years or so of operation.

AUVs and floats are also often encountered by curious marine mammals including, in the Southern Ocean, those with sensors epoxied to their body by human research teams keen to collect passive hydrographic information as the animals move through oceanspace. Deep-diving southern elephant seals (*Mirounga leonina*) are found throughout the Southern Ocean and enrolled into research regimes for their speed and long-range observation capacity, co-creating more than five hundred thousand open-source oceanographic profiles.[55] Moored buoys further assist all these bodies in their labour, connecting data with satellites overhead or via cable to seabed distributed optical fibre networks transmitting cellular acoustic or optical communications from AUVs and other sensor arrays. Critical to this network of knowledge production are surface ships and orbiting satellites receiving transmissions and redistributing them to onshore commercial data centres and public or private research institutions. The JASON satellite series is of special interest in this context; it was launched as an ocean-atmosphere observation collaboration between NASA and European space agencies in 2001. Named after the Greek mythological hero who journeyed far across the dangerous sea, the first JASON satellite was rendered inoperable in 2013 when hit by space junk and shifted to a graveyard orbit: a technological remnant that will circle the world for at least another thousand years.[56]

It should be noted that marine robotics innovation is typically tied to powerful institutions intent on maintaining power via surveillance and the emancipatory potential offered by such objects is restricted by operational parameters originally conceived by defence industry manufacturers.[57] Even reconfigured for scientific research and exploration, these ‘rebranded “good drones”’ (oceanographic AUVs and the like) are positioned as instruments operating in spaces outside of everyday life.[58] This digital infrastructure supports scientific endeavour in areas inaccessible to all except space-borne monitoring systems, and includes long-range AUVs like the UK National Marine Equipment Pool’s *Boaty McBoatface* plus robotic ARGO floats, deep water moorings, and ocean gliders deployed through Australia’s Integrated Marine Observing System.[59] The ‘smart ocean’ – an oceanic analogue of ‘smart cities’, where

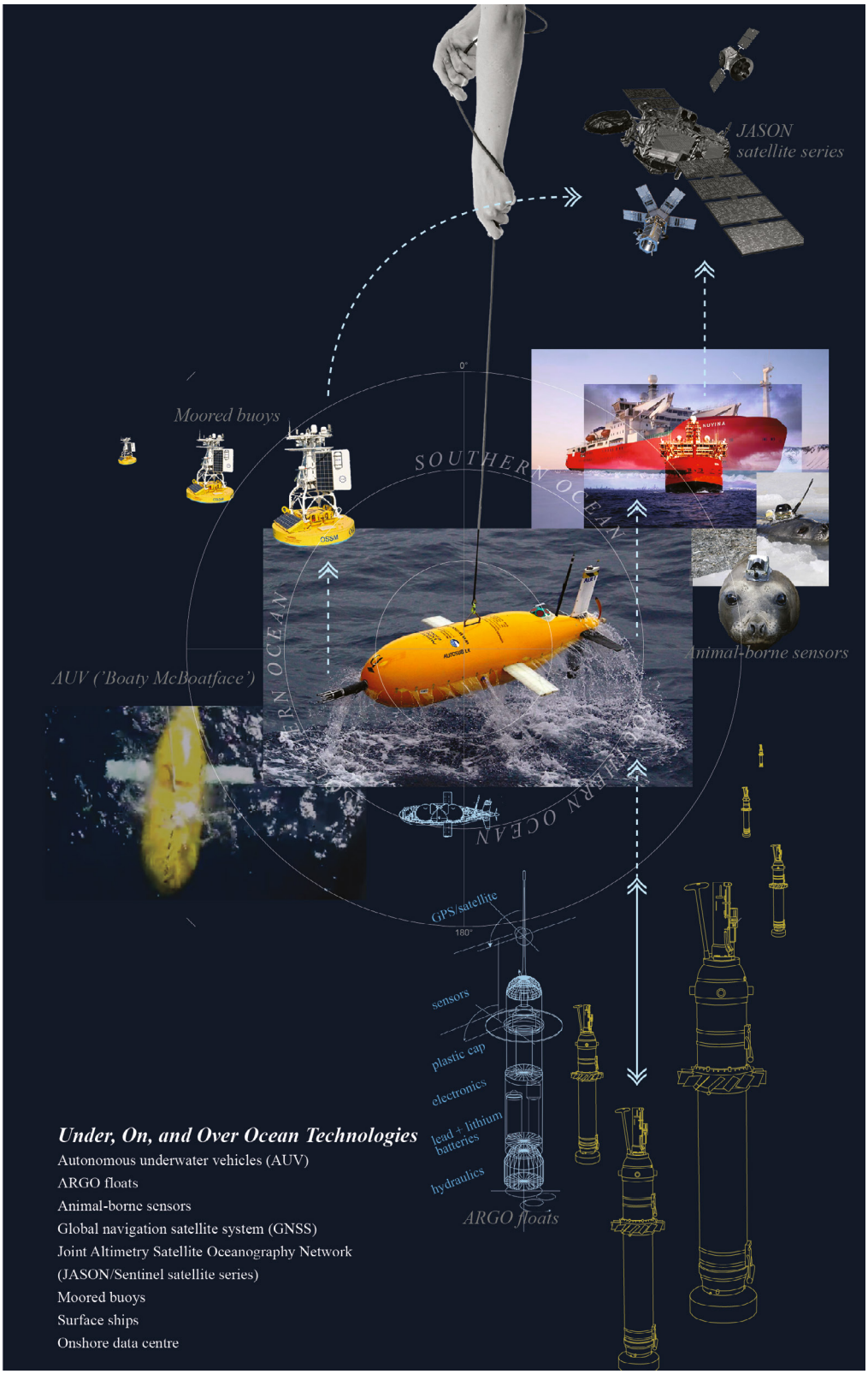


Fig. 2: Under, On, and Over Ocean Technologies. Illustrated photomontage: author.

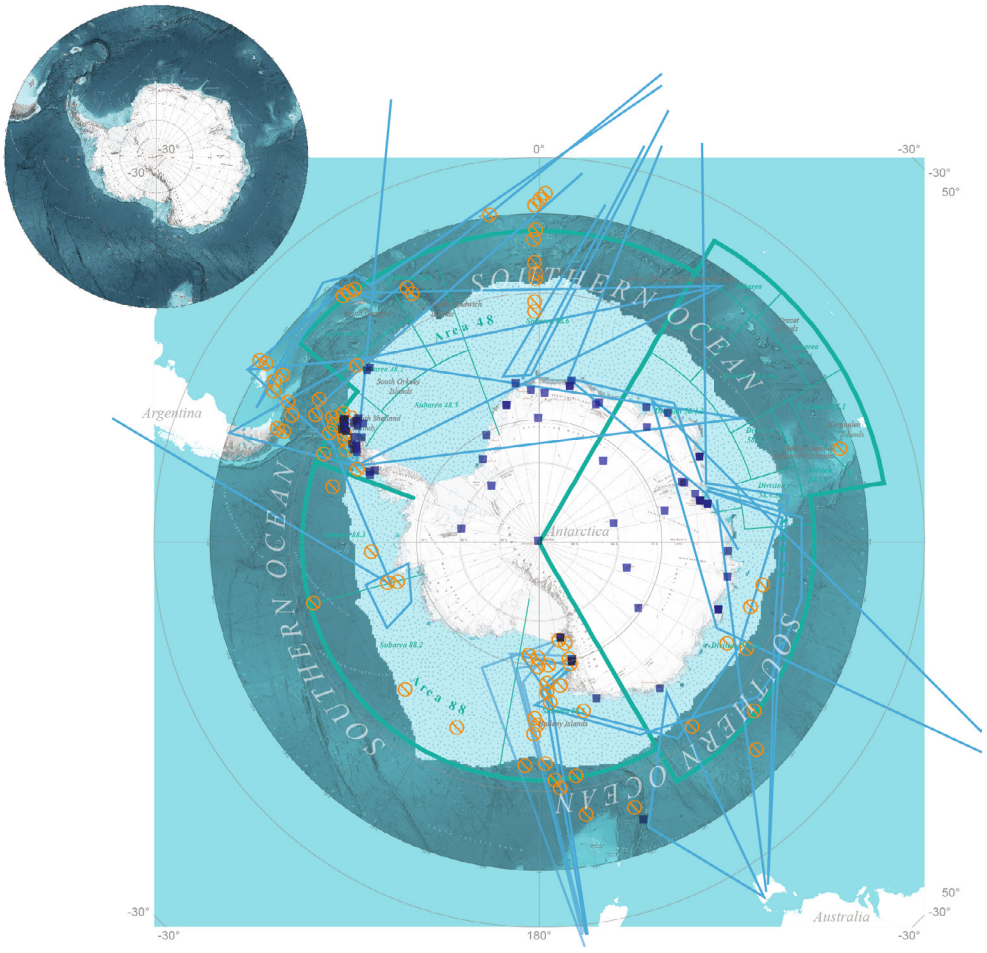


Fig. 3: The Observed Ocean. Illustrated map: author; includes data from Dorschel et al., *The International Bathymetric Chart of the Southern Ocean Version 2* (2022); Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); *Map of the CAMLR Convention Area* (2017); DueSouth Database of Upcoming Expeditions to the Southern Ocean. Antarctic – Planned Routes (2022); and Southern Ocean Observation System (SOOS). *SOOSmap – Plastic Debris* (2022).

environmental data gathering, sensing technologies and institutional relationships are arranged for more efficient marine governance via digital platforms – generates complex legal, ecological, and moral questions. Governance scholars have paid close attention to these socio-technical developments, and some geographers wonder if risks associated with the digitised ocean (in particular, a 'belief that divergent social and environmental interests can be reconciled with expanding capitalist relations through the proper combination of technological innovation and well-crafted policy') can be balanced with opportunities they might provide for the assertion of 'Indigenous data sovereignty' and meaningful ocean custodianship by First Nations.[60] Thus, extended forms of urbanisation continue to manifest in the Southern Ocean in surprising ways.

As many have argued previously, emergent forms of urbanisation require new representational modes and reflexive cartographies to set forth their analysis and interpretation. In figure 3, we can see the Southern Ocean as it is typically articulated: made abstract through a carefully selected set of open-source research data available from CCAMLR, the Scientific Committee on Antarctic Research, the Southern Ocean Observing System, the Norwegian Polar Institute's 'Quantarctica' GIS resource bank, the General Bathymetric Chart of the Ocean, and DueSouth (an online database of planned research, commercial and tourist expedition routes to the Southern Ocean launched in 2022). Figure 4 illustrates the absence of actual traffic uncovered by McCarthy et al. in their shipping visualisations, which revealed more complex port-to-port traffic networks through the Southern Ocean and beyond.[61] And finally, figure 5 makes use of datasets from Ocean OPS's open-source global ocean observation dashboard to register 'seeing' undertaken by a range of human, nonhuman, and 'not-quite human things' in the Southern Ocean via tracking ARGO float swarms, drifting and fixed buoys, animal-borne sensors, automated and crewed floating weather stations, expendable probes and AUVs. How we see or do not see the Southern Ocean assists in the construction of an authority through which certain urban knowledges and representations can become overstated. Similarly, reinscribing settler-colonial distinctions between what is considered appropriately urban or non-urban empties out remote environments and makes them available for extraction and exploitation at a distance. So, while new technologies have long been instruments for transformation in, and of, the ocean (witness the dramatic escalation of whale harvesting in the Southern Ocean as a result of nineteenth-century commercial harpoon innovations), contemporary floating robots and AUVs constitute new operators within this space: neither fully human nor nonhuman, yet lively and suggestive of new forms of agency.[62]

Untethered forms of agency

Scholars have only recently begun to explore the consequences of urban processes as they extend deep within the ocean.[63] Political geographer Jessica Lehman has lately called attention to global sensing technologies, which she argues signal that 'the ocean is no longer the constitutive outside but at the centre of modern government concerns, indicated by new enthusiasms for marine spatial planning, marine domain awareness, marine protected areas, and others'.[64] In the Southern Ocean, underwater technologies provide a permanent sub-surface expansion of observation, extraction and accumulation, and pair animal-borne sensors and remote bio-logging with an eye always directed towards commercial application. New notions of the 'robotisation of the sea' are championed by oceanographic institutions and defence industry advocates for their capacity to improve marine resource and global environmental management, but it is worth remembering that NASA's Jet Propulsion Lab have also been prototyping AI-embedded drones in the Southern Ocean in collaboration with scientific researchers and private interests to pursue extraplanetary resource exploration ventures.[65] The Southern Ocean might extend well beyond most human embodied experiences but it is only excised from conceptions of urbanisation in error. Semi-automated agents operating untethered within the Southern Ocean for thinly-veiled commercial benefit calls into question an Antarctic Treaty System claim of 'devoting Antarctica to science and peace', given scientific research seems to be, at least in part, directed by a prospecting fervour of human scientific, geopolitical, and financial ambitions in far-off cities. Operationalising the Southern Ocean for profit confirms our understanding of this space as an environment co-opted through extended urbanisation, and one largely unseen and unknown except through nonhuman means. This is not to suggest that humans are somehow external to these technologies. Quite apart from ways autonomous robots demand the support of human designers, programmers, and wranglers to function, architectural theorist Laura Kurgan also observes it is impossible to maintain a critical distance from their deployment. In her words, we are 'addressed by and embedded within them… Only through a certain intimacy with these technologies – an encounter with their opacities, their assumptions, their intended aims – can we begin to assess their full ethical and political stakes'.[66]

Paying close attention to the knowledges that drifting robots such as ARGO floats and more agential AUVs themselves co-create, allows for what digital ethnographer Sarah Pink calls the possibility of 'other voices' to come into representation.[67] Jackman and geographer Rachel Squire agree that there is a real need for 'approaching volume

through everyday encounters with objects, prompting revised reflections of instruments and attending to alternative instrumentalisations… [where] everyday objects are enrolled as instruments through which to navigate, mitigate, and disrupt water'.[68] In this context, underwater sensing instruments reveal human-nonhuman-technology relations in the Southern Ocean. The technological capture of any environment tends to prefigure its rapid urbanisation, but we must resist a narrow technical understanding of such processes. So too, media theorist Shannon Mattern critiques urban debates for their tendency to concentrate on 'smart city' logics when 'urban environments everywhere are characterised by a lot of messy materiality, residual media and different notions of ambient intelligence, sometimes even reflecting competing epistemologies and clashing politics'.[69] 'Seeing' extended urbanisation manifest in the Southern Ocean requires rethinking assumptions about cities, the technologies which scaffold them, the many bodies enlivening oceanspace, and representations that limit conceptualisations of the ocean. They also demand re-presentation of – and thus, active resistance to – the emptying out of certain environments.

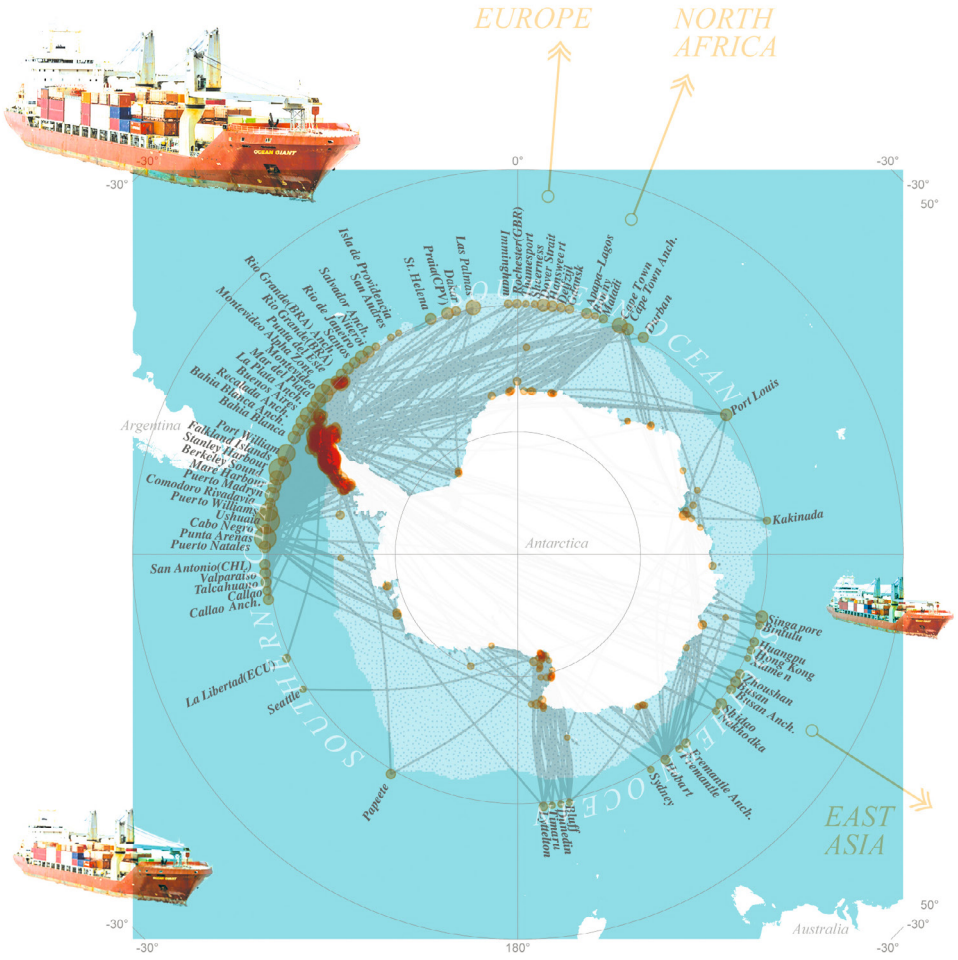
Unmoored worlds

Technologies investigated here in the Southern Ocean are primarily sensing instruments, and media sociologist Jennifer Gabrys reminds us that data produced by environmental sensing does not just generate information, it also gives form to experiences that themselves create new conditions. To wit, environments are not already-existing objects to be translated via devices, but worlds made through and with technologies.[70] An urbanising ocean which operates simultaneously with *and* beyond human presence must pay close heed to technologies that facilitate vision in lieu of our own. There is a real risk that underwater technologies may have their data conflated with actual human vision, as has been observed with other technological intermediaries. For, as artist and visual geographer Trevor Paglen has pointed out, 'most images are made by machines for other machines, with humans rarely in the loop'.[71] That being said, ubiquitous reliance on terrestrially focused surveillance and representation (driven by Google Earth and other satellite image platforms) can be disrupted by the unique character of data gathered by machines under the sea. If we cede autonomy of image-making to these bodies – (in)sights produced by subversive submersives – we might better understand the uneven and often unexpected implications of urban processes unmoored from human control. In keeping with political theorist and philosopher Jane Bennett's reference to a 'confederation of things', I argue that emerging assemblies of nonhumans, humans, not-quite-human 'things' and ocean environments are due close examination, as their relational possibilities allow for a radical re-presentation of urban processes transforming the planet.[72]

The figures created in support of this article's argument examine the Southern Ocean via cartographic methods underscoring that the urban, the ocean and the planet cannot be separated. They make substantive use of 'diffractive analysis', an approach proposed by feminist theorist Karen Barad alongside science and technology scholar Donna Haraway, which combines techniques drawn from art practice, history, and cultural studies as 'an inquiry into the material effects of difference through an embodied engagement with the materiality of the research data'.[73] Diffractive analysis engages critically with the processes of research to understand the data from 'within', a reference to Haraway's reworking of the term 'diffraction'. This means resisting canonical readings of data, and thinking these entities together and 'through' each other as

> a critical practice for making a difference in the world. It is a commitment to understanding what differences matter, how they matter, and for whom. It is a critical practice of engagement, not a distance-learning practice of reflecting from afar… We do not uncover pre-existing facts about independently existing things as they exist frozen in time like little statues positioned in the world. Rather, we learn about phenomena – about specific material configurations of the world's becoming.[74]

Thinking cartographies of the Southern Ocean *together* and *through* each other requires observing the relations of sensing assemblies that produce data, not just their geographical range. Figure 6 therefore resists any single perspective by montaging bodies of extended urbanisation in the Southern Ocean: an array of autonomous technologies, sensors, and satellites – and humans and nonhumans – that co-create representations at once undersea, on the water's surface, and in the cosmos above. It is worth recalling that early modern media of the Southern Ocean helped construct a 'golden age' of heroic exploits and imperial expansion, disregarding the increasing industrialisation enabled by sealing, whaling and other extractive networks in this space.[75] In the twenty-first century, representations of potential climate change catastrophe co-mingle with idealised wilderness imagery of the Southern Ocean, all the while ignoring the growing settlement of Antarctica and ways in which its surrounding ocean is utilised as a resource to support those and other urbanising populations. In both instances, certain types of representation are broadcast around the globe in order to match (largely Western) societal concerns. As visual culture theorist Nicholas Mirzoeff points out, 'seeing the world is not about how we see but about what we make of what we see'.[76]



Overlooked Urban Ocean

Recently revealed shipping tracking data identify a tenfold increase in previously known port-to-port networks connected with the Southern Ocean.

After MCCARTHY *et al.* 2022. "Figure 2: The port-to-port traffic network of all ships that visited Antarctica from 2014 to 2018", Ship traffic connects Antarctica's fragile coasts to worldwide ecosystems. *Proceedings of the National Academy of Sciences*, 119, p.4

Fig. 4: Overlooked Urban Ocean. Illustrated map: author; includes from Dorschel et al., *The International Bathymetric Chart of the Southern Ocean Version 2* (2022); Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); *Map of the CAMLR Convention Area* (2017); and McCarthy et al., 'Ship Traffic Connects Antarctica's Fragile Coasts to Worldwide Ecosystems', *Proceedings of the National Academy of Sciences* 119, no. 3 (2022): 1–9, 4 (Fig. 2).

Fig. 5: Seeing the Urban Ocean. Illustrated map: author; includes data from Dorschel et al. *The International Bathymetric Chart of the Southern Ocean Version 2* (2022); Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); *Map of the CAMLR Convention Area* (2017); DueSouth Database of Upcoming Expeditions to the Southern Ocean, *Antarctica – Planned Routes* (2022); and Global Ocean Observing System (GOOS); *Polar Basins Observing System: In situ operational platforms monitored by OceanOPS* (2022).

Kurgan pushes further and asks, ‘what [do] the technologies of spatial representation have to do with the spaces they represent, beyond simply representing them’?[77]

Radical new conditions

Underneath the machinery of extraction and exploitation in the ocean lie significant questions for representing urbanisation as it manifests outside usual conventions of the city. I argue that the Southern Ocean provides a compelling illustration of ‘not-seeing’ the ocean that is also, in Lefebvre's term, a deliberate ‘not-knowing’ of the ocean: a manoeuvre to excise always-becoming relations between our worlds, spatial ordering, and economic production. In contradistinction, underwater technologies can enable sensorially-rich representations of oceanspace that decentre the controlling eye of the human. Significantly, these can only be mediated through a confederation of humans, nonhumans, and remote encounters with other not-quite human things orbiting the planet itself. To note that we are all embedded within technological networks operating across the globe in the twenty-first century is not surprising, but a lack of intimacy with those relations as they exist underwater makes the long-standing disregard of the ocean (and in particular, the Southern Ocean) clear. Beyond simply recording data, objects, and processes, such technologies co-constitute the spaces in which they operate: as per Gabrys, they give form to experiences and create new conditions in, and of, our worlds.[78] For instance, the ancient Greek hero Jason names a series of oceanographic satellites circling the Earth in full knowledge that in this myth, he and his Argonauts (also the inspiration for ARGO floating robot workers, which aimlessly collect data around the world) take to the seas to seek out (but, more accurately, steal) the Golden Fleece: a symbol of royal power, wealth and dominion over the world.

Contrast this with the University of Tasmania’s launch of a new Southern Ocean AUV, *nupiri muka.* The name translates as ‘Eye of the Sea’ in *palawa kani*: a composite Tasmanian Indigenous language comprising remnants of a dozen other original languages spoken by ancestors dispossessed through the invasion of lutrawita/Tasmania by English and European settler colonisers since at least the eighteenth century. Historically, the Indigenous people of lutrawita/Tasmania were sailors and builders of seafaring vessels, and *nupiri muka* has been conceptualised to survey distant spaces and share information towards a greater understanding of the unfamiliar.[79] Whether *nupiri muka re*-presents oceanspace in radically different ways as a result of its carefully created nomenclature and framing in response to local knowledges of cultural context, history, and environmental sites is open to question; especially given that reporting of its voyages have so far been limited to scientific journals of conventional research outcomes.[80] Marine ecology scientists Elena Buscher and Darcy Mathews more recently found that co-developing a marine survey with the Songhees Nation in Ti’ches oceanspace, British Columbia, has been key to establishing an Indigenous-led underwater monitoring system using sensing technologies.[81] By mapping subtidal areas with low-cost remotely operated underwater vehicles and generating marine use planning guidelines based on culturally important species, the Nation has been able to negotiate protections against overfishing and increased shipping traffic, and support ongoing social and ceremonial custodianship of this space.[82] In these instances, engaging in technologies with cultural competency in mind help to counter the exclusion of the ocean from urban matters and unsettle *terra nullius* logics that continue to make certain spaces available for remaking in the service of those far removed from them.

Perhaps the real contribution to be made by these submersive technologies reaches beyond technoscientific activities (like revealing illegal extractive operations underwater or policing overfishing in remote locations), and instead could develop from a lack of fixed perspective and rejection of the primacy of sight when encountering unfamiliar phenomena. As agents of exploration with limited supervision, their capacity to provide unexpected and often unsolicited data may ultimately help resist the re-inscription of colonial norms back into the ocean. For the Southern Ocean cannot be understood through the flattening of knowledges or experience. Instead, as shown, it requires the subversion of human control and an invitation to participate in mutually recursive analysis with both nonhumans and non-quite-human ‘things’ alike. As an emancipatory possibility that would seem to emerge only from the dismantling of lexicons that currently work to order our worlds, the actually subversive role of these technologies might simply be in enabling us to continually make and remake sense of the transforming environments we inhabit across time and re-present relations we are forming and reforming throughout the entirety of the planet. In keeping with Barad’s insistence that objects and things do not exist in isolation, I therefore argue for greater collaboration with underwater things that are not quite human and yet not quite nonhuman, and acknowledge more-than-human knowing, observing, measuring and theorising acts within the world and co-produces it. As Barad herself says, ‘discursive practices and material phenomena do not stand in a relationship of externality to each other; rather, *the material and the discursive are mutually implicated in the dynamics of intra-activity’,* which seems to echo Lefebvre’s earlier argument that urban analysis should be concerned with ‘gathering together of what gives itself as dispersed,

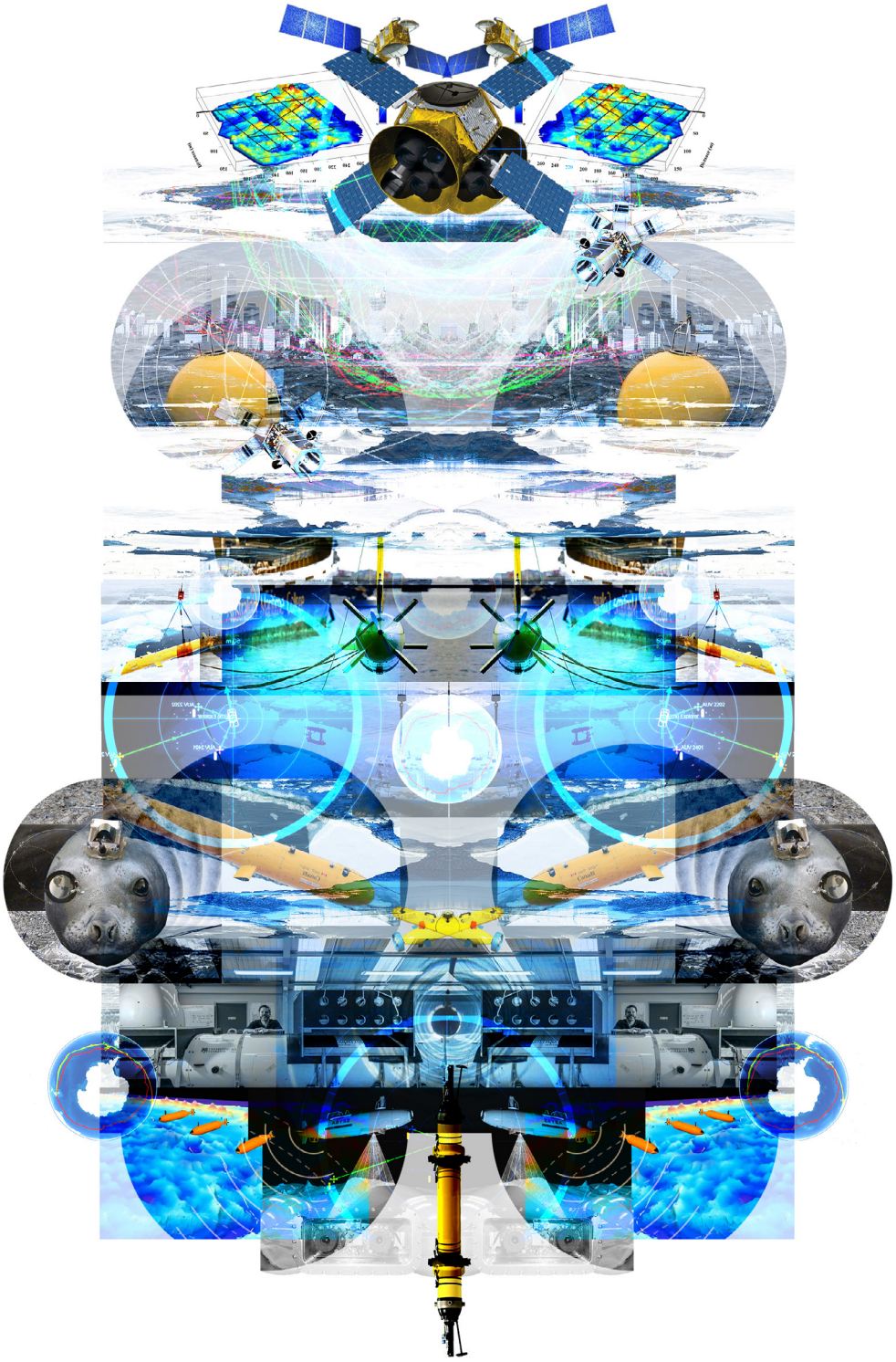


Fig. 6: The Extended Urban Ocean. Photomontage: author.

dissociated, separated, and this in the form of simultaneity and encounters'.[83]

Conclusion

The ocean may present complications for claims that urbanising spaces extend well beyond the container of the city, but unique characteristics of the Southern Ocean allow for a clear interrogation of spaces that limit conceptions of the urban in contemporary debates. By relinquishing prior frameworks, synthesising fragmentary information, and revealing difference within oceanspace, I have worked in this article to re-present the co-constitution of human and nonhuman relationships across a rapidly urbanising planet. A full consideration of humans and nonhuman relations within the water is absent from many urban debates. I have therefore used Steinberg and Peters's wet ontology framework to argue for the ocean as a critical lens for reflexive and relational thinking at interdependent urban, global, and microscopic scales, which is also in keeping with theorisations by Lefebvre on connections between cities and their 'elsewheres', and Brenner, Schmid and other urban scholars' investigations of the nature and consequences of extended urbanisation at the scale of the planet. Decentring a landed bias across disciplinary norms of space and time, and making use of new materialist approaches to reading data and resisting canonical constructions of imagery, I have created comparative cartographies to examine what not-seeing the extended urbanisation of the Southern Ocean signifies for the planetary reach of urbanisation more generally. What arises from this article is always-becoming evidence that here, in the Southern Ocean, forms of extended urbanisation are operating at the intersection of a scientific research-commercial speculation nexus of resource extraction and exploitation and surveillance through co-opting AUV, ARGO float and sensor data.

Ultimately, what I hope to highlight is that processes occurring in remote locations are not isolated, though they may develop in the interest of those much further away. As such, I argue that working through and with underwater assemblages to know and theorise can co-produce other worlds in which those processes can be observed and evaluated. Reorienting attention towards the proliferation of underwater vehicles, drifting robots and other technologies in the Southern Ocean confirms that extended forms of urbanisation can occur at a distance from humans, though not without 'lively' bodies altogether. If we avoid relations with the many others enrolled in the urbanisation of this planet (whether human, nonhuman or not-quite-human things), critical connections between ourselves, others, and the urban remain unseen even as they experience significant transformations together. The urban and the ocean are clearly bound together, but are now shown operating at a planetary, though largely unseen, scale and with humans far less in control than assumed.

Notes

1. Though the data supporting a (conveniently simple) 50 per cent marker for urbanity across the globe seems less confidently asserted today than when those debates first arose, some scholars have identified more troubling concerns within the discourse itself. They see its emphasis on morphological categories of the city at the expense of processual accounts of urbanisation tending towards reductive accounts of any possible urban age. Neglecting to engage with the unevenly experienced effects of diverse forms of urbanisation serves to obscure planetary processes that emerge directly from the continued growth of cities, such as intensified resource extraction, capital accumulation, and climate change impacts across wider territories than the formal container of any city. For detail, see both Hillary Angelo and David Wachsmuth, 'Urbanizing Urban Political Ecology: A Critique of Methodological Cityism', *International Journal of Urban and Regional Research* 39, no. 1 (January 2015) and Kate Shaw, 'The intelligent woman's guide to the urban question', *City* 19 (2015).
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Biography

Charity Edwards is a PhD candidate at the University of Melbourne School of Design and a lecturer in Architecture and Urban Planning & Design at Monash University (Melbourne), where she oversees the Bachelor of Architecture design studios alongside urban history and theory units at undergraduate and masters level. She is a registered architect, having practiced for twenty years across Australia, and continues to collaborate with artists, scientists, and communities to create built spaces, objects and landscapes. Her more recent research highlights the impacts of urbanisation in remote and offworld environments by investigating how such processes extend into the ocean and outer space through increasingly autonomous technologies. Her work has been published in *Dialogues in Human Geography*, *Society + Space Magazine*, and *Future West (Australian Urbanism).* She is a co-founder and member of The Afterlives of Cities research collective, which brings together expertise in architecture, digital fabrication, astrophysics, and speculative fiction to recover futures in space.

In the Garden of Anthropos: Conservation after Artificial Intelligence

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Abstract
The term 'planetary garden' was coined by Gilles Clément to refer to the privileged site of the planetary mixing of species that is managed by humans. In the face of the ongoing environmental collapse, we envision the garden as a new locus for symbiotic attachment and original exchange between human and non-human ecologies. Drawing on the garden metaphor, we discuss the conceptual and ecological impacts of human stewardship of the environment. Recognising ecosystems as changing fields of social and technical interactions, we evaluate how conservation strategies shift in tandem with these changes. We explore the influence of emerging technologies on human understanding of natural ecosystems and on societal approaches to conservation. Envisioning the future, we are mapping out the need for human-centric technologies to foster new forms of agency between humans and their environments. While any technological promise does not come without ethical and technical challenges, we advocate for ecological intelligence (EI), a spatialised human-AI collaboration scheme, as a critical condition for reimagining and upscaling conservation practices in the Anthropocene.

Keywords
planetary garden, conservation, ecological intelligence, artificial intelligence, biodiversity

In the face of the ongoing environmental collapse, humanity's impact on the environment is at the forefront of global attention.[1] With policymakers stressing the need for ecosystem management, strategies that attempt to integrate non-human species conservation with urban economies and capitalist production are emerging.[2] At the same time, a new range of technological developments offers the promise of better comprehending and managing ecosystems. Satellites in orbit, and sensors in the sky, in the wild and in handheld devices are employed to monitor ecosystem processes in real time.[3] Software tools running artificial intelligence (AI) algorithms are employed to extract and analyse vast amounts of data to reveal ecological patterns previously undetected or unexplored.[4] As AI transforms scientific methodologies it gives rise to new conceptualisations and normative evaluations of the natural world. The influence of technology on the balance between humans and non-humans, and on the shaping of global policies for the preservation of critical environments demand thorough consideration.[5]

In this article, we examine the conceptual and ecological impacts of human stewardship over the environment, focusing on how conservation objectives intertwine with cultural views of the natural world and how these views change as new types of ecosystems emerge. We trace the transition from the idea of restoring an ecosystem to a pristine state before human influence, toward practices of stewardship that promote a symbiotic attachment between human and non-human habitats. Addressing conservation from a technological perspective, we examine the role of technology in the virtual and material specification of the planetary garden. We observe how the transformation of environmental science and practice evolves into an Earth-encompassing garden intelligence, redefining human entanglements with natural ecosystems. How could this intelligence contribute to the democratisation and upscaling of ecosystem conservation and point towards new approaches for addressing ecological challenges? We advocate for ecological intelligence (EI), a localised human-AI collaboration scheme

that enforces human agency, methodological plurality, and knowledge sharing.

Dialogues on ecosystems and conservation

Making sense of the anthropogenic impacts on the environment is a longstanding challenge for researchers in environmental, sociocultural and design disciplines. With humans constantly reshaping ecological relationships, conventional models of the natural world as static vegetation units fall short in capturing dynamic human interactions with ecosystems or the climate. To provide a representation that captures the impacts of human determination of the environment, Erle Ellis and Navin Ramankutty introduce the idea of anthropogenic biomes, or 'anthromes', considering humans as integral components of ecosystem patterns.[6] Unlike biomes that are generally categorised by factors like vegetation, climate and wildlife, anthromes are defined by human activity such as urbanisation, food production and infrastructure.[7] The unforeseen exchanges between species and landscapes, a direct consequence of human presence, are altering ecosystems and transforming approaches to environmental conservation.

New types of ecosystems shaped under human influence and climate change disrupt the traditional understanding of what should be preserved.[8] To some, anthropogenic ecosystems like those in figures 1 to 4, changing and largely unclassified, represent the future of conservation. Abandoning the thought of restoring ecosystems to their 'pristine' state, some conservationists aim to understand and safeguard new forms of biodiversity in these evolving systems. To others, human-made and novel ecosystems are stark reminders of the irreparable harm inflicted upon nature.[9] Two distinct outlooks on conservation emerge: one advocating for substantial segments of the earth to be enclosed, isolated and copiously preserved; the other encouraging conservation within environments shaped by human activity. While the former upholds the ideal of ecosystem autonomy, the latter accepts the role of humans as caretakers of the planet perceiving ecological relations as designable under specific intentions and limitations.[10] Elements of both approaches resonate in environmental policies directing global conservation efforts, where the pursuit of 'restoring nature' coexists with the acceptance of universal human influence and the setting of moderate conservation goals.

To transcend the polarity of the outlined approaches, Bram Büscher and Robert Fletcher propose 'convivial conservation'.[11] Their pluralistic proposition of 'living with' incorporates indigenous practices and local community participation and positions conservation within a post-capitalist perspective. Creating ecological systems that transcend the distinction between nature and culture resonates with communities that espouse a philosophy of coexistence rather than dominance over non-human species. The bond between these communities and their environments has safeguarded ecosystems threatened directly or indirectly by human activity.[12] In Büscher and Fletcher's proposed scheme, conservation's reorientation towards such alternative paradigms becomes central, as 'taking responsibility for nature and taking responsibility for democracy come together' in 'making a world'.[13] Their political reformulation attempts to fuse some of the contradictions that are intrinsic to environmental management and conservation practices.

Sowing the garden metaphor

Conservation, culturally apprehended as human stewardship, entails the responsibility to safeguard and actively manage the natural world. The idea of a metaphorical garden encompassing the entire biosphere illuminates aspects of environmental stewardship moulded under societal, political and economic forces. For landscape designer Gilles Clément, the 'planetary garden' is the worldwide site where species and matter mix in ways that are induced and supervised by humans.[14] Clément's evocative descriptions resonate with evolutionary ecologist Daniel Janzen's observation on the human propensity to treat any landscape as their own garden.[15] For Janzen, the garden becomes the privileged locus of symbiosis, fostering an environment conducive to the continuation of non-human species. It can be likened to Noah's ark: the more species come aboard the greater their chances of survival. What transforms the planet into a garden is precisely this sort of management, which consists of coercive attachment and planned extinction. Janzen's garden scheme appears down-to-earth compared to experiments in climate engineering where the garden is reimagined as the metaphorical site of humanity's terraforming aspirations.[16] According to David Keith, an expert in atmospheric and climate sciences, global-scale modification of the planet's climate is inevitable. Humans are already 'in the gardening business with this planet' and should 'start making deliberate choices instead of altering the climate' indirectly.[17] Keith's gardening vision justifies an unconditional reliance on technology for radical environmental intervention on a global scale.

With the discussion of conservation unavoidably taking place within extended urbanisation, the direct and indirect impacts of technology on ecosystems reveal a complex ethical terrain where the sidelining of non-dominant cultures is a critical concern .[18] Driven by the desire to bend ecosystems to preordained designs, technological solutionism and its effect on human and non-human interactions deserves further investigation.

Fig. 1: The abandoned Lato-Kekrops mining site in the Tourkovounia hill range, less than five kilometres from the centre of Athens. Inactive for almost half a century due to the company's legal dispute with the Greek State and neighbouring municipality, the 200-hectare old quarry is being colonised by unidentified populations of ruderal species and urban flora. Photo: Christos Montsenigos.

Fig. 2: Watering of the Euphorbia Origanoides, endemic to Ascension Island, a British Overseas Territory in the South Atlantic. Registered as barren and uninhabitable in colonial reports and travel narratives until the early nineteenth century, the island today is a unique artificial forest and natural reserve. Its ecosystem has developed from over two centuries of reforestation, species introduction, and attempts in climate manipulation, and it presents the uncontrollable conditions that are characteristic of novel ecosystems. Photo: Lance Cheung (source: https://bit.ly/44ZSx8x, shared under CC BY 2.0 license).

Fig. 3: A botanical label and specimen distinguished from the surrounding flora in the McBryde Garden, located on the south shore of Kauai island, Hawaii. Established in 1970 in place of a nineteenth-century sugarcane plantation, McBryde and its neighbouring Allerton are two of five botanical gardens operated and managed by the non-profit NTBG (National Tropical Botanical Garden) institution dedicated to tropical plant research and conservation, and following a more traditional approach towards natural reserves and how they can be combined with scientific research. Photo: Katerina Labrou.

New machines in the garden

Historically, depictions of technology and nature have been in stark contrast. Contemplating the influence of technology in his 1969 book 'The Machine in the Garden', historian Leo Marx considered its integration into the pastoral landscape.[19] For the nineteenth-century imaginary, as depicted by Marx, machines were cast as a threat to traditional and idealised notions of nature. Today, technological omnipresence attests to the impossibility of distinguishing the natural from the anthropogenic, at the same time establishing the planet as a dynamic field under scrutiny.

Existing environmental technologies are inscribed in the garden-planet paradigm. The garden is mapped, monitored, and tended systematically to secure its growth. Satellite imagery and drone-based sensing; trap cameras, acoustic sensors and DNA sampling; citizen science platforms engaging the public in data reporting; scientific efforts are focused on identifying, documenting, and manipulating environmental and biodiversity patterns. [20] Technology introduces new ways to intervene and interact with the environment. Representing an array of operations that mimic human cognition, AI resets the boundaries of conservation. Sifting through vast amounts of climate and biodiversity data reveals patterns previously undetected or unexplored. Planetary monitoring is, by analogy, a necessary condition for establishing the garden on a global scale. In fact, the planetary garden would not be possible without the monitoring apparatus. Once established, this apparatus enables the garden metaphor to grow. It also lays the groundwork for control to flourish within the garden.

A radical thought experiment proposed by landscape architect Bradley Cantrell, biologist Laura J. Martin and earth scientist Erle C. Ellis, affirms the worldmaking potential of these technologies. The 'wildness creator' is a hypothetical AI control system designed to manage wild spaces through remote sensing and restorative acts based on surveillance data.[21] The authors envision AI as an alien mind that governs the conservation site, with autonomous agents performing operations such as controlled seeding or invasive species removal. Their provocative proposition suggests a new kind of autonomy for ecosystems – one that is initially constructed by humans but is ultimately self-sufficient. Building upon the concept of the wildness creator, Bradley Cantrell and Zihao Zhang suggest the need for a new intelligence that is specific to landscape architecture.[22] In their understanding, most implementations of AI systems overlook the complexities of human and non-human interactions. An AI that is tailored to the specific challenges of landscape architecture would need to actively engage with intelligent patterns that emerge in physical environments in order to 'create places that serve the higher purpose of social and ecological justice for all peoples and all species'.[23]

In observing the wildness creator's autonomous decision-making, questions about technology's limitations and inherent biases emerge. Could AI contend with the dynamism of environments in the wild? Any act of tending or eradicating species is founded on culturally constructed ideas of value. What conservation objectives are engraved in the system? Does it inherently distinguish between native and invasive species? What ecological or ethical implications arise from a system autonomously developing its values through trial and error? Are the system's values consistent with conservation? Who holds responsibility for making this judgment and halting its operation if it goes rogue? The wildness creator removes humans from the picture not only physically but also by operating as a black box. The lack of transparency leads to impenetrable technical and ethical conundrums that situate it within the realm of fiction.

Despite the increasing potential of advanced technologies to capture various aspects of the natural world, it is early to claim that natural complexity can be inscribed within and deciphered by the fixed frameworks of statistical models like machine learning and AI. Trained on data that represent quantifiable aspects of the physical world, statistical models identify patterns and correlations within these datasets. Physical and computational constraints like the sensor's field of agency set the limits of what can be captured and represented. Satellite images of the earth constitute numerical matrices before any layer of interpretation. Biodiversity data are only available for places where sensor stations are installed. While the patterns learned by the models are used to predict future trends, the data come from past measurements. The more dissimilar the future from the past, the more inaccurate the data predictions. In a rapidly changing environment and climate where unforeseen phenomena occur, the predictive scope of data models is constrained to a short timeframe. Could overreliance on these predictive mechanisms result in myopic solutions, limited to parameter adjustments rather than radical changes? Data models lack awareness of qualities that are subjective (depend on human perception), that are ambiguous (their meaning is shifting and abstract in nature), that are conceptual rather than quantifiable. Capturing the ever-changing ecological dynamics within cultural settings in numerical terms is hard. Uncovering their inner workings and predicting the long-term effects of cultural or political attitudes on the environment appears unattainable.

'Gardenification', the enclosure and attachment of non-human species to human-designed environments for

Fig. 4: With a surface area of almost three hectares, the Javits centre's green rooftop in Manhattan's Hudson Yards provides a habitat for dozens of local and migratory birds, several bat species, and thousands of insects. Despite their limitations and possible disputes about their status in conservation science and research, similar projects have the capacity to function as prototype sites for original observation, studying biodiversity and conservation in complex metropolitan areas. Photo: Alexandra Kotis.

protection as Jansen describes it, takes a new form. In the gathering of environmental data, we observe the enclosure of the entire planet in its smallest dimensions to render the problems more familiar and manageable. This 'datafication' of ecosystems generates a new virtual ecology permeated by the epistemic shortcomings of fragmentation. The new ecology of the planetary garden remains a field of biopolitical tensions between human and non-human agents, in which humans are part of the enclosure. Scientific monitoring, seen as a surveillance mechanism, implies the exertion of power and biopolitical control. Datafication becomes an effort to secure new ecosystem services that involve human and non-human entities, be they living organisms or technological agents. Data as the 'new wild' becomes integral to green and data capitalism as a new commodity and an inexhaustible resource of institutional greenwashing and funding.

Two centuries after the machines were first introduced in the garden, technology retains its ideological weight. The promise that technology alone can fix the damage of industrialisation sustains the illusion that current lifestyles can be maintained without altering the root causes of the climate crisis. To reconcile environmental protection with relentless urban expansion, the tendency of mainstream conservation is towards restructuring the way ecosystems operate within capitalist economies.[24] Efforts to draw from indigenous knowledge to improve resource management often fail to move the established mechanisms, treating the members of these communities as mere instruments of the apparatus. The question of whether technology can foster new relationships that transcend dominant conservation paradigms remains open-ended.[25] In our view, technology finds its place in the garden within a symbiotic structure that can enhance interspecies relationships and give rise to new forms of agency.

Towards a convivial conservation technology

If there is no way to escape the apparatus, can we redirect it to embrace the diversity of worldviews? Conventional models of technological governance go hand in hand with an understanding of conservation as general strategies or regulatory frameworks that are part of international law or national policies. Questioning the designs of generic solutions implemented uniformly across different regions, we advocate for conservation technologies of local relevance. This overtly spatial argument regards technology as an integral part of a geographical or geophysical region. With socio-ecological and technological systems evolving and adapting in tandem, conservation could acquire traits akin to place-making.

While techno-centric solutions, like the wildness creator, delegate human agency to technology, adapting the apparatus to human communities and their environments can enhance ecological interactions, and create new forms of agency and collaboration between them. Technologies that enhance networking and communication exemplify this direction. The blockchain emerged as a promising medium for managing interactions aimed at shared objectives, such as those in conservation. The consensus mechanisms of blockchain technologies enable action traceability within the network and enforce accountability, ensuring the implementation of collective decisions. For instance, blockchain's application in monitoring a fishery's chain of activities – from feeding and farming to trading – or in overseeing eco-tourism practices in a national park, can assure the sustainable and fair use of natural resources. Blockchain's transparency allows multiple network participants to direct funding towards initiatives that are provably sustainable. By eliminating intermediaries, a broader range of initiatives is possible, promoting diversity in conservation efforts. [26] Nonetheless, blockchain's technological complexity has made it challenging for the inexperienced to adopt it.[27] In another technological niche, advancements in AI seen in models that can communicate through human language and respond to visual or other inputs, point towards a more human-centric technical sphere.[28] The adoption of natural language for interacting with computational systems holds the promise of more equitable access to scientific knowledge and tools.

The future of conservation calls for collaboration between humans and non-humans, encompassing biological, material, and computational systems – to construct new knowledge about changing ecosystems. Differentiated configurations of the apparatus will serve as local repositories of this new, shared resource. Scientific expertise from natural, social and applied sciences, experiential insights from conservationists in the field, and data flows running in and out of the ecosystems will come together to formulate a spatialised ecological intelligence. AI's increasing ability to translate between various languages, from spoken dialects to programming languages or other forms of technical and regulatory communication, points in the same direction. This EI will support conservation by conversing about the condition of ecosystems, giving environmental data insights, making recommendations, or implementing citizen-led policies. Integrating both bottom-up and top-down knowledge structures, it will provide a platform for information sharing and communication between communities, researchers and policymakers, deepening the ties of the participants with their immediate surroundings. Its existence can set forth new interactions between humans and non-humans, giving rise to new understandings of the diversity of social, biological, hydrological, agricultural, technological and other systems.

A new garden scheme that nurtures resilient ecologies on an environmentally fragile planet is now conceivable. Transcending the culture of continuous surveillance, the sociotechnical framing of the EI promotes a convivial approach to conservation. With more people participating in conservation, more pluralistic approaches can exist. Leveraging EI, the system that supports their decisions and actions can be equally diverse. Knowledge aggregation and sharing, inside and across various localities can drive new scientific findings and facilitate the creation of sustainable systems on the planetary scale. In this extended agglomerated garden, new ecosystem categories can grow, giving way to new notions of resilience in the face of the climate emergency.

The EI will inevitably encounter ethical and technical challenges. Like any data-collecting apparatus, it will be prone to reproduce the prejudices, the inequalities or the errors that are present in the data. Bias can manifest in attitudes towards people, just as it can in perceptions of different species. The dissemination of contested scientific knowledge or the deliberate insertion of false information into the system can complicate its use. To ensure the accuracy, reliability and integrity of information within the system, continuous refinements based on human feedback and ethical consensus among people will be essential. AI is not meant to impair human judgment or substitute human decision-making. Humans will have to be in command and bear responsibility for upholding the rights of all participants.

Diversifying the apparatus is beyond vital to integrate the human perspective in today's datafied landscape. Without collective involvement, data remain fragmentary representations akin to fleeting snapshots of a rapidly changing world. Lacking social grounding or holistic integration, data representations can obscure the dynamism and interconnectedness of social and ecological environments. The role of EI in the planetary garden extends beyond merely collecting and distributing information. By bringing together social, natural, and technological systems, it aims to weave the fragments into personal, cultural, historical, scientific or other narratives that describe the changing environments and the collective decisions to protect them. Incorporating a human perspective into the garden scheme can create new knowledge, establish new conservation cultures and prompt new inquiries: Whose knowledge yields the greatest influence on collaborative schemes? How are conservation ethics redefined? Can non-humans gain a voice within this paradigm? These and many more questions suggest future avenues of exploration as we attempt to re-envision environmental stewardship in the Anthropocene.

Notes

1. Details on the goals and targets to be reached by 2030 are listed in 'Kunming-Montreal Global Biodiversity Framework', 15th meeting of the Conference of Parties to the UN Convention on Biological Diversity; also, WWF, *Living Planet Report 2022: Building a nature-positive* society, ed. R.E.A. Almond et al. (Gland, Switzerland: WWF, 2022).
2. More on the use of scientific methods to increase landscape productivity can be found in The Royal Society, *Multifunctional Landscapes: Informing a long-term vision for managing the UK's land* (London: Royal Society, 2023), royalsociety.org/topics-policy/projects/living-landscapes/multifunctional-land-use/.
3. An example of real-time satellite data can be found on the website zoom.earth.
4. There are examples of satellite data and visualisation tools from NASA (https://www.nnvl.noaa.gov/view/globaldata.html), Copernicus's Climate Data Store (https://cds.climate.copernicus.eu/cdsapp#!/software/app-era5-explorer?tab=app), and the European Space Agency (https://climate.esa.int./en/).
5. Broader initiatives in the US towards AI integration are outlined in: 'NSF announces 7 new National Artificial Intelligence Research Institutes,' National Science Foundation, 4 May 2023, https://new.nsf.gov/news/nsf-announces-7-new-national-artificial.
6. Erle C. Ellis and Navin Ramankutty, 'Putting People in the Map: Anthropogenic Biomes of the World', *Frontiers in Ecology and the Environment* 6, no. 8 (2008): 439–47.
7. Ibid.; see also Erle C. Ellis, 'Anthropogenic transformation of the terrestrial biosphere', *Philosophical Transactions of the Royal Society A Mathematical Physical and Engineering Sciences* 369 (2011), 1010–35.
8. On the emergence of a new ecosystem world order, see Richard J. Hobbs, Eric Higgs, Carol M Hall et al., 'Novel ecosystems: theoretical and management aspects of the new ecological world order', *Global Ecology and Biogeography* 15 (2006): 1–7. For designer ecosystems, see Matthew R.V. Ross et al., 'Designer Ecosystems: Incorporating Design Approaches into Applied Ecology', *Annual Review of Environment and Resources* 40 (2015): 419–43.
9. For a short argument in favour of novel ecosystems, see Emma Marris, 'Ragamuffin Earth', *Nature* 460 (2009): 450–53. For an introduction to the scepticism and reservations against conservation's reorientation towards novel ecosystems, see George Wuerthner, Eileen Crist and Tom Butler, eds., *Keeping the Wild: Against the Domestication of Earth* (Washington, DC: Foundations for Deep Ecology 3, 2014).
10. For a take on the first attitude, see Edward O. Wilson, *Half-Earth: Our Planet's Fight for Life* (New York: Liveright Publishing Corporation, 2016); also, Eileen Crist et al., *Protecting Half the Planet and Transforming Human Systems Are Complementary Goals*, *Frontiers in Conservation Science*,

Volume 2 (2021). For the second attitude, see Emma Marris, *Rambunctious Garden: Saving Nature in a Post-Wild World* (New York: Bloomsbury, 2011).

11. Bram Büscher and Robert Fletcher, *The Conservation Revolution: Radical Ideas for Saving Nature Beyond the Anthropocene* (London and New York: Verso, 2020); see Chapter 5, 'Towards Convivial Conservation', 158–98.
12. The contributions of indigenous communities in ecosystem protection, monitoring and restoration have been recognised by researchers and policymakers worldwide, for example in Alejandro Estrada et al., 'Global Importance of Indigenous Peoples, Their Lands, and Knowledge Systems for Saving the World's Primates from Extinction', *Science Advances* 8, no. 32 (2022): 1–19, also in Giulia C.S. Good Stefani, 'Indigenous Leaders at the Frontlines of Environmental Injustice and Solutions', NRDC website, 11 October 2021), https://www.nrdc.org/bio/giulia-cs-good-stefani/indigenous-leaders-frontlines-environmental-injustice-and-solutions; and Monique Broulliette, 'In Alaska, Tribal Governments Push for Larger Conservation Role' Undark website, 6 June 2023, undark.org/2023/06/06/in-alaska-tribal-governments-push-for-larger-conservation-role/ .
13. Jedediah Purdy, *After Nature: A Politics for the Anthropocene* (Cambridge, MA: Harvard University Press, 2015), 286.
14. Gilles Clément, '*The Planetary Garden' and Other Writings,* trans. Sandra Morris (Philadelphia: University of Pennsylvania Press, 2015).
15. Janzen explains the garden metaphor in: Daniel Janzen, 'Gardenification of Wildland Nature and the Human Footprint', *Science* 279, no. 5355 (1998): 1312–13.
16. See Benjamin H. Bratton, *Terraforming* (Moscow: Strelka, 2019).
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18. For a holistic consideration of the human impact on the ecosystem, see Eileen Crist, A*bundant Earth: Toward an Ecological Civilization* (Chicago: University of Chicago Press: 2019), specifically the chapter 'Human Supremacy and the Roots of the Ecological Crisis' .
19. On the conflict between technology and nature, see Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 2000).
20. Detailed discussion of the biodiversity monitoring technologies mentioned in this article can be found in Wolfgang J. Wägele et al., 'Towards a Multisensor Station for Automated Biodiversity Monitoring', *Basic and Applied Ecology* 59 (2022): 105–38. For 'humans-in-the-loop' approaches to biodiversity monitoring, see: Catherine C. Sun, Jeremy E. Hurst and Angela K. Fuller, 'Citizen Science Data Collection for Integrated Wildlife Population Analyses', *Frontiers in Ecology and Evolution* 9 (2021), https://doi.org/10.3389/fevo.2021.682124; also, Devis Tuia et al., 'Perspectives in Machine Learning for Wildlife Conservation', *Nature Communications* 13 (2022): 792, https://doi.org/10.1038/s41467-022-27980-y.
21. On the promise of wilderness management through AI, see Bradley Cantrell, Laura J. Martin and Erle C. Ellis, 'Designing Autonomy: Opportunities for New Wildness in the Anthropocene', *Trends in Ecology & Evolution* 32, no. 3 (2017): 156–66, https://doi.org/10.1016/j.tree.2016.12.004.
22. For a definition of landscape intelligence, see Bradley Cantrell and Zihao Zhang, 'A Third Intelligence', *Landscape Architecture Frontiers* 6, no. 2 (2018): 42–51.
23. Landscape Architecture Foundation, *The New Landscape Declaration*, June 2016, quoted in Cantrell and Zhang, 'A Third Intelligence'.
24. Aiming to create financial incentives for preserving rather than exploiting the environment, conservation policies are fraught with contradictions, even impossibilities. The Royal Society's Multifunctional Landscapes Policy Report is one example.
25. According to Büscher and Fletcher, 'the use of modern tools of conservation – including technologies, finance, 'smart' systems, governance and management – is of value only to the extent that they allow for more conviviality between humans and between humans and the rest of nature'. Büscher and Fletcher, *The Conservation Revolution*, 162. The role of technology is to strengthen existing relations and create new agencies.
26. terra0 (terra0.org), a conceptual prototype for managing specific land parcels that is based on the Ethereum blockchain, suggests the creation of technologically augmented ecosystems capable of autonomous action within predetermined financial constraints.
27. Read more on conservation technologies in general, and blockchain, in particular, in Catherine Corson, and Lisa M. Campbell, 'Conservation at a Crossroads: Governing by Global Targets, Innovative Financing, and Techno-Optimism or Radical Reform?', *Ecology and Society* 28, no. 2 (2023), https://doi.org/10.5751/ES-13795-280203.
28. OpenAI's GPT-4V(ision) model was an initial step towards multimodal AI. For a comprehensive analysis of language and image AI models, see Rishi Bommasani et al., 'On the Opportunities and Risks of Foundation Models' (Stanford: Center for Research on Foundation Models, 2021), arXiv:2108.07258.

Biography

Katerina Labrou is a designer and researcher at MIT. With studies in architecture, design computation, and computer science, her work explores the intersection of creativity, artificial intelligence, and human-machine interaction and collaboration. As a research associate at the Local Code Lab, operating between MIT and Northeastern University, she is actively involved in developing AI-powered collaborative design tools that enable local communities to engage in planning for resilient urbanization.

Christos Montsenigos is an architect and researcher, currently pursuing a PhD in architecture at the Peter Guo-hua Fu School of Architecture, McGill University. Supported by the Onassis Foundation and a Stavros S. Niarchos Foundation Fellowship for Excellence in Graduate Education, his current work focuses on the entangled histories of empire, conservation, environmental science, and landscape design in the eighteenth and nineteenth centuries.

Terra Forma Speculative Mapping: Paris Watershed and Underground Environment

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Abstract
This visual essay discusses an object-map of Paris basin soil and subsoil, commissioned for the *Element Terre* exhibition within the Architecture and Landscape Biennial 2022 (Versailles, France). To create this map, we contacted actors and researchers whose work is related to soil: earth scientists, materials specialists, and human habitat specialists. Using a model from the publication *Terra Forma: A Book of Speculative Maps*, we designed a specific reference system, the 'soil' model, to map entities, movements and conflicts in the underground environment(s). The resulting map aims to reveal what is going on beneath our feet, what is hidden from view, to go beyond representations that are limited to the surface.

Keywords
speculative mapping, Critical Zone, soil, subsoil, Paris

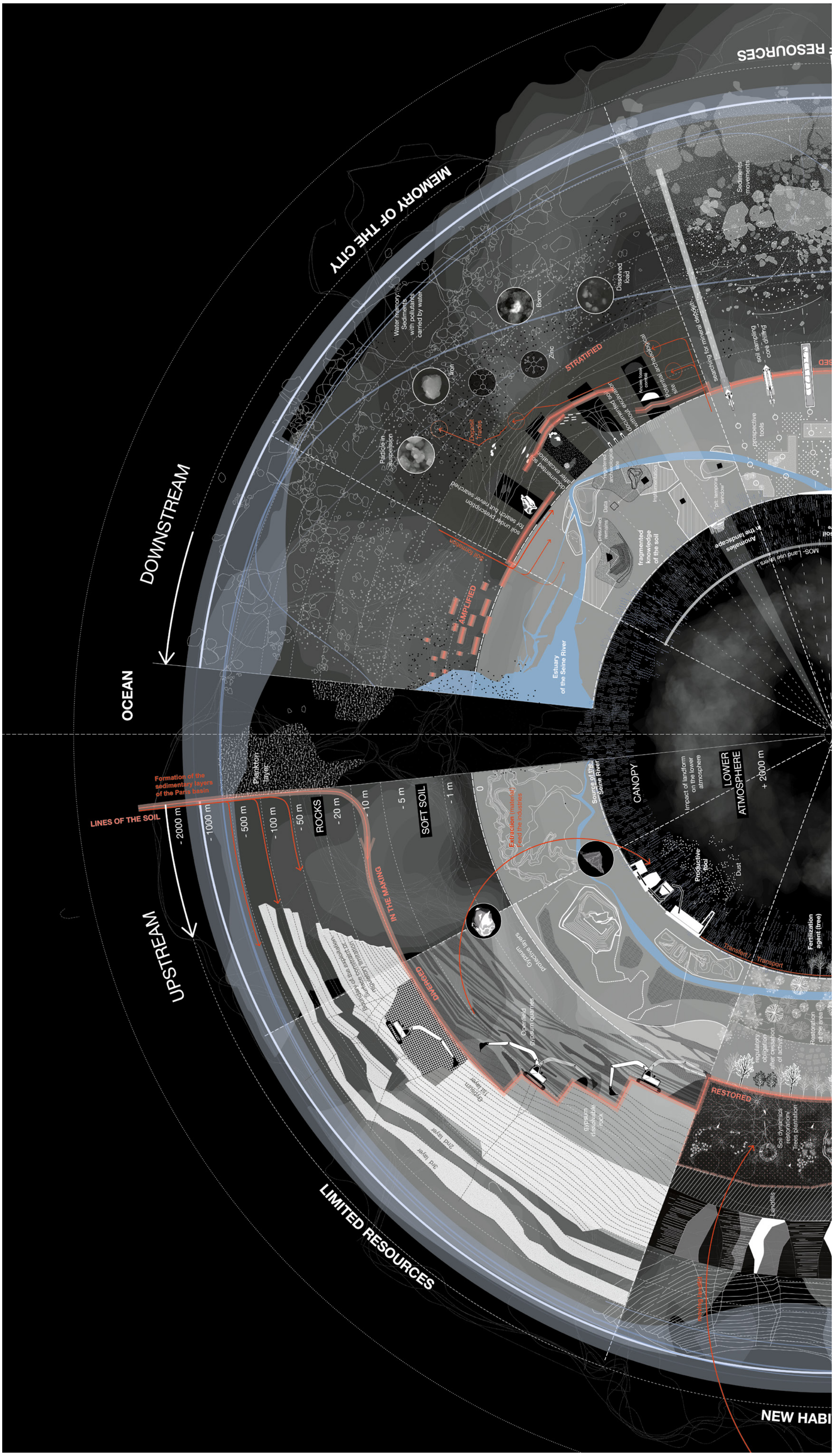
For the Architecture and Landscape Biennial 2022 (Versailles, France), we were commissioned by the Institut Paris Région (the institution in charge of the observatory and development of urban dynamics of Paris metropolis) to produce an object-map of Paris basin soil and subsoil within the *Element Terre* exhibition. To create this map, we contacted actors and researchers whose work is related to soil: earth scientists (geochemists, geophysicists, geologists), materials specialists (quarries, materials companies), and human habitat specialists (planners, archaeologists). The resulting map uses a model from the book *Terra Forma: A Book of Speculative Maps*, which suggests alternative ways of visualising the earth and its (living) elements.[1] We asked: is the territory in which we live sufficiently described, known and represented to meet the challenges of the environmental crisis? We think that current maps don't help us to understand and respond to this crisis, for a variety of reasons linked to the way and the historical context in which they were created.

We designed a specific reference system, the 'soil' model, to map entities, movements and conflicts in the underground environment(s). It aims to reveal what is going on beneath our feet, what is hidden from view, to go beyond representations that are limited to the surface. This projection moves away from the traditional planisphere to reveal the complexity of the critical zone (thickness, interactions with the surface, diversity of inhabiting entities). The globe is turned inside out to place the atmosphere at the centre of the map. The atmosphere is surrounded by concentric layers of soil. These are themselves surrounded and limited by the deeper rocks that form the peripheral edge of the map. In this way, there is no longer any outside; the earth is limited both above and below: we must live, build and feed ourselves within this thickness of a few metres.

Close-up of the soil map

The ground, and its depths, are often under-represented in the collective imagination, but also in that of the construction industry. Considered as a 'stable' surface on which to build, its components are neglected. Yet the ground is alive, and it is also the scene of transformations that will have an impact on life above ground. Soil and its resources are also the subject of speculation and disputes. The soil is an area to be defended, not just horizontally, but – and this is what we propose to explore here – vertically. In order to map the Anthropocene, we need to acknowledge the heterogeneous composition of these soils: inhabiting organisms, hosted objects. The understanding of the urban soil varies according to the actors: ground is either a hazard when cavities threaten to collapse, or a place where geochemical cycles are disturbed, or a cement layer (stopping the circulation of water), or a repository of ancient buried civilizations, or an abandoned entity to be exploited, a source of raw materials, a source of heat, and so on.

Fig. 1: Close-up of the soil map. Map: authors.


MEMORY OF THE CITY
DOWNSTREAM
OCEAN
UPSTREAM
LIMITED RESOURCES
LINES OF THE SOIL
Formation of the sedimentary layers of the Paris basin
Plankton layer
- 2000 m
- 1000 m
- 500 m
- 100 m
- 50 m
ROCKS
- 20 m
- 10 m
- 5 m
SOFT SOIL
- 1 m
0
Source of the Seine River
CANOPY
Impact of landform on the lower atmosphere
LOWER ATMOSPHERE
+ 2000 m
Estuary of the Seine River
fragmented knowledge of the soil
STRATIFIED
AMPLIFIED
IN THE MAKING
RESTORED
Water memory: Sediments with pollutants carried by water
Particle in suspension
Iron
Zinc
Boron
Dissolved load
Sediments movements
soil sampling core drilling
prospective tools
searching for mineral deposits
Productive soil
Dust
Fertilization agent (tree)

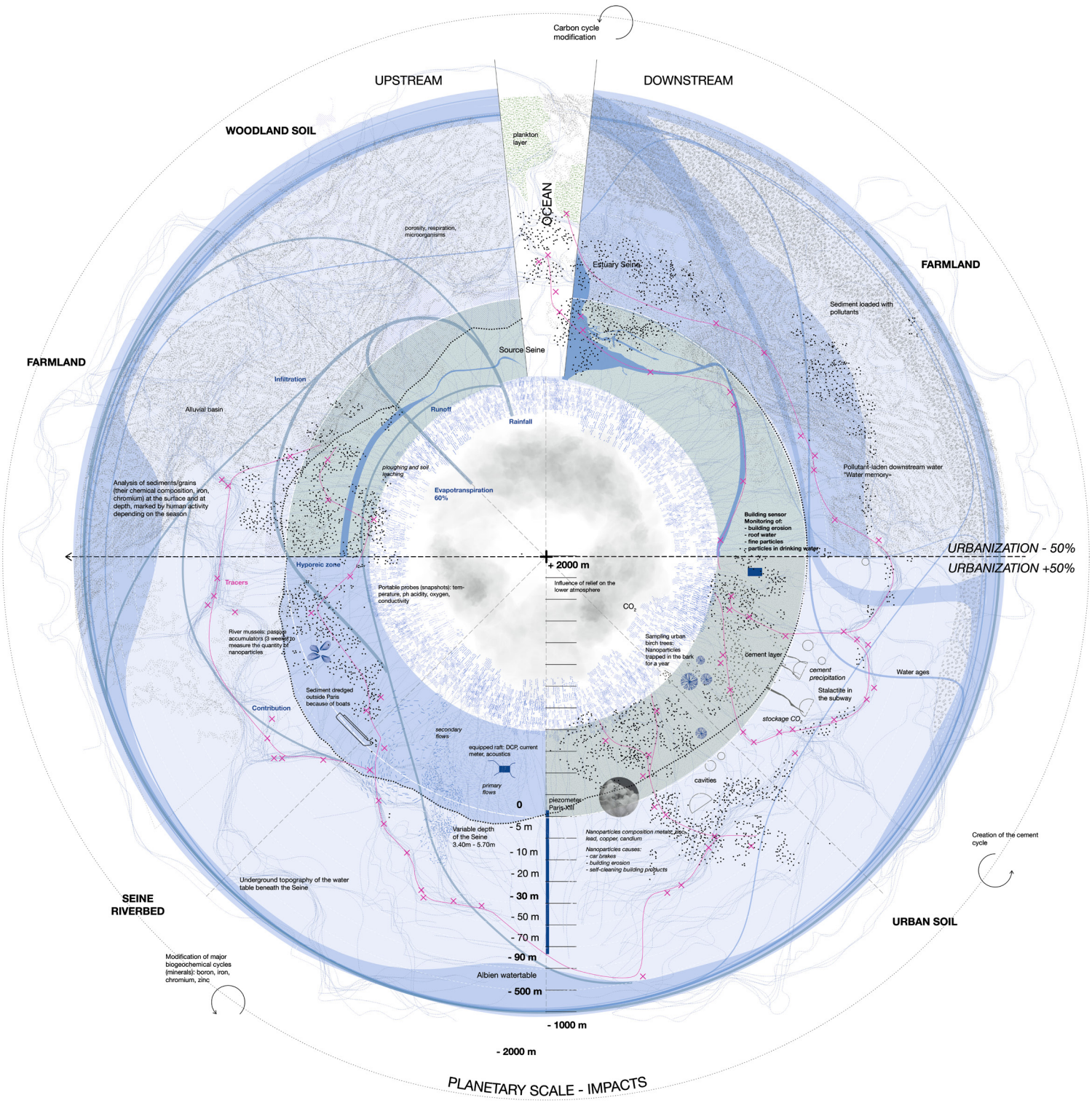
Water map: geoscientists' view of the Paris watershed
We had first a workshop with the geoscientists, which led to a 'watery' view of the soil, as the grains of the soil bond with water. However, the dragging of sediments outside the city disturbs the morphology and chemical composition of the riverbed. As a geochemist told us during the workshop, the relationship between soil and water is complex and requires further research:

> The Seine doesn't just collect surface water; there is also water that reaches the Seine from below, which can take a very long time. We need to sample the water table at its deepest levels. These waters are of different ages. The Seine is really a collection of something that has been everywhere. A real exploration.[2]

Water transports potential pollutants. It ages and has memory, it takes the chemical composition of the upstream city, the nanoparticles, pollutants, materials and so on, downstream. Water at the surface and at greater depth is studied, but we don't know its paths very well, especially at depth and in the city, where the connection between surface and depth is cut off. Then, in the city, another cycle is created with the reaction of water, carbon dioxide and concrete, which doesn't exist in the natural world: the cycle of cement.

As a result, the workshop and the map concluded that much more research is needed to monitor cities to understand the urban environment. The geoscientists we worked with during the workshop raised the idea of constructing a 'long term sensor building' to monitor the chemical fluxes, the reactions between water, air, heat, and the chemical residue of building materials.

Fig. 2: Water map: geoscientists' view of the Paris watershed. Map: authors.

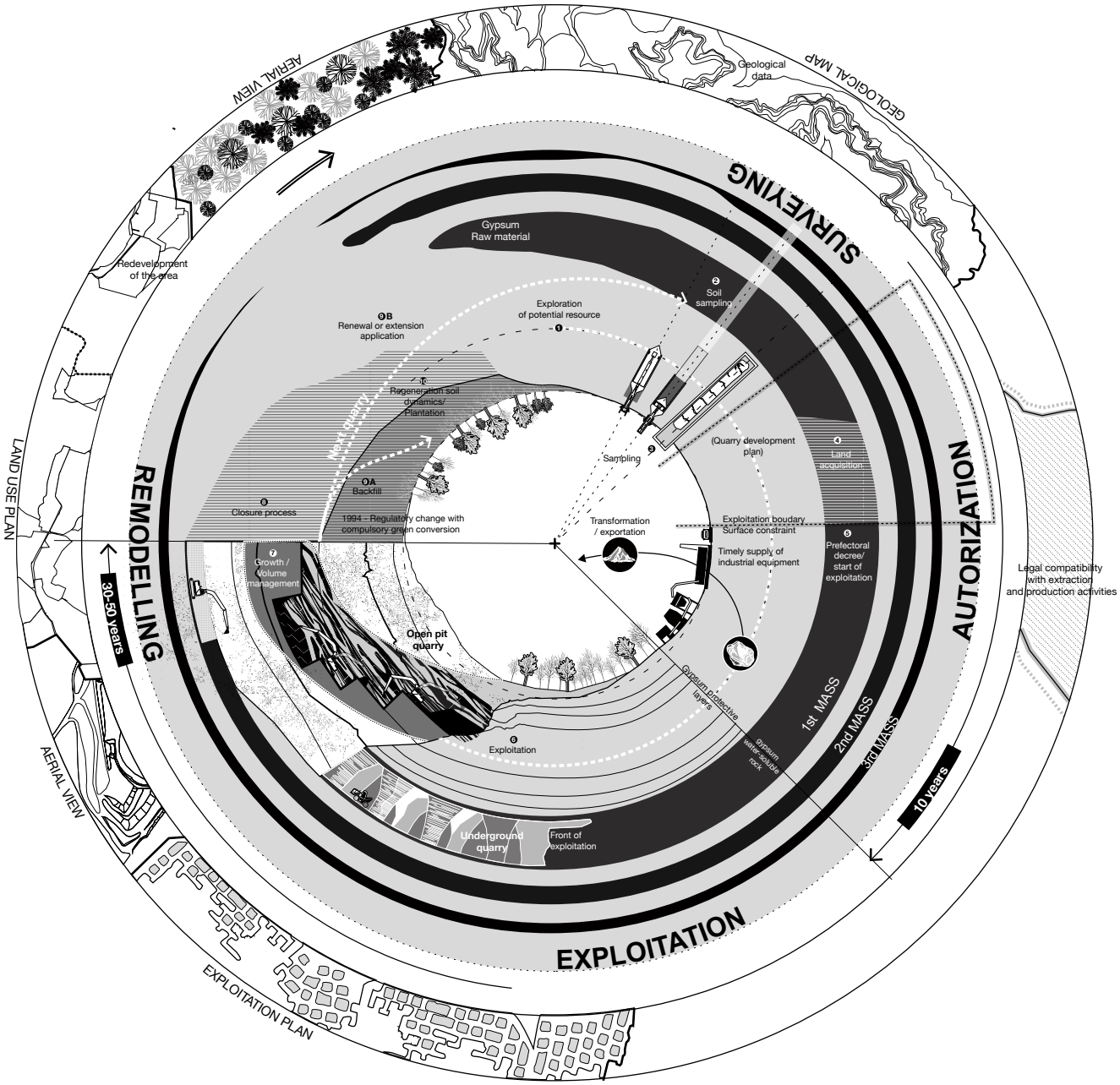

Carbon cycle modification
UPSTREAM
DOWNSTREAM
WOODLAND SOIL
plankton layer
OCEAN
porosity, respiration, microorganisms
Estuary Seine
FARMLAND
Sediment loaded with pollutants
FARMLAND
Source Seine
Infiltration
Alluvial basin
Runoff
Rainfall
ploughing and soil leaching
Evapotranspiration 60%
Analysis of sediments/grains (their chemical composition, iron, chromium) at the surface and at depth, marked by human activity depending on the season
Pollutant-laden downstream water "Water memory"
Building sensor Monitoring of:
- building erosion
- roof water
- fine particles
particles in drinking water
URBANIZATION - 50%
URBANIZATION +50%
+ 2000 m
Hyporeic zone
Tracers
Portable probes (snapshots): temperature, ph acidity, oxygen, conductivity
Influence of relief on the lower atmosphere
CO_2
River mussels: passive accumulators (3 weeks) to measure the quantity of nanoparticles
Sampling urban birch trees: Nanoparticles trapped in the bark for a year
cement layer
cement precipitation
Water ages
Stalactite in the subway
Sediment dredged outside Paris because of boats
Contribution
stockage CO_2
secondary flows
equipped raft: DCP, current meter, acoustics
primary flows
cavities
0
piezometer Paris-XIII
Variable depth of the Seine 3.40m - 5.70m
- 5 m
- 10 m
- 20 m
- 30 m
- 50 m
- 70 m
- 90 m
Albien watertable
- 500 m
Nanoparticles composition metals: zinc, lead, copper, candium
Nanoparticles causes:
- car brakes
- building erosion
- self-cleaning building products
Creation of the cement cycle
Underground topography of the water table beneath the Seine
SEINE RIVERBED
URBAN SOIL
Modification of major biogeochemical cycles (minerals): boron, iron, chromium, zinc
- 1000 m
- 2000 m
PLANETARY SCALE - IMPACTS

The quarry life cycle

This map integrates the interviews we conducted with planning actors such as managers of quarries (of gypsum, alluvial deposits). It raises issues related to exploitation and risk such as holes in the ground, displacement of land, and the controversial shortage of materials, as construction is expanding rapidly while quarries have a lifespan that will come to an end in the coming decades. Indeed, as an interviewee from the Paris-region quarry association reminds us, 'aggregates are the second-most used resource after water'.[3]

We map gypsum quarries, digging deep down, opencast or underground, and alluvial deposit quarries in the riverbed, the different layers of rock left bare, the holes left and the filling in of quarries (becoming feral infrastructures), but also what is considered new resources, new frontiers at depth: geothermal energy or CO_2 storage, which could lead to even deeper exploitation of soil. The materiality of this same soil – of the Paris basin – changes drastically compared to the one described by the geosciences: it is a more solid material into which we can dig to extract matter because this soil is already full of holes and poses the risk of collapsing. Controversially, the quarries exploit the river sediments that the scientists are concerned with.

Fig. 3: The quarry life cycle. Illustration: authors.

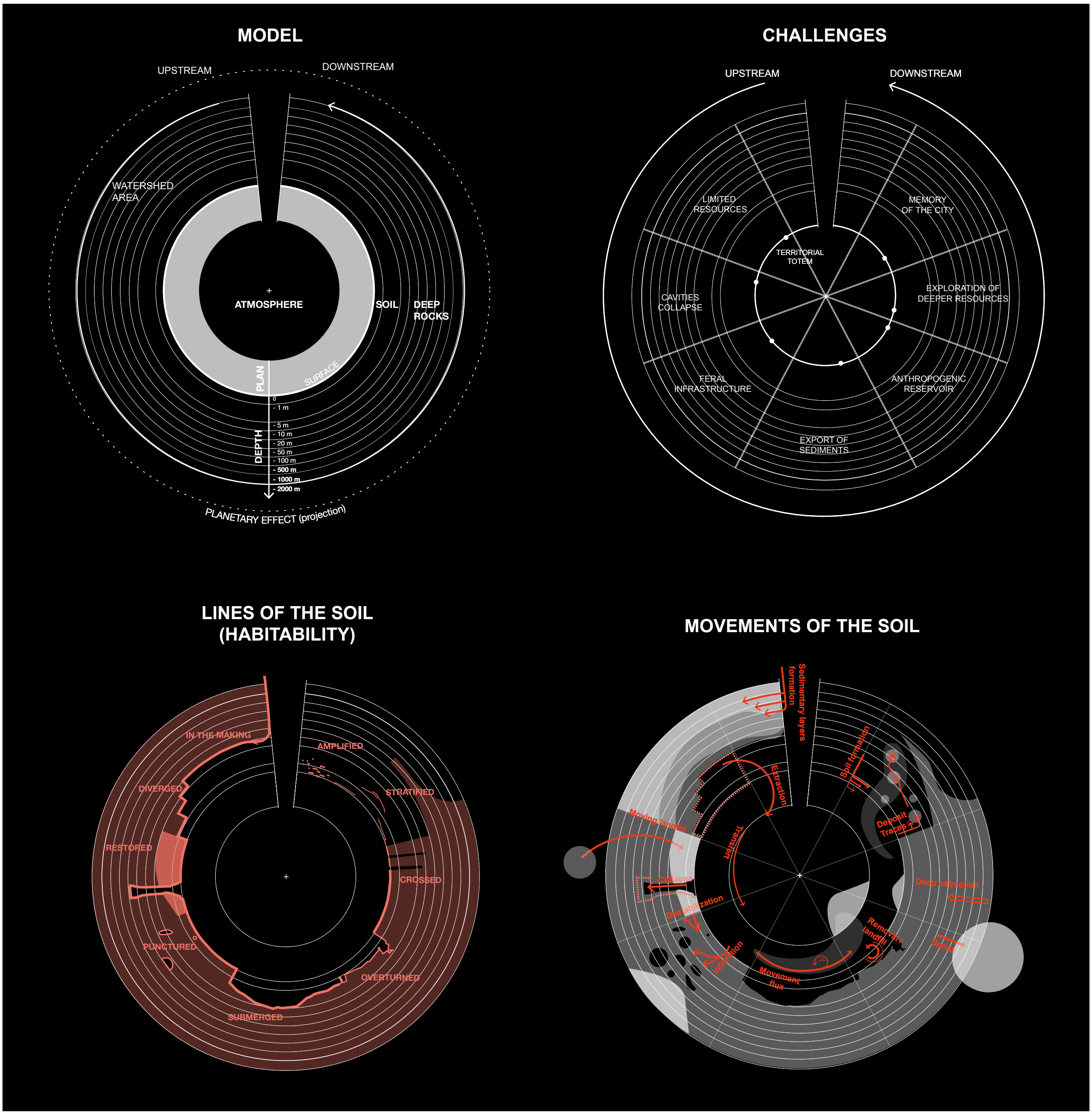

GEOLOGICAL MAP
Geological data
AERIAL VIEW
SURVEYING
Gypsum
Raw material
Redevelopment of the area
❷ Soil sampling
Exploration of potential resource
❶
❶B Renewal or extension application
❿ Regeneration soil dynamics/ Plantation
Plan de gestion environnementale
Sampling
❾
(Quarry development plan)
❹ Land acquisition
❸A Backfill
❸ Closure process
1994 - Regulatory change with compulsory green conversion
Transformation / exportation
Exploitation boudary
Surface constraint
Timely supply of industrial equipment
❺ Prefectoral decree/ start of exploitation
AUTORIZATION
LAND USE PLAN
REMODELLING
30-50 years
❼ Growth / Volume management
Open pit quarry
Gypsum protective layers
Gypsum water-soluble rock
1st MASS
2nd MASS
3rd MASS
10 years
❽ Exploitation
Underground quarry
Front of exploitation
EXPLOITATION
AERIAL VIEW
EXPLOITATION PLAN
Legal compatibility with extraction and production activities

Schemes of the construction of the map

This map explores the different depths at which soils are inhabited to identify where and to what extent the imprint of human activities is located. What we are particularly interested in, shown in red on the map and the diagrams, is the movement of the soil. Which soils are being moved? Which layers? How does this impact on soil composition? What is the impact on local and remote areas? This line shows the type of movement generated.

The ground line, which we are used to seeing as a flat horizon, is in fact a moving line, diverged, punctured, stratified, or submerged, and so on. It is a multi-layered line, with many variations, evolving over time as many events occur.

Fig. 4: Schemes of the construction of the map. Schemes: authors.


MODEL
UPSTREAM
DOWNSTREAM
WATERSHED AREA
ATMOSPHERE
SOIL
DEEP ROCKS
PLAN
SURFACE
DEPTH
0
- 1 m
- 5 m
- 10 m
- 20 m
- 50 m
- 100 m
- 500 m
- 1000 m
- 2000 m
PLANETARY EFFECT (projection)
CHALLENGES
UPSTREAM
DOWNSTREAM
LIMITED RESOURCES
MEMORY OF THE CITY
TERRITORIAL TOTEM
CAVITIES COLLAPSE
EXPLORATION OF DEEPER RESOURCES
FERAL INFRASTRUCTURE
ANTHROPOGENIC RESERVOIR
EXPORT OF SEDIMENTS
LINES OF THE SOIL (HABITABILITY)
IN THE MAKING
AMPLIFIED
DIVERGED
STRATIFIED
RESTORED
CROSSED
PUNCTURED
OVERTURNED
SUBMERGED
MOVEMENTS OF THE SOIL
Sedimentary layers formation
Soil formation
Extraction
Moving landfill
Transfert
Deposit Traces
Collapse
Deep extraction
Destabilization
Removal / landfill
Burial
Infiltration
Movement flux

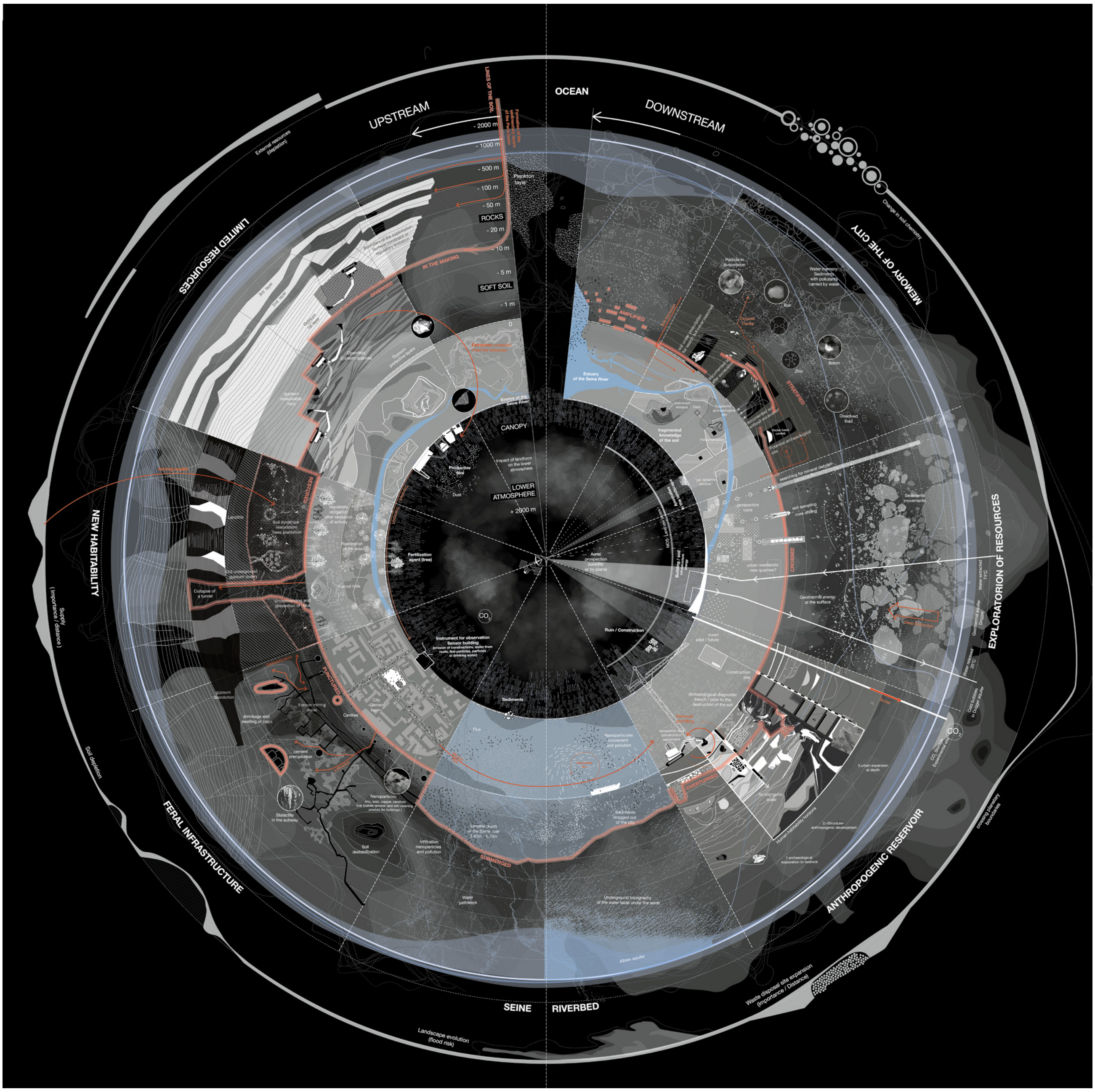
Soil map

This experience led to a broader reflection on how to reposition the city in its watershed, and in its underground environment, and thus to include in the understanding of the city previously excluded elements such as mines, quarries, underground water, what could be called environmental logistics. The map also highlights the impact of these elements at depth, which in fact establishes a connection between upstream and downstream. Because there is connectivity at depth, everything is linked, even if this is not obvious on the surface.

Thanks to the map's specific metric and frame of reference, it is possible to visualise these elements with the granularity needed to understand them. In other words, the map shows what the city depends on (which is too far away to be seen on maps using conventional metrics). In this case, the distances are compressed because we are using a different reference system aiming to look at the soil at depth over the entire perimeter of the watershed – the unit that enables the city to subsist. This would not have been possible without this interdisciplinary approach.

Our ambition was also to contribute to or co-construct, through collective design, a definition or understanding of the critical zone (a term that is relatively new): what is the critical zone? Is there a shared understanding of the critical zone? What are the common elements? Or those that are irremediably different and sometimes conflicting?

Fig. 5: Soil map. Map: authors.


OCEAN
UPSTREAM
DOWNSTREAM
LIMITED RESOURCES
MEMORY OF THE CITY
NEW HABITABILITY
EXPLORATORION OF RESOURCES
FERAL INFRASTRUCTURE
ANTHROPOGENIC RESERVOIR
SEINE
RIVERBED
LINES OF THE SOIL
- 2000 m
- 1000 m
- 500 m
- 100 m
- 50 m
ROCKS
- 20 m
- 10 m
- 5 m
SOFT SOIL
- 1 m
CANOPY
LOWER ATMOSPHERE
+ 2000 m
Soil depletion
Landscape evolution (flood risk)
Waste disposal site expansion (Importance / Distance)
Change in soil chemistry

Workshop at the biennial

This map shows the methods of tracing, observing or learning about or exploring the ground used by the various actors. The map shows the technical and scientific instruments that are used to explore this invisible underground world.

A workshop organised during the biennial gathered actors who are not used to collaborating or exchanging views, because of professional or institutional boundaries.[4] We built an assembly concerned with sharing the problems, which obliged all participants to go beyond normative or institutional statements. The map acts as a 'boundary object', questioning the habitability of the territory in a situated and pragmatic way: what can prevent or favour habitability, and thus detecting the contradictions inherent in the planning processes. Our map makes entities (inhabiting organisms and objects housed in the soil, rock or atmosphere) and processes (cycles, water and sediment paths, land movements) visible that are missing from conventional maps, but also from our traditional thought patterns. Thanks to the multiplication of frames of reference, issues and entities raised by each actor a cosmopolitical space for the Paris watershed is gradually composed.

Fig. 6: Workshop at the biennial. Photos: authors.


RÉSERVOIR ANTHROPIQUE
RESSOURCES EXPLORATOIRES

Notes

1. The soil map of the Paris watershed is the result of a study supported by the IdEx Université de Paris (ANR-18-IDEX-000), Centre des Politiques de la Terre and Paris Region Institute for Architecture Biennial. The workshop with the geoscientists of the Institute of Physics of the Globe was conducted in June 2021, with Jérôme Gaillardet (geochemist), Julien Bouchez (geochemist), Pascale Louvet (geochemist), Eric Gayer (geochemist), Marc Benedetti (geochemist) and François Métivier (geophysicist). Interviews with the quarries companies were conducted in February 2022. Participants: Eric Gomez (Director BRGM), Gilles Bouchet (Syndicat National des Industries du Plâtre), Etienne Fromentin (Unicem). Frédérique Aït-Touati, Alexandra Arènes, Axelle Grégoire, *Terra Forma: A Book of Speculative Maps* (MIT Press, 2022).
2. Julien Bouchez (geochemist at the Institut of Physics of the Globe), comment in a workshop hosted by SOC, IPGP Paris, 18 June 2021.
3. Eric Gomez (Regional Director Ile de France at BRGM), interviewed by the authors, 4 February 2022.
4. Workshop hosted during the Biennale in the exhibition space and conducted by SOC participants : Emmanuelle Blondeau (landscape studio TER), Virginie Crenn (GSM granulats), Ludovic Faytre (Institut Paris Région), Jérôme Gaillardet (IPGP), Laurie Gobled (Institut Paris Région), Eric Gomez (BRGM), JM Guihaume (Syndicat National des Industries du Plâtre), Thierry Hauchard (GSM Granulats and UNICEM) and Sophie Mambrini (Placoplatre Firm).

Biography

SOC (Société d'Objets Cartographiques) was co-founded by Alexandra Arènes, Axelle Grégoire and Soheil Hajmirbaba. The studio conducts research involving a network of actors from various disciplines with the aim of encouraging exchanges between the arts, sciences and architecture. Alexandra and Axelle wrote *Terra Forma: A Book of Speculative Maps* (MIT Press, 2022). Alexandra is Doctor in Architecture (University of Manchester, 2022). In collaboration with scientists from the Critical Zone, she develops maps of the earth's cycles: Gaïa-graphy. Axelle is an architect and doctoral student at the Muséum National d'Histoire Naturelle. She develops projects that contribute to renewing the representation of territories.

Walk Under the Midnight Sun: Mapping Capsicum Ecologies

Tekla Gedeon and Sebastian Gschanes

Fuzzy Earth, Hungary

Judit Szalipszki, Anna Tüdős and Emese Mucsi

BÜRO imaginaire curator collective, Hungary

Abstract

Walk Under the Midnight Sun is a large-scale carpet installation originally designed for the Hungarian Pavilion of the 2023 Venice Architecture Biennale, part of an exhibition proposal by Fuzzy Earth design studio and BÜRO imaginaire curator collective. The project invites the public to explore the entangled historical, social and architectural relationships within greenhouse cultivation practices. The protagonist of the installation is a regionally unique capsicum cultivar, the Hungarian wax pepper, known in Hungary as the Cecei paprika. The themes of the exhibition were inspired by Fuzzy Earth's 'Not Quite a California Wonder' research project.

Keywords

greenhouse cultivation, capsicum, food systems, installation, carpets

Walk Under the Midnight Sun is a large-scale carpet installation originally designed for the Hungarian Pavilion of the 2023 Venice Architecture Biennale, part of an exhibition proposal by Fuzzy Earth design studio and BÜRO imaginaire curator collective. The project invites the public to explore the entangled historical, social and architectural relationships within greenhouse cultivation practices. The protagonist of the installation is a regionally unique capsicum cultivar, the Hungarian wax pepper, known in Hungary as the Cecei paprika. The themes of the exhibition were inspired by Fuzzy Earth's 'Not Quite a California Wonder' research project.

In light of the global food and climate crisis, it is crucial to focus our attention on food systems, since the modes of production, distribution and consumption of food have become one of the main challenges for the coming decades. Since the green revolution and the advancement of food-production technologies, an ever-growing portion of cultivation happens in partially automated greenhouse systems. These agricultural landscapes cover larger and larger parts of Europe, but the public understanding of them remains limited. Through this project, we invite all to explore the otherwise hidden, black-box spaces of food production.

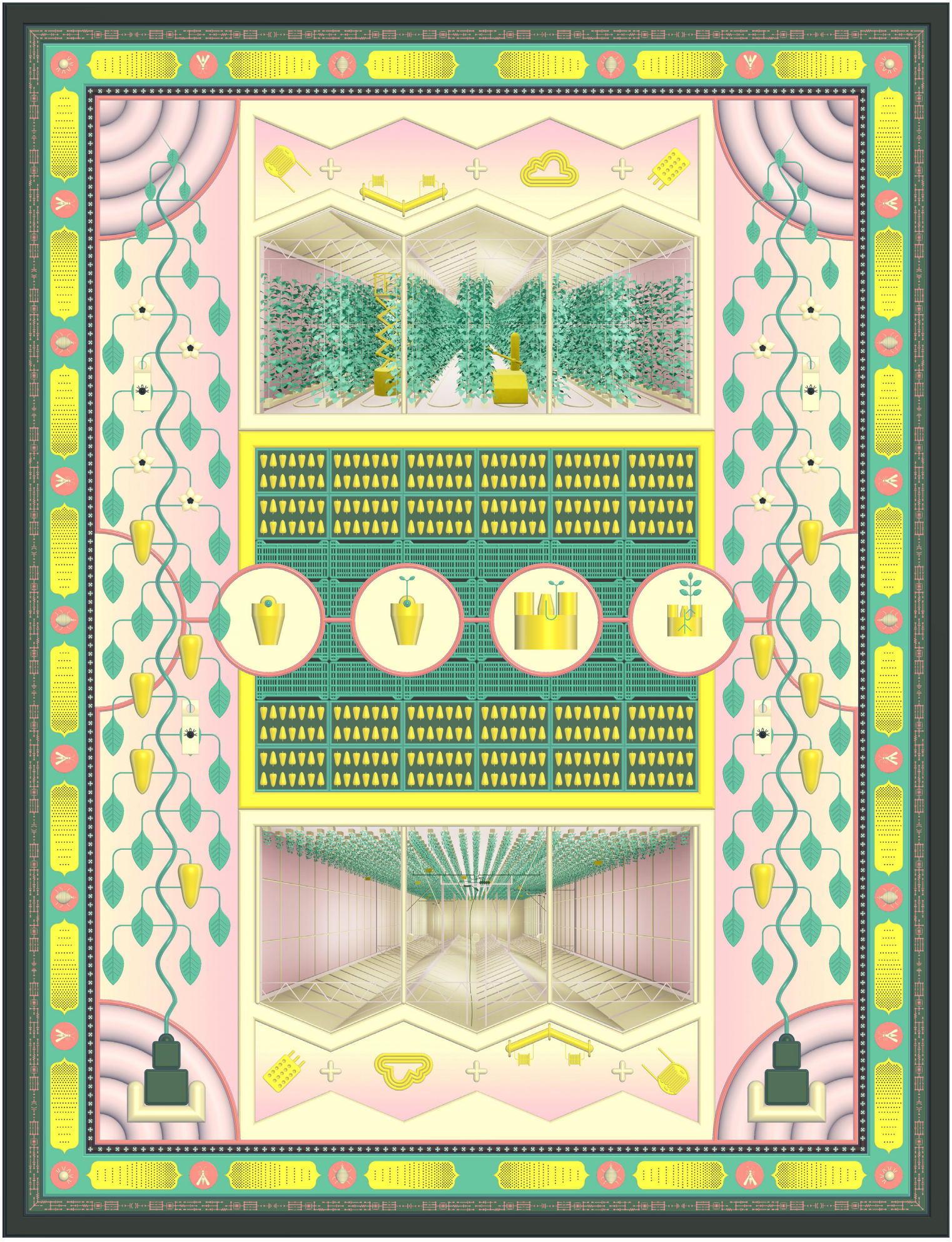
The selected medium is the carpet, a traditional architectural element that creates a space for storytelling. It guides visitors through the installation like a map and reveals its content from various perspectives and paths: each frame, symbol, and pattern is carefully located and designed to draw out the kin – natural, technological, or material –of the capsicum plant and to highlight both their dynamics and their changing relationships with their environment, both in time and in space. The carpet installation consists of seven thematic segments.

'Welcome to the Greenhouse'

The first carpet segment displays the Hungarian wax pepper in its own environment, the greenhouse. The vertically growing seedlings are surrounded by symbols that relate to the daily routine of greenhouse production: the circular flow of nutrients and water, the logistics of transport, and the yellow adhesive paper used to monitor insects. The patterns show a strong collaboration of the plants with their technological and digital kin. The use of computer-generated imagery and digitally printed patterns assist viewers in the exploration process.

Greenhouses are, in Marc Augé's terms, non-places.[1] As consumers, we have little access to these structures, yet they are eerily similar to each other, regardless of their geographical location, not only in terms of structure and materials used to build them but also in terms of the growing mediums, chemicals, software, robots, technologies and the seeds themselves that support and facilitate their cultivation. Although we know that the year-round continuous supply of peppers is made possible by the coordinated work of a multitude of tools and infrastructures, we do not see these processes in their entirety, and the walls of greenhouses, despite their transparency, can seem symbolically impenetrable to the everyday person.

Fig. 1: 'Welcome to the Greenhouse'. Photo: authors.

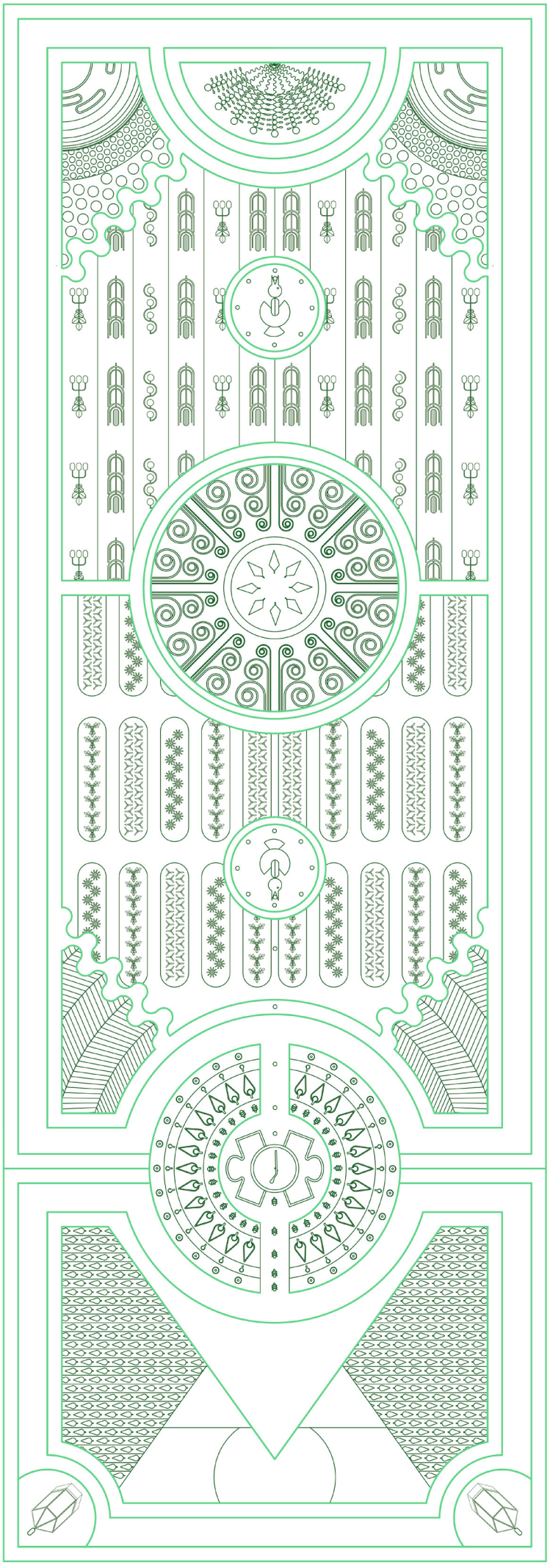


‘Origin Stories’ and ‘The Fifth Sun’

In the next section of the carpet, we explore the origin story of bell peppers. On the one hand, the capsicum plant is considered to be truly Hungarian and used as a vegetable or spice depending on its variety. However, we cannot ignore the fact that bell peppers originated in Central America and spread throughout the world during the colonial period, including to our country. The untamed ancestor, the chiltepín or bird pepper (*Capsicum annuum var. glabriusculum*), and its companion species are given special attention in the pattern by mapping their natural habitat in dry, rocky soils in poorly cultivated areas. The depiction also highlights the bird pepper’s early co-species: the shade-providing feather bush (*Lysiloma sp.*) and the birds (for example, the northern mockingbird) that transport the seeds to distant places. Other plants, such as maize, tomatoes and potatoes, that are native to the region but later spread and bred throughout the world through colonisation, are also shown in symbolic forms alongside the bird pepper.

The carpet segment titled *The Fifth Sun* illustrates ancient production methods, knowledge and rituals. The expression ‘fifth sun’ refers to the Aztec spiritual worldview; each sun represented a catastrophic event and a successive revival of society. This belief, which foretold the end of Aztec culture, heralded the Spanish invasion. The capsicum is shown here in the form of seeds. Among others, the episodes depicted on the carpet reveal pre-colonial processes such as the practice of drying seeds in mountainous areas to prepare them to cross the ocean and conquer the world. Seeds can be collected from their original ecosystem in the hope that they will germinate in their new home; they must, however, leave behind their co-species, their climate, and the traditional, ancient knowledge that nurtured them.

Fig. 2: ‘Origin Stories’ and ‘The Fifth Sun’. Photo: authors.

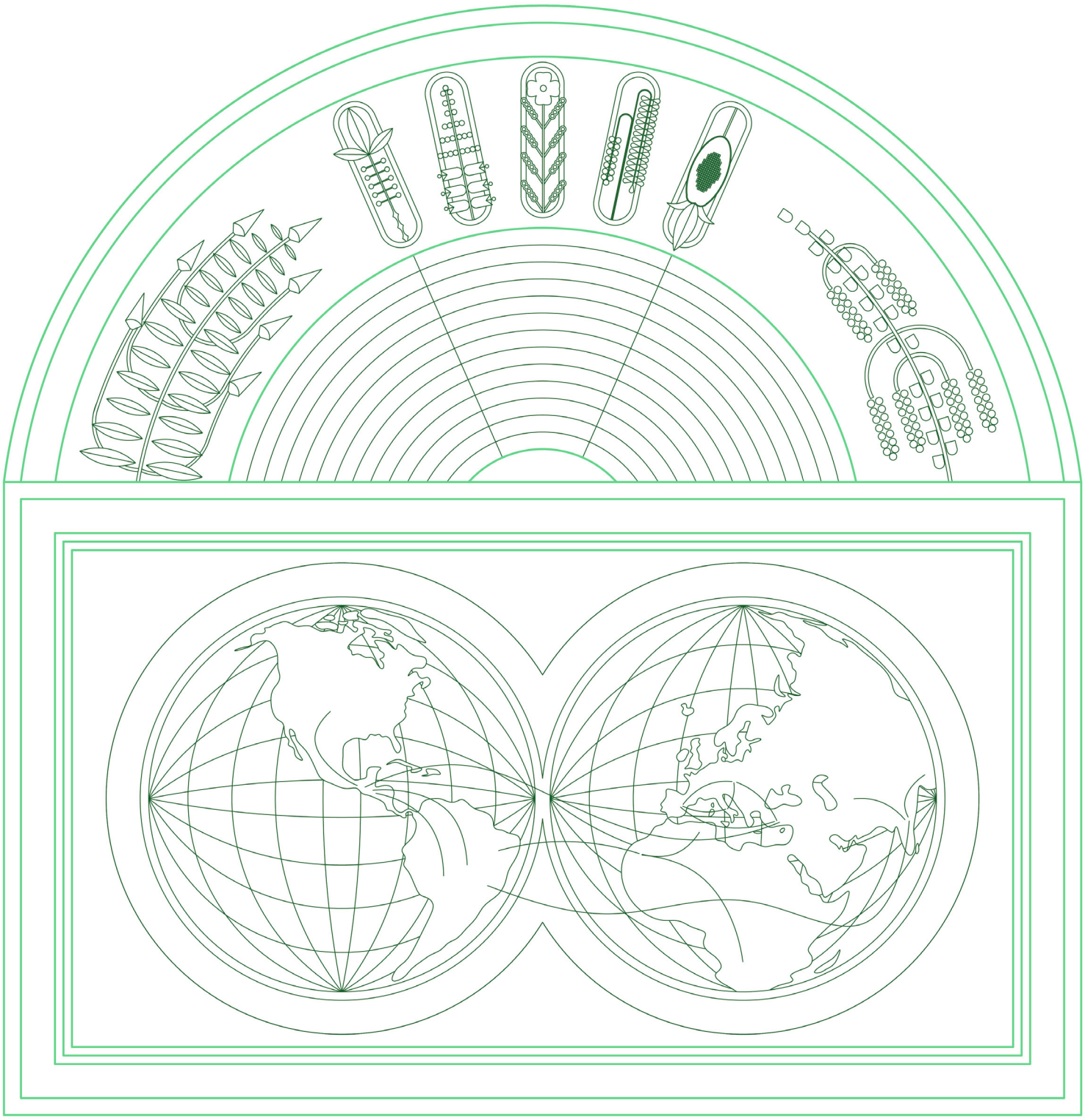


‘Across the World’

As part of the next segment, we follow the routes of the capsicum across the planet. The map consists of two globes that illustrate the rapid spread of the plant from Latin America to Europe and then to Asia between the fifteenth and the seventeenth centuries. The carpet shows the process of transformation that took place during and after this period: the breeding of capsicum in different areas led to the spread of different varieties by the end of the eighteenth century, such as the Aleppo pepper in Turkey and the Cheongyang chili pepper in Korea. These new environments differed significantly from the capsicum’s original habitat. The absence or replacement of companion species, such as birds or even shade-providing shrubs, contributed to the expansion of the pepper taxonomy in parallel with the breeding process.

The arrival of capsicum in Europe coincided with the first greenhouses, the construction of which was made possible by the developing steel and glass industries, and new heating technologies. These greenhouses were luxury buildings designed to house exotic plants, where capsicum was used purely for decorative purposes. There were many reasons for the spread of capsicum as a spice, but much of it was due to scientific experiments with a number of Latin American plants as a substitute for black pepper, which was the gold standard.

Fig. 3: ‘Across the World’. Photo: authors.

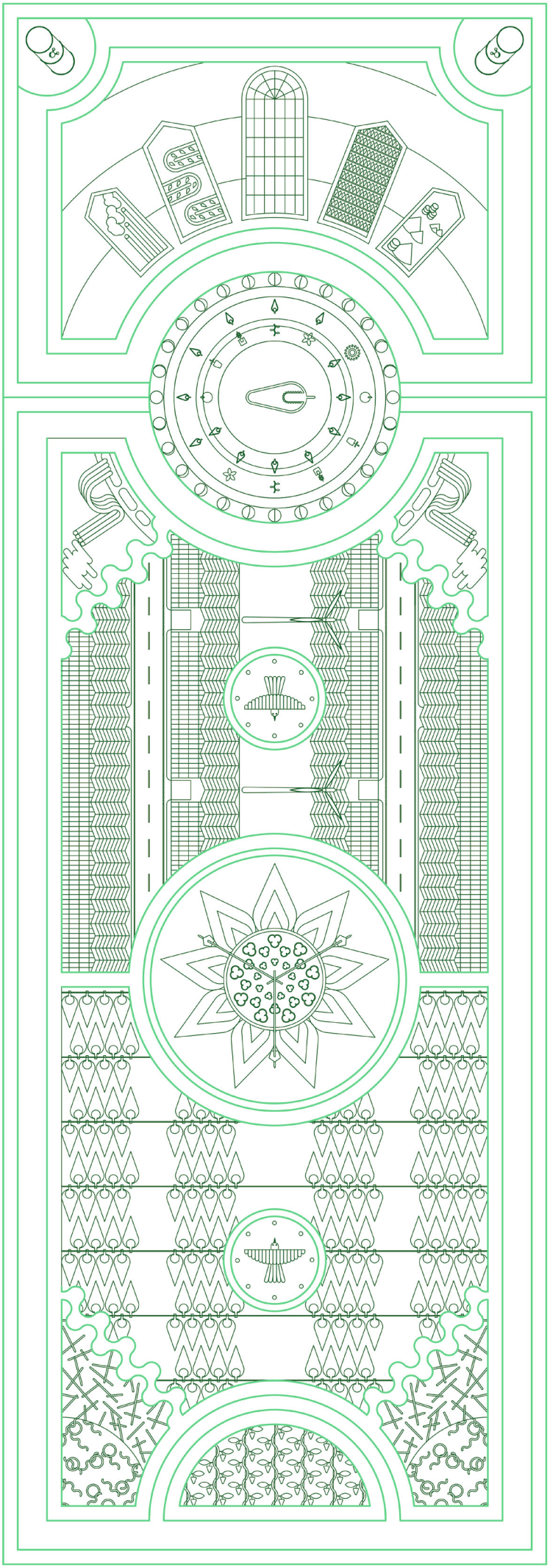


‘New Materiality’ and ‘New Roots’

The ‘New Materiality’ section of the carpet focuses on the different materials and technologies that have radically transformed the built environment and therefore the capsicum’s life during the second industrial revolution from the late nineteenth to the early twentieth century . The extensive use of glass and plastics created the first enclosed, controlled spaces for agricultural industries. The consumer demands created by globalising trade were met by increased crop yields. The transformation of energy production is represented by various symbols, and the accelerated concept of time is visualised in the sowing-and-harvesting calendar.

The next part of the carpet, titled New ‘Roots’, presents the bell pepper in a contemporary Hungarian social and agro-architectural context. The hot or sweet spicy paprika, as well as the sweet yellow Hungarian wax pepper bred from it, are local landmarks and symbols. The capsicum is one of the cornerstones of traditional Hungarian gastronomy, the basic ingredient of many dishes considered ‘Hungarian’, as presented on the carpet in the central Lecsó-scene (Lecsó is a Hungarian bell pepper stew traditionally prepared outdoors in a cauldron over an open fire). In addition to the place of the bell pepper as a plant in popular culture, the illustration also depicts the key elements of cultivation today. Inspired by the greenhouse complexes of the capsicum farm in Szentes, the ancient elements (such as soil quality, the importance of shading) are retained, but new solutions (the use of geothermal energy, sensors) are also referred to, to show contemporary Hungarian greenhouse infrastructure.

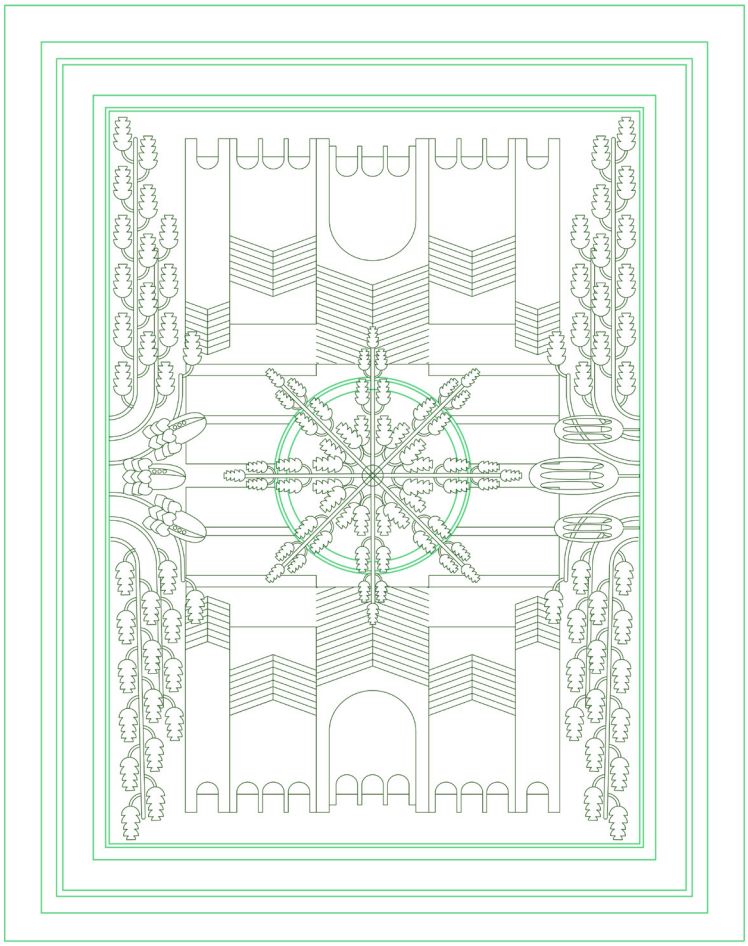
Fig. 4: ‘New Materiality’ and ‘New Roots’. Photo: authors.



‘Sky-High Tree’

The story of the capsicum does not end in the present; the carpet series also looks to the future. What speculative capsicum ecologies can we imagine today? How will the spaces of research, cultivation, purchase and consumption change, disappear, or merge together in the future? Will bell pepper plants continue to live their life as a plant subject to human control, or will they rebel against continuous delimitation, shortened life cycles and rushed production calibrated for aesthetic perfection and profit maximisation? Will they pierce the panels of the greenhouse with their branches, symbolically opening up and reuniting inside and outside?

Fig. 5: ‘Sky-High Tree’. Photo: authors.



Notes

1. Marc Augé, *Non-places: Introduction to an Anthropology of Supermodernity* (London: Verso, 1992).

Biography

Fuzzy Earth creative practice in Budapest was founded by Tekla Gedeon and Sebastian Gschanes.

Tekla Gedeon works with architecture, ecological storytelling and speculative design to create optimistic collective visions to respond to the current climate challenges. She was trained as an architect in London at the AA School. Her works internationally infiltrate unexpected spaces such as market halls, beaches, domestic spaces and gardens. She has taught architecture at the Budapest University of Technology and Economics and she has given lectures in a range of disciplines in the UK and Hungary.

Sebastian Gschanes is a gardener, landscape architect and horticultural researcher. He builds alternative worlds and reveals unseen layers of entanglements across species in the era of climate crises to inspire a more inclusive and resilient future. He creates spaces, objects, and events that explore our relationship with nature and technology. He studied landscape architecture at TU Delft and HSWT Weihenstephan-Triesdorf, and has designed and built gardens bringing together human and more-than-human participants in Vienna, Munich and London.

BÜRO imaginaire is a curator collective founded by Anna Tüdős, Judit Szalipszki and Emese Mucsi.

Anna Tüdős has a range of experience working in the cultural sector as a facilitator, curator and creative producer. She holds an MLitt degree in curatorial practice from the Glasgow School of Art and is a postgraduate student of health humanities and arts at the University of Edinburgh. Her recent work explores contemporary artistic positions concerned with physical and mental health, with a specific focus on the politics and social entanglements of urban playgrounds.

Judit Szalipszki is a curator and cultural worker. Following her BA studies in liberal arts at Eötvös Loránd University and in contemporary art theory at the Hungarian University of Fine Arts, she attended the Arts and Society MA programme at Utrecht University, and obtained a master's degree in Art Sense(s) Lab, a programme focusing on the senses of taste, touch and smell, at PXL University in Hasselt, Belgium. As a curator, her recent field of interest is the practice of artists and designers who regard food as a medium, the frontiers of art, design and gastronomy. Currently, she is working at Trafó Gallery in Budapest.

Emese Mucsi is a curator and art critic. Her projects bring together artists and photographers with photojournalists, writers and other thinkers to experiment with new approaches to photography. She graduated from the Faculty of Contemporary Art Theory and Curatorial Studies at the Hungarian University of Fine Arts in 2013, and from the Faculty of Hungarian Literature and Linguistics at the University of Szeged in 2017. She has been a curator of the Robert Capa Contemporary Photography Center in Budapest since 2018. She founded DOXA exhibition space and editorial den in 2022.

Footprint is a peer-reviewed journal presenting academic research in the field of architecture theory. The journal encourages the study of architecture and the urban environment as a means of comprehending culture and society, and as a tool for relating them to shifting ideological doctrines and philosophical ideas. The journal promotes the creation and development – or revision – of conceptual frameworks and methods of inquiry. The journal is engaged in creating a body of critical and reflexive texts with a breadth and depth of thought which would enrich the architecture discipline and produce new knowledge, conceptual methodologies and original understandings.

Footprint is grateful to our peer reviewers, who generously offered their time and expertise. In this issue, the following papers were peer-reviewed: 'Compulsive Desires: On the Entangled Realities of Lithium Extraction and the Limitless Quest for Energy', 'Platforms and Palimpsests: Urban Landscapes of Data in Northern Virginia', 'Insular Cowscapes: Technologies of Ecological Restoration', 'Plantation Technologies: More-Than-Human Histories of Operationalisation in the Palm Oil Production Territories of Johor State, Malaysia', 'Subversive Submersives: The Unseen Urbanisation of the Southern Ocean'.

Footprint is published by TU Delft OPEN Publishing and Jap Sam Books in collaboration with the Architecture Philosophy and Theory Group, Faculty of Architecture and the Built Environment, TU Delft, PO Box 5043, 2600 GA Delft, The Netherlands
+31 (0)152781830, editors.footprint@gmail.com

The hard copies, back issues and subscriptions are published and arranged by Jap Sam Books at www.japsambooks.nl

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ISBN: 978-94-92852-84-7 paper version www.japsambooks.nl
ISSN: 1875-1504 digital version TU Delft OPEN Publishing