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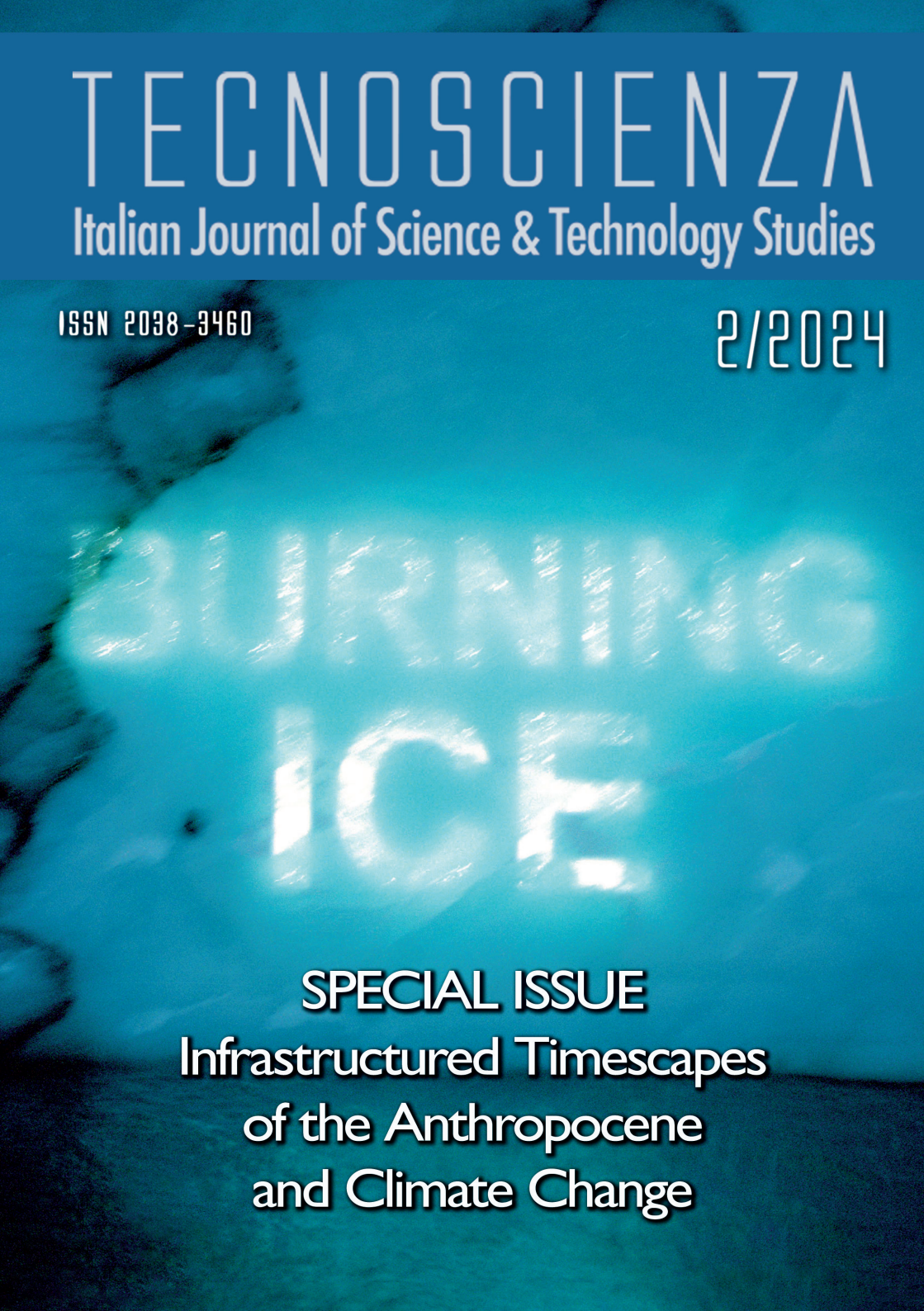

SPECIAL ISSUE
Infrastructured Timescapes of the Anthropocene and Climate Change

Burning Ice (2004) by David Buckland/Cape Farewell

Texts projected onto a glacier wall as the captain manoeuvres the Noorderlicht to within 5 meters of ice that has not been exposed to air for tens of thousands of years. It crumbles, crashing into the sea, carrying its history, soon to be melted away. A million years of the history of our planet is locked in ice two miles down. Once extracted, each tiny bubble releases air from the Earth's past, telling stories of temperature, CO_2 levels and the possibility of life. This ice we gently sail past, as dawn breaks on a cold morning, is the library of our past, that now, with our irresponsible actions, we are causing to melt – Burning Ice.

Cape Farewell (@capefarewell): https://www.capefarewell.com
Buckland Art: https://www.bucklandart.com
David Buckland: https://www.capefarewell.com/david-buckland/

There goes the ice, words by Robyn Hitchcock. Musicians: Robyn Hitchcock and KT Tunstall. Inspired by Cape Farewell's 2008 Arctic Expedition. Visual Artist / video by David Buckland: https://www.youtube.com/watch?embeds_referring_euri=https%3A%2F%2Fwww.interaliamag.org%2F&source_ve_path=Mjg2NjQsMTY0NTAz&v=voMMiXhk6Jw&feature=youtu.be

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Infrastructured Timescapes of the Anthropocene and Climate Change

Cover *Burning Ice* (2004), by David Buckland/Cape Farewell

Infrastructured Timescapes of the Anthropocene and Climate Change

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Abstract
This introduction aims to frame the main contents of the special issue and offers an overview of the collected contributions. It discusses key conceptual themes and reflects on how an infrastructural and temporal approach can open new understandings of climate politics. The core argument inspiring the special issue is threefold. First, the Anthropocene and Climate Change form distinctive "timescapes" that shape knowledge and politics in specific ways. Second, these timescapes are infrastructured, with infrastructure serving both as a key site for producing, organizing and extracting time and as an analytical category to look at temporal work. Finally, because the Anthropocene and Climate Change are temporally infrastructured, efforts at adaptation and mitigation are subject to time leaks, glitches, delays, accelerations, invisibility and performativity that affect time horizons. The introduction stresses the importance of keeping together a pragmatic, critical and speculative approach. It concludes by reflecting on how an infrastructural and temporal approach can shed light on the hegemonic frames shaping climate governance, and open up possibilities for alternative climatic regimes and political action.

Keywords
infrastructures; timescapes; temporal work; climate change; Anthropocene; climate governance.

1. Introduction

The intrusion of Gaia and the new climatic regime (Stengers 2013; Latour 2016; Latour 2018) have brought renewed focus on issues of time and temporality across Science and Technology Studies (STS), Political Ecology and Environmental Humanities. Amid the "great acceleration" (Steffen et al. 2015), the incoming reach of climate tipping points (Lenton et al. 2019), the precarious framework of global climate governance (Aykut and Dahan 2015), the growing mobilization for climate justice and the imperative to transition away from fossil fuels (Pellizzoni et al. 2022), time is finally into question. Taking time seriously into exam could help move concrete attention to the contested temporalities at work and to the unaccounted temporal work that makes our actual futures possible.

The Anthropocene and Climate Change confronts us with an epoch that reveals troubling historical legacies and casts "perilous times" ahead (Ripple et al. 2024), decentralizing humans,

reshuffling the relations of past, present, and future, offering large choice on the possible ends of the world (Danowski and De Castro 2017). The analytical categories of "timescape" (Adam 1998) and "infrastructure" (Star and Ruhleder 1996; Bowker and Star 1999) will guide our endeavor to explore how the entanglements of various paces, tempos, durations, sequences, and modalities of past, present, and future are materially organized in climate.

The core argument inspiring the special issue is threefold. First, the Anthropocene and Climate Change form distinctive timescapes that shape political engagement in specific ways. Second, these timescapes are infrastructured, with infrastructure serving both as a key site for producing, organizing and extracting time and as an analytical category to look at temporal work. Finally, because the Anthropocene and Climate Change are temporally infrastructured, efforts at adaptation and mitigation, as well as climate governance, are subject to time leaks, glitches, delays, accelerations, and performativity of novel time horizons.

To account for the timescapes of the Anthropocene and Climate Change, the special issue addresses symmetrically the time boundedness of infrastructures and the infrastructural boundedness of temporality. It explores how the past, present, and future are infrastructured and performed, as well as the way infrastructures are paced, synchronized and made durable. As infrastructuring relates to standards and classifications, which in turn interact politically with the objects they categorize and regulate (or fail to regulate), the special issue aims to engage with the politics of ordering climate through time. Overall, both the research essays and the dialogue in the Crossing Boundaries section seek to unfold the heterogeneous, coexisting, colliding and clashing temporalities of the Anthropocene and Climate Change. Critically engaging with ecomodernist approaches, the contributions explore the polychronic and more-than-human timescapes in which the Anthropocene and Climate Change unfold. The polychronicity ranges from the glitches of market-oriented approaches to climate neutrality, to the rhythms and deadlines of climate governance and climate-neutral targets, to the tempos of ecological regeneration and the relation between knowledge and temporality. The essays examine the infrastructured timescapes starting from empirical matters including water infrastructures, soil and forest management, carbon budgets and permits. The Crossing Boundaries delve into a theoretical reflection on timescapes across natural history perspectives and regimes of historicity.

To provide a common thread for the readers, I will articulate the topics and themes of the special issue following a well-known rhetorical argument used by STS scholars and according to three questions and related sections:

1. Do Climate Change and the Anthropocene have timescapes?
2. Do timescapes have infrastructures?
3. Which infrastructured timescapes for which climatic regimes?

2. Do the Climate Change and the Anthropocene Have Timescapes?

Too political to be approved by geologists, too natural to be endorsed by sociologists, the notion of the Anthropocene continues to be a matter of concern. Even more so, after the recent decision by the Subcommission on Quaternary Stratigraphy to reject its formal recog-

nition as a new geological epoch. Many scholars have actually welcomed this development as an opportunity to critically re-examine the understanding of our perilous times and establish unconventional transdisciplinary connections. An important acknowledgement in this sense comes with an official statement by the International Union of Geological Sciences (IUGS):

> The Anthropocene as a concept will continue to be widely used not only by Earth and environmental scientists, but also by social scientists, politicians and economists, as well as by the public at large. As such, it will remain an invaluable descriptor in human-environment interactions. It will not be recognised as a formal geological term but will more usefully be employed informally in future discussions of the anthropogenic impacts on Earth's climatic and environmental systems. (IUGS 2024, 2)

The special issue intends to respond to IUGS' call as an invitation to think that a decision about how to classify Earth epochs should not be the sole responsibility of geologists but should involve a transdisciplinary collective of knowledge and practices.

A further contribution comes from Social Sciences and Humanities scholars, who have been criticizing the concept of Anthropocene since its inception, for being a too generic category and eluding questions of responsibility. In response, a proliferation of neologisms arose against the idea of an undifferentiated "anthropos". Hallé and Milon (2020) list over 100 alternative "-cene" terms, including Capitalocene, Thermocene, Plantationocene, Plasticene, Trumpocene, coined to redistribute more accurately responsibility among entities for the alteration of climate: whether they be capitalism, fossil fuels, plantations, plastic, or the 45th and 47th president of United States. In the crowded list, the temporal category of "cene" (*kainós*, meaning new or recent epoch) has been so far the constant and the "anthropos" and its substitutes the overemphasized variables. As remarked by Bensaude-Vincent (2021), it is time to take the constant into full exam: while the variations of the Anthropocene question the "anthropos" as a subject, they leave the object – the notion of a distinct geological epoch – unexamined and taken for granted. As a result, the sheer proliferation of "-cenes" still risk overlooking the polyphonic and more than human temporalities while overemphasizing the human exceptionalism and the chronological framework. Rather than relying on clocks that promise universal commensurability, new ways of "telling the time" could help us to coordinate in a complex multispecies world with co-occurring and conflicting actions, values and trajectories (Bastian 2012), and build new perspectives. Bastian and Hawitt (2023) call for "phenological" perspectives that allow us to move away from viewing time as a uniform backdrop against which environmental changes occur and instead allow us to understand how temporal alignments and misalignments arise through the ongoing interplay of species. The polychronic and phenological approach to the Anthropocene aligns well with the actualization of natural history proposed by Paolo Savoia in this issue. As a method combining history, ethnography, and observation, a revived natural history allows to engage with what Tsing (2015) calls the "third nature" of phenomena. It attends to the fine-grained, site-specific stories of life in the ruins of capitalism, keeping alive fragile possibilities. Such an approach to reconfiguring nature-culture relations provides a counterpoint to the scalability logics of modern science and capitalism: the timescapes of the natural-historical accounts are diverse, fragmented and

cannot be reduced. These accounts do not constitute an overarching pattern, nor can they be "scaled up" but only situated. They prefer "smaller, unheroic understories" like those of local forest planning told by Irene Van Oorschot (*this issue*), where effective climate action requires mastery in "non-mastery" (Taussig 2020), attending to and working with complex temporal dynamics rather than trying to impose grand narratives of conservation or geoengineering.

The special issue welcomes a radical and material rethinking of time itself, which abandons the chronological "time arrow" and the ideas of bounded epochs for timescapes made of situated and entangled temporalities. The readers may find an example looking at Huub Dijstelbloem and colleagues' analysis of the Dutch Delta Works. They highlight the heterotemporality at play in climate adaptation infrastructure for water management to deal with sea level rise. Or in Rita Giuffredi and colleagues' critique of the "urgency frame" in soil degradation policies, arguing for a slower approach and attentiveness to the diverse human and non-human temporalities involved.

Finally, the question about the timescapes of Climate Change and the Anthropocene requires at least a further consideration of how the two concepts interact and interfere. Nordblad (2021) notes that the Anthropocene suffers from being an imagined distant future, collapsing the difference between past and future events. This "future perfect" perspective suggests the future is already determined, stifling political thought and creativity. Climate Change, in contrast, presents alternative future scenarios based on different emissions pathways. This establishes an open future and a temporal structure enabling political deliberation and action. In other words, Climate Change frames the geological temporality in a way that makes political sense, pragmatically facing how our political present connects to the future. Considering this important distinction, the special issue addresses Climate Change and the Anthropocene as conducive to temporalities that are at once different and entangled. Maintaining productive friction between both serves at least two important purposes. First, it helps resist both catastrophism that could lead to paralysis and forms of climate delay that minimize action. Second, it prevents reducing climate discourse to narrow policy questions while allowing pragmatic intervention, critical engagement and speculative imagination. In other words, the entanglement of Climate Change and Anthropocene temporalities could enable an approach that is simultaneously critical, pragmatic and speculative, one that can engage with both the political urgency of climate action and the slow transformation that the Anthropocene signals.

3. Do Timescapes Have Infrastructures?

Once the Anthropocene and Climate Change come to the fore as timescapes, they should be unpacked. This represents the main objective of the special issue, which focuses on the relationship between climate, time and infrastructures. Here the notion of infrastructure acts as an epistemic interface as well as a "thing" that mediates the relations between temporality and climate. The attention is directed to the question of "*when* is an infrastructure?" (Star and Ruhleder 1996), observing both categorical work (the work of making categories) and temporal work (the work of making time). The "when" of infrastructured timescapes involves both their maintenance and their durability through standards and protocols, as well as

the performed temporalities and rhythms which coordinate technologies and human beings (Coletta and Kitchin 2017; Volmar and Stine 2021) and enable specific temporal regimes.

Temporal and categorical work interfere and interact at different scales. In so doing, infrastructured timescapes act as "interscalar vehicles" (Hecht 2018): while categorical work makes objects naturalized differently across communities of practice, temporal work is needed to juggle and translate multiple, often conflicting temporalities and rhythms. This dynamic is evident in transitions from bunkers to data centers (Velkova and Plantin 2023), where the innovative collides with the obsolete, and global data flows interfere with local urban artefacts. The multiscalar perspective can stretch time to the extreme, connecting human and geological timeframes, as in the case of nuclear waste repository experts discussing how to get rid of nuclear waste (Ialenti 2021): their temporal work requires sophisticated practices of "deep time reckoning", ways of understanding and working across vastly different timescales, from immediate operational concerns to geological epochs in the deep future.

The articles included in the special issue address temporal work in a multispecies perspective observing the frictions between modernity and non-modernity. As Irene Van Oorschot's illustrates, Dutch foresters navigate bureaucratic procedures, seasonal rhythms, and speculative multispecies futures to coordinate conflicting temporalities. Likewise, Marie Widengård shows how environmental permits for transitions to renewable energy act as timekeepers mediating conflicting views: companies which want unlimited permits to secure long-term investments, environmental groups which argue for shorter timeframes given climate urgency, and courts which must balance these competing temporal perspectives. Ingmar Lippert's contribution on corporate carbon accounting explores the temporal politics of temporal work: companies manage emissions through provisional statements that enact and make carbon disappear across different settings and competing forms of knowledge. Following Huub Dijstelbloem and colleagues, time produces several "infrastructural compromises" between multiple temporal demands and regimes.

Temporal interferences and mediations create temporal uncertainty. The relation between uncertainty and infrastructures is explored by Vando Borghi (*this issue*) to deepen the political core of infrastructural capitalism. Infrastructural capitalism leverages temporal uncertainty to dispossess individuals of the capacity for action and knowledge, it transforms citizens into "uncertizens". Uncertizenship is an affordance of infrastructures designed within a specific regime of historicity (Hartog 2003) connecting temporality, infrastructures and statecraft. It is thus important to insist on the polychronicity of infrastructures and to dwell on the field of tension of the future where infrastructural capitalism is but one of the many possible design, to create time for political action. Infrastructural capitalism might make bodies and commodities circulating, but not necessarily accelerating. In this sense, the idea of temporal and political uncertainty resonates well with Mitchell's (2020) argument that infrastructures act as an apparatus for the creation of a delay and as a device for stretching forward the passage of time:

> The standard way of writing about infrastructure is to start from the question of space and treat time as a consequence. [...] But what if large infrastructure projects have another relationship to time? What if they are built not to speed things up, but to introduce a delay? What if the virtue of infrastructure is not the acceleration of time, but the ability to place the future further away? (Mitchell 2020)

Following Mitchell's notion of "econementality" (2014), infrastructures make possible the extraction of present value from future activities. They do this through financial practices that simultaneously defer costs and consequences while bringing future revenues into the present. A vivid example is the action of fossil industry and the extraction of vast amounts of "deep time" in the form of fossil fuels, which generated rapid growth while displacing the climatic consequences in an indefinite future. This is related to what Liliana Doganova (2024) calls "discounting", a mechanism introduced in early '900 and adopted by financial capitalism where present-day gains are generated by placing long-term financial obligations on future. Both Ingmar Lippert and Marie Widengård's articles in this issue confront with the financial and economic drivers shaping infrastructural timescapes: Lippert discusses how the temporal politics of carbon accounting enables companies to maintain a neoliberal agenda while claiming environmental responsibility; Widengård illustrates how the permit processes shape the "carbon timeprint" connecting the industrial present to climate futures.

This kind of temporal work complements the temporal work of making scenarios, where practices of envisioning the future are used by corporations to influence the political action towards the preferred ones (Andersson 2020). Such forms of "anticipatory expertise" (Aykut et al. 2019) based on established market dynamics are increasingly adopted to shape climate governance and require further scrutiny in how they make use of temporal work. As Luigi Pellizzoni points out in this issue, while such emergent anticipatory approaches break with modern temporality and questions probabilistic knowledge, they have serious ontological and governmental implications. The forms of knowledge based on pre-emption, urgency and uncertainty tend to create a "suspended present" that may both disclose non-trivial futures that could potentially enable every form of value extraction and power concentration while eluding responsibility for them.

While shaping the future, infrastructures are also related to the past and to the layered temporalities embedded within infrastructure itself. Infrastructural layers accumulate over time, with new components and standards built onto an installed base. These layers from different periods continue to persist in the present and the future. Conversely, as pointed out by Edwards (2010), knowing the future requires to interrogate the past. The work of "reanalysis" in climate knowledge infrastructures allows precisely the production of new knowledge about the future, looking at the records of the past with the new model of the present. Infrastructures also link different temporal scales, for example, from the slow time of precautionary practices to the faster rhythms of emergency responses.

Timescapes and infrastructures share a further characteristic: invisibility. This quality of being unseen links Adam's concept of time as an "invisible other" with Nixon's (2011) notion of "slow violence". Many complex phenomena unfold imperceptibly in the background, evading direct observation. Chemical processes, the gradual melting of icecaps, accumulating air and water pollution, GHG emissions, the spread of radionuclides, and the transmission of viruses all occur below the threshold of visibility. These hidden changes progress incrementally, often unnoticed and unspectacularly, until eventually materializing as visible, irreversible catastrophes. Similarly, infrastructures are transparent to use, invisibly supporting tasks without having to be reinvented or assembled each time (Star and Ruhleder 1996). Infrastructures are designed to reach beyond a single event or practice, providing a stable foundation that en-

ables activities without drawing attention to itself. This invisibility persists until a breakdown occurs. Following Rita Giuffredi and colleagues in this issue, invisibility is also produced by continuous crisis-setting in soil management, obscuring local knowledge and hindering inclusion and more-than-human relations.

The temporal work of infrastructured timescapes of the Anthropocene and climate change thus operate through multiple forms of invisibility – from the gradual accumulation of environmental damages to the hidden technical and bureaucratic systems that shape our relationship with time. The articles in this special issue contribute to this task by examining specific cases where temporal work becomes visible through moments of controversy, transition and negotiation.

4. Conclusions: Which Infrastructured Timescapes for Which Climatic Regimes?

The rejection of the Anthropocene by geologists is less a setback than an opening to re-imagine the temporal foundations of ecological thinking. By symmetrically problematizing the "anthropos", the "-cene", and the "climatic regimes", the contributions included in this special issue aim to develop new conceptualizations better attuned to the infrastructured and political temporalities of the contemporary ecological challenges, combining a critical, speculative and pragmatic eye.

Do Climate Change and the Anthropocene have timescapes? Yes, they do. Collectively, the contributions show that reckoning with the Anthropocene and Climate Change is a constant endeavor which means reckoning with a diversity of times – not just the relentless ticking of the carbon or modern clock and hegemonic temporal regimes, but a thicket of interacting, interfering temporalities. Considering the temporal implication of "-cene" draws attention to the issues of responsibility and agency. The Anthropocene and its variations leave to Climate Change the task of making such infrastructured timescapes politically and differently actionable concerning the modern temporal regimes. In this sense, the timescapes observed by the contributions highlight a shift from *chronos* and *krisis* to *kairos*, from a measurable time and a time of chasing emergencies to an evenemential time of transition and transformation (see Dijstelbloem et al., Giuffredi et al. and Pellizzoni in this issue). As the modern clock time fails to coordinate many of the most significant changes currently affecting the world a *kairotic* perspective could bring transformativity in governing our perilous times. Yet, the protracting of a suspended transitional present without an outcome could be instrumental to extract value from uncertainty and produce delay. We inhabit in such contradiction.

Will Climate Change be able to sustain the awkward inheritance of the Anthropocene and take over with radical political action? The contributions in this special issue suggest that current approaches remain mainly locked in market mechanisms and technological fixes. If global climate governance continues to prioritize these narrow solutions while avoiding more fundamental changes, it will likely fall short of addressing the scale and urgency of the climate crisis. The current condition resembles a tragedy of pre-emption, a sort of temporal lock-in where political action provokes the negative effects that it is assumed to address and mitigate. In dealing with future scenarios, politics must simultaneously confront the inertia of past policies, present-day

emergencies, and the future perils created by the effects of that very political action. Subsequently, immediate economic concerns and long-term environmental sustainability are inextricably linked as part of the problem, not the solution. In fact, the solution is a well-known part of the problem itself: first, because the climate regime in place addresses the GHG emissions as a "decarbonization of capitalism" (Aykut and Dahan 2015); and secondly because of the "climatization of global politics" (Aykut and Maertens 2021), in which climate change became a colonizing paradigm of other global issues and must be thus carefully studied. The lens of infrastructured timescapes could contribute to putting such a hegemonic frame under further scrutiny.

Do timescapes have infrastructures then? Yes, they do. Addressing climate through the lens of infrastructure and time brings to the fore the invisible and kairotic politics of temporal work, as in the accounts collected in this special issue. Looking at materially organized practices allows us to engage with the temporal "invisible others" of climate, otherwise difficult to discern and whose full impacts both suddenly manifest and anticipate a distant future. Together, an infrastructural and temporal approach to climate change and the Anthropocene could offer an original conceptualization of material aspects of climate politics and contribute to observing what extent climatization of politics could enable better infrastructure climate and climate justice in mundane settings, as well as in activism practices (Ghelfi and Papadopoulos 2022).

Finally, the contributions in this special issue provide valuable insights into how scientific, local and lay knowledge are shaped by the material organization of time and climate. Building on these findings, it is also important to consider how climate knowledge infrastructures are increasingly intertwined with digital infrastructures. Climate knowledge infrastructures are increasingly bound with digital infrastructure. While the special issue does not engage directly with the "digital timescapes" (Kitchin 2023) and the increasing role of "predictive policy assemblages" (Egbert 2024), it certainly offers concepts and approaches to deepen the digital and ecological juncture in climate governance (Hirsbrunner 2021). As observed during the pandemic, digitalization offers a very powerful and quick way to re-infrastructure a crisis as well as to exploit its intervals and delays. With Climate Change, we witness similar temporal mechanisms that are observable in urban climate transitions at the intersection between climate governance mechanisms and the digitalization of climate. I believe that this special issue will spur further exploration of the infrastructured timescapes through which planetary futures, presents, and pasts are being politically imagined and enacted.

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Tides of Time: The Dutch Delta Works as Time-Mediating Climate Adaptation Infrastructure

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Abstract
The relationship between infrastructure, climate change and time is a crucial but often misunderstood element of climate policy. This article argues that climate adaptation infrastructures mediate between different temporal regimes and can even be said to generate temporal regimes themselves. By examining the development of the Dutch Delta Works, a set of infrastructures initiated after the 1953 North Sea floods that killed more than 1,800 people, the article reconceptualizes the development from the response to the 1953 disaster to its current relationship with the consequences of climate change, in particular rising sea levels, river water inflows and weather fluctuations such as increased rainfall. By situating the development of the Delta Works in relation to *Kairos*, a period of transition and transformation, rather than *Krisis* as a response to an immediate disaster, the analysis presents a multifaceted perspective on the relationship between infrastructures, time and temporality. Developing the notion of infrastructural compromises to describe how infrastructures connect to and mediate between different temporal regimes, the analysis examines four episodes, each of which involves a different relationship to time and exemplifies different compromises between temporal regimes. As infrastructure development will be of paramount importance for the development and implementation of climate adaptation policies, it is crucial to arrive at a refined understanding of the relationship between infrastructure and time. A heterogeneous conception of time and temporality is needed to do justice to the mediating role of infrastructures in all these issues and the trade-offs that result from this interaction.

Keywords
climate change; infrastructure; time; crisis; climate adaptation; compromise.

1. Unfolding Climate Infrastructures

Waterloopbos, literally "Watercourse Forest", was an open-air laboratory located in a polder forest in the Noordoostpolder in Flevoland, the Netherlands. In the 1950s, it served as a test site for Waterloopkundig Laboratorium de Voorst, where large-scale models were built for the de-

velopment of waterworks, considered necessary after the 1953 North Sea flood in the southwest of the Netherlands, which killed more than 1,800 people. The disaster not only underlined the Netherlands' struggle with water, which has played an important role in the formation of the country's national identity, but also led to the creation of a national plan to protect the country against future floods. This so-called Delta Plan led to the construction of the Delta Works, a large network of protective infrastructures in the vulnerable lower parts of the Netherlands.

The Waterloopbos test site is a large water basin, 250 metres long and with the possibility of creating high waves, situated in the middle of a forest. Similar test sites were also used to develop waterworks for the port of Bangkok and the Danish coast, as well as for an oil port in Libya and the Willem Tunnel in Rotterdam. With the advent of computer simulation and other testing capabilities, these models gradually became obsolete. In 1996, the Waterloopbos laboratory was closed. A monumental artwork by RAAAF, which was completed in 2018, serves as a reminder of the area's former function, but also of the transience of the notion that the battle against water could only be won by developing indestructible structures[1]. Today, the Netherlands is at risk of even greater catastrophes as a result of sea-level rise, river water inflows and weather fluctuations causing severe droughts and heavy rainfall. Instead of "fighting the water", the new paradigm is "living with the water".

Figure 1.
Waterloopkundig Laboratorium De Voorst in the Noordoostpolder, Dam in the Haringvliet.
Source: Fotocollectie Rijksvoorlichtingsdienst

Waterloopbos is now a national nature reserve. The structures are overgrown and serve as a refuge for all kinds of life. But the importance of paradigm shifts and the different practices and

forms of knowledge they enable is also evident in RAAAF's work. It illustrates how much imagination can be unleashed when there is broad discussion and an acute awareness of change. The construction of the Delta Works was preceded by intense debates among experts, politicians and citizens (Bijker 2002). This article will use these controversies and resulting compromises as an avenue for analysing how the Delta Works have engaged with time and temporality.

Infrastructures for adaptation to climate change relate to different regimes of time: geological epochs, the long-term consequences of fossil fuel use, investment cycles, technology development trajectories, the length of regulatory and legislative processes, the periods of executive power of elected governments, tipping points and points of no return, subjective perceptions of time, and even eschatological visions of the end of time (see Rothe 2020 on this last point). There is a dynamic interplay between these time horizons and deadlines on the one hand, and their respective cycles, rhythms and tempi on the other (Wallis 1970). The distinction between time periods and time landscapes (Adam 1998; 2006) is not sufficient, as these are interdependent and in constant motion and conflict. Time periods and time landscapes accelerate, amplify, slow down or even stop each other altogether, complicating notions of governance, agency, knowledge, and time in the Anthropocene (Chandler 2018). Relatively little attention, however, has been paid to the temporal dimension of climate change adaptation infrastructures and the ways in which infrastructures mediate between politics and time. The relationship between temporality and the infrastructures used to adapt to climate change remains to be explored.

To study this relationship, this article starts with a historical example and examines the further development and planning of the Dutch Delta Works in the era of human-induced climate change. Studying this infrastructure and the planning process that preceded it allows for an analysis of the various relationships between technologies and time, making it possible to distinguish various temporal regimes and to explore the transition between and transformation of these regimes. Adaptation policies increasingly emphasise the use of flexible instruments to make societies more resilient to climate change, especially when it comes to rising sea levels and turbulent river flows. While the Dutch have long framed their relationship with water as a battle, the term "water management" has gained popularity when referring to adaptation policy in the Netherlands, as a way or strategy of "living with water" (Wieringa and Arts 2006). Through a combination of dikes and protection mechanisms, including more flexible structures such as basins, Dutch policymakers aim to build a resilient infrastructure that can be adapted as predictions regarding the consequences of climate change evolve.

The experiments at the Waterloopbos test site and the Delta Works are good examples of how infrastructure can be understood as being composed of various kinds of "folds". According to Latour (2002), folds, movement, and time exemplify how technologies consist of heterogeneous layers of matter and space, but also of time. He illustrates this with an elegant example, which is worth quoting at length:

> The hammer that I find on my workbench is not contemporary to my action today: it keeps folded heterogenous temporalities, one of which has the antiquity of the planet, because of the mineral from which it has been moulded, while another has that of the age of the oak which provided the handle, while still another has the age of the 10 years since it came out of the German factory which produced it for the market. When I grab the handle, I insert my

> gesture in a "garland of time" as Michel Serres (1995) has put it, which allows me to insert myself in a variety of temporalities or time differentials, which account for (or rather imply) the relative solidity which is often associated with technical action. (Latour 2002, 249)

According to Latour, when "we would reverse the movement of the film of which this hammer is but the end product, we would deploy an increasing assemblage of ancient times and dispersed spaces" (*ibid.*, 249). Elaborating on this thesis, this article will explore the idea that infrastructures, like Latour's hammer, are not only made of matter, movement and space, but also of time. We will argue that infrastructures not only consist of heterogeneous temporalities, but that they can also be regarded as dynamically composed entities that mediate between different temporal regimes. As the development of infrastructures will be of paramount importance for the development and implementation of climate adaptation policies, it is crucial to arrive at a refined understanding of the relationship between infrastructures and time. Issues of policymaking, financial investment, public support, research and development all relate to different regimes of time. A heterogeneous conception of time and temporality is needed to do justice to the mediating role of infrastructures in all these issues.

To develop this perspective, this article is organised as follows. Section 2 analyses the relationship between temporality, infrastructures and climate change in order to situate the relationship between the Dutch Delta Works and time. The analysis elaborates on some key notions that have been proposed in the field of science and technology studies (Vostal et al. 2019) to explore the relationship between time and climate change adaptation infrastructures. In Section 3, these notions are put forward to empirically analyse the development of the Delta Works. More specifically, we focus on existing adaptation pathways maps that are being used to anticipate climate change. By examining four episodes, we demonstrate the multiple relationships between infrastructures and time, while also identifying several mediating moments in their development. Section 4 discusses the consequences of relating infrastructures to different temporal regimes and conceptualises the time-mediating aspects of infrastructures, and of the Delta Works in particular. Based on an analysis of various infrastructural projects, the notion of "infrastructural compromises" is applied to describe how infrastructures connect different regimes of time and mediate between them. Finally, in Section 5, we present our conclusions and suggest a number of topics for further discussion.

2. Hetero-temporality: The Interaction between Multiple Time Regimes

The idea to conceptualize the relationship between time, infrastructures, and climate change in terms of "mediation" is inspired by Bruno Latour's analysis in *Down to Earth* (2018). In this essay, he breaks with an eschatological notion of time. Latour argues that climate change and the new climate regime do not imply the end of the world or the end of time. We are not witnessing the apocalypse. Instead, we are forced to anticipate an ongoing process of time that will only intensify our relationship with the planet and other beings in a new climate regime. To use the terminology of the philosopher of history François Hartog, Latour refrains from considering the transition from the Holocene to the Anthropocene as a *Krisis* – the Day of

Reckoning, in the Christian tradition – but regards it as *Kairos*, a temporal rupture that indicates an intermediary between the time of human beings and the time of earthlings (Hartog 2021, 429; 2022, 220-224). *Kairos*, in this sense, marks a period of transition and mediation allowing for a more variegated perspective on the relationship between infrastructures and time.

The philosophy of history interpretation of the transition to the Anthropocene offers important insights with regard to conceptualising the relationship between time and infrastructures, while also allowing for alternatives to the notion of "crisis". But how to distinguish and differentiate between the various modes of time in the new climate regime and the different forms of mediation? As Marquardt and Delina (2021, 1) argue, "time has become a key reference point for measuring the success, failure, and progress of climate action", as evidenced by the centrality of 2030 and 2050 in climate policies. However, the concepts of time and temporality are rarely problematised. For that reason, they stimulate "a closer investigation of the politics behind time-making in energy and climate research" (*ibid.*, 4). While this call to pay more attention to the relationship between politics and time deserves support, looking for the politics *behind* time-making might not be the most promising way of doing so. The use of the word "behind" suggests an instrumental relationship between politics and time, in which the former is supposed to be an agent treating the latter as an object of its own will. We therefore propose differentiating between multiple modes of time and temporality.

Climate change infrastructures operate as specific clockworks that aim to adjust political decision-making on climate issues. Meanwhile, these "clocks" have their own time settings. In their analysis of the temporal complexity of scientific knowledge production, Vostal et al. (2019) aim to unpack the relationship between time and technological development. They carve out three categories that seem applicable to the functioning of climate infrastructures as well. The first category, *experimental* temporality, is the kind of testing of time that occurs in laboratory work, where natural processes are made malleable by speeding them up or slowing them down. To provide an example, we again turn to the aforementioned Waterloopbos. A tide usually lasts about six hours, but the configurations of the Waterloopbos test setup made it possible to simulate a tide in a matter of minutes (Bijker 2019). *Cognitive* temporality refers to the "intentionality and agility of agents" (Vostal et al. 2019, 795). According to the authors, this category of temporality can be conceived as two different modes: as *quick* aha moments (eureka!), or as a *slow* and incremental process of gaining insight into complex phenomena, such as climate change. Predictions based on modelling are an example of the latter mode, which we will illustrate by highlighting adaptation pathways. Finally, *institutional* temporality comprises the administrative, communicative and regulatory work involved in the development of technologies, varying from the time it takes to get a paper published to securing funding, and including every step of the process, from the initial planning stage to the pilot, project and scale-up phases (Vostal et al. 2019, 794-798). In the following, we bring institutional temporality into the realm of governance and government where repeating cycles (e.g., elections every four years, terms of office, the time between the initiation of a project or a law to its implementation) contribute to structuring those domains. A clear example of institutional temporality is the Delta Act, which stipulates various terms for review, tenure and expenditure. This three-fold structuring of the problem is useful for analysing climate change infrastructures and the Dutch "Nationaal Deltaprogramma" (National Delta Programme, NDP), as the next section will show.

3. The Hetero-temporalities of the Dutch Delta Works

To analyse the hetero-temporalities of the Dutch Delta Works, four interconnected episodes are presented here, each of which has to do with the relationship between the Delta infrastructures, time, and water management practices in the Netherlands. We refer to these four empirical accounts as "episodes" because this suggests a temporal sequence. Our analysis of the episodes draws on the three temporal categories of Vostal et al. (2019) set out above: experimental, cognitive and institutional. The episodes are interconnected through their continuity, bringing lessons from the past into the present, anticipating the future in the present. Moreover, the links between them are emphasised by folding various times and temporalities into contemporary water security practices. The four episodes are also interconnected because – as we aim to show – they all contain specific forms of mediating with time and different time regimes, and compromises between various forms of time. The first episode outlines how the response to the 1953 North Sea flood materialised in the practices of Dutch water managers. The second pertains to adaptive delta management and the delicate balance between on-time investments and in-time interventions. The third episode discusses the scientific development of a mechanism seeking to responsibly establish a balance between on-time investments and in-time interventions. The final episode focuses on the question of how adaptive delta management and adaptation pathways maps are being used in the context of rising sea levels in the Anthropocene. In these episodes, various times and time regimes, timescapes and temporalities are folded into each other, thereby bringing the past and the future into present political decision-making.

3.1 The Delta Works: From Infrastructural Innovation to Institutionalisation

After the 1953 flood, the Delta Commission was established. Its task was to make recommendations to prevent future deadly floods. The commission advised closing off some of the dynamic estuaries (i.e., Veerse Gat, Haringvliet and Brouwerhavense Gat) using caissons, discharge sluices and concrete blocks (Bijker 2002). While this infrastructure created a safe living environment for the local population, it had a devastating effect on natural life in the estuaries, as local ecosystems were altered irreversibly. The closure of Brouwerhavense Gat cut off the Grevelingen, effectively creating a dead body of water. In fact, two weeks after its closure, the Grevelingen was referred to as a graveyard. The newly created lake and its shores were covered with dead, rotting animals and sea plants. This ecological disaster significantly changed public discourse, leading to new water safety and management practices. As a result of this "radical departure from centuries-old traditions", the NDP and the Delta Act sought to ensure a balance between safety and ecology instead of focusing solely on the former (Bijker 2002, 570; 583).

The Grevelingen graveyard taught policymakers two key lessons about Dutch water management strategies. First, concrete barriers in estuaries are not conducive to natural life and ecosystem development. They literally cut off natural cycles, making it impossible for life to flourish. Second, constructing a concrete infrastructural dam means that the dam's hinterland is rendered static for decades or even centuries. Keeping bodies of water open instead of closing them off thus helps to sustain life while also keeping open the possibility of various future interventions. The NDP adheres to this ideal of "keeping open" through the notion of

Figure 2.
Construction of the Haringvlietsluizen, 1962.
Source: Fotocollectie Rijksvoorlichtingsdienst

adaptability. Taking anthropogenic climate change into account, the interdisciplinary field of water management and water safety in the Netherlands has invested in knowledge, planning and institutions to anticipate the many future uncertainties and requirements.

The continuity from the 1953 North Sea flood and the subsequent establishment of the first Delta Commission, also in 1953, is to be found in the second Delta Commission, which was established in 2007[2]. The remit of this second commission was to advise about water safety within the context of the projected sea level rise as a result of global warming. In its 2008 report *Samen werken met water* ("Working with Water Together"), the second Delta Commission conducted an integral analysis of the various water-related challenges faced by the Netherlands in the centuries ahead. The report is based on the premise that the Netherlands must continue to be:

> [An] attractive country in terms of living conditions, work, investing and recreation. Safety and sustainability are the twin pillars on which the strategy for the coming centuries must be based. The best long-term strategy to ensure that the Netherlands remains a safe and pleasant country to live in is *to align its development with climate change and other ecological processes*. (Delta Commission 2008, 89, *emphasis added*, *authors' translation*)

The second Delta Commission clearly acknowledged that future climate change and sea level rise would have a significant impact on the Dutch delta. It also noted, however, that the pace and effects of climate change remained uncertain. In this context, the commission proposed a sustainable strategy by formulating its recommendations in such a way that they

could be "realised flexibly and gradually, responding to long-term developments" (Delta Commission 2008, 89, *authors' translation*). In other words, a number of key mechanisms to ensure the safety of the Dutch delta were formulated in 2008.

As a result of the second Delta Commission's recommendations, the NDP became legally established – and in that respect institutionalised. The NDP's position, including that of the Delta Commissioner, was laid down in the "Deltawet waterveiligheid en zoetwatervoorzieningen" (hereafter: Delta Act), in 2011. The Delta Act stipulates that there shall be a Delta Programme and a Delta Fund, with an annual budget of approximately €1 billion. It also sets out the powers and responsibilities of the independent government commissioner, whose term of office is seven years, with the possibility of renewal[3]. The purpose of the NDP is to ensure that the Netherlands remains safe, now and in the future, and that it has sufficient access to fresh water[4]. The NDP's ongoing tasks include signalling potential problems and adjusting policies and plans. It must report to the government and Parliament annually, and every six years the NDP's activities and objectives are recalibrated.

In this brief examination of the NDP, we observe mainly an *institutional* temporality, simply because the NDP is governed by a law that stipulates various time regimes (annual budget, recalibration every six years and a renewable seven-year term for the commissioner). This arrangement ensures the continuity of the NDP and the commissioner's work. At the same time, the commissioner's renewable seven-year term, together with their independent status and the annual prescribed budget, also keeps their work – and the NDP's work in general – relatively separate from the political domain and its short-term preferences and election cycles. This means that the institutional temporalities that partly constitute the NDP are coordinated in such a way that they are diachronic to the institutional political temporalities. But there's an order of temporalities, just as the political domain dictates that of the NDP.

3.2 Infrastructural Development as Investment

The "fight against water" and "keeping the polders dry" play a central role in Dutch policies and governance, and the Dutch have a long history of dealing with water and its turbulent tides, as well as a great deal of expertise in water management. However, it should also be noted that the development of the NDP involved several compromises. As historians have pointed out, compromises were an integral part of the decision-making process when water became a security issue (Kruizinga and Lewis 2018). One such compromise concerned the question of "how high is high enough" in terms of dikes and the investments needed to ensure water security. In the Netherlands, water levels are indicated as being above or below the Amsterdam Ordnance Datum (Normaal Amsterdams Peil, NAP). On Saturday, 31 January 1953, a high spring tide combined with a severe storm caused water levels to rise to over 4 metres above the NAP. However, the NAP delta norm of +5 metres, which was formulated to prevent future disasters and "would form the basis of Dutch water security policy for decades to come", was based on financial and statistical "assumptions and compromises" that "remained largely unchallenged until the twenty-first century" (Kruizinga and Lewis 2018, 24). As Kruizinga and Lewis (*ibid.*, 24) have shown, it took until 2004 "to publicly recognize that the delta standard was unverifiable and remained untested".

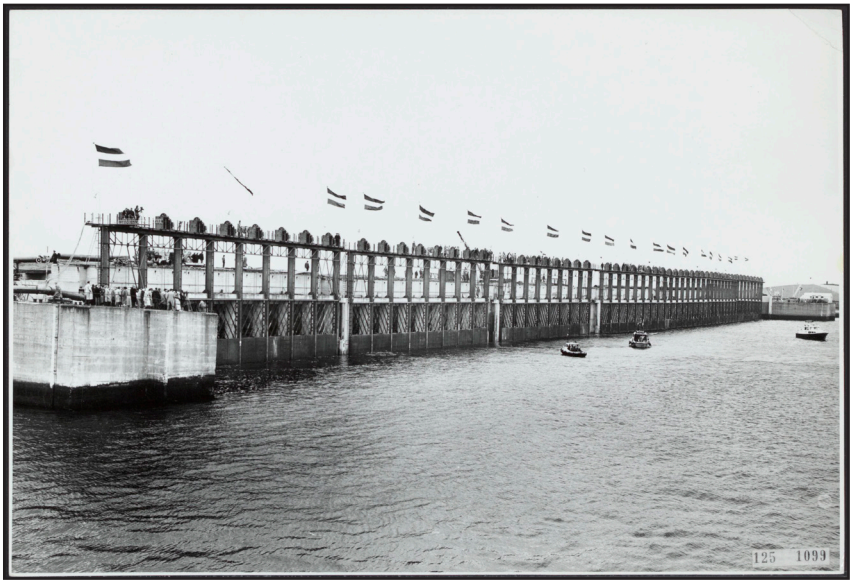


Figure 3.
Closure Veerse Gatdam, 1961.
Source: Fotocollectie Rijksvoorlichtingsdienst

The compromises made in the development of the NDP included financial and statistical aspects of water security, as well as different time regimes. In this respect, the lack of a scientific basis for the NAP delta norm in the 20th and early 21st century is highly problematic. Assumptions and compromises do not provide sufficient protection for the estimated 8 million people who live in areas that are prone to flooding. Because of climate change, growing existential threats will render traditional forms of water management through dikes, polders, pumps, dams or sluices partly obsolete. Whereas dangerously high tides were relatively easy to predict when sea water levels were stable, anthropogenic climate change is forcing Dutch water managers to take into account extreme long-term uncertainty. As a result, *adaptive* water management is becoming increasingly central to Dutch water security practices. Besides safety and sustainability, responsible adaptive water management also takes into account cost-effectiveness. On its website, the NDP defines adaptive delta management in various ways. For example:

> Working adaptively does not mean waiting until we are overtaken by new insights or developments, but being constantly alert and taking cost-effective measures at the right time[5].

Timing is at the heart of adaptive delta management. Infrastructural adjustments must be made *in time* to prevent floods, and investments must be made *on time* to ensure that they are cost-effective. This strongly resonates with the financial-economic rationale applied to trade-offs between contemporary financial investments and future benefits, or the discount rate. This

rate converts "costs and benefits at different points in time into comparable costs and benefits at a single point in time", taking into account variables like interest rates and depreciation of commodities (Newell and Pizer 2001, 1). An effect of discounting is that a resource (e.g., €1) has a higher value in the present than in the future. This also means that benefits in the distant future are given less weight in the planning process than benefits in the near future (Broome 1994), and that investments with long-term benefits hence become more expensive than short-term investments (de Goede 2015). In other words, from a financial perspective, the best moment to invest in reinforcing a dike is as late as possible, because investing too early is not cost-effective.

This episode underlines how a financial rationale folds the long term into the short term, thereby valuing the latter higher than the former. Water security cannot be discussed without a cost-effectiveness analysis, which is de facto a political analysis because, as Wood (2008, 266-267) argues, the relationship between short-term decision-making and anticipating future events in terms of political benefits, introduces a "political discount rate" based on the present political value of the future benefits of a given action. In this respect, the episode about infrastructural development as an investment entails a hybrid between two temporalities: *institutional* and *cognitive*. The former is dependent of political cycles, such as elections being held every four years, but it also involves depreciation periods of 10 or 20 years, for instance. The cognitive temporality slowly evolves over time, as cost-benefit analyses are, similar to climate change, complex objects with regard to financing, where modelling, future projections, and interpretations and valuations of the past coincide.

3.3 Infrastructures as Temporal Interventions

In addition to on-time investments, in-time interventions are crucial in water management and safety. If a flood can be prevented, it should be. But climate change is a complicating factor in determining the right time for physical interventions. The scientific literature on climate change is clear on several developments. For instance, there is consensus on the fact that the pace of climate change is increasing, and that atmospheric and sea temperatures will rise accordingly (Loeb et al. 2021). It is also widely agreed that extreme climate change effects are difficult to predict as the increase in weather extremes potentially renders past observations obsolete when it comes to assessing current and future weather patterns (Thompson et al. 2023). But climate tipping points are difficult to predict. They come about abruptly and that they will have a significant impact (Lenton et al. 2019). These developments make it more difficult to predict, for example, the rate at which sea levels will rise. In this respect, Lenton et al. (2019) state that a tipping point may have been reached in West Antarctica, as the "grounding line" where "ice, ocean and bedrock meet is retreating irreversibly" (*ibid.*, 593). If this tipping point also destabilises West Antarctica's ice sheet, they predict a 3-metre sea level rise "during the coming centuries to millennia" (*ibid.*)[6].

Given that approximately a quarter of the Netherlands lies below the current sea level and almost 60% of the country is prone to flooding, the predictability of sea level rise is an important issue for the Netherlands. The NDP reports an expected sea level rise of 1 to 2 metres by 2100 if the 2015 Paris Agreement's targets are met[7]. If these goals are not met – i.e., if global temperatures rise by more than 2 degrees Celsius – sea levels will rise accordingly. Even in this brief example, there are various uncertainties: *a sea level rise of 1 to 2 metres by 2100 if global*

warming is limited to 2 degrees Celsius. The NDP currently uses the Dynamic Adaptive Policy Pathways (DAPP) as a framework for decision-making in the face of uncertainty (Kwakkel et al. 2016; Haasnoot et al. 2018; Haasnoot and van 't Klooster 2018). Adaptive planning is about the identification of short-term actions and long-term options in relation to a specified plan, and requires active monitoring and signalling to ensure timely implementation or adjustment. The NDP's policy programmes and goals are consequently recalibrated every six years. DAPP defines various action series over time – so-called *pathways* – to achieve and secure future plans, based on the notion that policies, actions and decisions have an "uncertain design life and might fail to achieve their objectives sooner or later" (Haasnoot et al. 2018, 274). When DAPP determines that objectives within a particular programme will likely fail, it identifies these moments as adaptation tipping points. This indicates that targets will be missed and that a different policy pathway must be followed (see Figure 4).

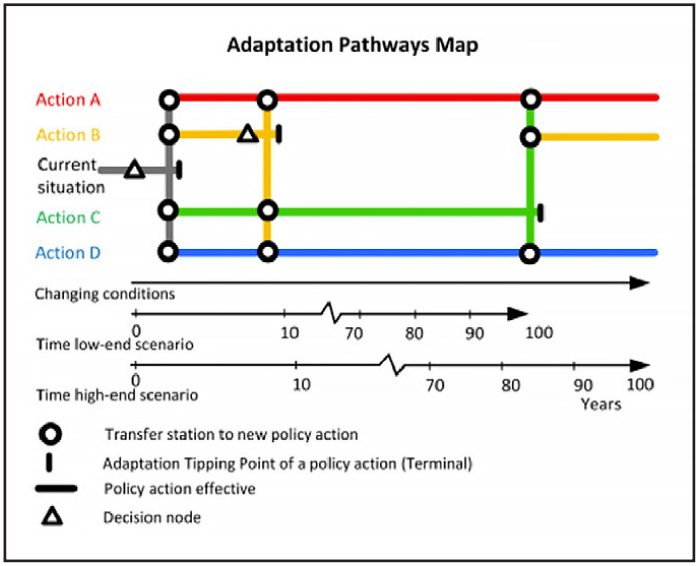


Figure 4.

Adaptive pathways map.

"An example of an adaptation pathways map [...]. In the map, starting from the current situation, targets begin to be missed after four years; an adaptation tipping point is reached. Following the grey lines of the current plan, one can see that there are four options. Actions A and D should be able to achieve the targets for the next 100 years in all scenarios. If Action B is chosen, a tipping point is reached within about five more years; a shift to one of the other three actions (A, C, or D) will then be needed to achieve the targets. If Action C is chosen after the first four years, a shift to Action A, B, or D will be needed after approximately 85 years in the worst case scenario (follow the solid green lines). In all other scenarios, the targets will be achieved for the next 100 years (the dashed green line)."

Source: https://www.deltares.nl/en/expertise/areas-of-expertise/sea-level-rise/dynamic-adaptive-policy-pathways

Thus far, we have looked at some of the complexities that the NDP must address. Among them are finding a balance between cost-effective investments and the right moment to build infrastructures to keep the Netherlands safe from flooding, and finding the best way to deal with uncertainties in relation to climate change developments and the effects of these global changes on sea levels. DAPP offers a method for navigating these challenges. In this respect, DAPP's temporality is about bringing the future into the present. DAPP's temporal map is hence an illustration of an *experimental* temporality, because it compresses the passing of time, from years to decades, into an orderly overview that dictates when what must be decided, as well as which potential pathways are left open and closed.

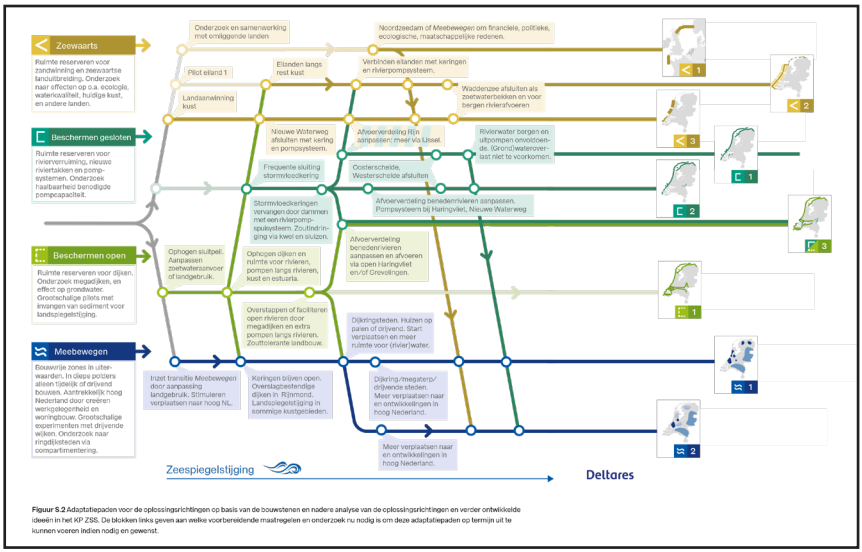
3.4 Infrastructures as Open Futures

What are the Netherlands' potential futures in relation to the struggle with water? It took the NDP, together with several scientific partners, years to fully develop adaptation pathways that can be implemented gradually, ensuring flexibility. With scenarios such as these – which provide the conditions for adaptability – the future is kept open to a certain extent. The adaptation pathways map provided above is schematic and rather abstract. Based on this method, Deltares developed four strategies for the Netherlands to cope with rising sea levels:

1. *Protect-closed*: protecting the coast from flooding and erosion through hard or soft measures, such as barriers, sand replenishment or wetlands. River arms are closed off (with dams or storm surge barriers);
2. *Protect-open*: same as above, but the rivers remain in open connection with the sea;
3. *Seaward*: creation of new, higher, seaward land to protect the delta from flood impacts;
4. *Adjust*: reduce vulnerability to the effects of higher sea levels through water- or salt-tolerant land use (e.g., buildings on stilts), raising land, spatial planning and/or migration. (see Haasnoot et al. 2019, *authors' translation*)

Each of these four scenarios has its own adaptation pathways. Similar to the adaptation pathways map above (Figure 4), the four scenarios also have adaptation tipping points, where a choice must be made to proceed on the chosen adaptation pathway or to stop and switch to another pathway. While some of the interventions are required in more than one adaptation pathway, other interventions render the other scenarios less likely. Consider Scenario 1: once river arms are closed off by concrete barriers, the only remaining option is to pump the river water into the sea. For example, if the Rijnmond and Oosterscheldekering were to be closed, the Seaward scenario would effectively become obsolete. Moreover, this would negatively impact the estuaries' ecosystems. However, scenarios for the distant future do still consider the possibility of diverting from Scenario 1 (Protect-closed) to other scenarios, such as Scenario 4 (Adjust). Over the past several years, adaptation pathways have matured. Hence, they now exhibit traits not only of *experimental* temporalities (see above), but also of *cognitive* temporalities. With regard to the latter, academics and practitioners worked closely together to develop a policy mechanism that provides insight into complex phenomena. This can be used, for instance, to decide which water security measures – or infrastructures – must be implemented at a given moment, and to determine the possible consequences a particular decision will have for future decisions. The relationships

between the developed scenarios are illustrated in Figure 5, which also shows when and where adaptation tipping points can be expected.



Figuur 5.2 Adaptatiepaden voor de oplossingsrichtingen op basis van de bouwstenen en nadere analyse van de oplossingsrichtingen en verder ontwikkelde ideeën in het KP ZSS. De blokken links geven aan welke voorbereidende maatregelen en onderzoek nu nodig is om deze adaptatiepaden op termijn uit te kunnen voeren indien nodig en gewenst.

Figure 5.
Relationships between the four scenarios, including adaptation tipping points.
Source: Haasnoot and Diermanse 2022, 13.

The required preparatory measures and research for each of the four scenarios are described in the four blocks on the left. The dots indicate adaptation tipping points, clearly marking future moments that must be considered in the present. In addition, because some adaptation tipping points exclude particular scenarios, it is necessary to always bear in mind the desired future. DAPP is thus a mechanism that can be used to formulate visions and preferred situations for future generations living in the Netherlands. It maps all possible decisions and their respective sequences, both in the short and long term. In this respect, the pathways and adaptation tipping points are starting points for managing short-term actions and long-term options (Kwakkel et al. 2016; Haasnoot et al. 2018), offering ways to mediate between them and to arrive at possible compromises. While Figure 5 is itself an example of *cognitive* as well as *experimental* temporality, as we argued above, it also embodies *institutional* temporality. Although the scenarios and tipping points are not clearly articulated in Figure 5, the underlying document mainly refers to the years 2100 and 2150 (and a few times to 2200) which is an indication of the planning horizon. Moreover, there is a particular sequence of measures, as some interventions make others impossible. This present-day focus on the long-term and policy consequences, together with the specific sequences for implementing new infrastructures, show that adaptation pathways coincide with *institutional* temporalities.

4. Infrastructural Compromises: The Delta Works as Mediators of Time

Global warming and its consequences such as rising sea levels and flooding are becoming increasingly unpredictable. This requires new approaches when it comes to planning, building, and investing in the Delta Works infrastructures[8]. Adaptation pathways play an important role in this. The four episodes discussed above demonstrate how various temporal regimes underlie planning and policy to ensure a safe and liveable country, and how they produce infrastructures. This foundation on which the Delta Works are built is shaped by politics, which leads us to explore two questions in this section. First, can time-politics be linked to the literature on infrastructures? And second, are there concepts that can help us articulate how infrastructures mediate time?

4.1 Infrastructures and Time-Politics

The literature on infrastructures has identified four distinct features that are helpful in thinking about the time-politics of infrastructures (Dijstelbloem 2021; Rowland and Passoth 2015). First, infrastructures usually consist of large-scale networks that are linked to specific local situations. Not all infrastructures are large projects that are designed and implemented top-down; they also emerge from singular events that form the building blocks of later structures. The notion of infrastructure does not reduce a myriad of technological policies and practices to a single constellation. Infrastructures shape shared worlds, not necessarily by directly providing public goods or shared facilities, but by producing particular connections that shape all kinds of associations between people and technologies. If infrastructures relate the general to the particular, a similar argument can be made for the infrastructural production of time and timing. The first two episodes from the previous section support this claim. Institutional temporalities as described in the first episode – annual budgets, recalibration every six years and a renewable seven-year term for the commissioner – also bring about the infrastructures themselves in a particular order, at particular moments in time, and timed to strike the right balance between necessity and cost-effectiveness. The latter is the outcome of a cognitive, slowly evolving temporality focusing on future projections and interpretations and valuations of the past.

Second, while infrastructures aim to create shared worlds, they can privilege some groups over others. Infrastructures include and exclude, they select and prioritise[9]. The second point can be elaborated by recognising that the benefits of time are not equally distributed. In other words, the people affected by short-term policies are not necessarily the same as those affected by long-term policies. Climate change is a good example. While past and present generations in the Global North are responsible for emitting large amounts of greenhouse gases by taking economic advantage of industrial infrastructures, future generations and people living in the Global South will bear a disproportionate share of the consequences of this behavior and lifestyle. Meanwhile, the Netherlands can afford to build protective infrastructures to ensure the long-term safety of people living in the Dutch Delta, thinking ahead to 2100 and 2150, while similar infrastructures are lacking in many vulnerable Delta areas in the Global South. At the national level, issues of distributive justice are also likely to be addressed through climate adaptation infrastructure. Countries are already implementing policies and strategies

of "anaged retreat" and "coastal retreat", continuing to protect some areas while reducing support for others (Siders et al. 2019).

Third, infrastructures are particularly concerned with the interplay between the visible and the invisible. As Larkin (2013, 336) argues,

> [I]nvisibility is certainly one aspect of infrastructure, but it is only one and at the extreme edge of a range of visibilities that range from the unseen to the grand spectacle and everything in between.

Infrastructures are composite entities that visualise and reveal specific events at different moments in time and space. This point emphasises that the relationship between infrastructures and time is not always visible. Again, this is illustrated by adaptation pathways, as these anticipate anthropogenic uncertainty and unpredictability. Consequently, plots of land or whole areas must be reserved to allow for the construction or expansion of future infrastructures. In this respect, future infrastructures are invisible (they do not exist yet) but nevertheless discernible as areas yet to be developed. Here we see how the Anthropocene's long-term uncertainty and unpredictability produce land, for instance in anticipation of rising sea levels.

Fourth, infrastructures are not just robust and stable building blocks that form the technical backbone of society. They are often highly mobile, intervening in specific situations. This point can be understood to mean that the development of infrastructures is not a linear process, but one that is characterised by accelerations, delays, tipping points and points of no return, as illustrated by DAPP.

4.2 Infrastructures Mediating Time

The four characteristics mentioned above contain various tensions, such as between the general and the particular, visibility and invisibility, and inclusion and exclusion, that are constitutive for infrastructures. Bowker and Star (1999) introduced the term "boundary infrastructures" to describe these constellations that mark, maintain and also emerge out of the juxtaposition of coherence and fracture[10]. For the purposes of this article, one of the interesting aspects of boundary infrastructures is precisely their mediating role. Below, we will explore whether infrastructures also mediate time. Do infrastructures perform as mediators that connect different temporal regimes? And are they capable of generating temporal regimes? If we continue the analysis of boundary infrastructures and look beyond their material and spatial characteristics to their temporal aspects, we might be able to formulate tentative answers to these questions.

One possible way to explore the mediating role of infrastructures is to examine the notion of compromise. Elaborating on the work of Boltanski and Thévenot (2006), Dijstelbloem (2021) applies the concept of compromise to the study of infrastructures. Compromises, in this context, are combinations of different technological systems that express opposing values.

> Wildlife crossings such as underpass tunnels, viaducts, fish ladders, and amphibian tunnels can be seen as infrastructural compromises between economic considerations of mobility and ecological considerations of keeping habitats connected. (Dijstelbloem 2021, 95-96)[11]

Applying this conceptualisation to the Dutch Delta Works makes it possible to identify a number of specific compromises.

One of these compromises appeared in the first episode, namely the attempt to avoid new ecological disasters after the closure of Brouwerhavense Gat, which cut off the Grevelingen. In order to create a new ecological connection, the Oosterscheldekering was developed (Bijker 2002). This 9-kilometre-long storm surge barrier was originally designed, and partly built, as a closed dam, but after public protests, huge gates were installed in the remaining 4-kilometre stretch to maintain the rhythm of the tides. Dijstelbloem (2021, 96) describes these as "sluice-gate- type doors, which allow saltwater marine life and local fishing behind the dam but can be closed when weather conditions require it". In other words, the gates are a compromise between security concerns and ecological requirements, allowing life to flourish and protecting the area's biodiversity. Twice per day, 800,000 billion litres of saltwater flow in and out of the Oosterschelde, helping to sustain a rich biodiversity by providing a home for non-migratory animals, a nursery for many species and a "roadside restaurant" for migratory birds[12].

Another compromise in the second episode concerned the discount rate, the financial-economic rationale for trade-offs between contemporary financial investments and future benefits that is used to strike a balance between cost-effectiveness and security when it comes to investing in flood prevention. A third example of a temporal infrastructural compromise were the climate change adaptation pathways that are being developed and implemented, as described in the third and fourth episodes. The NDP uses an adaptive strategy in this context to structure its present and future actions. Adaptive water management is discussed in many publications, but the following example corresponds to the episodes discussed above:

> In an adaptive plan, adaptation pathways capture the implementation process by specifying which measure(s) are to be taken now and which are planned to be implemented once certain conditions occur [...]. As such, adaptation pathways explicitly consider uncertainty and embed flexibility within planning. (Werners et al. 2021; see also Kwakkel et al. 2016).

Finally, the fourth compromise that can be identified concerns the management of short-term actions and long-term options by adjusting tipping points to align with starting points for climate adaptation action, or the management of the various temporalties described in the four episodes.

5. Conclusion

The Delta Works are a landmark in modern Dutch history and an international symbol of water management. Although their genesis has often been highlighted, the relationship between these infrastructural projects and time, and especially the heterogeneity of time, has received little attention. More generally, the analysis presented here aims to advance the conceptualisation of the relationship between time and different infrastructures. By shifting the perspective from *Krisis* to *Kairos* – from a response to immediate catastrophes to a period of transition and transformation – the Delta Works can be viewed as infrastructures that embody

different relationships with different regimes of time. Moreover, the analyses presented above suggest that infrastructures can also be seen as mediators of time, as the result of compromises between different temporal regimes. Given that the development of infrastructures will be of paramount importance for the development and implementation of climate adaptation policies, it is crucial to arrive at a refined understanding of the relationship between infrastructures and time. Challenges related to policymaking, financial investments, public support, research and development all relate to different regimes of time. A heterogeneous conception of time and temporality is needed to do justice to the mediating role of infrastructures in all these issues.

The first conclusion that can be drawn is that the notion of mediation as developed in the fields of science and technology studies (Latour 1994) and philosophy of technology (Verbeek 2016), which resonates with concepts such as "boundary infrastructures" and "infrastructural compromises", does not have to be restricted to mediation between humans and nonhumans, but can also be used to describe mediation with time and temporal regimes. Second, as demonstrated by the reference to the distinction by Vostal et al. (2019) between experimental temporality, cognitive or intentional temporality, and institutional temporality, the study of infrastructures and time should also include an analysis of how various forms of knowledge and scientific research relate to different forms of time. Third, elaborating on the notion of infrastructural compromises allows for the identification of specific forms of mediation between infrastructures and time. The episodes about the history of the Delta Works demonstrated the relationship between infrastructural experiments, innovation and institutionalisation on the one hand, and different time regimes and the interaction between time and timing on the other. This included a discussion of how the future is related to present to make investment decisions, as well as an examination of how pathways are conceived as a way of working with open futures, anticipating unforeseen ruptures in temporal regimes. Fourth, infrastructures can be seen as mediators themselves – mediators that create regimes of time. Infrastructures tend to function as vehicles that mediate between different regimes, rather than as artefacts that accelerate time's arrow and that are required to reach future adaptation goals as quickly as possible. They may connect and disconnect the present and the future *in different ways*, thereby enabling possible tipping points and preventing lock-ins and path dependencies.

The above analysis of the development of the Dutch Delta Works speaks to the progress made through various climate adaptation infrastructures. It shows that the interaction between past, present and future does not take place on a linear time scale, but is characterised instead by a hetero-temporality consisting of different, often conflicting time regimes (see for example the institutional temporalities of the NDP, which focus on the long term and were designed so as to not coincide with the political cycles or be affected by the short-term focus of policymakers). The time paths of political decision-making, technological development and financial investment vary and have a complicated relationship with the speed and, above all, the tipping points of climate change. At first glance, the debate about the need for new technologies to adapt to climate change fits into a "race against the clock" framework, in which technologies are seen as instrumental to achieving certain goals and levels of protection and security at a certain point in time. From this perspective, it is not surprising that the development of technologies is discussed in terms of trajectories. However, given the winding roads that characterise infrastructure development, a perspective that allows for more hetero-temporality

would be better aligned with the paths that technological trajectories are likely to take. The development of climate change adaptation infrastructures is deeply permeated with variable time regimes and hetero-temporalities. Taking path dependencies, possible lock-ins, points of no return, feedback effects and tipping points into account is crucial, and so is the mediating role of infrastructures in navigating the different time regimes that affect climate adaptation policies.

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Notes

[1] See: https://www.architectuur.nl/project/deltawerk-van-raaaf-en-atelier-de-lyon/ (retrieved October 28, 2023).

[2] The first Delta Commission was established after the 1953 North Sea flood.

[3] Dutch Water Act, Article 3.6, see: https://wetten.overheid.nl/BWBR0025458/2023-07-01#Hoofdstuk7_Paragraaf4a_Artikel7.22a.

[4] https://english.deltaprogramma.nl/; see also Memorie van Toelichting, 32304, nr. 3: https://www.parlementairemonitor.nl/9353000/1/j9vvij5epmj1ey0/vick7ow0jvzz.

[5] https://www.deltaprogramma.nl/deltaprogramma/wat-is-het-deltaprogramma/adaptief-deltamanagement (*authors' translation*).

[6] The reported 3-metre sea level rise is related to the melting of the ice sheet in West Antarctica. If global temperature rise is considered, estimations range from a 0.5- to 2-metre sea level rise by 2100. In scenarios based on a temperature rise of 3 degrees Celsius, the IPCC considers a 5-metre sea level rise possible, see: https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/.

[7] https://www.deltaprogramma.nl/deltaprogramma/vraag-en-antwoord/hoe-zit-het-met-de-zeespiegelstijging.

[8] Like the Delta Works, transportation networks, roads, railways, power grids, communication networks, digital infrastructures and knowledge infrastructures have been central to the study of infrastructures, and have entered the Anthropocene (Anastasiadou 2011; Barry 2013; Edwards 2003; Guldi 2012; Janác 2012; Lagendijk 2008; Lommers 2012; Mazur 2013; Misa et al. 2003; Pritchard 2011; Schueler 2008).

[9] The typical example to refer to is Langdon Winner's (1980) account of the Moses bridges, a network of infrastructures in Long Island, New York. These bridges were designed, according to Winner, to prevent buses from getting through, thereby limiting access to the beach and park for racial minorities, who typically travelled by bus. However, Winner's account has been heavily criticised and partly debunked (Joerges 1999; Woolgar and Cooper 1999).

[10] Merriman and Jones (2016) have argued that boundary infrastructures play "a central role in mediating the nation's heterogeneous internal relations" (Brady 2021). They state that "not only do the material and elemental properties of mobility infrastructures afford or enable particular practices,

but they also get caught up in affective relations or atmospheres" (2017, 7). The example they provide is that of Severn Bridge, "which unites Wales and England even as it demarcates between them: a literal boundary infrastructure, it means different things from different culturally and materially situated perspectives" (Brady 2021).

[11] Another example concerns so-called humanitarian borders, which combine humanitarian and security considerations, often resulting in compromised compromises.

[12] See https://www.np-oosterschelde.nl/discover-the-story-of-the-easter-scheldt/ (retrieved October 26, 2023).

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Beyond Crisis Talk: Making Time for Re-Searching New Narratives of Human Relations With Soil

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Abstract
In this paper, we focus on soil as a "contested terrain" emerging from the interplay of competing socio-political and cultural frames. Starting from the analysis of international reports on soil, we show how the urgency frame acts as a powerful discursive device that progressively reduces the inherent complexity of soil as a socio-ecological system, compressing the temporality of future perspectives and demarcating the inclusion/exclusion of non-human actors in soil communities. In the second part, we draw on examples of practice from our project BRIDGES to highlight possibilities for re-framing research as a "practice of attention" and experimenting with different temporalities and modes of relation with soil. Findings point to the need to address the fundamental questions that such an approach poses for all research communities. Bringing sedimented attitudes, perceptions, and ways approaching research to the surface, our experiences cast light on the importance of methodological choices for thinking differently about soil and about slowing down the narratives of research: not as a tool or resource, but as a shared process of crafting mutual relations amongst all kinds of practitioners, including more than humans.

Keywords
technoscientific narratives; environmental policies; urgency; soil; practices of attention; post-normal science.

1. Introduction

Pivoting on constraining the time available for action, urgency and "crisis" talks have become a key feature of contemporary policy discourses on socio-ecological issues. As critiqued across multiple domains (see for example Roitman 2014), "governing through emergency" tends to reproduce existing forms and relations of power, preserving the neo-liberal social order (Anderson et al. 2020), which, in order to grant its promise of freedom, is intimately relying on the management of danger and disorder (Pellizzoni 2011).

Due to its critical positioning in current environmental debates, the issue of soil is a case in point. Featuring centrally in global discourses on food production, biodiversity loss, land use, but also urban planning and climate regulation, it is by no chance that soil itself both underpins and encompasses all the critical zones identified by Rockström et al. (2009) as the "safe operating space for humanity". Yet, this raised attention sits alongside imaginaries of soil which remain largely connected to the rural past, disassociated from human experiences, sociality and economic practices in the urban present (Meulemans 2020; Granjou and Meulemans 2023). New contributions from soil science itself have put forward the need for a new anthropedology: "a proposed disciplinary development that understands human activities as integral to soil genesis" (Meulemans 2020, 251).

Echoing the dominant rhetoric of human agency in the Anthropocene, global discourses on soil will thus appear to swing between alternative conceptions. On the one hand, the urgency frame – in policy and scientific institutions alike – pushes for solutions in the immediate future. This way of presenting problems dominates funding calls from external organisations (e.g., EU funds, or private investments), a process that, for instance, is also visible in schools and Higher education, via systems and practices emphasising short circuits of input and outputs via measurable outcomes (Hancock et al. 2023).

On the other hand, while discourses of urgency prevail, the literature on soil has also witnessed the progressive emergence of counter-narratives, questioning the timescape imposed by techno-scientific interventions set on maximising fertility and productivity. Such narratives account for the times of soil renewal and are focused on relations with soil based on "care" (Puig de la Bellacasa 2015), including also local and indigenous knowledges, as well as experiential ways of relating and interacting with soils, as found in ethno-pedology and folk taxonomies (Krasilnikov and Tabor 2010; Lyons 2020; Martin et al. 2015).

Thus, to break the cycle of crisis-setting, it is necessary to reconsider the implicit assumptions underlying knowledge production practices vis-à-vis the natural system, with particular attention to the images of science and research that are transmitted and nurtured in current scientific and educational establishments (Burnard et al. 2022). To this regard, we are careful to state that it is not our intention to underestimate the warnings coming from the scientific community; quite the opposite, our analysis intends to identify the urgency frame in discourses about soil, in order to reflect on and articulate the temporalities for a more inclusive, and democratic relation with the soils upon which we intimately depend.

1.1 Focus of This Paper

Addressing the wider international debate on soil as a contemporary socio-ecological issue, this paper brings together contributions from the field of policy analysis with emerging literature in Science & Technology Studies (STS) to illustrate an example of collective praxis, whereby a multidisciplinary community of researchers sought to enter into dialogue with a plurality of ways of knowing, practices and modes of relating with soil. To achieve this aim, we first engage with an analysis of narratives pivoting around the concept of urgency produced by international bodies and communicated through the impactful reports on which public policies are grounded. We highlight the frame and limitations of technoscientific approaches driv-

en by urgency, characteristically informed by a linear trajectory from problem to solution and pragmatic, rationally planned actions, with experts as privileged knowledge-holders, often surrogating the public space for debate and deliberation (Benessia et al. 2012; Tallacchini 2015).

In the second part, we draw upon some of the experiences of BRIDGES (Building Reflexivity and response-ability Involving Different narratives of knowledGE and Science)[1] – a project involving the authors of this paper – to describe and discuss our experience of "slow" science (Stengers 2017) hinged on the practice of transdisciplinary research involving a community of peers, not only humans. BRIDGES engaged a group composed of senior and young researchers, practitioners, artists, students and citizens, in creating extended communities of research with soil, informed by the framework of post-normal science (Funtowicz and Ravetz 1992; 2020) and in accord with a socio-ecological and epistemic justice standpoint (Benessia et al. 2012). Our experience, positioned at the border between research and education, was denoted with an explicit attention to the emergence of tacit narratives shaping our work and our ability – as researchers – to relate with other perspectives and account not only the multiplicity of voices but also the copiousness of both human and non-human temporalities involved in soil care practices. The article will conclude with a discussion on the importance of methodological choices underpinning the creation of soil narratives; and specifically, the possibility of redirecting the narrative of urgency towards new practices of attention, denoted by a slow and continuous conception of time.

2. Background: Framing Human Relations with Soil in the Anthropocene

At a time of unprecedented global environmental change, the scientific community has characteristically endeavoured to "speak truth to power", bringing evidence to bear upon the pervasive disruption of a planet under pressure. Moreover, not only is science tasked to provide evidence informing decisions, but also to spur society into action: calling for innovation and investments to "fix" a world that is presented as increasingly fragile, inhospitable and unstable. Ostensibly framed within a techno-scientific view, nature is presented as "scarce", with resource extraction becoming more expensive and difficult to perform as such resources become less available (Déry 2007); metaphors like "peak oil", "peak nitrate", "peak phosphorus" are used to convey the anxious forewarning of an impending breakdown, by which a resource is heading toward exhaustion without equivalent efforts to renew (Puig de la Bellacasa 2015).

Indeed, we can identify the conceptualisation of the Anthropocene as an over-compassing master narrative of the troubled relationship between humans and environment. Since the concept was first proposed, in the late 90s, natural scientists, mainly in the geo-environmental sciences (Hamilton et al. 2015) have been extensively engaged in debating the thematic core and temporal boundaries of such epoch: when, where and why the radical break with the Holocene took place (Steffen et al. 2015). Randazzo and Richter (2021) have called this perspective "discontinuous-descriptive", underlining the radical discontinuity, interrupting the linear temporality, underlying such debate. Such framing of the Anthropocene, clearly highlighting the unfolding of catastrophic and unprecedented ecological changes (IPCC 2019), is particularly suitable to ground the pressing call to decision-makers for swift actions.

In opposition to this master narrative of the Anthropocene, Randazzo and Richter (2021) advance the so-called "continuous-ontological" approach, aiming at "mapping out ecological relationality and agency in a way that precedes, and will outlive, the current ecological changes that characterise the Anthropocene" (Randazzo and Richter 2021, 297).

Running counter to the "positivistic catastrophism" that fuels the construction of the crisis, the ontological relationality allows for an acknowledgement of the limits of human agency (Chandler 2018; Taussig 2020), and a refusal of the eco-modernist myth of technological mastery of nature (Lynch and Veland 2018), going towards a post-cartesian theorization, in which the networked agencies of both human and non-humans become the object of inquiry (Latour 2018). Hence what is at stake in the Anthropocene is "not the scientific measurement and political management of a set of ecological shifts, but rather a seismic shift in our understanding of being" (Randazzo and Richter 2021, 298).

While originating within a discourse primarily located within the natural sciences, particularly geology – which has recently, incidentally, dismissed the Anthropocene as a formal unit of the geological timescale (Witze 2024) – the narrative potency of this epoch has permeated the social sciences, intersecting with post-structuralist, eco-Marxist, and other debates (Bonneuil 2015). More importantly, it is something that has evolved from a debate about the "most appropriate unit of measurement for the crisis" to a reflection on the multiple relationalities and temporalities that traverse humans and non-humans, including the soil and its inhabitants.

2.1 Narratives and Counter-Narratives of Soil

As Cronon was urging, as early as in 1992, the challenge to scholars is "telling not just stories about nature, but stories about stories about nature", acknowledging that each and every label we give to phenomena or periods of time implies different narratives and prescribe different possible endings (Cronon 1992). Studies on shared imaginaries focussed on metaphors, collective representations, paradigms, frames and narratives show how such shared visions, most often tacitly evoked, contribute – together with power structures, interests and rational choices – to shape future developments: they define the horizon of possible and acceptable actions, impose classifications, legitimise actors, serve to identify relevant issues and, when used in public debate, can affect collective self-understanding and action (Jasanoff and Kim 2015).

"Land imaginaries", in particular, have recently been proposed by Sippel and Visser (2021) as influencing "the notions of what land is, what it can or should do, and how humans can or should interact with it" (Visser 2021, 315); they concern the shared, implicit ideas grounding how soil-related environmental issues are interpreted, the paths towards the desirable futures, the ethical norms underlying actions and the cultural dimensions related to space and place transformations.

While the dialectic interplay of narratives cannot completely account for the emergence of specific socio-environmental issues, their analysis in science-based policy discourses casts light on epistemic practices, how evidence is selected and used and the levels at which conflict is both managed and understood. Thus paying attention to counter-narratives is important to disclose alternative framings and to open up paths hitherto neglected, in terms of both thinking and action. Often counter-narratives have been used to describe and confer systematicity to minority positions, and have been particularly studied, among others, in the field of post-colonial

studies, to show the existence and relevance of non-Western conceptualisations and approaches (Schiebinger 2004). Counter-narratives are also suitable to account for more-than-human processes of world-making, as shown by anthropological (Kirksey and Helmreich 2010), sociological (Murdoch 2001), and geographical works (Whatmore 2006) of the last decades.

In our reflection, we refer to narratives of research as frames which define the focus of attention but also the way in which knowledge is produced and legitimated in academia, as well as their underlying values. This work sets the premise for a rethinking of research practices, recast as a practice of attention, with its inherent features of slow times, relations, reflexivity and care.

3. Part 1: Frames and Narratives Within Policy Reports

As regards big socio-ecological issues, the critical sensitive endeavour of knowledge collection, comparison, systematisation and editing that sits behind both problem-setting and problem-solving is actually realised within a few international bodies. They function as intermediate authoritative entities between the scientific community, tasked to produce sound and objective knowledge, and the governments, which are finally called to take action. A major instrument of communication of such efforts is the periodic publication of reports, condensing data and proposed policies for policy makers and the media. As such, those documents are well positioned to be analysed with the lenses of incorporated narratives and imaginaries, describing the deeply-seated cultural visions of human-environment relationships, as they are shaped within the scientific community and amplified for politics and society.

We focused on the decade 2012-2022, since FAO (Food and Agriculture Organisation of the United Nations) launched the Global Soil Partnership. Recognising soils as a crucial but neglected factor of food production, a number of initiatives and pilot projects were set in motion to raise awareness and support strategic networks, in order to "speak up" for soil and boost action (FAO 2022b).

We started from an initial focus on international bodies holding an explicit institutional mandate to address soil: FAO (Food and Agriculture Organisation) and UNCCD (United Nations Convention to Combat Desertification). These institutions are critical for their role in shaping the debate; their reports are normally commissioned to groups of internationally recognised experts, with the power of yielding influence over the terms of the debate. We then expanded the original set by following internal cross-references, proof of mutual recognition and legitimation as sources of authoritative and trustful knowledge, which allowed us to include IPCC's (Intergovernmental Panel on Climate Change), IPBES' (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) and GSP's (Global Soil Partnership) reports, in addition to those produced by joint institutional initiatives. Broadly following the example of Browne et al. (2018), we performed a theory-driven, qualitative, discourse analysis, in two subsequent steps.

First, we explored how the themes of crisis and urgency were semantically and conceptually articulated in the reports, recursively identifying the following discursive lines:

- *Crisis*: all the discourses articulating around the concept of crisis, depicting negative, fearful scenarios;

- *Urgency*: all the discourses containing a push to urgence;
- *Action*: all the discourses proposing actions as responses to problems;
- *Speed*: all the discourses referring to quickness (e.g., need of acceleration, timely action);
- *Pragmatism*: all the discourses referring to a pragmatic mindset in responding (e.g., tangible, viable, proven, evidence-based, etc.).

As part of this initial analysis, we also conducted an exploration of the themes of "uncertainty" and "care", in order to identify discourses pointing to alternative framings of the issues affecting soil and options for humans to intervene.

Secondly, we performed a close-reading of the reports with the heuristical lenses of the different temporalities of the Anthropocene, with a view to identifying actors and solutions which are made visible and possible within the different frames. Since these reports are usually structured with forewords and summary parts targeted to non-scientists, followed by lengthy accounts of technical information, after their extensive readings we carried out a thematic analysis of the parts devoted to summaries and recommendations. This is where conceptual framings are normally found, because these sections are specifically aimed at communicating with societal actors, as well as being the most common source of information relaunched by the media and policy discourses.

3.1 "Moving to a Crisis Footing": Framing the Roadmap to Tackle Soil Degradation

We are aware that each single Institution has both a story and a specific identity, which shaped its approach, vision and proposals; such diversity emerges clearly also from the respective reports. However, here we aim for a synoptic reading of their positions, to highlight some common features of crisis talking at the sensitive interface between research and society (particularly media and politics). Where relevant, we will underline peculiar institutional positions.

An urgency frame generally infuses policy with the necessity for action to address the specific issue of soil degradation:

> In a world of profligate consumerism, global supply chains, and a growing population, land resources – our soil, water, and biodiversity – are rapidly being depleted. As a finite resource and our most valuable natural asset, we can no longer afford to take land for granted. We must move to a crisis footing to address the challenge and make land the focus. (UNCCD 2022)

It is clear in this particular extract the sense of impending danger and calamity which portrays soil as waste-land, unusable and therefore in need to be remedied or salvaged by humans. The "universalist narrative of crisis" (Randazzo and Richter 2021), proper of a discontinuous frame, is also reminiscent of points if discontinuity in the recent past, such as the early Malthusian warnings of a geometric progression in population growth, coupled with the later neo-Malthusian ecological anxieties (Ojeda et al. 2019).

Urgency is then further fuelled by a linear logic demanding human intervention:

> It is no longer enough to prevent further damage to the land; it is necessary to act decisively to reverse and recover what we have lost. (UNCCD 2022)

Time is of the essence but the subjects who should be involved to undertake such changes or even to *contribute* relevant knowledge towards *understanding* the issues at stakes are concealed in the *third-person* written text:

> Time is of the essence. Current trends in natural resource depletion indicate production from rainfed and irrigated agriculture is operating at or over the limit of sustainability. Injecting a sense of urgency into making the necessary transformations in the core of the global food system is essential. (FAO 2022a)

When urgency frames are employed, some recurrent sub-discourses emerge:

- Crisis times require action;
- It is necessary to act quickly;
- It is necessary to act pragmatically;
- Non-action determines a threat, projecting a gloomy future.

These elements can be logically visualised as in Figure 1 below, which depicts an accelerating short circuit: the situation of crisis needs urgent, strong and practical action, or new crises will emerge, threatening our future and bringing us back to the need of acting urgently.

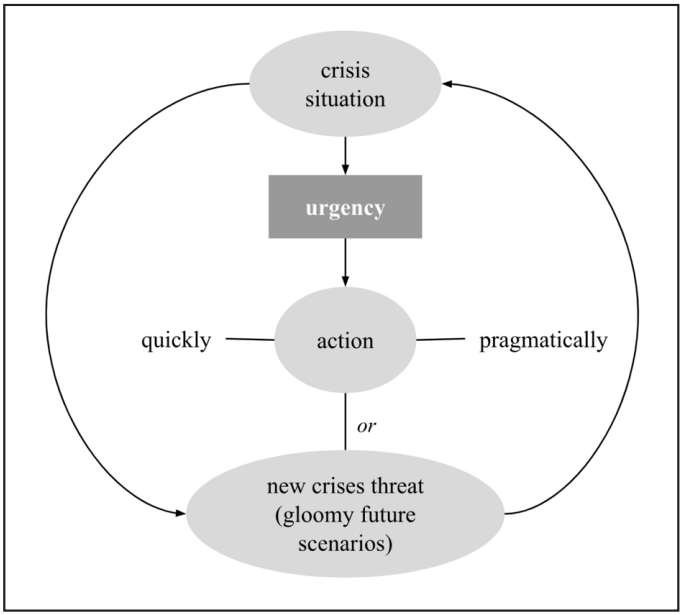

Figure 1.
The thinking pattern underpinning the urgency conceptual frame.

3.2 "A Full Package of Solutions": Crisis Times require Action

All documents share a common, abiding call to action, and the reports themselves conceive of their role as tools to systematise and assess the viable "institutional and technical responses" (FAO 2022a), leading to a "platform for action to avoid and reduce land degradation and promote restoration" (IPBES 2018). Most interestingly, the appeal to action in rhetorical terms works well as the opposite of inaction, appealing to the highest moral ground of acting to rescue and take responsibility for others. Indeed, inaction is specifically addressed as an expensive, destructive option. Alternative pathways involving the necessity to slow down, observe, reflect, relate, share experiences and negotiating values appear in fact only marginally.

It is necessary to act quickly. Inextricable from the emphasis on urgency, the need to act "immediately", "timely", "now" is the invoked time infrastructure. Although longer-term policies and different time scales are also mentioned, the continuous push to urgency suggests a contraction of time over increasingly short time-spans.

It is necessary to act with a pragmatic mindset. Reinforcing the intended call to action, this is presented as an "outcomes-oriented approach" (FAO and GSP 2022), which encourages thinking in terms of effectiveness, tangibility, practicality, and workability of solutions:

> A "full package" of workable solutions is now available to enhance food production and tackle the main threats from land degradation, increasing water scarcity and declining water quality. (FAO 2022a)

Impressing upon the soundness of proposals, extensive reference is made to the evidence-base, informed by data and illustrated by scientific plots. Particularly, IPCC and GSP stressed the value of robust knowledge assessment, performed by "hundreds of experts worldwide" (IPCC 2019), and the importance of quantifiable targets and indicators (FAO and GSP 2022), while FAO gathered experts from several institutions to describe the "state of the art" of research about soil, following the "tremendous growth in the methods available for the study of soil organisms by the scientific community" (FAO, ITPS, GSBI, CBD and EC 2020).

Just like the crisis defines the discontinuous-descriptive frame of the Anthropocene, so do the solutions, aiming to turn problems around and restore an optimal situation. Alongside the extensive use of technical knowledge, the reports also borrow from the culture of financial valuation, using concepts like "ecosystem services" and "natural capital", and a general tone of budgetary balance calculation (e.g., the dialectic degradation/restoration), the underlying logic being that "the worth of goods, things, activities, spaces, and other species can be essentially translated into financial evaluations" (Papadopoulos 2018, 31).

> No country can stand alone – alliances, coalitions, partnerships, collaboration, and cooperation will be essential to build, scale, and deliver the required mix of human, social, and financial capital needed to restore natural capital and transform land use systems. (UNCCD 2022)

As highlighted by Papadopoulos, cultural framings pivoting on valuation also act as "technologies of temporality", since they are sustained by an underlying objective of "appropriating the future" (*ibid.*, 40).

Notably, one of the documents feels compelled to report a critical position towards the prevalent Western concept of "ecosystem services", seen as coming from "instrumental value systems", and describes the effort of reframing it as "nature's contribution to people", to be used especially in reference to "relational value systems" (IPBES 2018).

Non-action determines a threat, projecting a gloomy future. Projected futures are painted with menacing features; even when the rhetorical appeal to urgency is less emphasised, the price of inaction is described as full of "soil threats" (FAO and GSP 2022). We are not discussing here the exercises of scenario-building based on available knowledge normally used by environmental modelists. We are referring to the logical conclusion of the appeal to urgent action: a sanction, in the form of a threat to humans, and their social or economic well-being:

> [...] [T]he human-environment relationship must drastically change to avoid catastrophic tipping points whereby the human power of exploitation is overwhelmed by the power of nature. (UNCCD 2022)

However, imposing an abiding sense of urgency to discourses quickly equates to a device of control, accelerating closure of the debate and narrowing the framing of the problems at stake, expedited by the delivery of effective solutions:

> Establishing the underlying causes of land degradation provides policymakers with the information needed to develop appropriate response options, technologies, policies, financial incentives and behaviour changes. (IPBES 2018)

In the case of complex socio-ecological issues, as is land degradation, problem-framing is particularly sensitive, given their value-based nature, their positioning at the intersections between different disciplinary descriptions, and at the crossroad of social realms. The risk here is that reports act as surrogates of open discussions, subsuming different positions and values, and directly proposing (practical) solutions.

Actors mentioned in the reports have differentiated roles: decision-makers are the first intended recipients of the messages (each document contains a summary for policymakers), alongside "planners and practitioners" (FAO 2022a), although also the whole group of "scientists, laymen and policy makers" (FAO and ITPS 2015) are targeted, and in some cases citizens are involved as "consumers" (FAO and GSP 2022). An implicit hierarchy is established: "governments, scientists, farmers, private sector, and local communities" all have the "shared responsibility" to "support target initiatives", while "youth, indigenous people and local communities" need to be "empowered" (UNCCD 2022); "farmers, pastoralists, foresters and smallholders [...] are nature's stewards and the best agents of change to adopt, adapt and embrace the innovation we need to secure a sustainable future" (FAO 2022a).

Hence, although all documents devote attention to indigenous knowledge and local communities' involvement, stating their right to "be given equal footing alongside modern scientific methods"

(UNCCD 2022), a framework for actual epistemic justice does not follow, and these actors are more often called to action at the end of the policy development line, to comply to pre-established solutions. Crucially, although all societal actors are judged relevant and necessary to address the problems concerning land degradation, the overall perspective of the reports is the technopolitical, Western one. Notably, it is a position that neglects the presence of others, human and non-human actors, resounding with colonial positions against minorities regarded as expendable (Zografos et al. 2020).

Alongside the analysis of urgency-related categories, we performed throughout the reports an exploratory search for alternative visions of human-environment interplay. For example, we tested the use of the concept of "uncertainty", to account for any understanding embracing a non-mastery relation with nature: when it is not denoted in negative terms (e.g., the uncertainty principle as a dangerous brake to the needed acceleration, used to avoid unpopular or costly decisions, as in IPBES 2018), the term is seldom employed. In some cases, FAO reports introduced the concept in the problem diagnosis, possibly opening up towards a post-normal understanding:

> The uncertainty of climate change and the complex feedback loops between climate and land present agriculture with amplified levels of risk that need to be managed. (FAO 2022a)

Interestingly, FAO is also the institutional body which more frequently employs the concept of "care" to denote the interplay with land:

> Taking care of land, water and particularly the long-term health of soils is fundamental to accessing food in an ever-demanding food chain, guaranteeing nature-positive production, advancing equitable livelihoods, and building resilience to shocks and stresses arising from natural disasters and pandemics. (FAO 2022a)

When interpreted as "stewardship", the same conceptual approach is mostly used to describe the interplay with minority groups, like indigenous and young people.

In sum, although reasonably employed by international bodies seeking to draw the attention of the public and policy-makers towards severe environmental situations, the usage of a crisis talk cannot avoid the major flaw of representing a narrative of time contraction over the shortest periods in the future, i.e., while declaring the need for a resolute jump towards the future, it actually forces a stuck on an eternal, uncanny, present (Bryant 2016). Restricting the space and time available for reflexive discussions and evaluation of problems and possible solutions, and favouring the enactment of action-oriented responses, the urgency frame short-cuts the space for action. To produce a paradigm change, critical discussion of the process of production of scientific knowledge, including its actors and values represents the foundation stone, which is exactly what the urgency frame tends to constrain, finally leading to an actual inability to change.

3.3 Short-Cutting Time / Short-Cutting Relationships in the Reduction of Controversial Issues

The analysis of the narratives incorporated within the reports' discourses showed how the political framing of ecological issues is generally confined to what we have termed as the

"urgency frame", expression of the so-called "governance through time" (Pellizzoni 2020) or "chronopolitics" (Kaiser 2015). The urgency frame is pervasive in European policy documents of the first two decades of the Millennium, promoting innovation in terms of economic and techno-scientific progress: it is necessary to act quickly, it is argued, as serious dangers loom over the "European way of life", threatening to destroy it (Giuffredi 2019).

"Governing through emergencies" has been critiqued for its promise of a crisis resolution based upon a sharp distinction between normal and extraordinary times, often happening at the expense of weaker strands of society (because of class, race or gender), whom, on the contrary, are familiar to chronic states of crisis ("slow emergencies") (Anderson et al. 2020).

In the context of environmental governance, a notable mechanism for implementing urgent and time-effective measures is the short-cutting of biological relationships. Whether it is about soil depletion or the need to contain a biological infection that is harmful to humans, the *most effective package of solutions* will focus on restricting the spreading of a disease by isolating the sick from the healthy (i.e., quarantine); or minimise its damage through collective interventions (i.e., prophylactic measures); or even by selecting resistant and tolerant varieties as in the case of plant epidemics in agriculture. In such cases, the reduction of biological complexity of a problem may be accompanied by a reduction in the complexity of knowledge at disposal, not only in terms of "scientific cultures" serving the problem, but also for the possibility of including non-academic actors in the debate over potential solutions.

A noteworthy case revolves around the management of the Xylella crisis in the Italian context (Colella et al. 2019; Milazzo and Colella 2022), which is illustrative of such reductionist practices. Following a wave of olive tree deaths in the province of Lecce (southeast Italy) in 2013, a bacterium identified as *Xylella fastidiosa* triggered an emergency procedure under the then-existing European phytosanitary policies (2000/29/EC). Along with other prophylactic procedures targeting plants' and insects' lives, infected olive trees and those at high risk of infection in the area were removed and destroyed, in order to contain the spread to other healthy plants.

One of the most interesting aspects of the phenomenon was the emergence of local movements which, employing various tactics (street demonstrations, legal actions, formation of autonomous research groups, etc.), openly critiqued the bio-securitarian framework ruling the containment action, but also the science underlying such decisions.

The general thesis upheld by this wave of mobilizations was that the death of the olive trees was not to be attributed solely to the Xylella pathogen, but it was the result of a more protracted crisis rooted in the depleted state of soils. While the scientific and institutional response focussed on the urgent removal of the known pathogen, the civic mobilizations sought to reclaim the possibility of "healing the plant" through experimental practices involving a wider range of expertise as well as other representatives of institutions willing to listen to their proposals. The effect of time compression and the consequent social struggles can be depicted through the visual metaphor of the hourglass (see Figure 2). As urgency-infused discourses reduced the breadth of the debate by focussing on symptoms or apparent causes, the complexity of the issue reappears elsewhere, for example in the calls for protection of soils, or as collateral effects re-occurring after the action.

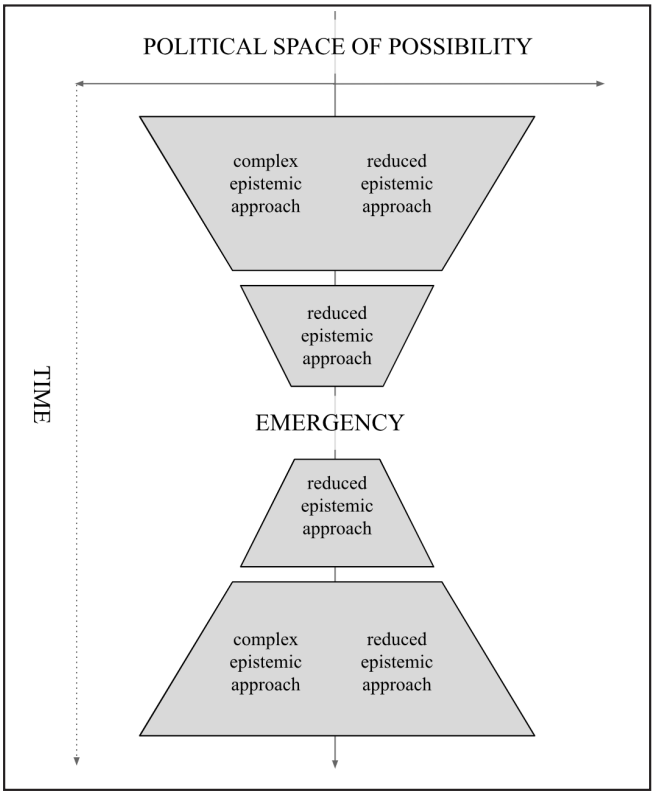

Figure 2.
A schematic depiction of the "hourglass" structure of time induced by emergency: urgency infused in discourses pushes to reduce the available epistemic options, excluding the more complex hypotheses, only to reinclude the complexity of the issue after the action. The reduction of hypotheses causes a shrinking of the political space available to a narrow set of knowledge producers, reducing the social robustness of the political choice. The image is adapted from (Colella et al. 2019).

4. Part 2: Evolving Understandings of Soil

Hegemonic understandings of soil, and of its relations with humans, are challenged by the emergence of alternative visions within and outside the Academic community, rooted on a rethinking of the nature-culture dialectic. Starting from the second half of the 1990s, newer takes on materialism and matter stood in opposition to humanist (and dualist) traditions predicated on a separation of mind and body, humans and non-humans (Coole and Frost 2010).

In this context, soil becomes a space to experiment with new reflective research practices that are open to public involvement and a "technoscience from below" (Krzywoszynska et

al. 2018; Meulemans 2020), encompassing experiences of transdisciplinary research across the sciences, humanities and the arts (Meulemans et al. 2017). Doing research about soil will thus bring into focus some new questions both for policy-making and for science, asking "whose science", "whose logic" and what kind of research processes can be deployed to understand the problematic and fundamentally dialectical relationship between human communities and soil.

4.1 BRIDGES: Experimenting in the Minor Key

Encompassing research and education, the BRIDGES project was designed with a focused attention to the narratives shaping research and the researchers' ability to relate with other perspectives and the more than human soil. In line with the ideas of post-normal science (Funtowicz and Ravetz 1992; 2020), in which the quality of a research process is grounded into a multiplicity of perspectives and visions framing a problem, the project promoted the creation of a community of research involving a multiplicity of legitimate actors – humans and more-than-humans – in researching with soil.

Such approaches, based on exchange of practices and involving different forms of knowledge and disciplinary perspectives, are visibly minoritarian, and are particularly disavowed by the ties and requests of traditional Academic Institutions. Hegemonic narratives of scientific research rooted in the mastery of disciplinary expertise are introduced from the very early stages of education, and consolidated further into one's research career; hence the task of setting out alternative ways of doing research requires a critical and reflexive stance that must be explicitly introduced and nurtured within the research community. The underlying questions of the project were: how to develop an ecological approach to our research practices transcending disciplinary views and common attitudes to nature? How do we enact attentive and inclusive practices? Which epistemic posture, dispositions and languages lead to re-framing soil and research narratives?

The process was articulated around a series of transdisciplinary workshops involving young and senior researchers, and a research-artistic residence in the rural environment of Pianpicollo Selvatico[2], in the high hills of Piedmont in Italy[3].

We began this process by working directly on ourselves as a group of senior researchers, who would later in the project guide the young researchers and local citizens. Amongst us were: 1 science educator, 3 science communicators, 1 sociologist, 2 visual artists, 1 philosopher of science/photographer, and 3 natural scientists with cross-disciplinary expertise in botany, geology and agricultural sciences. We note here that the mix of discipline within our group was not dictated by the ambition of piecing together expertise to solve a set problem as set out by International funding agencies promoting multi and interdisciplinary networks to address the global challenges. On the contrary, we sought to create a space for critical reflection and dialogue amongst ourselves and with the soil in order to surface and to explore the values and tacit narratives that we hold, transcending the particular interests of our disciplines (Khoo et al. 2019). Throughout the process we took reflective notes of our discussions and audio and video recorded our conversations. Two of us (Giuffredi and Colucci-Gray) were also acting in the double capacity of participants and participant observers in charge of taking notes and offering those as stimuli for shared reflection over the course of the project following the practice of participatory action research in community and educational settings (Chevalier and Buckles 2013).

4.2 Working Across Frames of Experience

Our experience set out to examine the dynamics of such a collective experiment of working with the soil in its multi-dimensional and multi-levelled complexity. Important in this regard are the insights of Gregory Bateson (2000) who referred to the "pathologies of epistemology" that inhibit the unconscious, perceptive and fundamentally sensorial processes in order to recover the "experience of knowing what one feels" and "feeling what one knows", as very particular ways of knowing that are rooted in one's body. One such experience was led in our project by two artists – Andrea Caretto and Raffaella Spagna – who involved us in the performative act of "digging" the soil.

Digging is one of the most immediate and perhaps most fundamental of human activities. We dig to find water, minerals, food and we dig in order to plant seeds and work the soil. But following Bryant (2007), digging seen from an arts and humanities perspective is perhaps one of the closest metaphors we associate with doing research.

The challenge and the opportunity were to experience the research process as situated in lived and embodied situations, with every single object and every single change experienced in the course of the relation with soil *mattered*. This approach took charge of recent critiques of attentiveness (see Krzywoszynska 2019), cautioning against the more simply construed idea of care-giving encoded in protocols and best practices etc., moving instead with Stengers' (2006) call for slowing the time of research and making place for «hesitating». In this sense, research as attentive practice would not simply "seek out" but tend forward towards those interrelations and interdependencies that may not be immediately visible. As Haraway (2008) also described it, soil as the ground for research acts as a spatio-temporal "place" of "power, knowledge and technique, [and] moral questions" (*ibid.*, 205). From the diverse ethnographic records collected (interviews transcriptions, group discussions recordings, fieldnotes), the experience of "slow", reflexive science led to critically re-examining some taken-for-granted features of research, and opened the space for addressing them. We can organise and briefly describe such reflections in parallel with our analysis of the features of the urgency frame, as follows.

Urgency frame	**Slow science experience**
Crisis time require action	The fatigue and the opportunity of inaction
It is necessary to act quickly	Unaccustomed to slowness
It is necessary to act with a pragmatic mindset	The need for relentless reflection
Non-action projects a gloomy future	Response-ability over our common futures

Table 1.
A synthetic view of the features of the urgency frame, as identified and analysed in the devoted section, and some categories of reflection stimulated in the participants to the BRIDGES project by the experimentation of alternative vision and practices of research.

- ***The Fatigue and the Opportunities of Inaction***. The BRIDGES digging experience was framed within an indefinite time of observation. The mandate was to close the observation only when all of us agreed to have had the time to observe and note down *everything*. This requirement was felt particularly challenging by some of us: some reported feelings of boredom and fatigue of staying within *an indefinite present time*. Conversely, space was opened to note and record feelings and affective dispositions that are commonly neglected in our working lives (especially when compiling research accounts), such as sensorial experiences (hot/cold, smells and perfumes, hunger/thirst) and the opportunity to notice the presence (or the absence, in some contexts) of animal and plant creatures, insects, worms, maggots, different types of grasses, trees and their roots, along with careful and meticulous noting down of the material properties of the soil (dusty/dry/hard/soft/moist). A certain difficulty was also reported regarding the lack of a proper language to name the objects of observations; alternative ways to describe the observations were then proposed, including sketching the objects and testing the features of soil by preparing colours for painting.
- ***Unaccustomed to Slowness***. The experience of digging was performed over the course of all 4 days and it was only at the end of the period spent together that we realised the importance of having been away from our everyday commitments and in a context that invited a curious openness (Haraway 2016). This aspect became particularly apparent when the same experience, constrained in time and space, was proposed in an urban setting (a public park in Milan). Some participants reported a negative opinion on the experience, perceived as being not so meaningful and uncomfortable: the urban context appeared to reduce the space for openness to encounters, in many ways different from the experiences reported by those of us who had been in the rural context of Pianpicollo. Dishabituation to slowness also emerged when dealing with the life of researchers, packed with deadlines, anticipation of outputs and impacts, and in general based on "human" times, removed from the times of relations and the times belonging properly to non-humans. This was a problem which affected planning in the project as researching with soil also demanded taking account of its rhythms, the seasonality of plant and animal life as well as the unpredictability of the weather and how this was to be reconciled with the timelines of human working lives. Resonating with the observations of Meulemans (2019), our experiences spoke to us about the importance of recognising the modalities and the specific context in which we come to know soil.
- ***The Need for Relentless Reflection***. Over the course of the project, it became apparent that the journey towards a new way of doing and being in research necessitates times and spaces for reflection, that are not simply individual but shared within a community. This led to modifications in our communication infrastructure to accommodate discussion on emerging issues: in-presence meetings under the guidance of more expert colleagues as well as online research conversations amongst us, shared documents for writing down ideas and the creation of a photographic repository as a memory of our journeys, a way of remembering the community and bringing it together, each time offering a new perspective. Later in the project, when we worked with the group of young researchers, it was notable the need at every meeting to re-discuss the grounds of

their research work: for example, when dealing with the idea of developing participatory indicators of soil fertility, the debate centred on the meaningfulness of such an instrument, for what purpose and for whom; a critical stance towards the overwhelming measuring attitude of the natural sciences emerged regularly as a point of discussion. Many young researchers reported that creating the space for discussion of pre-existing structures and assumptions was one of the most revitalising features of the project.

- ***Response-Ability Over our Common Futures***. As the project is currently ongoing, the next steps in this inquiry will revolve around addressing the fundamental questions and dilemmas that such an approach poses for all research communities wishing to account for the needs of soil communities. Bringing sedimented attitudes, perceptions, ways and modes of approaching research to the surface, and recasting cognition as part of a set of artistic-relational practices, was the first methodological choice we made to physically bring soil to our own attention; focus and reflect on the role of intermediaries in this contact-zone, those being our values, prejudices but also our pre-existing knowledge and the tools chosen (or not chosen) for our inquiry. In this sense we began to think differently both about soil and about research: not as a tool or resource, but as a set of mutual relations amongst crafting practitioners of human-nature relationships.

5. Conclusions: Re-framing Narratives of Research as "Practices of Attention"

Rhetoric based on urgency is widely diffused across Western countries' science policy discourses. Soil in this case is not only the ground upon which we walk, but it is also the terrain of the debate; it is perhaps more appropriately understood with capital "S" as suggested by Ulmer (2017), to mean a state of being which can be framed differently according to alternative master narratives; one such narrative foregrounds results and outcomes over subjects and relations; while the other, which we pointed to as a narrative of attention, is the one which highlights processes of mutual interdependencies and co-evolution, and can be referred to as the narrative of Slow (Stengers 2017).

Guiding our experiments was the idea of moving in the opposite direction of the narrative of urgency, widening the range of perspectives and points of view and thus slowing down rational action, by making visible and possible dimensions of our existence which are normally negated, silenced or left unconscious. As Coole and Frost (2010, 5) observe, ontology facilitates the study of the "existence[s] that shape our everyday relationships to ourselves, to others, and to the world". In this regard, Slow Ontology is not simply about expanding time to the point of grinding to a halt, or even justifying the lack of action, but it offered us a lens through which to re-examine methodological practices, and our experiences in BRIDGES showed some opportunities but also difficulties. While framing a relationship with Soil within a Slow ontology has the potential to multiply and expand the possibilities and dimensions for knowing, this approach challenges the current system of competitive funding, demanding researchers to work in a hurry as they chase the next paper or the next contract. Time constraints are always problematic for projects but even more so in a project like BRIDGES, which has the ambition

to develop relationships and community, make tacit narratives emerge and promote a transformative process. Further research is thus required to understand the extent to which master narratives can be reformulated in everyday research practices within and beyond academia.

From this perspective, we can at least start exploring what might be alternative rhythms of inquiry running alongside the industrial beat of economic production. In the Slow framing, we can ask different questions of our own research communities: how diverse are the relationships that are being forged and with whom? What values underpin our practices, aspirations and perspectives? And how far and for how long are we letting the other enter our perception, and be prepared to listen? Such questions revolve around methodological choices that are dialogical and sensorial; they do not operate via logical-analytical thinking but they seek patterns, connections, and story-telling, calling for a more-than-human, entangled approach to research with and through the multiple epochs of Soil.

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Notes

[1] See: https://www.progetto-bridges.it.

[2] See: http://www.pianpicollo.org/.

[3] Not covered in this paper's account of the BRIDGES project was the final experiment – inspired by Citizen science – involving a number of citizen networks engaged in different forms of soil care activism in the urban area of Milan (Criscuolo et al. 2024). Inspired by the European Responsible Research and Innovation (RRI) Approach (L'Astorina and Di Fiore 2017), the citizen science experiment headed towards a responsive and iterative process aimed at discussing and collectively co-producing "soil fertility indicators", based not only on techno-scientific but also social, political, and esthetical categories.

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Neoliberal Timescapes of Infrastructuring an Environmental Footprint: Configuring Carbon Emissions as Flexibly Substitutable Placeholders

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Abstract
Environmental discourses shift over time. Corporations are interested in maintaining efficient systems that translate their operation's environmental impacts into specific environmental discourses, such as carbon. For this purpose, corporate environmental management systems employ accounting. In accounting apparatuses material environmental relations are represented digitally. I attend to maintainers of such digital infrastructures and analyse how they enact the corporation's environmental relations as sufficiently stable. I show that achieving such stability over time is indeed a critical project because the socio-technical relations of the infrastructure routinely threaten such stability. To devise a time-sensitive infrastructural analysis, this problematisation adopts Barbara Adam's timescapes perspective and Lucy Suchman's concept of configuration. Annelise Riles' notion of the placeholder supports theorising the specific political quality of the infrastructural relations. I draw on ethnographic research into corporate carbon accounting in a transnational company. The empirical material consists of an ethnographic story composed of key artefacts of the accounting infrastructure and participant observation of situated engagements with these artefacts by the environmental managers; specifically, I address situations in which participants enact too swift emission reduction, the synchronisation of emissions and the versioning of environments. This story powers detailing how time is imagined and inscribed in critical infrastructural relations. Across these analyses, I problematise how the managers of these corporate carbon emissions continuously (re)configure the latter into an appropriately flexible environmental reality. In sum, I argue that complex temporal politics are at work within maintaining emissions in the corporation to produce tailored versions of environmental realities, effecting a neoliberal timescape.

Keywords
neoliberalism; time; placeholder; carbon; accounting; capitalism.

1. Introduction

The Anthropocene finds critics questioning the role of capitalism in that era (Moore 2016). Temporality matters in both, the Anthropocene and in capitalism. Bensaude-Vincent (2022)

sensitises us to the power relations stabilised through the imaginary of linear scales characterising the Anthropocene, and calls for an analytics of the Anthropocene's timescapes. However, Nordblad (2021, 341) argues for turning our attention from conversations about the Anthropocene to the temporalities of climate change, as the latter invites attention to the way the "political present" is connected to "long term" change. Whilst across disciplines climate change has been analysed as perceived through time (Pahl et al. 2014), how specifically time is evoked as a resource and as a medium for sustainability governance is a much more recent concern (Bornemann and Strassheim 2019). Corporate sustainability governance connects the political present to the long term issue of climate change by mobilising technologies of accounting and accountability – to know their environmental impact and present themselves as responsible environmental citizens (e.g., Rämö 2011), in a mode of self-governing, characterising neoliberalism (Wickramasinghe et al. 2021). In the borderlands between STS, studies of the anthropocene and climate change and critical studies of accounting and finance, with an interest in timescapes, I ask how corporations achieve carbon accountably in and with time.

Contemporary hegemonic corporate environmentalism engages with questions of environmental crises very much in terms of climate change, specifically in the multi-governmental dispositif of carbon governance (Nyberg and Wright 2015). The large corporate players inhabiting the Fortune Global 500 list, which ranks companies by revenue, largely account for their environmental relations in terms of carbon (see review by Thaker 2019, 248). That the corporate environmental self takes the form of carbon resonates with an international regime of emission trading as a market solution to climate change[1] that – whilst deeply problematised in terms of the reliance of "counterfactuals in climate change mitigation" (Lohmann 2005, 203), in the way it imagines and configures selves as "do[ing] their bit" (Paterson and Stripple 2010, 341), as built on market solutionism (Leonardi 2017), which is now hidden within "sustainable responsible investment" (SRI, see Tarim 2022) or "environmental, social and governance" (ESG, see Dimmelmeier 2024) – is still maintained and innovated through policy proposals for tweaking international protocols (e.g., Michaelowa et al. 2022) to eventually deliver the desired emission reductions. In regional and national translations of the international regime, some corporations are legally obliged to reduce emissions (non-compliance risks being fined); other corporations are free whether to reduce emissions, for instance by buying offsets on the VCM, the voluntary carbon market (Lippert 2017). Reasons for such voluntary practice include, inter alia, reacting to public shaming and managing reputational risk (Harmes 2011). For governing such (imagined) emission reductions, emissions need to be rendered known, thus positing reliable accounting. STS has provided critical insights into the epistemic and calculative premises and infrastructures of emission trading and accounting (e.g., Lohmann 2005; 2009; MacKenzie 2009; Lippert 2018) and how these are enacted across scales of governance (Simons et al. 2014).

A key device in climate governance and its mundane management forms are baselines (see Ureta et al. 2020). These are key, because to reduce emissions by some percentage, the earlier emission state needs to be known. Of interest then are not only the large time horizons of geology, but also of recent pasts and near futures in the production of ubiquitous management entities like carbon footprints.

STS analyses of infrastructures are attuned to understanding the situated practices of maintenance and their entanglement with heterogeneous networks of humans, devices and discourses (Bowker and Star 2000). Much labour that achieves maintenance is hidden and silenced (Star and

Strauss 1999). Crucial to infrastructure not only for science, but also for governance, are numbers. Numbers are employed to strengthen relations of trust, by emphasising mechanical forms of objectivity over reliance on individual subjects (Porter 1995). The trope of the bean counting bookkeeper involved in accounting expresses that achieving and, then, employing numbers itself involves labour (Lippert and Verran 2018). The device of baselines can be infrastructurally located as part of accounting (Ureta 2018). And the saturation of heterogeneous accounting practices (Robson 1992) with temporalities within corporations is well established (e.g., Anderson-Gough et al. 2001; Keenoy et al. 2002). STS shows similarly that markets and trading involve temporalities, not only as a resource but also as a space that is actively shaped (e.g., Knorr Cetina and Bruegger 2002; Joerges 2003; Preda 2006). To understand the environmental governance dispositif, a study of early voluntary carbon accounting techniques can be helpful, as it provides insights on the installed base based on which contemporary practices of "greening" capitalism are built. To address these techniques, I need an analytics attuned to the ways relations are achieved between carbon, time and capitalism, as well as technologically and discursively co-configured.

With this paper, I mobilise ethnographic fieldwork from within a transnational corporation to explore how corporate carbon is known in situated practices, between devices, infrastructures and people. Seeking a contribution to an environmental STS focus on temporality within the social technology of corporate sustainability management, I am specifically interested in how baselines are achieved and how time is woven into environmental accounting knowledge practices. In that material-semiotic knowing, I argue, complex temporal politics is at work to produce tailored versions of environmental realities. I identify labour as a promissory focus for STS to trouble such reality-making.

In the following, I set out from laying out my analytical sensibilities, present the materials and methods and then present an empirically informed story of practices, agents and artefacts of the transnational's corporate social responsibility unit and the way they shaped the corporation's carbon footprint with and in time. In an analysis of the timescape of corporate carbon accounting, I develop a critical argument that problematises complex temporal politics within the transnational's infrastructure that risks "sustaining the unsustainable" (Blühdorn 2007). With that, I argue that the timescape I find can be well analysed as neoliberal.

2. Analytical Sensibilities: Configuring Timescapes in Data Practices

The timescapes analytics has been developed by Adam (1998). This approach is originally interested in the politics of industrial time, a Newtonian time, and its tensions with various forms of times in the wider techno-natural environment. As part of this, she is concerned with the way clocks and calendars shape organisations and cultures, how the dominant knowledge culture of science measures time, and how time is put to service for industry and economy. With that, she approaches time that is imagined and practised as a "resource that is open to manipulation, management and control" (Adam 1998, 11), allowing to "de-temporalise" time itself, and by extension other entities and relations. The dominant form of time appearing in clocks and calendars is abstracted from, and outside of, context, not affected by the time embodied within the phenomena. In contrast, she suggests, other and specific forms of time can exist within

interaction and relations, such as within environmental pollution, but also in the relation between sun, earth and a tree. Such latter forms of time, she argues, are Othered by Newtonian time, thus cannot be well accounted for within the industrial timescape[2]. The timescapes approach serves to tune into various knowledge forms that are differentially sensitive to how time works in techno-natural environments. The timescapes analytical sensibility provides resources for critically inventorising the various forms of times, temporalities within the phenomenon.

Towards analysing the relation between carbon, corporate conduct, clocked and calendared contexts, an analytics fit to analyse the relations woven between these is needed. Suchman's (2012) method device "configuration" has the capacity to address the ways imaginaries and specific materialities, more or less natural, are related. She invites us to explore what is figured within figures. This method calls for unpacking typically naturalised socio-technical artefacts. This provides insight into the various imaginaries, stories and investments that shaped the making of the artefact, it pays attention to what the artefact design takes into account: "every artefact enacts its singularity through delineations of that which it incorporates and those things that are beyond its bounds" (*ibid.*, 50). Specifically, through this method, the ways specifically formed figures are related move into the focus – where the effect of these relations constitutes a con-figuration[3]. Part of such configurations are the humans who engage in configuring, so that a configuration con-stitutes its subjects as well as objects. The figures, then, are themselves never antecedent, but have their own anteriorities; figures emerge as made, not found. Key for her is that by analysing configurations, the "politics of cultural historical imaginaries" (*ibid.*, 52) is problematised. Such understanding can help making artefacts, but also unmaking or remaking these.

To bridge the broad sociological critical timescape approach with the empirically detailing focus on configurations, I need a language that helps to analyse the way figures and formats are enacted over time, the way their relations are created, modified and destroyed, the way carbon is configured within short time horizons of corporate accounting practices. Riles's (2010) study of legal knowledge practices infrastructuring collaterals for finance hedgers provides such an analytic language. With it, we move attention from seemingly abstract ideas (which finance alike conversations about the Anthropocene or climate change are saturated by) to the epistemic-material engagement with documents. She focuses on how legal technicians achieve to facilitate relations of trust in trading "futures" between banks under conditions of less than full knowledge (because the future cannot be known). Placeholders stand out in her analytics. These are documentary technologies that get users to invest trust in the promised future, by "demanding" and "engendering" that trust (*ibid.*, 803). Placeholders achieve that by evoking sufficient certainty about a knowledge claim in the present while recognising that such a claim could be otherwise and allowing the claim to be revised in the future, when better knowledge becomes available. As an effect of such knowledge practices in the present, pasts and futures can be modified.

With these three authors' sensitivities, I suggest, we can approach analysing the modes in which timescapes are configured in data practices. I envisage an intersection of these analytics in the focus on how (carbon) figures are enacted in situated practices of capitalist forms of finance industry, and in how these figures' relations, their con-figuration, not only shape the subjects and objects involved, but also how present, past and future relate, and what these become. Thus, time emerges within this analytical apparatus as imagined, inscribed and materialised – as effect of a configuration.

3. Locating Materials and Methods

The material I present in this study is based in fieldwork across 20 months in a transnational financial services corporation, conducted between 2008-10 (Lippert 2013). The corporation belonged and still belongs to the global top 100 corporations, a Fortune 100 player. My work within the corporations' headquarters (HQ) was an effect of privileged access and the chance of compatible interests – I was searching for a site to study the lived culture of corporate environmental managers, "agents of ecological modernisation" (Lippert 2010), and they needed support in managing the interface between their Corporate Social Responsibility (CSR) unit's environmental and the corporation's IT experts, as their environmental knowledge infrastructure needed better maintenance.

Imagine the workers in the company mostly in suits, busy, not all employed directly by the company, but also by a range of consulting firms and other providers of expertise. Within the CSR unit, locate me within the Sustainable Development team, which was not only responsible for environmental accounting, monitoring and reporting, but also for strategic considerations about how the corporation's environmental conduct mitigated or increased the transnational's reputational risks.

My research soon focused on the data practices within their environmental and carbon accounting, as that was something they were most concerned with. I was interested in how carbon data was situationally achieved as well as numerically, textually and visually translated to heterogeneous stakeholders. That accounting infrastructure and its effect still play a role today. It is this infrastructure, rooted in Western countries' 1980s-1990s discourse of ecological modernisation (Hajer 1995), that was repurposed in the early 2000s to allow the company to reflexively engage with the emerging climate discourse. And this infrastructure is employed in today's routinised claims to carbon neutrality.

This focus on carbon accounting intersects with the wider literature on carbon markets in STS and beyond. This literature has well recognised that for these markets to work, various greenhouse gases have to be made "the same" (MacKenzie 2009). While our learning about negative emissions is still unfolding – consider the different politics of making forest or indigenous carbon (Paladino and Fiske 2016; Neale 2023) – little research is available on the production of emissions, positive carbon[4]. We know that for environmental markets to work not only the traded entities (negative carbon), but also the universes in which these entities figure and build relations (e.g., to positive carbon), need to be standardised. Where others have focused on the standardisation of corporate carbon accounting (Lovell and MacKenzie 2011), my material engages with the lived reality of corporate accounting, in which standards do not, unsurprisingly, work deterministically (Lippert 2013).

These analyses build on the wider performativity of economics literature (Callon 1998), which shows that markets are configured in always specific ways. The specific market that my fieldwork relates to is the voluntary carbon market. Addressing with my material the early formation of this market (in the late 2000s) is of interest to critical analysis, because it presents us with an insight into how, without state interference, corporate actors freely and, supposedly rationally, configure themselves as "green" (a form of neoliberal environmentalism, aka ecological modernisation, see Pellizzoni 2011) – where this greenness was in that phase performed

through the grammar of carbon, which could easily be substituted, in the corporate perspective, by other grammars, such as water footprinting or accounting for ecosystem services (Lippert 2015). In that broader sense, my ethnography speaks to STS analyses of metrics, data and accountability in environmental markets (e.g., Asdal 2008; Sullivan 2018; Nost 2022).

The ethnography I conducted can be understood as a discourse or dispositif ethnography (Keller 2019). I lay out, and problematise, the ethnographic apparatus that I enacted for this analysis elsewhere (Lippert 2014; 2020, 306-308). The field was highly dynamic (for instance, a subsidiary with many front-office employees was sold, which effected an increase of the core carbon indicator of emissions per employee), and the accounting apparatus was reconfigured (Lippert 2015). Yet, I observed, too, an inter-organisational governance apparatus (that still is in place) that had effects on the reconfiguration process itself as well as over the transnational's environmental conduct; that governance apparatus involves hegemonic audit firms, a global NGO and practices of "scrutiny" by agencies that produced rankings like the Dow Jones Sustainability Index (Lippert 2014). Now I present anonymised material, selected based on a qualitative data analysis process that explored my corpus of material in relation to time. For this paper, I construct an empirical story, based on that selection of materials, and subsequently analyse it based on the sensibilities sketched above.

4. Achieving Emissions in Time

Inside the transnational's HQ, the head of the Sustainable Development team, Victoria, often provided visitors with the company's Sustainable Development Report, revised each year, to show and explain the team's work. In that document's show of the corporation's emissions, we are presented with a visualisation that captured my eye (reproduced as Figure 1). A serene landscape – enjoy the lakeside mountains, endless nature! – with a textbox overlay. The overlay comes with the headline "Employee footprint" and it further reads "Each employee had a footprint of [*X* thousand] kg in [the year] 200[*y*]. To achieve our [let's say 2015] target, this needs to fall by a further [*z* hundred] kg". At the same time, this artefact's serene landscape appears timeless, visually suggestive of the transnational's carbon footprint as aligning the company with nature – an information of eternal alignment? With these information equipped, I developed an interest in how emission management was coordinated in and with time. The team's objective was to reduce emissions, and for that data about past emissions were needed that could be related to a time horizon, reaching till 2015, the year the emissions were to be sufficiently reduced. And to achieve these reductions, I also learned, the company developed seemingly countless locally designed plans.

In the HQ, one worker who reviewed these plans was the temporary staffer Elise. She was the assistant to the HQ environmental accountant (and the latter's superior was the head, Victoria).

In a phone conversation with me, Elise told me about a problem she encountered while checking the data submitted by subsidiaries for the last reporting year. The case came from the Korean subsidiary. She explained, the Korean environmental bookkeeper had not only reported resource consumption facts to the HQ but also reports of plans to reduce their emissions through particular emission-saving activities. There was something amiss, she made

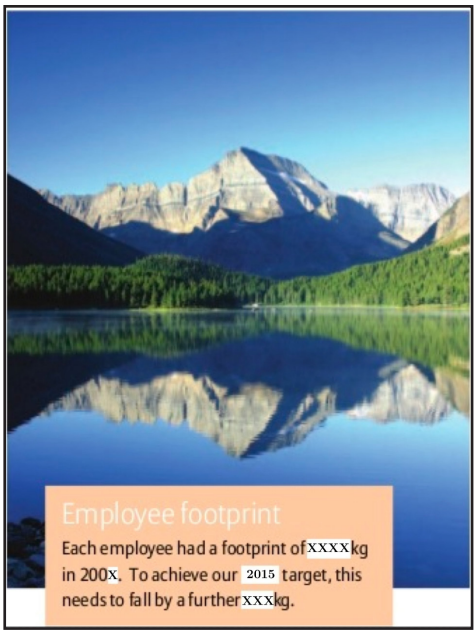
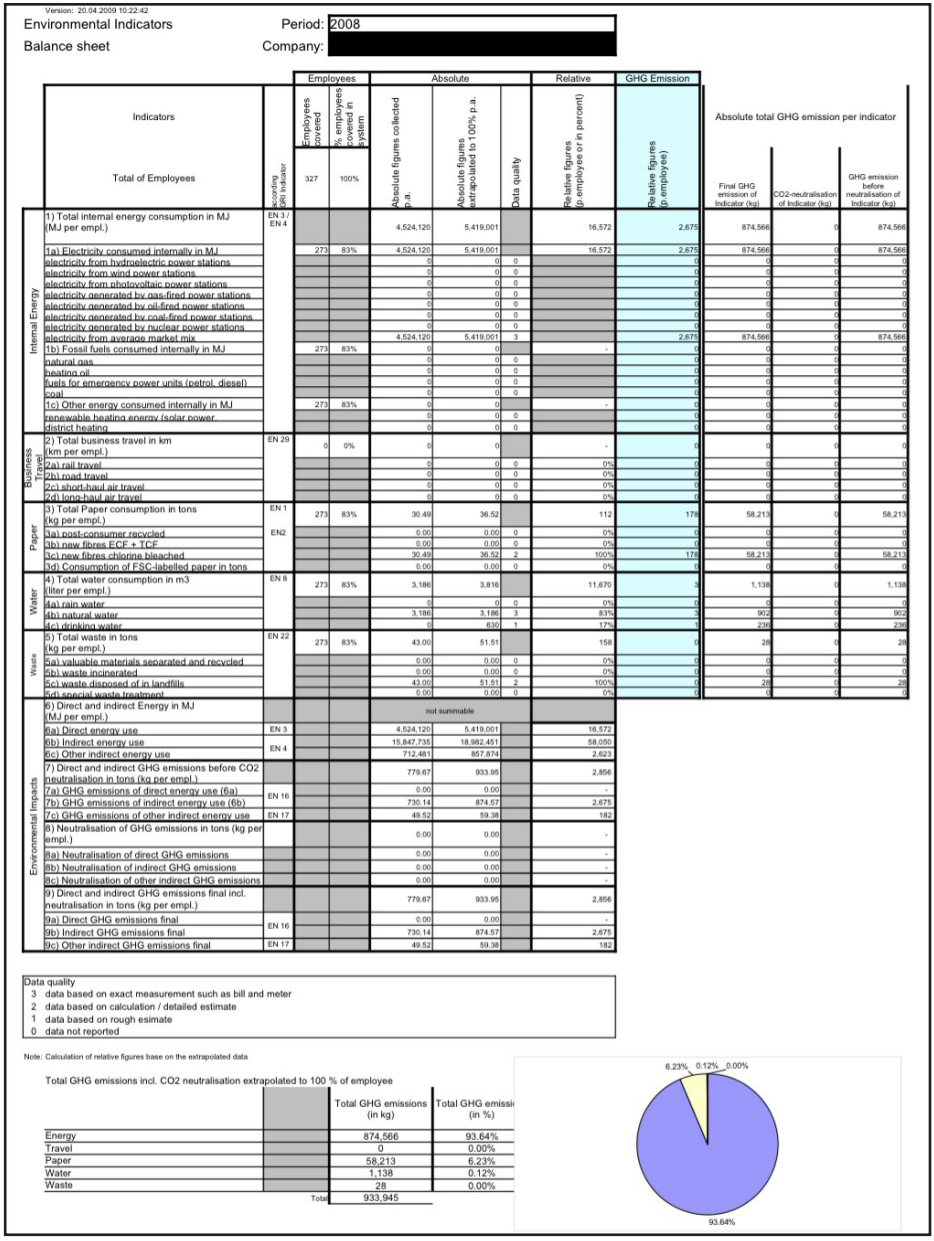


Figure 1.
"Employee footprint", extract from the corporation's Sustainable Development Report (reprinted from Lippert 2013, 206).

clear. "That sucks! Somehow he saves more than he has"[5]. In this interaction, I perceived her as aghast by a physical impossibility, a problem of logic that not only implied the bookkeeper as misunderstanding physics, but also constituted a problem for her, as she had to ask for revisions that would make emissions and reductions fit.

Elise was not only reviewing subsidiaries' reduction plans but also their reports of emissions. For that, she primarily drew on two forms. One was the so-called environmental balance sheet, that summarised all the data reported by a subsidiary for a given year, called reporting period, e.g., for 2008 (see Figure 2). In this spreadsheet, data was highly differentiated, including for instance data about electricity or water consumption or travel data. When I wondered where these balance sheets came from, I was told these are produced by the HQ's Lotus Notes database.

That Lotus Notes database was also providing subsidiary agents with data entry forms (reproduced as Figure 3), which constituted the second type of forms, Elise drew on for her review work. Based on checking and analysing the data reported through the data entry forms, Elise and her superior produced the balance sheets. So, while the data entry forms held the data inputted, the balance sheets presented the intermediate output of the data gathering process; and final emission data were published, e.g., as overlay on picturesque landscapes in brochures for the public.



Version: 20.04.2009 10:22:42

Environmental Indicators Period: 2008

Balance sheet Company: [redacted]

	Indicators	according GRI indicator	Employees		Absolute			Relative	GHG Emission	Absolute total GHG emission per indicator		
	Total of Employees		Employees covered	% employees covered in system	Absolute figures collected p.a.	Absolute figures extrapolated to 100% p.a.	Data quality	Relative figures (p employee or in percent)	Relative figures (p employee)	Final GHG emission of Indicator (kg)	CO2-neutralisation of Indicator (kg)	GHG emission before neutralisation of Indicator (kg)
			327	100%								
Internal Energy	1) Total internal energy consumption in MJ (MJ per empl.)	EN 3 / EN 4			4,524,120	5,419,001		16,572	2,675	874,566	0	874,566
	1a) Electricity consumed internally in MJ		273	83%	4,524,120	5,419,001		16,572	2,675	874,566	0	874,566
	electricity from hydroelectric power stations				0	0	0		0	0	0	0
	electricity from wind power stations				0	0	0		0	0	0	0
	electricity from photovoltaic power stations				0	0	0		0	0	0	0
	electricity generated by gas-fired power stations				0	0	0		0	0	0	0
	electricity generated by oil-fired power stations				0	0	0		0	0	0	0
	electricity generated by coal-fired power stations				0	0	0		0	0	0	0
	electricity generated by nuclear power stations				0	0	0		0	0	0	0
	electricity from average market mix				4,524,120	5,419,001	3		2,675	874,566	0	874,566
	1b) Fossil fuels consumed internally in MJ		273	83%	0	0		-	0	0	0	0
	natural gas				0	0	0		0	0	0	0
	heating oil				0	0	0		0	0	0	0
	fuels for emergency power units (petrol, diesel)				0	0	0		0	0	0	0
	coal				0	0	0		0	0	0	0
	1c) Other energy consumed internally in MJ		273	83%	0	0		-	0	0	0	0
	renewable heating energy (solar power, district heating				0	0	0		0	0	0	0
					0	0	0		0	0	0	0
Business Travel	2) Total business travel in km (km per empl.)	EN 29	0	0%	0	0		-	0	0	0	0
	2a) rail travel				0	0	0	0%	0	0	0	0
	2b) road travel				0	0	0	0%	0	0	0	0
	2c) short-haul air travel				0	0	0	0%	0	0	0	0
	2d) long-haul air travel				0	0	0	0%	0	0	0	0
Paper	3) Total Paper consumption in tons (kg per empl.)	EN 1	273	83%	30.49	36.52		112	178	58,213	0	58,213
	3a) post-consumer recycled	EN2			0.00	0.00	0	0%	0	0	0	0
	3b) new fibres ECF + TCF				0.00	0.00	0	0%	0	0	0	0
	3c) new fibres chlorine bleached				30.49	36.52	2	100%	178	58,213	0	58,213
	3d) Consumption of FSC-labelled paper in tons				0.00	0.00	0	0%	0	0	0	0
Water	4) Total water consumption in m3 (liter per empl.)	EN 8	273	83%	3,186	3,816		11,670	3	1,138	0	1,138
	4a) rain water				0	0	0	0%	0	0	0	0
	4b) natural water				3,186	3,186	3	83%	3	902	0	902
	4c) drinking water				0	630	1	17%	1	236	0	236
Waste	5) Total waste in tons (kg per empl.)	EN 22	273	83%	43.00	51.51		158	0	28	0	28
	5a) valuable materials separated and recycled				0.00	0.00	0	0%	0	0	0	0
	5b) waste incinerated				0.00	0.00	0	0%	0	0	0	0
	5c) waste disposed of in landfills				43.00	51.51	2	100%	0	28	0	28
	5d) special waste treatment				0.00	0.00	0	0%	0	0	0	0
Environmental Impacts	6) Direct and indirect Energy in MJ (MJ per empl.)				not summable							
	6a) Direct energy use	EN 3			4,524,120	5,419,001		16,572				
	6b) Indirect energy use	EN 4			15,847,735	18,982,451		58,050				
	6c) Other indirect energy use				712,481	857,874		2,623				
	7) Direct and indirect GHG emissions before CO2 neutralisation in tons (kg per empl.)				779.67	933.95		2,856				
	7a) GHG emissions of direct energy use (6a)	EN 16			0.00	0.00		-				
	7b) GHG emissions of indirect energy use (6b)				730.14	874.57		2,675				
	7c) GHG emissions of other indirect energy use	EN 17			49.52	59.38		182				
	8) Neutralisation of GHG emissions in tons (kg per empl.)				0.00	0.00		-				
	8a) Neutralisation of direct GHG emissions				0.00	0.00		-				
	8b) Neutralisation of indirect GHG emissions				0.00	0.00		-				
	8c) Neutralisation of other indirect GHG emissions				0.00	0.00		-				
	9) Direct and indirect GHG emissions final incl. neutralisation in tons (kg per empl.)				779.67	933.95		2,856				
	9a) Direct GHG emissions final	EN 16			0.00	0.00		-				
	9b) Indirect GHG emissions final				730.14	874.57		2,675				
	9c) Other indirect GHG emissions final	EN 17			49.52	59.38		182				

Data quality
3 data based on exact measurement such as bill and meter
2 data based on calculation / detailed estimate
1 data based on rough esimate
0 data not reported

Note: Calculation of relative figures base on the extrapolated data

Total GHG emissions incl. CO2 neutralisation extrapolated to 100 % of employee

		Total GHG emissions (in kg)	Total GHG emissi (in %)
Energy		874,566	93.64%
Travel		0	0.00%
Paper		58,213	6.23%
Water		1,138	0.12%
Waste		28	0.00%
	Total	933,945	

Figure 2.
Environmental balance sheet (reprinted from Lippert 2013, 176).

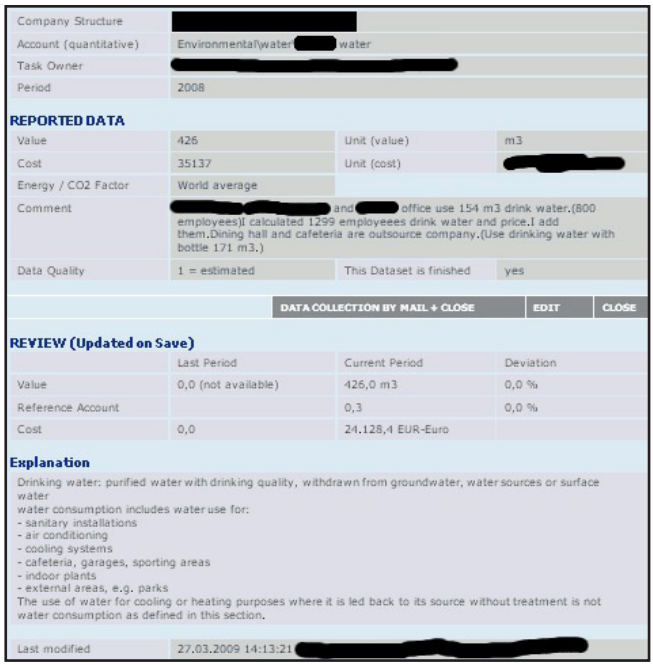


Figure 3.
Data entry form (reprinted from Lippert 2013, 81).

I note that both forms did not only specify the reporting period, but also came with timestamps. At the very top left of the balance sheet, I noted a temporal identifier in small script, "Version: 20.04.2009 10:22:42"; the data entry form employed "Last modified: 27.03.2009 14:13:21".

Here is one such use in which the timestamp mattered: Elise sent to me by email some balance sheets for data testing purposes. Later I had a conversation with her superior. He told me: "Best, bin these". These were old; new ones existed, he made clear.

The timestamp, thus, allowed making a distinction between balance sheets. The same held for the data entry forms and queries on these. Here is another way in which the system's timestamps were productive. Whilst my colleagues focused on analysing subsidiaries' emissions, I was tasked to optimise the central database. One day, Elise called me and reported a problem with the environmental database's data reporting mechanism. I logged onto the system, wanting to scrutinise the reporting query she had initiated, which was indicated by a specific timestamp. I failed. I could not identify a reporting query with that timestamp. Some emails back and forth followed. She sent a screenshot of the query to me. I could not see the query on my interface, although I should have been able to. Here was a situation in which two work processes overlapped: analysing and reporting environmental data (Elise's task) and working towards optimising the information infrastructure (my task). Technically, I was under the impression that I was granted admin rights for the database. But I could not access her query.

As it turned out the problem related to so-called load-balancing. As our company IT department contact explained, a time lag existed between the two servers Elise and I were using; data synchronisation could take several minutes. Data difference was caused by not yet synchronised data between the servers.

Beyond these internal uses of timestamps within the team, we also drew on these when the balance sheets were circulated within the company and beyond. Such circulation of environmental balance sheets took for instance the form of sending the spreadsheets by email to colleagues for approval, up and down the hierarchies; the sheets were printed, even distributed to "external" organisations like rating agencies (imagined as then informing contemporary SRI or ESG indices). Based on some of the feedback, balances would be corrected, updated or in another way revised.

I learned that depending on all kinds of "things" and "concerns" – such as detecting data errors, receiving updated data from other parties, new ground for interpreting the reporting task – subsidiary agents were positioned to update and correct data. That this was not an exception for the system was indicated by the presence and visibility of the timestamp. Data could be more or less old. Any change was reflected in a changed "last modification" date.

The other temporal marker on the spreadsheet and the data entry form was the reporting period. I learned about its significance in a meeting back in January 2009 with the HQ staff. In this, not only was the period printed on the documents, it was also the subject of the conversation. In the meeting the head, Victoria, declared: "after all, this year [2007] ends in one, [or] two, weeks". The reporting period for [2008] starts in February, she added.

When HQ asked subsidiary bookkeepers to fill data in the entry forms, the bookkeepers were supposed to enter facts about consumption that occurred within a particular reporting period. However, the bookkeepers needed time to "collect" data. At the end of a calendar year, the consumption facts were normally not known by bookkeepers; many bookkeepers probably celebrated new year rather than engaging with environmental accounting. The company's environmental managers organised the accounting prescriptions such that the prescriptions allowed the actual reporting to take place during the early weeks of the subsequent calendar year. Thus, after a calendar year, it took some more time until the reporting period closed and bookkeepers were not to report or revise data for the preceding calendar year. And the cutoff point of a reporting period was decided upon in meetings like the one in which Victoria located 2007's temporal position.

For the accounting process it was significant that the reporting periods were well communicated to the bookkeepers. The latter needed to enter all the relevant data till the end of the reporting period. To end the period, HQ accountants increased the period marker by one, e.g., from 2007 to 2008. Hectic weeks were typical surrounding these shifts of the period, as subsidiary bookkeepers had to be reminded of the deadline, and rushed to enter data, while HQ agents reviewed the data they saw coming into the database. Subsidiary bookkeepers had no chance to edit the period field in the data entry form. This prevented bookkeepers from altering data retrospectively. From now on, they could only add and edit data for the "current" period.

This technical configuration constrained the doing of emissions for bookkeepers; however, the period marker could be edited by HQ's database administrators. This was to be a theoretical possibility only. Victoria repeatedly emphasised she wanted environmental data to be in proper, i.e., linear, temporal order. The timing of cutoff points was of importance to ensure that all the required data for a reporting year was in the central database before moving on to the next period.

That these cutoff points mattered significantly I noted in April 2009, when the Brazilian subsidiary contacted us. They asked to "correct [2006] data" because, as they said, "we checked the data [...] and saw that it's totally wrong". However, the database prevented them from editing that prior reporting period's data. Victoria then checked their proposed new data and subsequently wrote to her team:

> [A]s far as I can see, the[ir] numbers deviate significantly from [the prior] numbers. Most of them seem to be more "realistic": thus it is better to take the new numbers, since a better reduction potential can be achieved as well. [...] I [...] urgently ask you to correct the balance sheets and [the database].

That this mattered showed in the numbers. With Figure 4, I visualise the amounts of the 2006 reporting period, before and after the "correction". Quantitively, from the December 2008 account to the mid-April 2009 account, the 2006 carbon footprint increased to ≈ 152 %.

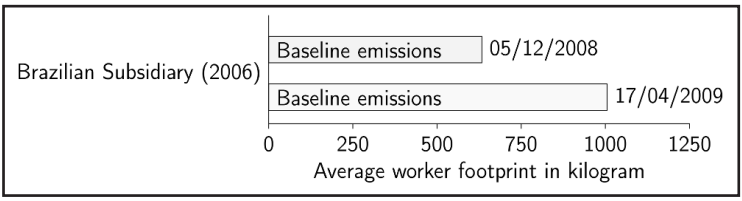


Figure 4.
Baseline year, 2006, emissions of Brazilian subsidiary: date of balance sheet right of bar (revised from Lippert 2013, 230).

Such changes as well as the causes for these changes, required the HQ team to engage with many details, costing too many hours. For this, and related reasons, the team joined forces with other units of the transnational to switch the entire environmental data gathering and processing system from its Lotus Notes base to a seemingly more promising SAP system. In fact, my work consisted very much of supporting this transition process. In one of my final conversations in the field, meeting in a café, I chatted with Elise about her work process and her worries in this transition. She told me that she was asked to manually transfer data from the Lotus Notes database into the SAP system. And, she told me, an automatised data transfer had been possible – but was not wanted. She had to manually transfer data to check the quality of the prior reporting periods' data and, if necessary, adjust that data. Soon afterwards, the corporation had managed to reach its publicly declared emission reduction target – even before the targeted year.

A scandal? Is this an exception, or routine, I wondered. Is it normal that past emissions are set and unset, written and rewritten, over time, are past emission realities simply forgotten?

5. Timescape of Corporate Carbon Accounting

My empirically grounded story shows the mundane practices and infrastructure involved in corporate carbon accounting, as required for a "successful" capitalist corporation's sustainability management, which operationalises its "discursive" relation to climate change (Lippert 2011a). Here I re-narrate the story to foreground the complex temporal politics at work within the discursive production of emissions as accountable entities.

The visualisation from the Sustainable Development report, see Figure 1, provides us with a surface impression of the complexity of corporate carbon. Immediately, the report's reader finds a seemingly untouched Nature, which can be read as evoking environmentalism and concern about climate change, that is related to corporate emissions and to the corporation's staff[5]. This illustrates the shift from questions of Nature to the managerial take on carbon. For the company's managerial approach, key is change, implying they consider their emissions in relation to time; the corporation is normatively orienting itself by way of time, for over time the emissions are to be reduced. In the textbox, we find reference to the most recent footprint, a past that changes each year, and to a target year (future). Implicit is the baseline, a foundational past, enabling the calculation. This visualisation, therewith, presents us with a quite straightforward chronologically organised timescape, in which reader and corporate emissions are positioned between baseline and target. However, this chronological order is juxtaposed with an untouched, endless Nature, a horizon of eternal beauty. I argue, this visualisation presents a version of carbon, saturated with temporal relations, that is only the tip of the complex temporal politics invested into the making of the figures inscribed within the report.

5.1 Carbon Figures and Their Temporal Orders

The yearly reports were the public and rhythmicised product of the team's effort in environmental reporting for the transnational. For this reporting, they operationalised a reporting period, which appeared all over, dominantly as inscription on both, balance sheets and data entry forms. In this way, carbon figures produced were always tied to a reporting period. I analyse this period as coming with an inner and an outer temporality.

Inside, a cyclic temporality was organising the activities of the team. Year after year, in each reporting period, a management cycle effected a rhythmicity like seasons: data collection was followed by data analysis, followed by reporting, planning emission reductions and then, ideally, by reducing emissions; then the cycle would start anew with collecting data. Even though this summary of the cycle is highly idealistic, it indicates the diachronic character of generating carbon inscriptions: over time, positive emissions are accumulating and are to be reduced (planning for negative emissions); it takes time, many hours and months, to account for both the positive and negative emissions.

Outside, periods were imagined as following one another in a linear temporal order. While the period was typically designated like a year, the reporting period existed alike a fiscal year. The period 2009 could last from, say, February 2009 to January 2010. In that period (e.g., till end of January 2010), bookkeepers were to enter consumption data of 2009, and after the period's end, the team and others could compute and review emissions, ask for corrections,

etc., and compile a report for 2009 in spring 2010. Victoria's declaration that "after all, this year ends in one, two, weeks" refers to such a reporting period, uttered in the phase before a shift of period. The movement from one period to the next established another diachronic process that was in principle independent from chronological time.

We find traces of both diachronic processes across my story, for instance in the process of circulating balance sheets for review across the company in the weeks before a report got finalised (within the period's management cycle) or in Victoria's positioning of the shift from one period to the next within chronological time. However, the story also shows that carbon was taking form in ways that crossed the boundaries of the circle, and effecting disorder in the linear sequence of periods (case of setting the reporting period back to 2006, say in April 2010, allowing to revise earlier years' carbon figures, as in the case of the Brazilian subsidiary). Such disruptions of the expected frames happened too often from the HQ's perspective. In literature, the temporal maelstrom within management is well recognised (Adam et al. 2002). With Callon (1998) we can address these phenomena of carbon figures not fitting in as overflows. Therewith I highlight that emissions are unsettled and (re)set within and across the framework of periods.

To allow the members engaged in this accounting work to not lose track of emission figures, emissions came with timestamps, that located emissions diachronically, too, within chronological time, here seemingly proper Newtonian, as postulate-able with Adam (1998). Elise and I used timestamps to identify emission reporting queries, Elise's superior used timestamps to discern between older and more recent balance sheets. In that sense, timestamps took on the role of reflecting when, in chronological time, a carbon figure was created or modified, and this powered coordinating the readers of these timestamps. In that sense, the timestamps were meant to serve as metadata, attached to carbon, but not part of carbon.

The timestamps came with a specific format, owning to a specific history: the company had once employed a German environmental accountant. And in Germany, dates are formatted as [Day.Month.Year(after the beginning of the Christian temporal world order)]. Both particular dates (27.03.2009 and 20.04.2009) were probably well understandable even for users who would have expected a [Month.Day.Year] notation – served by the contingent fact that the day count was larger than twelve. I find, to read time, the user had to be equipped with particular understandings. Temporal identification thus was not universally defined but contextual and relative. The reader had to learn how to read this notation of carbon figures correctly. This resonates not only with Star and Ruhleder's (1996) point that membership within infrastructure needs to be achieved, but also with the politics of notations and calendars (Joerges 2003). A carbon figure thus was necessarily also involving an interpreter, human or otherwise, who would be equipped with the resources that enabled them to locate carbon in time.

However, as the diachronic process description also indicates, not only were interpreters prompted to locate carbon figures in the chronological order of time, also the conditions of enactment shaped what kind of carbon figure turned into reality. This is an ontological point. Consider for instance Elise's superior who used the timestamp as a guide to shape which carbon would circulate. The temporally situated figures of interpreters, of carbon data points, of notations (and more elements) were put in relation to each other, effecting carbon as consisting of several figures, assembled in a specific way. Carbon emerges as configured. In carbon as a configuration, time is not only metadata, but it becomes part of the configuration, effecting a complex carbon figure.

The episode in which Elise and I engaged with the reporting queries indicates a further way in which the timescape of carbon required active and machine-supported attention. Whilst members typically proceeded within their diachronic process, Elise and I stumbled upon the issue of asynchronicity. As became clear, the synchronicity of carbon figures was not given, but needed to be achieved. That was, because the carbon figures did not exist singularly at one place but where distributed across servers located in different buildings. And, resonating with Mol's (2002) analyses of the different enactments of atherosclerosis in different wings of a hospital, carbon, located within different servers or otherwise different situations, can be enacted differently[7]. The work of synchronisation consisted of distributing these different computational enactments to specific time-places, thereby rendering locally existing versions outdated, regularly overwriting prior carbon realities.

The infrastructure to produce carbon figures, thus, involved several forms of time: it consists of a diachronic process as well as a/synchronic moments; time is outside of carbon figures as metadata, and it is folded into the situated enactment of carbon; beyond the chronological order of time, carbon figures took, and were given, form, too, through reporting periods that were on their outside nominally ordered linearly but practically could sidestep the sequential chronology, a form of disorder; whilst inside, the work across a period was structured cyclically, yet, again with overflows. With Vostal et al. (2019) the role of the human agent in this infrastructure can be addressed as engaging in "agentic synchronization". They develop this concept to point to scientists' capacities to deal with experiments' various temporalities, achieving to synchronise the latter. In my story, the corporate employees figure as agential figures within carbon – navigating, placing and altering as what, where and when carbon becomes synchronically configured.

5.2 Configuring Carbon Well?

The configuration of carbon was not only dependent on machinic factors and on humans who have shaped these machines. Carbon, I argue, was also configured quite directly by humans and their expectations of what carbon is in relation to time. Consider the case of Elise problematising the Korean plans of reducing their carbon footprint. She considered the Korean account of their emissions saving plan problematic, because the subsidiary made plans to reduce emissions by more carbon dioxide equivalents (CO_2e) than they emitted. The problem, specifically, were neither the emission saving plans per se, nor their amount, but their timing. Whilst Elise and her colleagues would be able to position emissions (i.e., positive carbon) and emission reduction action (i.e., negative carbon) on a chronological timeline, this case shows that where on such a line negative carbon was to be located depended on some normative logic of when these negative emissions ought to take place. In other words, for Elise, proper carbon included a sequential structure in which a certain amount of emissions could be subsequently reduced rather than preceded by emissions reductions. Her comment suggests that planned emission reductions had to be timed well. This opportune time for negative carbon differs from chronological time. Time studies suggest the Greek concept *kairós* to refer to the opportune time for some action (Cipriani 2013); and here Elise evokes implicitly such kairotic time.

I noted, too, that for the team that handled emissions, retrospective changes of past emissions, whilst possible, were ritually detested. Again, in the configuration of carbon, I find the prescription of better and worse timings for certain treatments of emissions. Members

repeatedly confirmed that emissions that were several years old, ought not be touched. The instance of Victoria having to elaborate her reasoning to change the old Brazilian emissions illustrates the exceptional character of such changes.

These two traces of structuring carbon not only chronologically but also kairotically, afford zooming out and differentiating these practices' commitments. I suggest that team members could situationally perform, and choose from, three archetypical mentalities of carbon accounting. Each mentality comes with a different understanding of how emission reductions should be timed. First, an environmentalist mentality would want to maximise any means to reduce emissions or to create emission sinks. I consider this environmentalist mentality as coming with a realist epistemology: real emissions and effects of reduction instruments on the real footprint are actually measurable. Second, an accounting mentality can refrain from addressing this as a question of "real" emissions or emission reductions "out there". Accounting can take a constructivist stance. What counts is what the book states (Lukka 1990). Third, the business mentality asks how emission reduction can be aligned toward sustaining the business. In short, if the subsidiary employs all greening measures this year then in future years, they won't be able to tell success stories (Lippert 2011b). It makes business sense to delay emission reduction measures for future green progress narratives.

Elise modalised the Korean subsidiary's emission reduction plans as missing something, indicating that something was not correct. What was that something? Given that Elise's job entailed coming across various deviances from explicit reporting norms (an, unfortunately, ordinary experience for her), which she would then routinely process towards rectification, in this situation that "something" was extraordinary. Also it was the role of Elise's superior and Victoria to enact the business mentality. Elise considered that something so extraordinary that she modalised it, called out, in a vulgar manner, that it was really bad, a deep violation. That something was the plan to "sav[e] more" emissions than they had emitted – a question of sequence. I read this combination of modalisation and sequence description as indicating the realist mentality: specifically, Elise suggested that it is not correct when the amount of emissions saved exceeds the positive emissions of the subsidiary. I suggest that her problem only existed because of the kairotic ordering of the actions of emissions reduction and production.

The case of Elise's realist problematisation of the Korean subsidiary's plans indicates a commitment to real linear time, a timeline on which emissions and their reductions are sequentially ordered. However, I shall show next, this realist mentality does not entirely dominate the carbon accounting timescape.

The case of Victoria's engagement with the Brazilian data is noteworthy because of its immediate consequence for the management approach that presumes a baseline. Baselines are typically assumed to be stable and reliable grounds against which later measurements are compared. Ureta et al. (2020) underline that baselines come into existence through the practice of baselining. This literature resonates with my analysis that carbon is enacted, and that various versions of carbon can exist in parallel, calling for ongoing agential synchronisation. This also means that the baseline can be multiple; and in the case under discussion, Victoria conducts work of baselining, rebasing, that is making one baseline win over another.

Ontological multiplicity in baselines implies, furthermore, that baselines are not simply effects of a specific baselined entity, but also of the time of baselining. Baselines are situation-

ally configured. The difference in Figure 4 was possible precisely because the accounts were not accounts *of*, but *for* emissions "out there"; the accounts were accounts *of*, i.e., produced with and in, the reporting infrastructure. And the two versions of carbon were enacted in two differing configurations of and within that infrastructure.

The baseline increase to ≈ 152 % had economic implications. If later, say 2015, emission data was not changed, the higher the baseline year's emissions were, the easier was it to reach the reduction target. Within the relational configuration of baseline(d) entities, a consequence of the multiplication of baselines can be the legitimisation of shifting targets, that is shifts of the targeted reality. A critical analysis of the effects of so-called digitalisation on environmental relations might consider such legitimisation highly concerning, underwriting the illusive character of hegemonic promissory discourses of sustainable development and ecological modernisation (Lippert 2022), but here I focus on how understanding the consequence of shifting targets allows a deeper understanding of the temporalities involved.

Organisationally, this consequence was hidden behind the overarching norm of arranging periods externally in a linear temporal order and behind occasional practical reasons interfering with this norm. Practical reasons varied; a predominant reason was that a subsidiary declared having now learned that old data included errors. This simple declaration matters. First, this declaration implies a story about repairing errors. In the past reporting was faulty and, luckily, that error was now recognised and, therefore, should now be repaired. Second, this is a story about cyclic learning. Corporate environmental management systems are, after all, all about helping the company to learn about its environmental impacts and learning to improve its environmental performance. That is at the core of the management cycle I described as performed across a reporting period. Across that period, slowly, the company learns about its emissions, and as part of that, to know their emissions better, accountants check data for plausibility (and ensure data corrections).

I posit, too, a broader infrastructural cycle that operates at a slower pace than the year-to-year learning cycle of the environmental management system. The infrastructural cycle is shaped by the IT infrastructure and database renewal pattern. Storage systems, including metadata standards and database configurations are subject to change. Elise's account of the switch from the Lotus Notes to the SAP database indicates that such changes afforded another opportunity for learning, including legitimising corrections. Before data would be transferred to the new IT infrastructure, the data would be reviewed, cleaned, to ensure the new setup would start with a freshly tuned base for further data collection.

These cyclic temporalities were part of the temporal infrastructure of doing emissions. Within each cycle data was not stable; each data point was in principle, and often practically, replaceable. But also outside of the cycle, data could be easily replaced by better data. In a database, thus, each data point was subject to potential and often actual modification, adjustment, update, repair. To think about this character we can draw on the notion *placeholder* as Riles (2010) uses it. With this notion, we are able to grasp a key part of the quality of carbon statements. Like a legal fiction, carbon emissions are created to *overlook* them. A legal fiction is a way of legal technicians to make an assumption about a certain status of which all participants know that it is merely an assumption and, thus, its truth value is not of interest. I like to argue that carbon emissions statements have a similar status. Riles (2010, 803) defines placeholder in this way:

> [T]he placeholder's central feature is that it forecloses the question of the moment for the near future, not by resolving it, but by papering over it, we might say, by creating a dummy solution subject to future reevaluation. [Thus, the] placeholder is a tool of forgetting, of putting to one side.

Every data has a future – a future of being looked at, overlooked or changed. Each moment of looking is also a possibility to overlook and to not change. What the data is, is not as relevant as that there is data. The accountants would never deny the possibility that they learn better; no account is complete; the data is always subject to change. But each data is also always available for near future action, to be read again, to be present, to re-configure the body of the corporation's environmental knowledge.

6. How a Neoliberal Timescape Allows Forgetting about Carbon

Social sciences and humanities have underlined the role of corporations and capitalism in causing the Anthropocene including climate chaos. For an analysis of the infrastructures of timescapes of the Anthropocene and climate change, I turned to a transnational corporation. The way this corporation has engaged with climate change was not directly caused by climate legislation but can be presumed to be an effect of, as it were, "free" market relations, thus allowing insight into practice under conditions of self-interested corporate behaviour, that is under neoliberal governance. This paper specifically addresses how carbon accounting was infrastructured, and how, in effect, carbon was shaped, with a focus on the way time figured in carbon practice.

Ethnographically, I showed a complex timescape characterising not only the outside of carbon but also folded into carbon as a figure itself. Inside carbon, we find troubles within several diachronic processes as well as in achieving the synchronisation of carbon. I indicated how carbon was ideated as well as structured in an ordered repetition of cycles within which carbon figures were to be produced and released into public communication. However, I showed instances of overflows, where the order within and across cycles was interrupted, effecting the legitimisation of not only shifting baselines but also of shifting targets – constituting disorder. Competing mentalities operate within the corporation, where some logics seek to enact realist understandings of emissions mobilising kairotic time and other logics seek managerial optimisation of emissions that, as it were, luckily, are also in the companies' interest. Easily, in this temporal complexity, emission reductions, including carbon neutrality, can be conjured up.

The corporation engaged in an ontological politics of when. This means that the corporation did not only exploit the possibilities of the multiplicity of carbon as a datascape to generate specific emissions for the current reporting period (Lippert 2015), also the corporation achieved to locate these carbon figures at will across time. The amounts of emissions of a specific reporting period are flexibilised through this politics of when. For the company it matters that the baseline exists; the amount of emissions at the baselined reporting period is subject to strategic practice. This finding does not only resonate with Adam's (1998, 40) consideration that "everything is present now", in my case meaning that pasts and futures are folded into carbon in present practices of configuring carbon. It also resonates with Riles's

(2010) work on placeholders insofar as the baseline setting was not as important as that there was a baseline. The carbon accounting infrastructure of this corporation was configured as a tool for forgetting about emissions. Not only did the corporation operate and optimise the infrastructure in a way that allowed rewriting carbon figures, but the contingent nature of carbon figures allowed to then forget about carbon, as, effectively, this corporation showcases how it can achieve conjuring carbon neutrality whilst not threatening its superb capitalist performance. With its carbon "machinery", it allowed itself to forget about carbon.

Critically I could end this in terms of the systemic message that greening companies via carbon governance can sustain the unsustainable, as Blühdorn (2007) called it. However, I propose a problematisation that pays attention to the corporation's achievement of carbon as a sufficiently flexible figuration. This flexibility is not so much characterised by an industrial, Newtonian, time, but much more by the strategic temporal politics at work, effecting then not an industrial timescape, but a neoliberal timescape. Pellizzoni (2011) characterises the nature of neoliberalism as governing through flexibility and disorder. Corporate carbon accounting thrives on two significant forms of disorder: shifting baselines for measuring emission reductions and shifting targets for these reductions. My analysis foregrounds how the neoliberal timescape powers forgetting about environmental concerns as these become routinised and substitutable signs.

Forward-looking, I suggest that STS contributes to analysing capacities of human agents, whether staff or activists, engaged in the infrastructures of environmental governance, to reconfigure the environments they engage in. For that I suggest borrowing from STS accounts attending to workers in other domains – consider Suchman's (2012) work on healthcare workers or Dányi and Csák's (2021) work on social workers – which underline agents' diverse forms of highly relevant knowledges that are most apt to inform intervention in and governance of their respective domains. Let us seek out those with capacities to trouble neoliberal timescapes that sustain climate chaos.

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Notes

[1] In a nutshell, the Kyoto protocol, "implementing" the United Nations Framework Convention on Climate Change distinguishes between two groups of countries; the first group committed to reducing emissions, which they could achieve domestically but also using "flexible mechanisms" such as emissions trading, e.g., via the Clean Development Mechanism (see Ninan 2011).

[2] In critical social movement studies, a neoliberal timescape is proposed as differing from the industrial (Gillan 2018).

[3] The hyphon in con-* serves to emphasise its meaning as a prefix co/-con-/com- that refers to the joint achievement of its effects. In that sense, the formulation co-configuration is tautological and not necessary.

[4] A notable exception with focus on positive carbon is Ubbesen's (2015) work on the Danish national greenhouse inventories.

[5] Elsewhere I translated Elise's colloquial vulgar expression as "That bites" (Lippert 2013, 496), but in hindsight, "sucks" seems to be a more apt translation.

[6] And, of course, readers who hire, fire or experience a part time position, can imagine how difficult it is to count employees (see also Lippert 2013, 185-193); the untouched Nature could be analysed critically, too, in terms of not showing the imprint of anthropos on nature.

[7] I analyse such enactments elsewhere in terms of multiplicity (Lippert 2015).

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Forest Futures in the Making: Legal Infrastructures and Multispecies Speculation in Planning Climate-Adaptable Forests

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Abstract
Forests are increasingly thought of as a crucial instrument to combat a host of climate change associated stressors and threats such as soil erosion, atmospheric CO_2, and heat stress. As such, forests have become enrolled in seductive progress stories of envisioning future climate change mitigation and adaptation. In this article, I trace how these seductive visions are materialized in practices of planning and planting new forests. Drawing on fieldwork and interviews with practising foresters in the Dutch National Forestry Agency, this piece tries to tell smaller, unheroic understories of new forests in the making. In so doing it creates the necessary empirical and conceptual space to attend to the way multiple temporalities become implicated in the making of "forests for the future". Tracing the agencies of legal infrastructures, the rhythms of seasonal plant life and human labor, the intrusion of climate change, and the speculations on future multispecies becoming that characterize these practices of planning and planting, this piece highlights how temporalities matter to the way we think and practice our response-abilities in times of ecological crises.

Keywords
temporality; climate change; environmental policy; forests; multispecies theorizing; resilience.

1. Forest Promises, Progress Stories

Forests make for good stories. Given rising CO_2 levels, desertification, increasingly frequent droughts, and rising temperatures, forests are increasingly approached as crucial allies in our struggle against runaway climate change. In their landmark article "The Global Tree Restoration Potential", for instance, Bastin et al. (2019) suggest we think of forests as instruments in climate mitigation efforts. In addition to the protection of existing forests, they point out that the active afforestation of 0,9 billion hectares of currently unforested areas may contribute to the capture of up to 205 gigatons of carbon. The Trillion Trees initiative – a cooperation of Birdlife International, the Wildlife Conservation Society, and the WWF – moreover asks us to imagine forests as "our greatest hope"[1]. Within these narratives, afforestation becomes

a crucial tool in the human arsenal to combat climate change and a powerful way to dream "dreams of progress" (Tsing 2015, 155).

These promises of mitigation-through-forestation are by no means uncontroversial. Commentators point out that estimates of its potential vary widely; that a commitment to afforestation may end up endangering foodways, particularly in developing countries; and will "lower ambition mitigation and [contribute to] lock-in situations in other sectors" (Doelman et al. 2020). Other commentators have pointed out that afforestation projects, particularly as they are tied up in carbon offsetting schemes and markets (e.g., the Reducing Emission from Deforestation and Forest Degradation or REDD framework), in fact promote "carbon colonialism", in which forest peoples are disciplined into the "green economy" (Dehm 2016).

Yet the promise of forests remains, the stories told seductive. These progress stories proliferate, too, in the Netherlands. In this densely populated country with roughly 11% of forest area[2], forests and promises of afforestation play an important part in imaginaries of circularity and hopes for carbon capture. In its 2019 climate accord, the national government committed itself to the afforestation of an area of 37.000 hectares across the Netherlands before 2030 as part of a move toward climate-neutral land-use in 2050 (Rijksoverheid 2020). Here, too, the extent to which such afforestation strategies will indeed meaningfully contribute to carbon neutrality and climate mitigation is very much in question. The actual additional capture of carbon may be rather modest – official projections range between 0,4 and 0,8 million tons yearly for the entire 37.000 hectares of "new forest". Commentators in the Netherlands have nevertheless responded hopefully and enthusiastically; some welcomed the "forest strategy" or *Bossenstrategie* as a belated yet ambitious attempt to prioritize forests within broader nature and climate policies (van Duinhoven 2021). In this sense, these afforestation ambitions represent powerful and mobilizing *stories* that gather allies – and generate funding – in the present (Doganova and Kornberger 2021).

Part of the power of the vision of mitigation-through-afforestation, however, also lies in the way these visions reproduce the logic of modern progress stories (Tsing 2015), in which a largely abstracted Mankind appears as a heroic savior. In temporal terms, afforestation-through-mitigation stories make possible an imagination of the future in which we *will have acted* (Povinelli 2021). Implicitly neoliberal, this narrative told in the future perfect tends to sideline concerns with the *emission* (rather than storage) of carbon, and is characterized by a technocratic horizon in which authorized agents – forestry agencies, national and international governments – will have taken the necessary steps to capture carbon. Capitalizing on a broadly emerging interest in and fascination with forests and trees in the Netherlands and beyond (Nixon 2021), the story of mitigation-through-afforestation does a considerable amount of political work in assuring us that action is being taken so that we may traverse the present and arrive in a greener future.

While afforestation strategies present powerful stories of human agency in an age of climate calamity, they are also partial: they highlight some agencies and not others. On the one hand, they pay too little attention to the human actors – foresters – that are tasked with turning them into a reality and tend to gloss over the rather more complex workings of state or state-adjacent bureaucracies tasked with realizing them. On the other hand, they magnify the role of human actors and designs, and provide little insight in the agencies of nonhuman

actors in the making of forests: the agencies, for instance, of soil and its nutrient status and hydrological characteristics, and perhaps even more tellingly, they neglect the agency of trees in the composition and orchestration of forests. Indeed, if these afforestation stories do not only *do* work in mobilizing allies (Doganova and Kornberger 2021), they also *demand* work: new forest do not materialize out of thin air.

For the foresters whose afforestation practices I studied planning and planting new forest raises difficult and above all pragmatic questions. Where do we locate "new forest" in a densely populated country as the Netherlands, and at the cost of what other landscape types, uses or values? Concretely, how do we find space in the Dutch planning contexts, in which existing space is overlaid with intricate bureaucratic webs of planning classifications? These questions do not only have spatial dimensions, but temporal ones as well. How do we time actual planting work so that it does not disrupt the seasonal habits of trees and other forest life forms? How, crucially, do we make sure these new forests can themselves stand the test of climate change – the test of time? How will we account for climate change-associated threats like acidification, more extreme weather events (storms particularly), changing species ranges and increasing risks of insect, bacterial or fungal plagues in the making of a forest for the future?

In this piece, I bring these practical and everyday planning and planting realities into view in order to complicate grand narratives of afforestation. This piece, by empirically attending to the making of forests for the future, thematizes in particular the role of multiple temporalities. Approaching foresters as bureaucrats whose work is organized in reference to project temporalities as well as embedded within legal infrastructures, I particularly zoom in on moments of *temporal interferences* (van Oorschot 2021) that emerge out of a tension between the schematized forward push of projects, the slow pacing of bureaucratic procedures, and the seasonality of tree growth and human (guest) labor schedules (Section 3). Moving on to a discussion of the particular *kinds* of forests that are being planned (Section 4), I examine these planning practices as active in the orchestration of particular versions of future forests, in which tree and forest temporalities play a crucial role. Planning a new forest, for these foresters, is a practice of anticipating future relationships between trees, and entails an understanding that it is necessary to give the beings with whom one composes – in this case, trees – the chance to establish relations among each other. It is, in other words, a practice of taking trees and tree species seriously as "architects" in the forest as a multispecies assemblage (Tsing 2015, 169) and in that sense constitutes an open-ended, speculative mode of making and managing forests.

Together, these sections complicate the framing of afforestation as either an unproblematic solution to climate change or as naïve and ultimately empty political posturing in the name of sustainability. The *understories* I am tracing here, by contrast, bring us down to earth – where in the end we always already are – and position us in complex bureaucratic and ecological worlds. These "smaller, unheroic stories" (Bensaude-Vincent 2021, 217) also bring into view the crucial role of *multiple temporalities* in forest planning and planting. They show how progressive, future-oriented practices are enacted within a *temporal thicket* of bureaucratic temporalizations, seasonal rhythms of plant growth and seasonal labor, and projected and emerging multispecies relationships between trees.

2. From Scientific Forestry to Emerging Concerns with Climate Change: Situating the Dutch Forestry Agency

In this piece I draw on data gathered in the context of two related research project: the first on the circulation of "resilience" within environmental policy circles globally and within European environmental policymaking; the second, an ethnographic analysis of climate-adaptation in actual environmental management practices in the Netherlands. Especially this second project informs the analysis I will be presenting here, which concentrates on the way Dutch environmental managers within the National State Forestry Agency (Staatsbosbeheer) give shape to its stated purpose to "help in different ways to mitigate climate change and its consequences" (Staatsbosbeheer 2020a, *author's translation*). In contribution to the 2019 government Climate Accord, in which the cabinet communicated its goal to afforest 37.000 hectares in the Netherlands, the Agency aims to afforest an area of 5000 hectares before 2030. In the following I will briefly situate this project within the history of the Agency, and comment on my own attempts to find an empirical footing within it.

2.1 The Dutch State Forestry Agency: Modern Forestry and Beyond

Staatsbosbeheer is in many ways uniquely positioned to help contribute towards the climate goals of Dutch government. It is the largest environmental management agency in the Netherlands, and historically has had close ties with the Dutch state going back to the late 19th century. Over the 19th century, import of cheap wool from Australia had made sheep-herding in the Netherlands' eastern, nutrient poor soils less economically viable. Seeking a rational solution to the problem of these now unproductive wastelands (*woeste gronden*) the Dutch government appointed a set of experts to exploit these areas through forestry in 1899, which group then was established as *Staatsbosbeheer*, the National Forestry Agency (Boosten 2016). In its early history, the Agency prioritized timber-production in rationalized same-age monocultures, which aligned the Dutch approach with modern scientific forestry efforts throughout Europe from the early 18th century onwards. This type of forestry, often called scientific forestry, emphasized the planting of a relatively select number of fast-growing tree species and felling these all at once at the most economically opportune moment in their growth cycle, which decisions were made based on increasingly sophisticated modes of calculating future yields (Doganova and Kornberger 2021). Temporal orientations were crucial in constituting both the forest and the state itself. Over and against peasant communities or indigenous populations, whose use of the forest was deemed unsustainable, the state, as an "enduring, solid, and unitary" power (Mathews 2011, 31), both required and guaranteed continued and sustainable timber yields (Radkau 2008; Mathews 2011). This temporal orientation to timescales beyond that of the typical human being continues to be evoked in the Dutch saying *boompje groot, plantertje dood*, which translates to "[when the] tree [is] big, [the] planter [will be] dead". The continued and sustained use of forests, moreover, would in scientific forestry be realized through the reduction of trees to "self-contained [and] equivalent" objects (Tsing 2015, 168). Despite romantic approaches to forests as spaces of wilderness beyond and outside of civilization, forests in the Netherlands are disturbances planted on already

disturbed grounds. As such they tell stories of "the relations between capitalism, state formation, and plant colonization" (Mathews 2018, 146). In the Netherlands, as elsewhere, these "power-laden histories of natural-resource extraction and state-making leave traces on tree and landscape form" (Mathews 2018, 395). Forests become legible as the outcome of – and the continual unfolding – of both ecological and state histories (Tsing 2015; see also Hourdequin and Havlick 2015). A good example is Figure 1, showing a plot of Sitka spruce, visually rendering evident the standardization of trees in single-age and single-species stands.

Yet over the second half of the 20th century, Dutch forestry also experimented with other ways of managing, or indeed "doing forests" (Tsing 2015). They did so in response to emerging concern with the vulnerability of monoculture stands to bacterial or fungal plagues, and reaction to a series of extreme storms in 1972 and 1973, which demonstrated the vulnerability of straight rows of trees planted in monocultures to sudden gusts of strong wind. Moving away from scientific forestry and its emphasis on monocultures of single-age forest plots, Dutch foresters developed what is now called "integrated forests management" (see van der Jagt et al. 2000; van Raffe et al. 2006). This mode of management not only combines different forest uses and environmental values – recreation and enjoyment, production, and ecological values – but is also characterized by selective felling (rather than the felling of entire stands at once) and a greater emphasis on diversity, both at the species and age level. Emphasizing multiple nature values, including tourism and recreation, additionally assisted the Agency in drawing out its public role and in financially sustaining itself – a more pressing concern once it was semi-autonomized and delinked from the Ministry of Agriculture, Nature and Food Quality in 1997 (Committee Evaluation Staatsbosbeheer 2003).

2.2 Climatizing Forestry: Doing Dutch Forests in the 21st Century

Up until a few years ago, however, forests were not central to Dutch environmental policy agendas. A series of largely right-wing cabinets and post-2008 budget cuts significantly affected the National Forestry Agency's financial bottom line, as a result of which it has had to rely more on income from recreation and tourism and on timber production. Meanwhile, EU legislation and directives such as EU Birds and Habitat Directive and Natura 2000 often targeted more open and varied landscapes, so that rather little attention was paid to Dutch forests. At the same time, the consequences of climate change for Dutch forests became more palpable. Hotter summers with more and more severe heatwaves and extreme weather events such as storms significantly have affected the vitality of Dutch forests over recent years. In combination with high levels of nitrogen deposition from livestock production, these stressors are especially consequential for forests on the sandy and poorer soils of East Netherlands, planted in the 19th century (Boosten 2016). Particularly plot-wide infestations by the European spruce bark beetle or *Ips typographus* – its name referencing the calligraphic traces it leaves beneath spruce bark – required foresters to clear entire plots, leaving landscapes of stumps in their wake.

In producing a concern with the very viability of forests in the future, these events set into motion a policy process that increasingly sought to draw out links between climate change and the potential of forests for mitigation and adaptation efforts. This *climatization* of forestry (cf. Aykut et al. 2017), was accompanied by a proliferation of "environmental regimes of anticipa-

Figure 1.

A production stand of declining Sitka Spruce on the Utrechtse Heuvelrug, affected by the green spruce aphid *Elatobium abietinum*, one of the plagues to which such monotonous stands are particularly vulnerable. Photograph by the author, December 2022.

tion" (Dolez et al. 2019), in which scientific experts (particularly from the Dutch University of Wageningen) as well as a diversity of forestry NGOs such as the Belgian-Dutch *ProSilva* took on a crucial role in developing ways to monitor and experiment with forestry and to translate scientific or experimental knowledges into usable information for foresters on the ground.

It is at this historical juncture that we see the new Dutch Forest Strategy emerge in 2020. Buoyed by a global focus on trees and tree cover as crucial instruments in climate mitigation as well as by the emerging visibility of the unfolding consequences of climate change for the Dutch forests, a variety of environmental, private, and state actors came together to craft a strategy to revitalize Dutch forests. Based on this intensive collaboration, the Dutch Minister of Agriculture, Nature and Food Quality Carola Schouten presented the National Forest Strategy in 2020. Called "Forest for the Future", the plan expresses a commitment to "a healthy, future-proof, and societally valued forest" (Ministry of Agriculture, Nature and Food Quality 2020, 4). It highlights the "different uses of the forest" (*ibid.*, 4) and the "importance of passing these along to future generations" (*ibid.*, 4). To enable this, "policy is required that makes it possible to make decisions in the future as well" (*ibid.*, 4) While the Forest Strategy is focused on the execution in the coming ten years, "it has a horizon reaching into the next century" (*ibid.*, 4); after all, "forest requires a long-term trajectory" (*ibid.*, 4). Concretely, it highlights two crucial ways to future-proof forestry in the Netherlands: one, the revitalization of existing forests, and second, the planting of 37.000 hectares of new forest, amounting to a 10% increase in forest nationally. New forest, the Forest Strategy elaborates, will help to "realize biodiversity goals and to capture carbon, as we have agreed to do in the Climate Accord [of 2018]" (*ibid.*, 9) but will also contribute to "more possibilities for recreation, a lessening of heat stress in cities, improved soil water storage, and additional timber production for the circular economy" (*ibid.*, 9). Passages such as these highlight how the storage of carbon – so present in transnational narratives about the possibilities of afforestation – is folded into the strategy as one of several forest "ecosystem functions". In the same year, the National Forestry Agency published its own organization strategy for the next five years. Resonating with the Forest Strategy, it was titled "Resilience and Connection" (Staatsbosbeheer 2020b), and similarly emphasized the many different functions and uses of forests which it would seek to enhance by revitalizing existing forests and planting new forests. In response to the national goal of afforesting 37.000 hectares, it committed itself to planting 5000 hectares of new forest.

In this piece, I examine how this afforestation plan was realized in practice. Part of a broader research project into modes of valuing forests in an age of climate calamity, this piece draws on an ethnographic research project into forestry in action. This project has an observational component, which consists of field-visits and excursions into forests with the forester in charge (done in three locations in the provinces of Limburg, Noord Brabant, and Utrecht), and of observing everyday forestry practices, particularly moments of forest inspection (what is called *de schouw*). It also comprises the in-depth study of plans, documents, and strategy proposals that accompanied the adoption of the Forest Strategy, as well as a mapping of the concerns and challenges as these are detailed in the professional journal *Natuur, Bos, and Landschap* ("Nature, Forest and Landscape") and in the Agency's own magazine, *Staatsbosbeheer Magazine*. To uncover the practical implementation of the "new forest" project specifically, I selected five "new forest" locations in different provinces and on different soil types

(sand or clay) in conversation with two high-ranking decision-makers within the Agency. Over October and November 2022, I interviewed a total of 13 foresters or project managers tasked with the practical implementation of the project, two public spokespersons of the Agency, one high-ranking decision-makers in the Agency, and one forest advisor within the agency. The data gathered within these interviews are complemented by observations, photographic materials, and policy texts where appropriate to the argument in this piece.

Over the course of these interviews, it became evident that issues of time, periodization, and the future were absolutely crucial to these projects. On the one hand, "the future" is continuously evoked as requiring actions in the present. In that sense, the future is a powerful ally (see Doganova and Kornberger 2021). In the words of one of the interviewees, "it gives us opportunities": it allocates funding and crucially, opens the doors of municipal and provincial authorities, which – as I will discuss below – play an important role in authorizing spatial reallocation requests. At the same time the temporal boundedness or the "projectness" (Law 2002) of the project, which ends in 2030, also raised some flags for some of the foresters. Used to thinking in much longer timescales, these "temporal dissonances" (Wiber 2014) between policy timescales and realities on the ground are a source of worry for these foresters; the same project manager warns us that:

> [Y]ou simply can't change your internal policies every four years. What you plant now will be there for 70, 80 years. The descendants of these trees will there be for another hundred [years] at least.

However, as I elaborate in the section below, legal-bureaucratic temporalities, seasonal rhythms, and speculations on future multispecies relationships in the forest-to-be take on especial significance in these planning and planting practices. In the following, I analyze these temporal concerns in more detail, as they hold the key to understand and situate the "progress story" of afforestation within the bureaucratic and multispecies worlds these foresters inhabit.

3. Reclassifying Nature: Legal Infrastructures and the Intrusion of Seasonality

The Forest Strategy reinvigorated a holistic, nation-wide concern with Dutch forests, yet its implementation is irreducibly local. In the early stages of the new forest initiative, project managers assigned to the new forest initiative were firstly and crucially tasked with finding the *space* to plant new forests. In the densely populated and spatially regulated country of the Netherlands, this would prove to be an especially challenging task.

Particularly influential in the context of the new forest initiative is the so-called Dutch Grant Scheme for Nature and Landscape (*Subsidiestelsel Natuur en Landschap*), or SNL[3]. This grant scheme details and indexes the subsidies that the twelve Dutch provinces make available for the purpose of maintaining "specific characteristics" of various "nature types". The SNL is developed specifically to classify (what it understands as) "nature" into 17 non-overlapping classes that require their own management types. Within these types, more granular distinc-

tions may be made. For instance, nature type "forest" is composed of four classifications, including wet forests (N14), dry forests (N15), forests with a production function (N16), and cultural-historical forests (N17). In doing so, the SNL folds within itself multiple logics of ordering landscapes. On the one hand, it draws on landscape elements such as hydrological metrics and soil composition to distinguish between nature types (e.g., sandy soil, clay soil). At the same time, these classifications also enact social histories: the forests on dry soils in the East of the Netherlands are precisely the forests that were planted in the 19th century. The SNL is shaped by economic considerations as well. For instance, the standard cost that is calculated – and hence partially subsidized – for "forests with a production function" is much lower than it is for other types of forests, as the economic value of timber production taking place in these forests is subtracted from the overall operating costs.

A forest, then, is not just a forest. It is also a category in a broader grant scheme and as such active in the distribution of responsibilities and funds. The SNL in precisely this sense is an important *legal infrastructure* (Turner and Wiber 2020), connecting provincial governments, planning authorities, and nature managers in a "web of relationships" (Turner and Wiber 2020, 8). Designed explicitly as a uniform, broadly recognized "nature language", the SNL also relies on particular epistemologies, bringing to the fore not just natural elements such as hydrology and soil composition but also human histories of use (in the category of the cultural-historical forest) and human designs for extraction (in the category of forests with a production function). And last, it also codifies specific forms of doing forests, as it specifies the type of management and its purpose and defines it as consisting of the maintenance of an area's fundamental characteristics. In so doing it materializes and solidifies specific landscape forms. In its regulative and legal operation of defining the type of management appropriate to specific types of nature, then, the legal infrastructure, like any legal artefacts, of the SNL is also *performatively active* in co-producing the realities it is meant to regulate (Pottage and Mundy 2005; van Oorschot and Schinkel 2015).

For casual wanderers through the Dutch landscape, this legal infrastructure is not especially evident; infrastructures, much like landscapes themselves (Mathews 2018), often fade into the background of social action. The project managers and foresters I spoke with, however, are intimately familiar with its ordering force. Finding space for new forests, for them, meant that they had to request formal changes in the classification of specific areas with the relevant (provincial) authorities. Yet reclassifying nature is a rather sensitive and risky process. It was sensitive, as the Agency's project managers would have to make the case that in reclassifying nature from one type to another, no other important nature types were effectively lost, for instance, natural areas with rare species or areas that are crucial to other national or supranational regulations such as Natura2000 or the EU Birds and Habitat directive. As a solution to this dilemma, project managers often selected areas classified as nature type N12.02: Herbaceous and fauna-rich agricultural fields. As these plots were often used as agricultural fields up until recently and have a history of fertilization, their soil tends to be rich in nutrients. For that reason, they are also less likely host to endangered or rare species, as these are usually outcompeted by relatively common, fast-growing herbaceous plants that end up dominating a particular site. As project manager Rinke explains:

> We've been looking for these areas that, ecologically speaking, lag behind in their development. So for instance with these grasslands, you'd like to see a development in the direction to a certain vegetation stage, but you're not getting there because of [the dominance of] certain species.

Trying to select sites that, in the eyes of these project managers, "lag behind" in their development, these project managers however ran up against bureaucratic rules and regulations. Precisely because these nature classifications are not simple descriptions but active in the distribution of legal accountabilities and responsibilities, bureaucrats or local politicians could resist or dispute the proposed reclassification. For instance, in one case provincial bureaucrats argued that the relatively low ecological value of specific agricultural fields was a function of the Agency's management, which primarily consisted of annual mowing to retain the area's open character, but did not include more expensive management interventions, such as the removal of the top, nutrient-rich layer of soil. "But we are not charged with *developing* these areas", project manager Hans objects: "We are tasked with *maintaining* their fundamental characteristics". Here, the emphasis on selecting sites that "lag behind" in terms of their ecological potential led to time-intensive discussions about the precise distinction between maintaining fundamental characteristics, e.g., through annual mowing, and *developing* its fundamental characteristics, for instance through the (costly) removal of the top layer of nutrient-rich soil. Depending not only on local politics but also on the whims of specific bureaucrats, then, proposals to change the formal classification of areas into a forest classification may receive either a "go" or a "no go". Sometimes, such decisions are reached quite fast – within a few weeks – but legal regulations on government communication and decisions tended to give bureaucrats quite a long time to decide.

Given the time span of the project – the ten years between 2020 and 2030 – a delay of a few months or even half a year may not seem to make the difference, yet there are nevertheless repercussions that reverberate through forward-oriented logic of planning. A particularly pressing concern for the foresters I interviewed was the rhythmic temporality of seasons, and the effect of climate change on these seasons. For one, planting season is usually in the winter, between the moment the young trees lose their leaves on the one hand, and the start of the bird breeding season on the other. However, climate change is causing milder autumns, so that the period the young trees are in leaf is extended. Climate change is also causing spring to arrive earlier and in so doing, is moving up the breeding season of bird species. Effectively, then, the planting season is growing shorter and shorter. Project manager Lore estimates that:

> [I]t now realistically comes down to planting in January and February, really. So if you really want to make progress, it isn't practically plannable.

Additionally, not all trees can be planted using labor-extensive, mechanical methods. The heavy machinery used to plant new forests in neat rows is not usable on waterlogged soils, for instance on the heavy clay found in the North and West of the Netherlands. Planting by hand is certainly a possibility, but often requires low-waged migrant labor. This, too, represents a seasonal intrusion in the planning process, as these migrant workers often travel

back to their families in eastern European countries during December and January. Working through these tensions, the Agency has in the first two years of the project managed to realize the planting of 450 hectares of new forest (Staatsbosbeheer 2020b), which amounts to space of only 12%, an observation which suggests that the projection of 5000 hectares by the end of 2030 may be rather optimistic.

Trying to make space for new forests, then, is also a matter of negotiating between the forward push of the project and the realities of both human and nonhuman seasonal rhythms. Legal infrastructures, bureaucratic due process, and seasonal temporalities produce either propitious occasions – a "go" is received in time to order and plant new trees in a small window of time – or lags and interferences. Legal infrastructures and the procedures that detail the reclassification of natural areas are capable of halting or pausing the forward trajectory of a project, and may lead to a further proliferation of formal communications and requests. These legal-bureaucratic "syncopated rhythms" (Wiber 2014) leave an indelible mark on the planning of new forests as they shape where such forests may be planted and when, while climate change and its impact on seasonality is creating even more pressure points in the temporalities of planning a forest. These pressure points, I want to suggest here, can be thought of as *temporal interferences*, in which human designs and modes of temporalizations are undercut or brought into tension with nonhuman rhythms and cycles. Derived from the study of legal procedures and documents (van Oorschot 2018), the notion of *temporal interference* draws attention to moments and encounters within which legal modes of ordering space and time confront, and emerge in tension with, other temporalities. These forests, then, are not so much taking shape *in* time as being shaped *by* legal, forward-oriented temporalities and their interferences with the changing rhythms of human and nonhuman seasonality.

One way to tell smaller stories about grand narratives of mitigation-through-afforestation, then, is to stay with the bureaucratic infrastructures these foresters inhabit. Top-down plans of afforestation may mobilize allies and (not unimportantly) funding, yet always unfold and materialize within legal infrastructures and their particular modes of ordering space, agency and responsibility, and time. Crucially, however, they also unfold in specific sites and locations, where landscapes are transformed and trees are planted. In the following section, then, I resume this understory by highlighting the particular composition of the planned and planted forests, and emphasize in particular how speculations about multispecies relationships and temporalities inform the forester's forest plans.

4. Speculating on Multispecies Relations: Working With and Against Non-Human Temporalities

The moment an area is marked out for forestation, project managers develop a detailed sense of what *kind* of forest they seek to establish. Operating with a temporal horizon that transcends the "projectness" of the new forest initiative, project managers aim for these forests to be as "resilient" to both known and unknown future developments and phenomena. A good forest, in other words, is a forest that will be there into the next century. Resilience or, in Dutch, *veerkracht*, is a notoriously fuzzy notion. Rooted in the study of ecosystems

(Holling 1973), the notion of resilience tends to be used to refer to the capacity of specific ecosystems to respond to, bounce back from, or adapt to unpredictable episodic or long-term ecosystem disturbances. It is not difficult to fathom why this conception of ecology, having its roots in the 1970s, has been especially influential in the last decades. After all, climate change is a collection of unpredictable stressors par excellence. Even though climate models afford some sense of trends over time, they "are however imprecise in forecasting when and where the next megafire, superstorm, of flood will be" (Petryna 2018, 571). Runaway climate change "renders untenable the very concept of projection" (*ibid.*, 570), so that it becomes imperative to make ecologies resilient to these unpredictable stresses.

In this sense, planning and planting a "vital" and "resilient" forest is a matter of anticipating not just (known, theoretically calculable) risks, but also of taking into account the reality of unpredictable and unknown "disturbances" that disrupt models and expectations based on past observations. For the foresters I worked with, the paradigmatic example of such unpredictable disturbances are bacterial, fungal or insect plagues, for instance, the above mentioned and disastrous spruce bark beetle *Ips typographus* or the equally destructive fungus *Hymenoscyphus fraxineus*, causing Ash dieback. Some of these plagues, like the *Ips typographus*, are native to Dutch ecosystems, and only become a problem when trees are weakened due to prolonged stressors. Others may be imported through global entanglements of trade and commerce to then ferally proliferate within disturbed landscapes (see, e.g., variety of species brought together in the Feral Atlas[4]).

One never knows when such plagues strike precisely but when they do, their consequences are dramatic. While the broad field of forestry has devised different ways of anticipating the unknowable, and developed crucial knowledge practices such as monitoring and sensing in order to keep track of change over time (see, e.g., Gabrys 2020; Dolez et al. 2019) the question for the foresters I studied here is a less a scientific one and more a pragmatic one: how do we make sure the forests we plant now will stand the test of time? Here, their choices at the species level are revealing of the way these known and unknown disturbances are anticipated in actual practices. At the species level, foresters are for instance increasingly selecting more drought and heat-resistant species, yet these must also be species that are capable of surviving other weather extremes and irregularities, such as late spring frost or the temporary inundation that results from partial flooding. Specifically, the littleleaf linden (*Tilia cordata*) and the European hornbeam (*Carpinus betulus*) are selected to respond to these anticipated disturbances. The littleleaf linden can handle not only periods of drought but also temporary inundation, hence contributing to its expected resilience in a changing climate characterized by weather extremes. Meanwhile, the European hornbeam can withstand both droughts and spring frost.

However, the resilience of forests to unpredictable future stressors is not just enacted as a matter of choosing individual species. It is also a matter of knowing how to *combine* tree species. A helpful visualization is Figure 2, a reproduction of an image detailing the planting plan of one of the afforestation locations. In this image, we see the different planting plots as these have been decided upon by the project manager and the local foresters. The colors and numbers in the map correspond to a detailed list of species that are to be planted within these delineated spaces. Looking at the species list, we see for instance that plot number 4, denoting

an area of 0,38 hectares, is to be composed of three tree species: the littleleaf linden, common oak, and birch in a proportion of 70%/15%/15%. But this plot is relatively homogeneous compared to plot number 16, which includes six species: hazel, common privet, redcurrant, sweetbriar rose, basket willow, and hawthorn.

Figure 2.
A schematic overview, taken from a planting plan, detailing specific plots.
Courtesy of Staatsbosbeheer.

This image testifies to one of the core techniques used to design these new forests: the techniques of *mixing* and *lumping*. The mixing of multiple species together, first, is not necessarily new – it has been a staple in Dutch forestry since the rise of "integrated forest management" in the 1990s – yet it is thought to be uniquely suited to allow a forest to stand the test of climate change. In a mixed forest, even newly emerging pests or plagues represent a fairly small problem. Even if a fungus, bacteria, or a type of insect devastates one particular tree species, forester Larry explains, "you'll still have some forest left", and remaining tree species may happily colonize the open spaces in the forest that follow such plagues or pests. Importantly, mixing is also a technique that mobilizes relationships between trees. Through mixing, it is possible to complement trees that require hospitable soil with species that generate especially nutritious leaf litter. The littleleaf linden chosen in the above example is well known for its capacity to enrich depleted soil because its leaf litter degrades relatively fast. Trees with such leaf litter, which also include for instance the European hornbeam, are often referred to as "caring" or "nursing" (*verplegende*) trees, and planted in the vicinity of trees whose leaf litter has a less "caring" effect on the soil's top layer, such as the acidic leaves of the oak or beech.

However, too much mixing is undesirable. Tree species, after all, have different needs and different growth speeds. Fast-growing species that do well in full sunlight, for instance, may literally come to overshadow other species with their quickly developing crowns. To avoid this from happening, foresters may also strategically lump some species together, so that fast-growing species compete mostly with each other rather than with slower growing trees. Figure 2, again, captures both the technique of mixing and of lumping quite precisely. While creating an overall mixed forest, variation in specific plots is much smaller, which ensures the optimal growth conditions for the different species.

4.1 Working With and Against Species- and Ecosystem Temporalities

Mixing and lumping as spatial choices are inextricably bound up with temporal considerations, specifically those having to do with the phenomenon of *succession* in forest ecology. Succession, any introduction to forest ecology tells us, is the process by which afforestation is expected to take place in the absence of human interference (Bijlsma et al. 2010). Starting with open field home only to lichen, succession is the process by which a specific area gradually evolves into a fully established forest. After the colonization of such an area by small annuals, then perennials and small shrubs, and then finally, shade-intolerant trees, succession theoretically ends in a so-called "climax forest", which in these Western European conditions, depending on elevation and soil type, is usually a broadleaf forest composed of a relatively small number of species. Making new forest, then, can be described – as one forester does – as "kickstarting the succession dynamic":

> There's the phenomenon of succession of course, but really, we don't want to wait for that to happen. We want to plant trees now, in order for a forest microclimate to establish itself quicker.

In order to establish this desired forest microclimate, foresters plant sun-loving and fast-growing species that tolerate relatively poor soil. Foresters privilege Birch, for instance, as it is a good example of a "pioneer tree" that, without interference, would likely establish itself in such conditions anyway, much like the willow and black alder that are also a staple of afforestation designs. These trees provide adequate shade for more shade-tolerant species and their leaf litter enriches the soil, hence contributing to the survival of trees that depend on this rich layer of humus. Another pioneer species is the poplar, a species recently rediscovered for its capacity to metabolize nitrogen and in so doing, creating a more hospitable soil type for species like the oak. In later stages, the pioneer species will likely themselves be outcompeted by other species. This is not necessarily a problem: as they are decaying, they may start to qualify as "veteran trees", home to cavity nesters and other critters.

Planning a forest is, on the one hand, then, a process of kickstarting a more-than-human phenomenon of succession and forest development: of composing and cranking up an assemblage of evolving relations between tree species. But it is also a practice that requires, in the words of my informants, "aftercare", both immediately after planting and in the (much) longer term. In the early days of the new forest, aside from occasional watering and fencing

saplings off from hungry deer, it is especially important to make sure young trees survive their transplantation and the circumstances in their new habitats. But aftercare does not end there. Over time, specific tree species themselves may also become a problem for other species or even the desired forest at large. Here, it is not so much growth speed but growth *curves* over time that may create trouble. Beech trees, for instance, are relatively slow growers in their youth, but when they do arrive at their adult sizes, are highly competitive: not only do they cast a lot of shade on the forest floor, but their leaf litter is also so acidic as to suppress many kinds of vegetation and tree growth in the understory. Figure 3 is a picture, for instance, of a beech-dominated part of a forest, in which the understory has been markedly suppressed.

While planning a new forest is then understood as "kickstarting succession", this ecosystem temporality may also cause problems in the much longer term. Climax forests are notoriously unvaried due to the competitive advantages of climax trees, and an unvaried forest is vulnerable to unpredictable stressors. Planning a new forest in the present also generates the necessity, then, for continued and long-term management, one forester explains:

> [A]fter 30 years or so, we'll have to have a look if we need some work to be done, whether the species are developing themselves well or whether we have to correct a few things. We try to steer a little, and to make space for the species we like to see there.

"Correcting a few things", "steering a little": these phrases reveal the modalities of environmental management – and perhaps care – that become necessary for a forest to not only become but also *stay* varied and mixed. Succession can be "kickstarted", but it must simultaneously be kept in check in the longer run.

Planning a new forest emerges as a practice, here, speculating and *continuing to observe* what specific species are capable of – what relations they seek, what webs of interdependence they sustain, what modes of becoming they thwart. Noting that this process is fundamentally experimental and ongoing, forester Pete emphasized that organizational knowledges for this type of management are not always there:

> [Y]ou can't really go on anything, because fifty years ago, they [foresters] didn't work like this. We're consistently trying out new things and drawing lessons from it.

Coupled with unpredictable climate change, this makes the particular shape and form of the eventual forest – in Dutch, its "end image" (*eindbeeld*) – "highly uncertain". Planning a new forest, then, is an irreducibly anticipatory and speculative practice, in which the specific agencies of trees are mobilized to orchestrate a "vital" and "resilient" forest. It is also a practice of anticipating, in a Spinozan register, *joyful* relations between trees: relations that multiply the possibilities of individual trees and of the forest itself as an emergent effect thereof (see van Dooren et al. 2016). But planning a forest is also a practice of guarding against potential *sad* relations in these possible multispecies worlds, for instance, that between "invasive" species and the forest, or between species with different growth tempos. Crucial to these evolving and ever-changing multispecies relations are the differently paced habits and tendencies of tree species, which together make up the "polyphonic assemblage" (Tsing 2015, 23) that constitute a "forest".

Figure 3.
A beech-tree dominated part of a forest in the Veluwe, the Netherlands. Typical is the marked lack of an understory due to the acidic leaf litter of the beech. Photograph by the author, November 2022.

5. In the Thicket of Time: Understorying Anthropocene Response-abilities

Tracing the work practices that are set in motion in response to progress stories of climate adaptation, this piece has aimed to tell smaller, perhaps unheroic stories. Stories of foresters as bureaucrats who are writing reports and requests, attending meetings with local politicians and bureaucrats, and drafting up detailed planting plans behind their computers. Stories, too, about the particular kinds of forests being planned, and the particular kinds of management and care these forests will need in the future. In so doing, this piece has brought multiple temporalities into view. Aside from the long durée of forest ecology, we have encountered the pacing of bureaucratic due process and the agencies of legal infrastructures in ordering planning work. We have encountered, too, the way seasonal rhythms, themselves increasingly "out of joint" due to climate change, are throwing up unexpected temporal interferences that disrupt the project's forward-moving push. We have also encountered the forest itself as a becoming composed in time, and of times: emerging out of the differently paced growth curves and needs of particular tree species, these new forests appear, in Tsing's crucial phasing, as "polyphonic assemblages" (2015, 23) that require continued observation and care.

Taken together, these observations suggest that future-oriented work is itself irreducibly shaped by multiple temporalities. Plans, strategies, and visions may sketch progress towards a better, more sustainable future, but are active first and foremost in generating practices in the bureaucratic and ecological now (Doganova and Kornberger 2021). As such this piece builds on and extends approaches to future-making in actual practice, showing in particular how legal-bureaucratic forms and their agency, as well as nonhuman agencies and vulnerabilities shape the becoming of a planned forest. In this way, these observations can also be read as a response to a more hidden motif in dominant understandings of the Anthropocene, which paradigmatically approach it as the intrusion of geological time into human time (Chakrabarty 2018, 5). Yet this piece suggests that matters are more complicated. Not only is climate change deeply affecting the way we envision futures; the very practices we design in response are themselves irreducibly shaped by *thickets* of crisscrossing temporalities shooting off into various directions and futures.

Thinking in the temporal thickets of practice generates different stories. If, with Haraway, we emphasize that "the point is to make a difference in the world, to cast our lot for some ways of life and not others" (Haraway 1997, 36), we need a mode of thinking that is capable of starting "in the action" (*ibid.*, 36). Specifically in thinking time, I find resonance with Bensaude-Vincent (2022, 213), who emphasizes that we must have eye for the "small unheroic stories" and the "diversity and heterogeneity of temporal regimes" (*ibid.*, 217) to think ways to become and compose with nonhuman others toward an uncertain future. Caring speculation must be crucial in such attempts, precisely because forecasts and projections are betraying their limitations in times of runaway climate change (Petryna 2018, 570). Here, too, there might be important lessons for us to learn from and *with* these foresters. Engaging with the possibilities and desires of individual species within broader webs of interdependence and care, the speculative practices as I highlighted them here strike me as places from which to think broader modes of responding to ecological crises. Neither conservation of pasts states,

nor top-down, technocratic planning for the future suffice, after all, to meet what we euphemistically call "challenges". Instead, a radical sense of openness towards possibly nurturing and caring webs of interdependence that we may compose with seems more promising indeed. Composing-with, here, is neither a matter of full control, nor of a hands-off emphasis on "rewilding" (which often requires quite a bit of technocratic management and control). Instead, it is seeking a mastery in "non-mastery" (Taussig 2020). If we seek a "politics that grows not from opposition to or critique of our current systems but one that grows from attention to another way of being, one that involves other kinds of living beings" (Kohn 2013, 14), in the practices of these foresters we may just find the possibility of a broader ethics of engagement.

Notes

[1] Source: https://trilliontrees.org/.

[2] Forest cover in the Netherlands, World Bank Data 2021: https://data.worldbank.org/indicator/AG.LND.FRST.ZS?locations=NL.

[3] Bij12, *Het subsidie stelsel Natuur en Landschap (SNL)*: https://www.bij12.nl/onderwerp/natuur-subsidies/snl/.

[4] See Tsing, Anna L., Deger, Jennifer, Keleman Saxena, Alder and Zhou, Feifei (2021) *Feral Atlas: The More-than-human Anthropocene*. Available at: https://www.feralatlas.org/ (retrieved November 18, 2023).

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Foreclosing Infrastructure: On Permit Time and the Permission to Transit From Fossil to Renewable Fuels

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Abstract
Building on research on the time and temporality of infrastructure and climate, this article focuses on permit time, or the environmental permit as a temporal form of control. Based on an analysis of three environmental permit procedures in Sweden related to the fuel transition, the article argues that the permit can be seen as a process and device for managing and synchronising different times and temporal standpoints. Permits often lead to conflict and protests among various other stakeholders, involving temporal controversies, negotiations and compromises on infrastructure and climate futures. Permit processes therefore offer a fruitful means of studying the making of timescapes, as permits have often been issued on a continuous basis, but climate timelines and carbon rhythms may be changing this situation. Uncertain futures and the "carbon timeprint" of infrastructure may explain why Swedish courts are turning towards time-limited permits.

Keywords
infrastructure; time; temporality; permits; fuels; climate transition.

1. Introduction

How long should carbon emissions be permitted? This question comes under scrutiny when industries apply for environmental permits to establish new climate-friendly infrastructure: for example, when fuel companies aim to shift their production towards low-carbon fuels, renewables, or biofuels. In many countries, environmental permits are traditionally granted without a time-limit; however, such "eternal" permits are increasingly challenged, given the imperative to gradually diminish carbon emissions (Nordic Council of Ministers 2023). While the fuel transition is considered pivotal in addressing climate change, it is important to acknowledge that also low-carbon fuels contribute to the emissions driving climate change. Consequently, permits for new fuel structures often spark controversy, leading to lengthy negotiations and compromises regarding the duration and extent of permitted emissions, that is, how far into the future a permit and its permitted emissions may reach. Environmental permit processes thus perform crucial temporal work in this sense, yet this

aspect has largely been overlooked in literature focusing on infrastructure and climate times (e.g., Edwards 2003; Appel et al. 2018; Hetherington 2019).

This article contributes to research on infrastructure and climate by highlighting the permit as a temporal form of control. Based on a time-based analysis of three environmental permit processes in Sweden, I argue that the permit can be seen as a process and device for managing and synchronising different times and temporal standpoints. In this view, permit time is part of the infrastructured "timescape" of climate change. By "timescape", I refer to Barbara Adam's multi-dimensional view of time, and the understanding that different temporal elements, such as timeframe, timing, tempo and duration, may be out of synch but can be synchronised to fit certain interests (Adam 1998). The timescape perspective allows us to analyse infrastructure through the time horizons of permits and how the permit shapes not only the lifespan of infrastructure but also annual carbon emissions and the accumulation of carbon over time. Permit processes offer a fruitful means of studying the entanglements between the different temporalities of infrastructure, fuel production, and climate transition, and their mutual relations according to different actors.

The analysis centres around three recent permit applications by Preem, Sweden's largest fuel producer and one of Sweden's largest carbon emitters. Preem is striving to become the world's first climate-neutral petroleum and biofuel company. However, when the company applied for the environmental permits to implement its fuel transition plans, lengthy permit procedures and negotiations followed, and its old permits to produce fossil fuels were also called into question. Among the questions were whether old permits should be allowed to continue, and whether new permits should be issued with or without a time limit. Hence, permit processes offer an important analytical inroad to how different kinds of time and temporal standpoints clash, are negotiated and managed. In Europe, courts have been given the administrative powers to rule over major permit processes, a situation which gives courts a distinct control over the negotiations, and over infrastructures and their environmental impacts (Nordic Council of Ministers 2023). Swedish permit procedures imply that the company submits its application to the environmental court, whereafter relevant authorities and the public may submit comments which the applicant can respond to. Thereafter, a hearing is held (Swedish Courts 2023). Thus, the process leading up to the hearing is quite deliberate and may result in compromise. Disputes, however, do not merely occur in courts where permits are ruled upon, but also in the media and on the streets since permits often lead to protests, demonstrations, blockades and legal appeals by concerned citizens, climate movements and non-governmental organisations. These sites of climate controversy have been studied as a question of just transition (Lövbrand and Brodén Gyberg 2023). The low-carbon fuel promises have largely been understood as "techniques of futuring" (Oomen et al. 2021) as they give meaning and shape to a fossil-free future, one that may merely extend the fossil-intensive present (Brodén Gyberg and Lövbrand 2022). Building on this, I argue that the permit processes themselves are interesting sites for time and temporality scholars. As the analysis will demonstrate, diverse temporal standpoints clashed, and the courts were not always consistent in their verdicts but issued a mix of timeless and time-limited permits. Climate times also caught up with the corporate plan to expand fossil fuel production.

Hence, the permit offers an interesting inroad to examine temporal work from the more hidden and inverted view of infrastructure, such as from the legal angle (Bowker and Star 1999).

The timescape perspective has proved helpful for showing how different notions of time clash and are synchronised in the creation of climate-smart worlds (e.g., Kitchin 2019; Bensaude-Vincent 2021). More commonly, though, the low-carbon transition is approached by scholars as a temporal process, focusing on its duration, pace, and sense of urgency, as well as how its effects evolve over time (Delina and Sovacool 2018; Martiskainen et al. 2021; Sareen et al. 2021; Sovacool 2016; Sovacool et al. 2019). What is often overlooked is a more explicit examination of the temporal politics involved. Science and technology studies prompt us to inquire into how timelines, speeds, and other temporal notions are constructed and influenced by power dynamics, knowledge systems, interests, and technological progress (Marquardt and Delina 2021). This article therefore explores the various perspectives on permit durations, the underlying knowledge and interests shaping temporal viewpoints, the significance of conflicting timescales, and how courts intervene and mediate the temporal differences that emerge when new fuel structures are proposed. Indeed, it is crucial to examine the temporal intersections among infrastructure, climate and transition, and to consider who holds the authority in shaping these dynamics.

The following theoretical overview of the entanglements of infrastructure, climate and permit times includes an overview of permit times in Sweden to exemplify and background the analysis. Thereafter the Swedish context, methods and the three permit cases are described. The three cases are then analysed, followed by a concluding discussion that draws together the temporal role of permit processes.

2. Conceptualising Infrastructure, Climate and Permit Times

The temporal relations between infrastructure and the environment have long preoccupied scholars. Infrastructure is a slippery term, but it involves structures that connect and speed up. Timothy Mitchell (2020) has highlighted, though, that large infrastructure, such as energy plants, filling stations and roads, does not merely accelerate matters. Rather, their sheer scale, durability and political backing give them the power to delay and lag. A reason for this is that infrastructures typically demand large investments which rely on long-term payback to recover their high costs. While infrastructures have been built on the promise of speed, modernity, progress and development, they contribute to "engineered" landscapes and institutions and environmental impacts that last over time (Edwards 2003; Appel et al. 2018). In the economic sense, infrastructure is built in anticipation of a long-term future. They rely on "the long now" (Ribes and Finholt 2009), and political and legal guarantees are instrumental for securing this durability (Mitchell 2020).

2.1 Permit Times

Building on this, I argue that the environmental permit is an important device that may help stretch and protect the long-term lifespan of infrastructure. Like infrastructure, environmental permits tend to be oriented to the long term, and they often sustain the "long now" since permits are decided based on the present situation and are authorised by a given legal infrastructure and protected by current laws and regulations. When permits are unbounded in

time, it means that they take on a perpetual temporality, a continual and uninterrupted timeframe that may extend beyond the legal arrangements and political agreements that granted the permit in the first place. These so-called perpetual, eternal, endless or timeless permits are our long timekeepers because they reach far into the past and extend far into the future.

A review over Nordic environmental permitting processes shows that environmental permits are generally open-ended, except in Iceland where permits are issued for a specific period and must be reviewed at least every 16 years (Nordic Council of Ministers 2023, 41). In Sweden, there are many eternal permits that, together or alone, have major environmental and climate impacts: approximately 850 of Sweden's 6,000 permit-requiring operations were granted in accordance with the 1969 Environmental Protection Act and have not been retried according to the newer Environmental Act of 1999 (Miljöprövningsutredningen 2022). About 40 permits are older than 40 years, and the oldest permits date back to 1971. Time limits are used, for example, when environmental impacts are not yet known, or there is a need to evaluate new products or processes before giving an indefinite permit. Permit temporalities depend on many factors. Even in legal systems that are regarded as relatively close, there are differences that work "under the surface" (Nordic Council of Ministers 2023, 6). Permit time also differs between sectors. In Sweden, fuel permits tend to be indefinite in time, while quarries and wind and fish farm permits are time-limited (*ibid.*, 54-55).

Environmental permit time is a much-debated issue, though, specifically in relation to the political urge to fast-track permit processes to achieve a faster climate transition. Permit processes take time in themselves, involving environmental impact assessments and permit procedures, with their lengthy consultations, remits, public hearings and requests for supplementary investigation and information, and decision-making and appeal processes that may further prolong the processes. In practice, a "permit" is often multilayered and containing a combination of decisions made throughout the years as a company's activities may be regulated by different, amended, and add-on permits (*ibid.*, 39-41). These multi-layered permit timescapes have not attracted much attention among temporality scholars, but we can learn from migration research that the question of temporary and continuous permits and their processing time is central for how people perceive time and how it is controlled (cf. Maury 2022).

2.2 Synchronisation

One challenge now is to synchronize permit times to urgent climate times. A lagging aspect in Sweden is that permits are currently assessed against the Environmental Act, which has not been updated to consider the climate framework and climate law introduced in 2017. These stipulate that climate must permeate all politics and lead to the achievement of Sweden's climate goals. However, the environmental law that regulates the environmental permit does not yet reflect this ambition. In this way, permits contribute to the *when* of infrastructure (Star and Ruhleder 1996) as they refer backwards to the past. Permits may, therefore, serve as temporal barriers to change. Industries can delay renewing permits to avoid stricter rules and regulations. This is problematic because it allows operations to continue unchanged even when a re-examination would lead to significantly different requirements (Miljöprövningsutredningen 2022). A public worry therefore is that eternal permits may help conserve old technology

(Nordic Council of Ministers 2023, 70). In contrast, in Norway, the permit holder is required by law to work continuously to reduce emissions and adopt new technology, and changes that aim to reduce carbon emissions rarely require a new permit process (*ibid.*, 58-60).

2.3 Studying the Permit Timescape

What power, then, could the state-issued environmental permit have over the carbon emissions of fuel infrastructure? How can permit authorities possibly intervene in the temporality and permissibility of infrastructures and their carbon emissions, and what is the role, and opinions, of concerned citizens, climate movements and environmental organisations? When analysing these questions, it is also important to consider that time is a multi-faceted notion and that temporal standpoints can differ. As Adam (2008) has argued, questions surrounding timescapes are not merely about "when", "how fast" or "for how long" but are also about standpoint and perspective. It matters, for example, whether one assesses an infrastructure's impact on climate change from the standpoint of the present laws and regulations, or from the future. Institutions generally design the future for the benefit of the present and act as if the future is theirs to shape; that is, they approach the future from the standpoint of the present future. An alternative approach would be to orient actions from the future present. This would mean to consider that we are "acting and trespassing in the rightful domain of others", a perspective which belong to the realm of morals and ethics (Adam 2008, 7). The latter standpoint suggests that we must take responsibility for the future that comes with infrastructure. Adam's timeprint helps draw attention to this latent, potential effect of infrastructure and how far its impacts extend not just across space but also across time. Adam and Groves (2007) define the timeprint as the temporal equivalent to the "ecological footprint", a concept which asks us to consider the potential overreach of certain activities into the space of others. The "carbon footprint" similarly sums up the carbon emissions associated with producing and using a product. I believe it is useful to draw on these concepts to capture the "carbon timeprint" of permits. By "carbon timeprint" I mean the carbon emissions permitted by a permit over a specific duration. I will use this metric in the subsequent analysis.

3. Permission to Transit From Fossil to Renewable Fuels in Sweden

The remainder of this article focuses on Preem's fuel transition and the permit processes that have both held up and upheld infrastructural change in Sweden. Preem is Sweden's largest oil refinery company with two refineries on the west coast of Sweden, in Lysekil and Gothenburg. According to Preem's website, these together have a refining capacity of more than 18 million cubic meters of crude oil per year, which represents 80 percent of Sweden's refinery capacity. The company is also Sweden's largest producer of renewable transport fuels, and its current ambition is an annual production capacity of five million cubic meters of renewable transport fuels by 2035. Preem regards itself as a central actor in fossil-free transition and has been a close ally in Sweden's race to become the first fossil-free welfare state, by 2045 (Brodén Gyberg and Lövbrand 2022). Recently, the company brought forward its own climate target

and accelerated its measures to achieve climate-neutral operations with net-zero emissions throughout the value chain by 2035. The future has been a fundamental part of its image from its inception: the name derives from the English word pre-eminent, and its symbol, the happy bear, was meant to embody the company's soft, friendly profile (Wilson 2008). Its green plans have been matters of dispute, though.

3.1 Permit Cases and Material

We turn now to Preem's permit processes surrounding three projects: the so-called ROCC project, which was a residue oil conversion complex aimed at the production of low-sulphur fossil fuel, and the Syntas and HVO projects which aimed at processing HVO (hydrotreated vegetable oil) and animal fats to produce renewable diesel and aviation fuel. Figure 1 illustrates these three projects and the case proceedings that were a central part of the analysis. I refer to these materials in the text by using their case code. For the ROCC project in Lysekil, I analysed the application case M4708-16 and the appeal case M11730-18, as well as the materials published by environmental and social movements and the media, specifically articles in Sweden's most prominent morning paper, *Dagens Nyheter* (DN). For the Syntas project in Lysekil, I analysed the application case M5514-20 and the appeal case M8900-22, and for the HVO project in Gothenburg, I analysed the application case M2673-19 and the appeal case M11764-21. The court proceedings offered substantial material, including the company application and the opinions of authorities, individuals, and organisations, as well as the ruling. For this article, I focused on the summarised court proceedings as well as the original opinions by the four major environmental movements: 1) Swedish Society for Nature Conservation (SSNC), 2) Protect the Forest, 3) Friends of the Earth and 4) Greenpeace Sweden. The material was in Swedish, and translations, which have been checked for accuracy, were generated using online services. In analysing these materials, I focused on the different opinions of the stakeholders about the temporality of the new fuel infrastructure, and what temporal controversies and differences emerged, as well as how the court mediated and passed judgement on temporal issues, specifically what pertains to the duration of the permit. Ultimately, I wanted to understand how the environmental permit shaped and was shaped by infrastructural and climate times, and how permit processes can be seen to synchronise different kinds and understandings of time.

3.2 When Permit Processes Occupy Time: Foreclosing the ROCC Project

In 2016, Preem submitted an environmental application to the Land and Environmental Court for the ROCC project at their refinery in Lysekil. The permit involved the rebuilding and expansion of the refinery, from processing 11.4 to 13.9 million tonnes of oil per year. The reconstruction was mainly meant to enable the conversion of sulphur-rich residue oil into sulphur-free and metal-free fuels for marine transport. The International Maritime Organization had sharpened the rules regarding sulphur in shipping fuels, and Preem believed the market for oils with high amounts of sulphur would come to an end. The new structure involved a slurry hydrocracker whereby the oil molecules would be split into smaller molecules with the help of hydrogen. However, hydrogen processing is an energy-intensive process, and

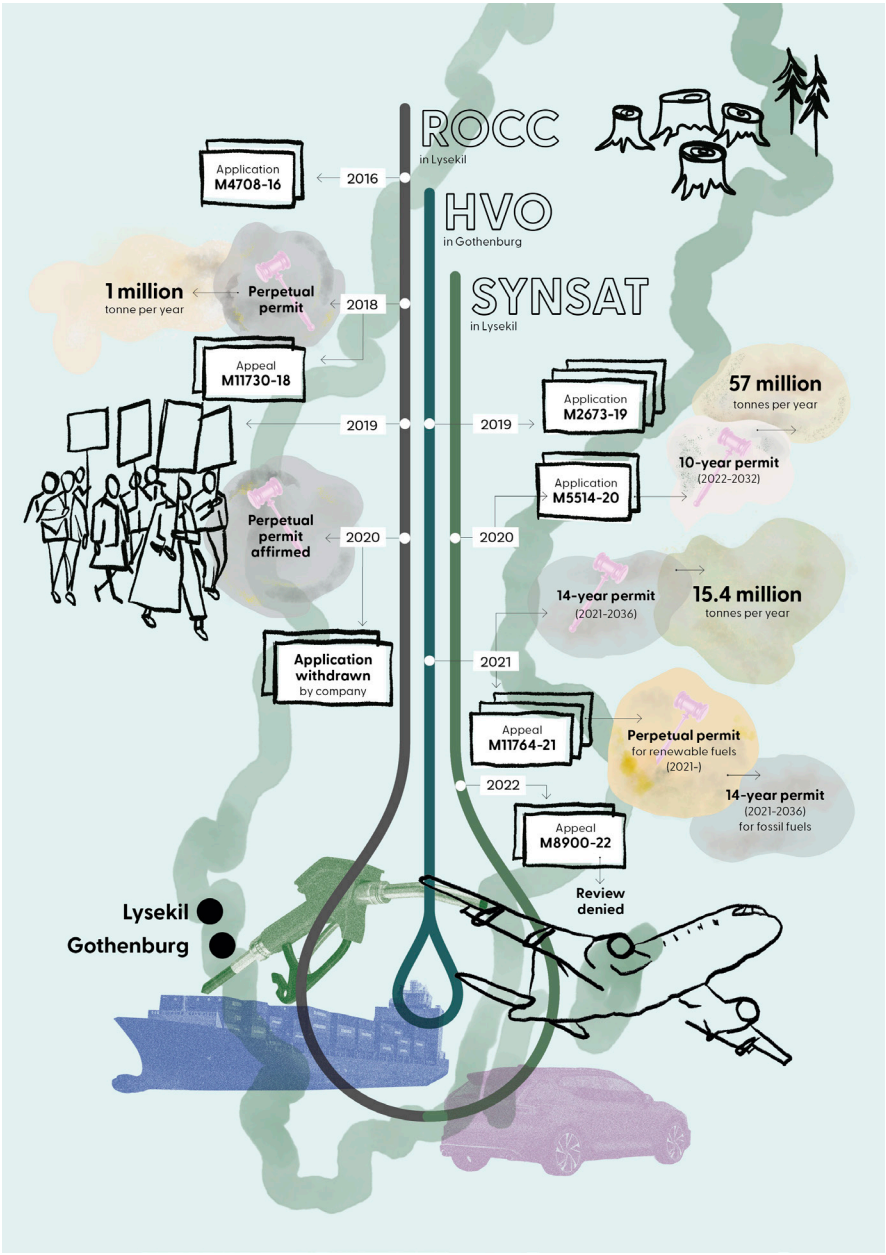

Figure 1.

Three permit processes were analysed, involving permit applications, public contestations, court proceedings and appeals. The clouds in the sky represent the "carbon timeprints" that accumulate from the permit decisions. Illustration: Victoria Skoglund.

the restructuring would lead to a doubling of the plant's emissions from 1.7 to 3.4 million tonnes of carbon per year. The proposal was very controversial on the grounds that it would turn the refinery into the largest emitter in Sweden, in sharp contrast to the demands by environmental organisations to phase out fossil fuels (Lövbrand and Brodén Gyberg 2023). The justification was that the new technology would reduce emissions in the transport system with nearly the same amount released through the hydrogen process, and that there were no other alternatives for green shipping fuels in sight (M4708-16, 48). The reconstruction was framed as a necessary and desired development considering the market's and society's increasing demands for more environmentally adapted products, which meant that refineries "must successively change or be dismantled" (*ibid.*, 67). The reconstruction was expected to cost SEK15 billion, and it would begin in 2022 at the earliest (*ibid.*, 33-34).

In 2018, the Land and Environmental Court granted the permit. This was the starting point for a massive mobilisation against Preem's plans to expand fossil-fuel production. The umbrella Network "Stop Preemraff" (Nätverket Stoppa Preemraff) was initiated by a small group of activists but quickly grew to include a wide set of individuals and organisations fighting for a common cause – a sustainable and just future (see Lövbrand and Brodén Gyberg 2023). For the Network, the project was deemed a climate disaster and shameful for a country such as Sweden, which held itself out as an international climate leader. Several environmental organisations and around hundred individuals appealed the decision, and the higher court agreed to review the case (M11730-18). After pressure from the environmental organisations SSNC, the Swedish Environmental Protection Agency (SEPA) and the Green Party, as well as two thousand emails from individuals, the government also made a first-time decision to assess the permissibility of the application based on climate concerns. That is, some permits may be preceded by a governmental decision on permissibility before it can be granted. In such cases, the court hands over its opinion to the government to guide the decision on permissibility, which in turn should only be a preliminary decision and "not a guarantee for a permit at the end of the day" (Nordic Council of Ministers 2023, 30).

From March 10-13, 2020, the court hearing and on-site inspection took place in Lysekil. The event gathered a large crowd: the judges and experts from the Land and Environmental Court, representatives from the company Preem along with its consultants, the Provincial government, SEPA, the appellants, media, researchers, environmental and social movements, and concerned citizens. On June 15, 2020, the appeal court gave its opinion to the government. It did not change the lower court's judgement but agreed that a permit should be granted. Like the lower court, the appeal court had no issue with granting a perpetual permit which would allow the operation to continue indefinitely into the future. According to the appeal court, the climate issue had no bearing on the decision. The court declared that the new climate law and goals had not led to any changes in the environmental legislation, which sets the ground rules for the permit assessment. Rather, the climate law only contains guidelines for the government's climate-policy work. The climate law, therefore, was deemed to have no legal effect on the permit review of individual activities, specifically not for businesses that are part of the emissions trading system for greenhouse gases within the EU. The court reasoned that for the Swedish climate goals to be met by 2045, the ambitions set out in the EU's emissions trading system must instead be raised (Swedish Courts June 15, 2020).

While the court's opinion should guide the government's decision, the governing Social Democrats and Green Party were free to make their own assessment and weigh in on wider social interests than the court had done. The Green Party expected that the government could use the new stop rule that had been introduced to halt activities that threaten the fulfilment of Sweden's climate goals (DN September 5, 2020). However, to journalists following the case, it was not clear whether the government could decide freely or must abide by the same laws as the court. This lack of clarity suggested that any decision could be appealed to the Supreme Administrative Court and to the European Court of Justice. Journalists, thus, foresaw that the final decision would lag (DN September 20, 2020). During this delay, Preem promised to reduce the emissions from the reconstructed fuel plant, from 3.4 to 2.7 million tonnes per year. The company avoided making these promises legally binding, however, e.g., by agreeing to a carbon-reduction schedule in the permit, on the grounds that the company had no control over legislation or the supply or costs of renewable resources; as the company representative stated to the press: "entering a legal process with commitments we have no control over is difficult" (*ibid.*). The newspaper, in turn, made sure its readers understood the magnitude of Preem's loose promises by projecting that the amount would still make the refinery in Lysekil Sweden's single largest source of emissions (*ibid.*).

Environmental and social organisations and concerned individuals intensified their protests. An "Occupy" movement was formed which organised actions across the country "to stop Sweden from committing one of the biggest climate mistakes of our time" (Stoppa PreemRaff 2020). While manoeuvring the COVID-19 restrictions, a range of dispersed activities took place in August–September 2020: postcards and emails were sent to those in power, debate articles were written, demonstrations were held, and streets and refineries were blocked by crowds of people (Stoppa PreemRaff 2022). Greenpeace's "Rainbow Warrior" ship blocked an oil tank out at sea while activists occupied Preem's head office, poured an oil-like substance and hung banners from the rooftop. The banners emphasised the priorities at hand: "Paris or Preem", "Change the system, not the climate", "Climate Justice for all", "Our future, not your business". Like other temporal "Occupy" movements, the Swedish-wide network reclaimed time as collective, shared and hopeful (cf. Brigstocke 2016).

Public resistance likely played a central role in foreclosing the application case. "We did it!", cheered the movement, as the company withdrew its application on September 28. This was seen as a milestone for the movement that had mobilised "to stop Sweden from committing one of our times' biggest climate mistakes. Together we blocked 1 million tonnes of carbon dioxide per year!" (Stoppa PreemRaff 2020). However, the company denied that the push-back from civil society had anything to do with the closure. Rather, Preem announced that the discontinuation was "a commercial decision based on a balance of the project's profitability and technical feasibility" (Preem 2020). The COVID-19 crisis and its effects on the world economy had contributed to the project being no longer commercially viable, while new political decisions, such as a more ambitious reduction obligation, had increased the demand for renewable fuels and improved the investment climate for those kinds of investments instead. The Network, though, doubted the financial reason would have worked on its own: "had the application not been appealed in the first place, they would probably have already started construction" (Stoppa PreemRaff 2022).

These are all temporal speculations, but they show that the timeframe is much more than chronological. The four-year delay turned out to be decisive. The signs that time was running out for fossil fuels had become clearer. The company said the external circumstances could not have been predicted in 2016, but four years on, they had made the ROCC application obsolete (Preem 2020). Media speculated on the politics of the delay, whether the Green Party in power had handled the application "by exhausting the oil company with an incredibly long legal process" (DN September 20, 2020). Indeed, four years earlier, the Paris Agreement had been the loose governing tool, but since then, Sweden had introduced a climate policy framework and climate law which stipulated that climate must permeate all politics that are pursued and must lead to the achievement of Sweden's climate goals (DN September 29, 2020). The dragged-out process moved the decision to a new temporal context where the company decided to leap straight to renewable fuels. According to Preem (2020), the decision to close the ROCC project beforehand had freed up resources to accelerate the renewable transition, and a new application was quickly submitted to enable large-scale production of renewable fuels.

In the media, this corporate decision was framed as a historical one and a sign that climate change had brought about "an era where emissions count and can determine investments" (DN September 29, 2020). According to one editorial, the decision was "not a one-off, but a trend break" towards neoliberal climate action wherein being climate-smart pays off in the long run:

> It is much healthier and more effective to have a policy that creates incentives for companies and individuals to steer their own actions towards a climate-smart existence, than for governments to step in and poke at individual company issues. Partly because in this way you avoid arbitrary abuse of power, but above all because it creates a long-term perspective and stability that makes the calculation predictable for companies that want to invest in innovative and fossil-free solutions (DN October 15, 2020).

In the next sections, we will see that renewable projects also have some issues with time.

3.3 When Permits Become Limited in Time: The Ten-Year Synsat Permit

On December 23, 2020, Preem submitted a new permit application for a Synsat project in Lysekil (M5514-20) aimed at refocusing the plant towards renewable fuels and biofuels. The hydrocracker that had been designed to convert heavy fossil-based oil was to be repurposed to process biomaterials, such as rapeseed oil, pine oil and recycled frying oil. The restructured plant aimed at processing HVO, which is short for hydrotreated vegetable oil, but can contain animal fats as well. HVO had become a popular fuel in Sweden. Unlike biofuels, it has diesel-like properties and can be mixed with fossil diesel at any rate. It began peaking in 2016 when it was sold as renewable diesel in mixed or pure form. Preem also planned to adapt it to aviation fuel. The reconstruction would allow a renewable share of up to 40 percent, which corresponded to up to one million cubic meters of renewables. In the application, Preem pointed out that it was an environmental improvement measure and an important step in the urgent transition to achieve Sweden's climate goal by 2045. It would lower transport emissions by 1.2 to 1.7 million tonnes of carbon per year. The climate benefit was premised on

the accounting rule that renewables are climate neutral. Preem hoped an amendment permit would suffice for this beneficial project, and that it could simply be added onto the original permit from 2004. After all, the original production would not increase but would stay within the maximum annual throughput of 11.4 million tonnes. Over time, fossil fuels would gradually decrease to make room for renewable fuels.

However, stakeholders began raising the idea of making the permit time-limited. There were doubts that the move to renewables would contribute to a climate transition, specifically since fossil-fuel production would continue at high levels and the application was vague on the volumes and biomaterials that would be used. Due to these uncertainties, SEPA and the Provincial government believed there was a need to time-limit the permit to the end of 2030. SEPA believed that if the Synsat permit was set to run out in 2030, it might trigger a reassessment of the entire operation. By 2030, the original permit would be more than 25 years old. The Provincial government agreed and anticipated that when the expiration time came, there would be more opportunities to consider carbon in permit reviews and more clarity on whether it was possible to regulate carbon emissions. The expectation was that carbon regulations might also cover industries that are part of the carbon-trading system in consideration of EU law (M5514-20, 70). Thus far, the Swedish courts had found no legal backing for considering carbon emissions beyond the fuel plant, despite Sweden's climate law that was introduced in 2017. By suspending the process, a time limit might work like a lifejacket until climate-sensitive rules came on board (cf. Appel 2018).

Environmental movements were not as accommodating. They opposed the expansion and argued that the basic permit needed to be reconsidered "now", not later in time. SSNC claimed that permission for extensive carbon emissions was not compatible with the Swedish and EU climate goals, especially since the EU rules stipulated that all sectors should play a role in achieving climate neutrality by the year 2050, regardless of whether or not they were covered by the emissions-trading system (M5514-20, 80). The Network found further support for this thinking in the preparatory work for the Environmental Act which stipulated that "Permits that have been issued according to older law for unlimited time must be able to be time-limited, if it is necessary for Sweden to fulfil their international commitments" (cited in M5514-20, 103).

The environmental movement Protect the Forest contributed to this reasoning by calculating the annual carbon timeprint. It was not only that Preemraff Lysekil releases 1.7 million tonnes of carbon at the refinery, but that 11.4 million tonnes of crude oil would generate emissions in the magnitude of 7 million tonnes of carbon dioxide in the extraction stage and around 50 million tonnes of carbon dioxide in the consumer stage. This amounted to a total of 57 million tonnes per year, which was larger than Sweden's territorial fossil emissions (Protect the Forest in M5514-20, Annex 34). Greenpeace also pointed out that the atmosphere does not differentiate between a "black" or a "green" carbon dioxide molecule, but that all emissions within the next ten years will cause climate damage. The basis for counting biofuels as climate neutral is that the now-living plants that are burned up will eventually grow back and bind the carbon into the biomass. Yet, the environmental organisation drew attention to the critical time aspect, noting that the timeframe that this calculation relies upon "is far too distant" in relation to when reductions are needed (M5514-20, 86-87).

> It takes 60-120 years before the trees that have grown back have taken up the same amount of carbon released when they were felled. Science is at the same time clear; we must already now radically reduce emissions. If the trees had instead been allowed to stand, the emissions would have been prevented. The trees had also continued to bind large amounts of carbon during the same time. (Greenpeace in M5514-20, 87)

Greenpeace argued that producing biofuels was a counterproductive use of time since biofuels merely provide fossil companies with a green alibi: "It is a socio-economic misprioritisation, lost time for critical climate work, disaster from a climate and environmental point of view" (*ibid.*, 88). Environmental movements were quite coordinated in their view that renewable fuels had no place in a climate-smart future.

The company seemed certain that the legal tradition of issuing perpetual permits would hold, especially for renewables, which were part of the future; and it was adamant that facilities that "are rebuilt or built to produce renewable fuels should reasonably not be time-limited because they will have a designated socially important function for a long time to come". A time limit would make the urgent transition more difficult (*ibid.*, 117). The company made clear that a lack of "guaranteed legal survival" would make it difficult for the project to proceed:

> The requested changes are based on billions of investments that will be subject to depreciation and may have a repayment period that runs up to – and past – the proposed time limit. Carrying out the changes and then running the business with a given end date for the change permit is, to say the least, difficult in terms of being able to obtain the capital that the changes and maintaining the operation require. If the permit is in danger of ending at a certain time, uncertainty and risk increase to a significant extent, which in turn means that the possibility of obtaining financing decreases and the cost of financing the project increases. (*ibid.*, 115-116)

Preem confirms here the long infrastructural time that they argued was needed to recover the investment (cf. Mitchell 2020). A perpetual permit was so important to Preem that the company offered to submit the entire operation to a permit review by the end of 2025, provided that the Synsat permit was not time-limited (M5514-20, 117). In the eyes of the court and authorities, however, the crux of this promise was that it would not be legally binding. The court did not see this as a viable bargain, and SEPA read it as an invitation to regulate the transition more strictly.

On June 20, 2022, the Lower court granted a time-limited permit for the Synsat project, valid until the end of 2032. The court gave permission for a yearly throughput of 11.4 million tonnes and 250,000 tonnes of fossil or biogas, and the ruling specified that a maximum of 1 million cubic metres could be renewables. A time-limited permit means that a new review must take place for the business to continue; otherwise, the project must be abandoned and revert to the operations that were covered by the original permit. The court admitted that a time limit can be costly and time-consuming for the company, but it suspected that the permit would be outrun by fast technological developments. Another motive was the "doubts" and "inconveniences" concerning the renewable raw materials that would be used (*ibid.*, 125-127). These were mild terms that glossed over the many counterclaims that had been raised by the environmental movements. The company had deferred many of the decisions to the real-time sit-

uation, to "the present present" (Kitchin 2019), which made the future very uncertain. Preem meant that the share of renewable raw materials would vary over time depending on availability, price/margin, changed sustainability criteria and changes in regulations, and thought it was important not to tie the permit to certain explicitly stated raw materials or carbon reduction. Again, a more binding transition plan was considered impossible (M5514-20, 19-23, 118). The court judged that a ten-year temporary permit was fair under these circumstances.

Three environmental organisations appealed, but the Appeal court saw no reason to review the case. In the appeal, however, Greenpeace offered the carbon timeprint of the permit to emphasise the effect of the permit over time. A throughput of one million tonnes of raw material per year meant "it is a decision that concerns ten million tonnes of raw material, which is far beyond the amount most permit processes deal with, even those without a time limit" (M8900-22, Annex 3).

Greenpeace further highlighted that Preem's facilities in Lysekil and Gothenburg alone would account for more than 100 percent of Sweden's emission budget in 2045. This would conflict with competition law as there would be no emission space left for other industries. In this view, the court had foreclosed Sweden's climate future in substantial ways. Greenpeace noted that the court gladly considered matters that worked in favour of Preem's application, but to be perceived as fair, it must also consider processes that disadvantage it, such as the EU's phasing-out of combustion engines and the stricter requirements for the protection of standing forests and biodiversity (M8900-22, Annex 3). Friends of the Earth pointed out another temporal disorder which was that the government had preceded the Synsat permit procedure by granting a green credit guarantee for the project the day before the court hearing. This was perceived as the wrong order of doing things. Critics suspected that the government had influenced the court's decision and thereby violated the independence of legislative power and justice (M8900-22, Annex 1). This out-of-order decision-making troubled citizens' trust for the legal and political apparatus, but it was not cause enough for the Appeal court to review the case. The Appeal court had already stated its views on infrastructure for renewable fuels in the application case of the HVO project, to which we turn next.

3.4 Permits As Opened and Closed: The HVO Project

The HVO project in Gothenburg was initiated in 2019 when Preem sought permission to process 7.6 million tonnes of raw materials. Preem already had a permit for processing 6 million tonnes of raw fossil materials and wished to acquire a permit for an additional 1.6 million tonnes of renewables. The company admitted that the reconstructed plant would demand more energy and emissions, but the increase was justified by the overall reduction of fossil emissions at the end of the pipe, which was "more than 30 times larger than the increase of fossil carbon from the refinery" (M2673-19, 51).

On September 10, 2021, the court issued a temporary 14-year permit, valid until end of 2036. The court believed that Preem was moving in the right direction but noted that the company's high fossil-free ambitions were not equally manifested in the applied-for levels. The promise of a green transition clashed with the sustained fossil-fuel volumes, and the court judged that the pace of the transition demanded a tighter time-control, hence the time limit. Again, the 2036 endpoint was a compromise. SEPA argued that the permit should be valid until the end

of 2041. The Provincial government proposed the end of 2035 so that it aligned with the provincial goals. The Environmental and Climate Committee of Gothenburg City also wanted a time-limited permit but trusted the court to arrive at an appropriate duration (*ibid.*, 73).

The environmental organisations had tried to convince the court that retrying the entire operation was not only possible but also desirable. The Network that was determined to stop Preem's expansion leaned on climate experts who argued that climate issues can indeed be considered in environmental assessments. In jurisprudence, though, there was a prevailing belief that carbon emissions should not be regulated in individual permits. The reason was that emissions are of a more global nature than the local environmental issues that are normally considered in permit assessments. However, the Network tried to nudge the court to rethink climate as an environmental issue:

> Legal practice has long been to draw a dividing line between environment and climate, a line that in reality does not exist. Natural science says the exact opposite, that environment and climate are closely intertwined and cannot be considered independently of each other. Jurisprudence should reflect the reality we live in and acknowledge that Preem Gothenburg's emissions contribute significantly to both the climate crisis and the crisis in our environment (Network Stoppa PreemRaff in M2673-19, Annex 82).

From the Network's perspective, it was completely unreasonable to grant permission to continue to emit such large amounts for many years to come "when what we should be doing is demanding phase-out" (M2673-19, Annex 82). When the Network calculated the timeprint of the 14-year-long permit, it figured it would increase the production of fuels by 25 percent which would increase emissions by the same percentage. The annual emissions of carbon dioxide would amount to 15.4 million tonnes per year and accumulate to a much larger figure over the years.

> In total, during the 14 years that the permit applies, the emissions will be approximately 215 million tonnes of carbon dioxide. About two-thirds of Preemraff Gothenburg's production is exported and one-third is sold in Sweden. Emissions in Sweden from Preemraff Gothenburg's products will be 71 million tonnes of carbon dioxide, which corresponds to roughly a quarter of Sweden's remaining emissions budget (Stoppa PreemRaff 2022).

The "timeprint" (cf. Adam 2008) weighs heavy when the climate is concerned. According to environmental law, such activities should not be carried out since they risk that many people "will have their living conditions significantly worsened or the environment will deteriorate significantly". This would also violate the Convention on the Rights of the Child, since the depletion of biodiversity destabilizes the Earth's system and triggers food and water crises that threaten children's right to life: "the children of the future will be hit even harder". The Network emphasised that not only human lives were at stake. Sweden already has 1,200 species that are acutely or highly threatened, of which half belong to the forest, which would be threatened by biofuel production. The legitimacy of the fossil-free welfare state was also called into question. To the Network, Sweden, as a welfare state, has an obligation to take the lead in the transition (M2673-19, Annex 82).

The 14-year-long HVO permit was appealed by actors across the board (M11764-21). Despite the short appeal period of just three weeks, a total of 110 appeals were submitted by organizations and individuals, and many requested injunctions to prevent the company from starting to build before the case was heard. The company also appealed. Preem agreed to the time limit pertaining to fossil-fuel production but contested the time limit for renewable fuels and for the fossil carbon needed for renewable production. At this point in time, Preem had pushed its climate goals ahead to 2035, which might explain why the company so easily agreed to time-limit its production of fossil fuels. The Appeal court agreed to review the case and ruled in favour of the company's claims.

On June 1, 2022, the Appeal court revealed its verdict (M11764-21). The court removed the 2036-time limit for the renewable stream and the time limit was also lifted for the fossil fuels used in renewable production. The court found no compelling reason to limit these flows in time. Clear reasons were needed to break the tradition of granting timeless permits, and the court did not foresee any viable alternatives to using fossil oil and gas in the production of renewables. However, a limit on the yearly throughput of crude oil by 2036 was deemed desirable, and since the parties had agreed, this was easily decided. This was an important milestone. The company had applied for a permit to expand renewables and ended up with a time limit for the fossil fuel operation. Hence, new permit processes may undo what was permitted before and set new rhythms, timelines and deadlines. But the permit procedures alone cannot achieve this. Instead, many factors shaped the timetables that were agreed upon by the company, authorities and the court. The environmental organisations, however, never signed off on the idea that renewables were part of the long-term future. Greenpeace Nordic punctuated this notion in a recent publication: "The sky is full" (2023) develops the idea that it does not matter whether fuels are fossil or biogenic but all carbon emissions prolong the climate crisis. Figure 2 reflects this notion that carbon timeprints accumulate in the air.

4. Concluding discussion

In this article, I have argued that we can gain a deeper understanding of the infrastructured timescape of climate change by considering permit times. The analysis of three environmental permit processes in Sweden shows that the time of the permit is a central timekeeper in the climate transition. Permit proceedings expose the temporal differences and tensions that exists when new low-carbon fuel infrastructures are proposed against the backdrop of old fossil-fuel permits. The multiple opinions on the time horizons of new fuel structures suggest that temporal issues are difficult to agree upon. Nonetheless, new times are "made" through these processes.

First, when permit processes occupy time, and when processes are lengthy and delayed, the passage of time can play a powerful role. The ROCC project, which aimed to expand fossil fuel production, was eventually withdrawn by the company itself. The sense of climate urgency and changing market conditions seemingly rendered plans to expand fossil fuel production obsolete. This is telling in light of the political ambition to fast-track permit procedures in order to accelerate the climate transition. A crux of speedy procedures is that they leave less time for democrat-

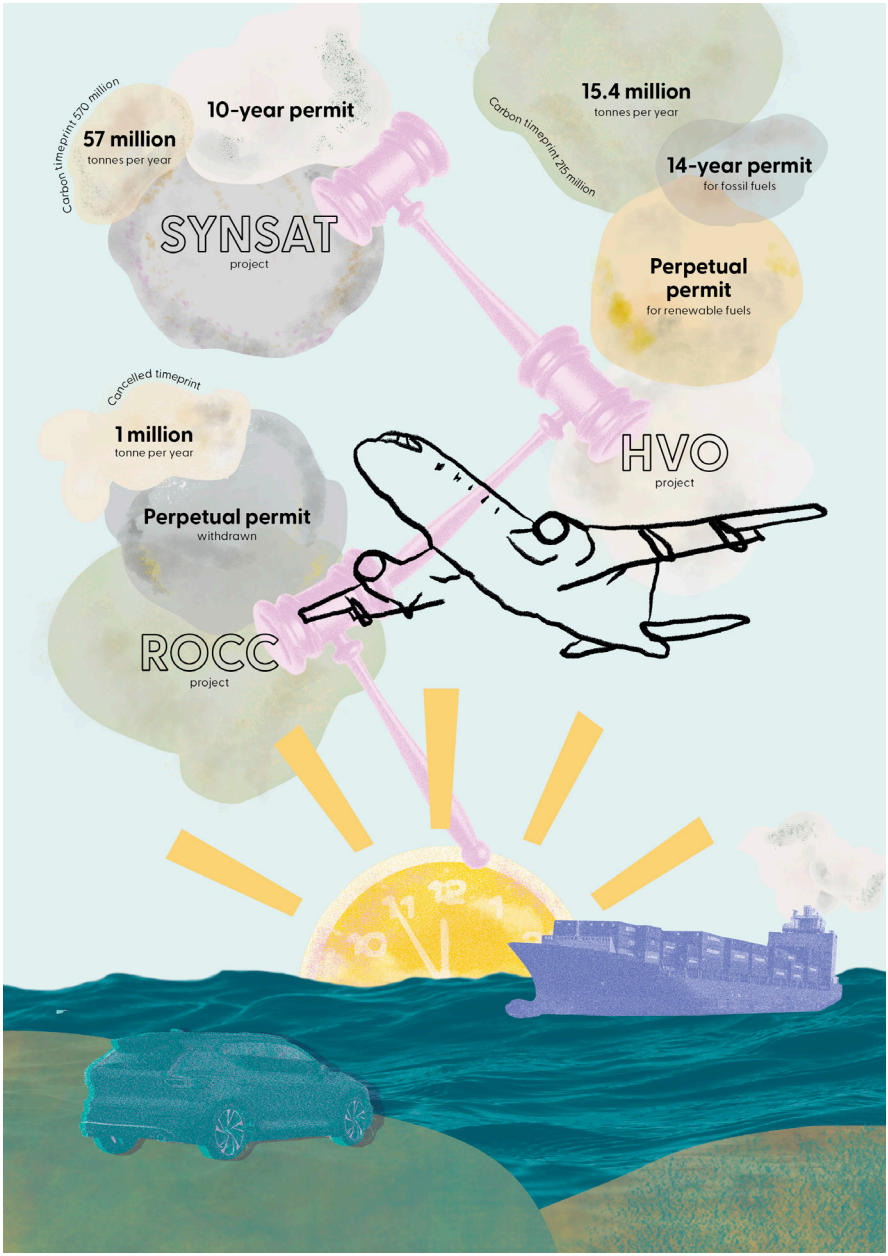

Figure 2.
Today's permits shape tomorrow's climate through their carbon timeprints. Carbon emissions accumulate over the length of the permit, or indefinitely if permits are unlimited in time. Illustration: Victoria Skoglund

ic processes to settle the many temporal controversies that emerge when new infrastructures are proposed. The Nordic permit review also notes that is necessary to weigh the political urge for swifter permit processes against the need for transparency and public participation in the permit system (Nordic Council of Ministers 2023, 41). Courts and the legal sphere must also be challenged to account for carbon emissions in permit reviews, and to recognize that today's permits cannot merely be judged from the standpoint of the present but also from the future. Permit decisions are matters of temporal justice, but many issues raised by concerned citizens and organisations were left aside, such as the broader and long-term impacts of the new infrastructure.

Second, when permits are becoming limited in time, it may suggest that the era of eternal permits is running out. Time-limits were proposed not merely as a way to manage uncertain technologies and environmental impacts, but the negotiations also resulted in time-limits for conventional fossil fuel production. New practices thus emerged to constrain the temporal reach of infrastructure and their carbon emissions. Perhaps controlling the length of time was one way to manage the climate transition when using carbon as legal justification was deemed a no-go. By introducing time limits, the carbon timeprint also became easier to imagine and estimate. Time limits, therefore, do something to how one can perceive and contest the infrastructured timescape of climate change. Perhaps eternal permits are even becoming a thing of the past. It may be that we are approaching a moment when courts decide that eternal permits are untimely, and that it is necessary to go beyond linearity and predictability towards a conception of time as open to unpredictability, recognizing our poor knowledge of potential outcomes (Adam and Groves 2007; Adam 2008; McNeilly 2018). While the fuel company mobilised uncertainty to avoid a strict climate transition plan, uncertainty may also be used by permit authorities to constrain the reach of uncertain infrastructure. Time-limited permits have previously been used for uncertain projects, but in these uncertain climate times, they may move from being the exception to the standard. Still, time limits are not welcomed across the board, but they have become part of permit practice and discourse; for example, a recent permit overview recommended that Swedish permits should be reviewed every tenth year and that no permit should be more than 40 years old (Miljöprövningsutredningen 2022).

Third, when permits can be both open-ended and time-limited, the choice gives an indication of how specific fuel futures are perceived. Seemingly, the difficulties of foresightedness seeped into the courts' deliberations on requiring time limits for the horizon of fuels, but not in straightforward ways. While the lower court granted temporary permits for co-processing fossil and renewable fuels, the higher court revoked this decision and firmly made renewables part of the long-term future. Hence, the permitted temporality that has emerged through these cases is both continuous and temporary, as well as controversial. By "foreclosing infrastructure" I mean to signpost the possibility that infrastructure may be closed ahead of time, and that once issued permits can be time-limited or revoked. But "foreclosing" also works as a reminder that infrastructure may reach far into the future and accumulate climate damage that forecloses the future of next generations (cf. Appel et al. 2018). It is an important reminder that infrastructure works on time in numerous ways that are not well understood (Mitchell 2020). While we might want to think about infrastructure as structures that speed things up, such as the flow of energy or the climate transition, infrastructure does not merely make things run faster. Infrastructure can work as an apparatus of delay (Mitchell 2020), even as an appartus that fore-

closes futures. For those counting on renewables being climate neutral, these permits will help accelerate the climate transition, but for those who count the carbon timeprint, the permits will merely delay the climate transition and potentially foreclose human and nonhuman lives in the process. This moral understanding of time differs significantly from the temporal standpoint taken by the courts, where available technologies, contemporary regulation and local environments delimited what was considered. Even so, climate temporalities seeped into the deliberations and continuously influenced what was permitted: those who applied, intervened, appealed and judged used climate rationales to both oppose and support the permits. The ways multiple temporalities must be juggled supports Adam's (2008) notion that "the more types of time involved, the more difficult becomes the task of synchronisation and timing".

In this way, the permit adds a layer to the temporal notions of infrastructure. If imagination is about the possible, aspiration about the desirable and anticipation about the likely (Appadurai 2013; Aalders 2020), then permission is about the permitted. Like other modalities, permission is not about what will happen but about what can happen – the possible. This offers an additional way to think about infrastructure as matter out of time by focusing on that which is legally allowed, but not what is obliged. This legal acceptance, and questions of permission and permissibility, warrant more attention. The deliberative processes associated with permits will also continue to be interesting entry points for understanding and changing the perception and control of time. Old, perpetual permits are difficult to uproot using legal means, but perhaps permit processes can be one avenue where actors come together to reconsider the continuation of the past in the face of climate change. Permit processes do not merely work by looking forward; they fold time by revisiting past decisions and potentially overturn their hold on the future. New infrastructure and its permit processes may, in this way, trigger new temporal relationships, as they can work back in time and erase old permits and make new times happen.

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M11730-18	Svea Hovrätt 2019 (information by Higher court).
M5514-20	Vänersborgs Tingsrätt, Markoch miljödomstolen 2022 (ruling by Lower Environmental court).
M8900-22	Svea Hovrätt, Markoch miljööverdomstolen 2022 (protocol by Higher Environmental court).
M2673-19	Vänersborgs Tingsrätt, Mark- och miljödomstolen 2021 (ruling by Lower Environmental court).
M11764-21	Svea Hovrätt 2022 (protocol by Higher Environmental court).

Time, Infrastructure and Knowledge: Rethinking Temporality in the Anthropocene

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Abstract
The contributions included in this Crossing Boundaries section reflect upon infrastructural temporality, chronopolitics and natural history in relation to the Anthropocene and climate change. Vando Borghi examines infrastructure capitalism and regimes of historicity, arguing that infrastructural synchronization dispossesses individuals of agency, producing "uncertizenship". He invites us to delve into "ruins thinking" and an "epistemology of coordination" to inhabit this condition and re-territorialize infrastructures. Luigi Pellizzoni interrogates whether the Anthropocene narrative represents a break from or continuity with late capitalist modernity's politics of time. Addressing the concept of "non-trivial futures", he argues that the Anthropocene aligns with and strengthens capitalism's recursive temporality and secular eschatology, opening space for conservative or reactionary designs. Finally, Paolo Savoia traces a "revival" of natural history in the environmental humanities, enabled by temporal short-circuits between the 16th and 21st centuries. Early modern natural history is revealed as preluding anthropology that blurred nature-culture divides and anticipates a notion of "third nature" which challenges the scalability logic characteristic of modernity.

Keywords
Anthropocene; regime of historicity; politics of time; infrastructural capitalism; uncertizenship; natural history.

1. Guest editor's note

The three contributions in the Crossing Boundaries section follow up a discussion initiated at the workshop "The Faces of Gaia. Climatic regimes, Social orders, and Senses of Ecology", held on June 6 2024 at the Department of Philosophy, University of Bologna. This workshop aimed to critically examine the complex temporalities and worlding practices unfolding in response to Climate Change and the Anthropocene.

The participants to the following dialogue engage with the entangled, non-linear time of ecology in which the pursuit of alternatives to growth-based models has yet to catalyze transformative change. They interrogate the climate exploring their scalar dynamics, un-

derlying interests, mobilized entities, and political, technological and ecological entanglements, proposing novel approaches.

Rather than framing climate crisis as a punctual emergency confined to the present, the contributions situate it as a process redefining policies and relations of coexistence, social orders, and timescapes. Attention was directed to redefining nature-culture relations, to shifting future-making logics and the ideas and interests shaping climate adaptation and mitigation efforts and their supporting knowledge infrastructures.

The dialogue works at the intersections of critical theory, sociology, political ecology, philosophy, history of science. It reflects upon infrastructural temporality, chronopolitics and natural history in relation to the Anthropocene and Climate Change. Vando Borghi examines infrastructure capitalism and regimes of historicity, positing that infrastructure synchronization dispossesses individuals of agency, producing "uncertizenship". He invites to delve into "ruins thinking" and an "epistemology of coordination" to inhabit this condition and re-territorialize infrastructures. Luigi Pellizzoni interrogates whether the Anthropocene narrative represents a break from or continuity with late capitalist modernity's politics of time. Addressing the concept of "non-trivial futures", he argues that the Anthropocene aligns with and strengthens capitalism's recursive temporality and secular eschatology, opening space for conservative or reactionary designs. Finally, Paolo Savoia traces a revival of natural history in the environmental humanities, enabled by temporal short-circuits between the 16th and 21st centuries. Early modern natural history is revealed as a preluding anthropology that blurred nature-culture divides and anticipates a notion of "third nature" which challenges the scalability logics characteristic of modernity and capitalism.

Across these diverse perspectives, the pieces reveal the complex temporal politics at stake in conceptualizing and responding to contemporary ecological transitions. In doing so, they open possibilities for alternative chronopolitical imaginaries, conceptualizations and inventions.

Uncertizenship: Infrastructure, Ruins and Regimes of Historicity

Vando Borghi

More than twenty years have passed since the accident, yet I have been asking myself ever since: what was I bearing witness to, the past or the future? ... I see Chernobyl as the beginning of a new history: it offers not only knowledge but also prescience, because it challenges our old ideas about ourselves and the world... Chernobyl is, above all, a catastrophe of time.
Svetlana Alexievich, *Chernobyl prayer. A Chronicle of the Future*, 2016

Where imagined future ruins were once the objects of metaphysical fancy or hubristic imperial dreams, the modern ruin is always, to some degree, a palpable, all-too-real remnant of the future.
Brian Dillon, *Fragments from a History of Ruin*, 2005

1. Infrastructure capitalism and regimes of historicity

Our present is that of infrastructure capitalism.

> By infrastructural capitalism, we refer to a form of capitalism that is built on the production and expansion of intersecting physical and digital infrastructures, [...] This concept encompasses the concrete infrastructures of roads, cities, high – speed rail, and logistics transportation [...]. At stake in infrastructural capitalism is the material base of all other forms of materiality of capitalism, namely extractive capitalism, monopoly capitalism, and digital or platform capitalism. (Lin and Ngai 2021, 651)

In truth, it is not just about the "material basis of all the other forms of materiality of capitalism", but more broadly about the way in which our experience of our relationship to the world and to other living beings depends in an increasingly decisive and capillary way on the infrastructures on which contemporary forms of life are built (Borghi 2021). Moreover, infrastructure capitalism is not only capitalist but also neoliberal: an unprecedented interpenetration of state and market structures produces what Keller Easterling has called "extrastatecraft" (Easterling 2014), flanking the expansion of market logic with an increasingly intense neoliberal bureaucratisation of the world (Hibou 2012).

It is therefore in infrastructure capitalism that the relationship between past, present and future takes shape, i.e., the "regime of historicity" (Hartog 2003) with which we are concerned. The regime of historicity to which we belong has several aspects of continuity with the past. It is a past in which the relationship with time is highly spatialised, expressing in the concrete expansion inherent in the colonial conquest of lands the idea of a globalising modernisation projected into the future. A temporality characterised by linear and homogeneous evolution, on which the very idea of development was and is based.

Not only development in the socio-economic sense, but a more general "Cosmopolis", to use Stephen Toulmin's expression, in which even knowledge has become increasingly abstract, deterritorialised, detached from specific problems and experiences, as has the temporality with which it is associated (Toulmin and Toulmin 1992). In this space-time combination we can easily see the roots of the project of *scalability* (Tsing 2012) as a specific way of structuring the relationship with the world, a projectuality that banishes all diversity and specificity, imposing itself in an equal and standardised manner in every context. The infrastructures of contemporary capitalism are part of this history.

2. Uncertizenship: Infrastructure Synchronization and the Planet

However, alongside the elements of continuity that infrastructure capitalism represents in relation to the past, there are also elements of discontinuity. In a nutshell, these discontinuities can be summarised in two main themes. The first concerns the unprecedented degree of *synchronisation between infrastructures of things and infrastructures of experience* (Borghi 2021). This has to do with the peculiar ontology of infrastructures, about which I will say more in a moment. The synchronisation of infrastructures has been initiated, on the one hand, by the changes in the organisation of production processes that began in the late 1970s, aimed at introducing just-in-time, and, on the other hand, by the revolution in logistics, which has played an increasingly important role since the invention of the container in the 1950s, to the point of becoming the core of the interpenetration of production and distribution processes. These two drivers then merged with a financial economy capable of producing or consuming wealth in *real time* (that is a sort of gen just-in-time extended to the whole of social life). The synchronisation of infrastructures (of things and experiences) constitutes the completion of a globalisation project of which these transformations are an integral part. A project which, however, the more it is realised, the more it encounters the *planet*, to use Chakrabarty's terminology (Chakrabarty 2021). The "home-world delivery" that Günther Anders (1992; see also Fuchs 2017) spoke of in the 1960s, referring to the world that increasingly enters the everyday lives of individuals through the mass media, now takes on the objectivity of "capitalist realism". Infrastructure capitalism places *connectivity* at the centre of its logics of development, promoting the imaginary institution of a *frictionless* society in which this connectivity functions through and thanks to the (apparent) complete synchronisation between the social life of things and the processes of psychic and collective individuation.

The second element of discontinuity concerns the *dramatic expansion* of the "social-reproductive contradiction" (Fraser 2016), which has gone from being a question limited to social reproduction in the strict sense and its declination in terms of the patriarchal gender division of labour, to a more than human reproductive contradiction. A contradiction that lies at the heart of this encounter between the project of the "globe" and the "planet". This contradiction, to stay with the theme that concerns us – that of "regimes of historicity" – introduces a time horizon that is different from that of the globe. In the time horizon of the globe, referring to the existential, intergenerational, historical dimension, forms of relationship with the world are inscribed that interfere with the time horizon of the planet and the biosphere.

The condition of *uncertizenship*, i.e., "citizenship of uncertainty" (Scoones and Stirling 2020), is therefore that of all of us who inhabit the time of the encounter between the globe and the planet, of the dramatic misalignments between them, of the suffering that this encounter produces on a broad scale that extends from the earth system to the bodies, affective and mental structures of living beings. A state of uncertainty that can no longer be managed by the tools and apparatuses of risk management and that requires a profound change in our design logics. The "design hope" that years ago Tomas Maldonado (2022 [1970]) spoke of is in fact a radical rethinking of the scalability that characterises our design logics. We need to change the way we pay attention to, and therefore our practices of evaluating, what we have around us, in order to subordinate the logic of production to objectives other than human reproduction.

3. Infrastructure As a Process and a Paradox

Let us return to the central theme, the regimes of historicity in the times of infrastructures. To understand this relationship – between infrastructures and the time dimension – it is necessary to consider infrastructure as a *process* rather than an object. This has to do with the peculiar ontology of infrastructures: as a vast literature has now made clear, they are both things and relations between these things. Infrastructure constitutes the material and immaterial architecture through which social life flows and takes shape. In this sense, as suggested by Susan Leigh Star (Star and Ruhleder 1994), the question that guides the understanding of such process concerns "when is an infrastructure" more than what or where. With regard to the temporal dimension in particular, the ontology of infrastructure leads to a paradox. Infrastructure (a verb would be better: infrastructuring) consists of the formulation of a promise of the future and, at the same time, of its ruin. A process of ruination that does not only occur when infrastructures fail or come to a standstill. It is constitutive of the infrastructure itself.

The idea of the future based on the imperative of the progressive expansion of world control is the clearest demonstration of this paradox. The more this concept of controlling (and exploiting) the world has been imposed, the more uncontrollable the world has become. The future, as the space of the *possible* (Borghi 2019) becomes the stake in the confrontation with the constitutive paradox of the infrastructure. Of the possible, as the horizon of our future, it has indeed been affirmed that "there is no alternative", whether it be the conclusion of a very critical diagnosis that absolutizes the present condition; or whether it be, on the contrary, the consideration of those who maintain that the present is the best of all possible worlds and must be preserved as such in the future. But the relationship with the future also consists in a space in which the social-reproductive contradiction is addressed through an infrastructural design centred on care, as a relational logic between living beings and between them and their ecosystems. Thus, the possible exists in any case, in the folds of reality; but far from being the linear temporal evolution bound to the present and the past, it is itself a terrain of conflict: the conflict over the possible and its meaning.

4. Infrastructure, Capacity to Aspire and Proleterianization

The future, Arjun Appadurai has made clear (2013), is a cultural fact. As such, thinking and planning about the future is an asymmetrically distributed capacity in society. It is a *capacity to aspire* (*ibid.*), a capacity to think and navigate in the future, that some are able to elaborate in richer and more sophisticated ways than others because of their social, educational and cultural conditions; a capacity that is denied to some because it is precisely what is lacking in conditions of social, economic and cultural marginalisation. The impoverishment or denial of the capacity to aspire means the inability to imagine that one's future can be different and better than the present into which one has been thrown. Thus, if the relationship to the future is defined as the capacity to aspire, the question to be asked in the present is: in what ways is this capacity reconfigured – expanded or impoverished, enriched or destroyed – by the processes of infrastructuration (and ruining) that characterise our social horizon?

This question needs to be further clarified in relation to the characteristics of the infrastructures we are talking about. Their lifeblood is the large-scale processing of information and knowledge, to which we all contribute our raw materials, and their transformation into data. As already mentioned, connectivity is the functional imperative that characterises their most recent development, beyond their specific socio-technical characteristics, the prerequisite for the synchronisation pursued by infrastructure capitalism. But this connectivity contributes to the further development of a fundamental characteristic of the relationship between human beings, technology and knowledge. I am referring to what Bernard Stiegler calls "proletarianization" (Stiegler 2020). It consists in the loss of control over the knowledge that citizens themselves help to produce, and consequently in the marginalisation to the point of irrelevance of their own experience of the problems of their everyday lives. From the sphere of production, introduced by the so-called "scientific organisation of labour" at the beginning of the last century, it has spread to the sphere of consumption, to the point of penetrating every sphere of infrastructured social life. The knowledge we contribute to produce comes back to us in the form of a multiplicity of situations in which our experience of problems (and the knowledge associated with it) is disempowered.

5. Ruins Thinking: Uncertizenship, Multiple Times and Nonscalability

Reflection on the temporal dimension of infrastructures inevitably leads to the intrinsically political nature of the regime of historicity in which their design is inscribed. That is, the political dimension of the infrastructural process is expressed in the regime of historicity it incorporates and, more specifically, in the interpretation of the field of tension and conflict that is the possible. As Andrew Barry (2020) has noted:

> [T]he development of infrastructures can be *inventive*, opening up new possibilities or *anti-inventive*, reducing the space of future possibility [...]. In short, the development of infrastructures generates an ontological politics of both uncertain and future possibility. (Barry 2020, 98)

The dominant infrastructural design tends to reproduce the settler terraforming regime of historicity. The latter replicates the strategy of abstraction and de-territorialisation (Harrison and Sterling 2020) inherent in scalability as a model for relating to the world and the future. It is the "plantationocene" (Haraway 2015; Haraway et al. 2019) regime of historicity in which the promise of future infrastructure is formulated according to a teleological, linear and homogeneous conception of time. More generally, the promise of modernity is at work in infrastructure as a programme of progressive expansion of human reach and control over the (living and non-living) world (Rosa 2019; 2020).

But, as has been pointed out by many observers, "our stories of time and infrastructure are always stories of multiple times" (Jackson 2017, 172): the time of the different materials assembled, that of their multiple impacts on the environment and, vice versa, of the environment itself on infrastructures, that of the life cycle of people, of their knowledge; the time of wear and maintenance, of change and decay. The condition of uncertizenship demands precisely to openly confront this temporal plurality, with the co-presence in infrastructural planning of the promise of the future and its ruin. In other words, uncertizenship demands the adoption of "ruins thinking" (Wakefield 2018; Quintana 2022; Bennett 2020; Hennion and Monnin 2020). Not the renouncement of the possible, or the expectation of a pedagogical catastrophe, or even the mere aestheticizing contemplation of ruins, but rather the choice of "staying with the trouble" (Haraway 2016), of being in the field of tension of the future, of staying in the field of tension of the "possible" and the conflict that runs through it.

For this to be possible, it is indispensable to counteract the process of proletarianization that infrastructures have intensified; it is necessary to promote practices of re-territorialisation of infrastructures that make them permeable to situated and specific contexts of interaction; it is necessary to open them up to the (social and institutional) learning of regimes of attention that allow for the care of localised contexts of life, of the multiplicity and diversity that characterise them, and thus open them up to a nonscalability conception of the relationship with the world and the future. To inhabit uncertizenship therefore means to overcome the epistemology of crisis and emergency, through which infrastructural solutions are systematically imposed that contribute to the weakening of any "voice" of citizens and to the disempowerment of their experience of problems in the search for specific solutions, and to elaborate instead an "epistemology of coordination" (Whyte 2020), that makes the maintenance and reproduction of interdependencies between living beings and between them and their ecosystems, as well as the temporal plurality associated with them, a fundamental constraint on infrastructural processes.

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Reopening Time? On the Chronopolitics of the Anthropocene

Luigi Pellizzoni

1. Introduction

The notion of politics of time, or "chronopolitics", registers that, as the way of relating past, present and future with one another is crucial to the social order, it is also a field of power struggles (Kaiser 2015; Opitz and Tellmann 2015). However, different understandings of the politicization of time are possible. One is exemplified by the concept of "regime of historicity" (Hartog 2003). The idea is that each epoch, each society, is characterised by its own way of articulating past, present and future. This constitutes "the unthought of a culture, the framework that we cannot see, that we cannot decree, but which organises our experience of time" (Bensaude-Vincent 2016, 92). Though a regime of historicity has major political implications, these are not conceived as the (expected or unexpected) outcomes of deliberate actions. Said otherwise, in this framework time exerts a passive political function.

Things look different if one considers time from the vantage point of the notion of dispositive. Foucault (1980) calls dispositive an ensemble of disparate things (materials, technologies, texts, ideas and so on) that performs a governmental function, shaping power relations and channelling conducts. This happens first and foremost by conveying a regime of truth. What are the facts and their relevance; how they are connected; who is entitled to speak and act on the matter – a truth regime entails a narrative, that is, a dramaturgy where an initial and a final state of affairs are linked by deploying a series of implicit and explicit causal factors (actors, forces, events etc.), with related value attributions and moral lessons (Bonneuil 2015). All that takes place over time; it requires and enacts a certain temporality.

Foucault stresses that a dispositive is not the outcome of a deliberate design but rather an effect of the interweaving of its elements. Yet the latter *do* stem from choices and actions. Time, thus, appears in this framework actively politicized. Indeed, for Foucault a dispositive develops in response to "an urgent need" (1980, 195). Urgency evokes the unexpected emergence of a threat to the ruling order. Like an antibody, a dispositive takes shape to address and neutralize it. It is therefore inherently conservative or reactionary.

Responding to the threat of climate change seems today a – perhaps *the* – most urgent need for capitalism, especially if one regards it as not just an economic system but an "institutionalised social order" (Fraser 2014), comprising economic, political, social and cultural conditions, from free labour to private property and free access to non-privately-owned resources, to social reproduction and consumption models. Responses so far basically consist, on one side, in an expansion of markets – especially financial – to previously uncommodified resources and processes (Pellizzoni 2021); on the other, in the co-optation or repression of social mobilizations (Pulver 2023; Forst 2024). What about the narrative that supports such politics? A clue that time is crucial therein is the success enjoyed by the notion of the Anthropocene, which has rapidly moved beyond specialist discussions to involve the social sciences and humanities and the general public. Its advocates claim that the case for the Anthropocene may support an environmental politics more attuned to events that deploy at a geological time scale, that is, more radical and more consistent over time than hitherto. Critics oppose that the awareness of geological times may lead to a sense of futility of any conceivable action. Yet, a preliminary question is: does the narrative of the Anthropocene make any difference compared with the politics of time that characterizes late capitalist modernity?

Addressing this question means first of all making sense of such politics, and then gauging whether and to what extent the time of the Anthropocene aligns or clashes with such politics. Goal of this paper is to outline a tentative answer. I begin by dealing with the modern account of time, as an arrow that connects past, present and future, and its governance implications. I then show how such conception has been challenged by governmental approaches that build on a reiterative temporality and a related eschatology. Third, I reflect on how, with its stress on "deep time", the case for the Anthropocene seems to reaffirm and strengthen the linearity of time. Yet, I argue, Anthropocene time actually aligns with, and strengthens, late capitalism's politics of time. The latter can be challenged only by turning it against itself, as some mobilizations seemingly try to do.

2. The Crisis of Time in Late Modernity

A number of scholars have stressed that modernity breaks with earlier relationships with time (e.g., Luhmann 1976; Koselleck 1985; Hartog 2003; Bensaude-Vincent 2016). Two connected aspects gain salience. First, the account of time that comes to dominate the cultural and organizational aspects of social life is linear and quantitative, rather than cyclical and qualitative as typical of pre and non-modern societies. This means, second, that the future is open. The present derives from the past but is not bound to reproduce it, or more in general to follow a fixed trajectory in its progress. Implied in this view is an account of human agency as powerful enough to affect significantly the course of the events.

Driving the events in a desired direction entails envisaging possibilities and acting in such a way as to restrict or select among them – drawing, in other words, the "future present" as much as possible to the "present future" (Luhmann 1976); what will be to what we can anticipate about it. The future thus "becomes cause and justification for some form of action in the here and now" (Anderson 2010, 778)[1].

For a relatively long period, the relationship between present future and future present has been sufficiently stable. This period begins with the emergence of probabilistic and actuarial sciences in the late eighteenth century (Hacking 1990). Probability "defuturizes the future without identifying it with only one chain of events" (Luhmann 1976, 141). Determining the margins of error about what is going to happen makes the future at once open and controllable. The limits of probabilistic prediction begin to be acknowledged in the 1920s, with Keynes's and Knight's reflections on uncertainty in economic decision and Heisenberg's indeterminacy principle in physics. Yet, the governmental implications of uncertainty and unpredictability begin to gain salience much later, between the 1960s and the 1970s. With the rise of disequilibrium and complexity theories and the gathering of evidence about the systemic character of failures in predicting the impacts of technologies, "incalculable risks" increasingly come to appear the norm rather than the exception. This paradoxically stems not from a lack but from an abundance of knowledge. Indeed, the more the scientific insights and the technological means expand the possibilities of intervention in the world, the more the uncontrolled, uncontrollable and unknown aspects of the world become relevant to the decisions (Wynne 1992).

Over the years, this issue gains growing relevance. The problem of the governance of innovation pointed out some time ago by David Collingridge (1980) concerns technological lock-ins. The more established a technology is, the more we know about its impacts, but the less the freedom we have to change it. More recently, Alfred Nordmann has argued that the anticipation of the future can be "trivial" or "non-trivial". To anticipate the impact of a technology one can sometimes rely on experience or historical precedents. But the more "disruptive", the more a "game-changer", a technology is expected to be, the lesser the past experiences and the present knowledge come to help.

> [The] imagined future is a different world, inhabited not only by different technologies but inhabited by different people, too: by the time the envisioned new technologies have insinuated themselves into the fabric of society, this will be a society of new people in that they will have integrated these new technologies with their system of values. (Nordmann 2014, 89-90)

Collingridge highlights a contradiction between agency and knowledge: the more actionable the future is, the less one knows about what to do, and vice versa. Nordmann stresses that, beyond a certain point, the actionability of the future turns into its opposite. It is not just a question of technological lock-in. The point is that, if there is no way to establish a connection between present future and future present, the latter becomes a mere exercise in speculation. The future is no longer an open but an occluded horizon. The view in front is not just too wide or deep, but immersed in a dense fog. The stronger the beam of our speculation, the more its light is reflected towards us. The increasing role of science fiction in anticipatory exercises (Zaidi 2019) depends on the assumption that, by stretching the imagination beyond the limits of reliable connections between the present and the future, there can be more chances of grasping something behind the curtain of fog. But this is nothing more than a hope.

To some extent the difference between trivial and non-trivial futures is captured by the difference between prevention and precaution. The language of prevention is a language of probabilistic prediction of undesired events and cost/benefit calculations of action or inac-

tion. The language of precaution is of relevant but inconclusive evidence, worst case scenarios and search for proportionality between threat and action (European Commission 2000a). Yet, the timeframe of precaution is linear, just like that of prevention. Indeed, ever more so, since the consequences of the actualization of the threat are deemed irreversible. It is worth noting, however, that the governmental trajectory of precaution has been remarkably short (Pellizzoni 2009). Blossomed between the 1980s and 1990s, precautionary policies were already waning at the beginning of the 2000s. Moreover, support came almost exclusively by the EU and (some) European countries, arguably due to the weight of a social democratic heritage in prompting a response to growing public unease with the socio-ecological impacts of techno-science (European Commission 2000b), and to environmental organizations' pressures. Yet, the harsh controversies over precautionary policies erupted at the core of global capitalism, the WTO, are a clue not only to Europe's relative isolation but also, and above all, to the limits that a linear temporality was raising against capital accumulation, as ever more based on extracting value from the vital dynamics of the biosphere and from ecological turbulences (Cooper 2008; 2010).

3. Another Take on Time

Indeed, with the crucial shove of the "military-industrial complex" (Ritter 2008; Lakoff 2017), capitalism was already turning to something quite different from precaution. New anticipatory approaches have begun to gain salience since the late 1990s. One is "preemption". The idea, become prominent in the American security strategy after 9/11, is to anticipate threats that have not yet manifested themselves, through an incitatory action. The assumption is that, "since the threat is proliferative in any case, your best option is to help make it proliferate more – that is, hopefully, more on your own terms" (Massumi 2007, § 16), seizing the opportunities thus created. By "producing what it is meant to avoid" (Massumi 2015, 196), action generates the reality that proves its own validity. As G. W. Bush once declared, "Some may agree with my decision to remove Saddam Hussein from power, but all of us can agree that the world's terrorists have now made Iraq a central front in the war on terror" (quoted in Massumi 2007, § 17). That is to say: removing Saddam Hussein was the right thing to do because Iraq has become what justified such action. Preemption renders futile any attempt to distinguish between failure and success, wrong and right choices.

Then there is preparedness. Its origins date back to the Cold War, in relation to nuclear attacks, subsequently extending to bioterrorism (Lakoff 2017). Its take-off, however, is roughly contemporaneous to preemption. A major boost came from the WHO (e.g., 2009), which increasingly embraced it in reply to insurgent or resurgent infectious diseases. The Covid-19 crisis brought to public attention that national health systems were supposed to have and apply preparedness plans. Recently preparedness has invested also food security (OECD 2020; Pellizzoni et al. 2024). To be "prepared" here means being ready to react to unforeseen, unpredictable, hidden threats. Rather than eliciting its manifestation the task is catching early signs. To this end, a crucial role is played by vigilance performed by "sentinels" (Lakoff 2017; Keck 2020), such as monitored living beings (e.g., migratory birds, non-vaccinated poultry and human travellers) and detection systems, such as laboratories for early

infectious disease detection. Early detection and rapid response are expected to modulate the expression of the threat, so as to make it manageable.

Preemption and preparedness, therefore, are not the same thing. Yet, they bear strong similarities, especially regarding their take on time. The purpose is not, nor can it be, to prevent the actualisation of the threat but to handle it; not crisis resolution but crisis management. Hence, they both entail a potentially endless reiterative process, whose purported goal – the elimination of the threat – justifies action while ever receding into the horizon as a result of action itself. Also the past is affected – ontologically, not just cognitively. Since it has *become* one, Iraq *must have been* already a cradle of terrorism. And whether Sars-CoV-2 originated from "nature" or "technology" turns out a moot question, not just for the growing difficulty in distinguishing among the two, but above all because its very existence shows it was a possibility bound to actualize sooner or later (Pellizzoni 2025). As these examples suggest, new forms of anticipation disclose governmental opportunities otherwise precluded, or likely to be fiercely contested. With the "war on terror" crimes against civilian people were reclassified as necessary police operations without any actual consequence for its political promoters and supporters. With the Covid-19 crisis a potentially limitless extension of the state of emergency was met with feeble complaints, while largely unnoticed went the fact that policies such as the Italian zoning system blurred anticipation with "chasing" and adapting to the virus, making it impossible to assess their actual effectiveness (Pellizzoni and Sena 2021)[2].

It may be useful to note that the same mechanism is at work, in an inverted way, regarding "disruptive" technological innovation. The receding end point here is not catastrophic but regenerative: food, health and long life for all, cheap and pollution-free energy, and so on (Pellizzoni 2020). This bright future is always presented as within reach – almost. Opposing forces (conspirationists, radical ecologists, anti-scientists, lack of brave investors...) allegedly hamper its actualization. In this way a space opens up, otherwise unavailable or much more contentious, for decisions on innovation increasingly adventurous and subtracted to public discussion. This of course is not limited to technological hype. The "war on terror" has offered lucrative opportunities to security firms and the military industry, while the Covid-19 emergency has significantly enlarged the room for publicly funded research on, and marketization of, vaccines.

In sum, with preemption and preparedness, as well as with the case for technological game-changers, "non-trivial" future is addressed by way of a secular eschatology. If the end point is catastrophic, then the forces that make it recede are "good"; if it is regenerative, these forces are "bad". Forces and counter-forces operate within a sort of messianic temporality where chronological time is replaced by kairological time – the time of the "now"; a suspended, endless present whose decisiveness is ceaselessly claimed yet always deferred, while offering unprecedented possibilities of value extraction and power concentration. This suspended present becomes the past of something yet to come – a "future past" in Luhmann's (1976) terms. Actions are decided by performing what Fredric Jameson (2005) calls "archaeology of the future". Such archaeology can of course build on sufficiently reliable connections between present and future. But when the future becomes "non-trivial" its archaeology authorizes any sort of things, including the craziest and the most violent, unequal and unjust.

4. Anthropocene Time

We can summarize the above in two points. First, the time structure of emergent anticipatory strategies breaks with the modern one. Linearity is replaced by a reiterative structure that departs also from Biblical eschatology. In the Judeo-Christian apocalyptic, catastrophe precedes regeneration and its actualization is postponed by a force (the *katechon*, often identified in the Church or the State) that is at once good and bad (it delays the end of the world, thus also the advent of God's kingdom). Moreover, messianic time is linear (though inscribed in the circle of the eventual reunion of creation and creator, Earth and Heaven). You cannot go back and forth, but just push ahead, opposing the opposing force; or you can surrender to it, arresting your progress towards the apocalyptic moment[3]. What we are faced with, instead, is a Janus-faced, split, eschatology, which moreover blurs and continuously remoulds present, future and past. This kind of temporality can be found at work also on the side of climate mobilizations. While apocalypticism is part of the ecologist narrative since at least the early 1960s, with Rachel Carson's *Silent Spring*, and has expanded after the rise of the climate threat in the 1990s (Northcott 2015; McNeish 2017), "post-apocalyptic" mobilizations have recently gained momentum. For Extinction Rebellion, Last Generation and similar movements collapse is inevitable and indeed already happening, hence the need to accept and cope with it while still mobilizing on the basis of a sort of paradoxical hope (Cassegård and Thorn 2018).

The second point is that this time structure has major governmental implications. The examples provided indicate which sort. Any type of anticipation "justifies measures and interventions in the present without laying claim to having proof that they will effectively avert the threats posed" (Lemke 2024, 7). The acknowledged soundness of the procedure works as an exonerating clause from responsibility "if things turn out differently" (Luhmann 1998, 70). Yet, new anticipatory approaches expand to unprecedented extents the room for manoeuvre, as the eradication of the threat becomes a vanishing point.

However, the case for the Anthropocene seems to run counter to this temporal dispositive. There have been and there are many discussions over the alleged new geological era, which outside specialist debates[4] concern especially its beginnings, for their political implications. Establishing when the Anthropocene begins means defining causal factors and appropriate replies; protagonists and supporting actors, victims and culprits. For example, if the Anthropocene begins with agriculture, then the responsible is the human species. If the Anthropocene begins with the great travels and the colonization of the new world, then the responsible is capitalism. If it begins with Watt's steam engine (1784), then the responsible is industrialization. If it depends on the "great acceleration" begun at the end of World War II, then the issue is late capitalism and globalization (Pellizzoni 2023).

What these accounts share is the claim that geological time has intruded in the time of human societies. Though by no means a new topic[5], the relationship between natural history and human history has gained unprecedented saliency. Dipesh Chakrabarty, a leading scholar of postcolonial theory and subaltern studies, has especially focused on the issue. For him, climate change corresponds to a "form of [epochal] consciousness that does not deny, decry, or denounce the divisions of political life while seeking to position itself as something that comes before politics or thinking politically" (Chakrabarty 2015, 142). This consciousness

regards the compresence of two temporal regimes: on one side that of geological history and of humans as a species; on the other that of human history, of culture and politics (Chakrabarty 2018). Human history has always been nested in natural history, but the latter was conceived as a backdrop of the former, while today the mutual intertwinement of the two regimes appears ever more evident. The attempt to disentangle human history from natural history[6] has produced its opposite, leading humans to interfere with long-term geological and biological processes which they are unable to manage. Yet, and crucially, these "conjoined histories" (Chakrabarty 2021) entail different "modes of thinking, [...] kinds of knowledge and [...] ways of comporting" (Chakrabarty 2019, 24). This conjunction and simultaneous disjunction poses unprecedented problems of governance.

Bruno Latour provides a comparable account, to the extent that he also stresses the intertwinement of different temporalities. Yet, their disconnection or disharmony is portrayed differently. His reference metaphor is not the Anthropocene but Gaia. The Greek goddess had been brought to the fore of ecological discussions by James Lovelock and Lynn Margulis (1974), to claim that the living and non-living parts of the planet compose an interacting system, the biosphere, endowed with self-regulating capacities. For Latour, however, this interacting system should not be interpreted holistically, as the idea of a "living planet" suggests, but as a network of autotrophic processes, i.e., forms of regeneration from elements in the system, in which the exchange of material and information by microbial actors plays a crucial role, and which unfold on diversified temporal and spatial scales, in the absence of an overall order (Lenton and Latour 2018). Gaia, therefore, expresses "no other order, and certainly no superior order, than those intertwined agents have been producing through their entanglement" (Latour and Lenton 2019, 6). In this framework one has to consider not only the different temporalities of natural and human history, the contrast between "deep" and "shallow" time they entail, but the internal fractures of the former. Compared with Chakrabarty's account, the challenge for climate politics seems here even greater.

Indeed, the notion of deep time has gained growing traction, not only in regard to climate change but also to technologies such as nuclear waste management (Ialenti 2020) and cryopreservation (Lemke 2024). Like that of natural history, the notion of deep time is not new. It also dates back to the late eighteenth century (Northcott 2015). However, its association with the Anthropocene gives it a dramatic tone it originally did not possess. On one side, the onset of the Anthropocene depends on the connection between the distant past of long-term geological processes and the near past (whatever the exact beginning) of humans' acquired capacity to interfere with these processes. On the other, human action – or inaction – is assumed to have long-term effects. The deep future is as relevant as the deep past[7]. Moreover, the Anthropocene narrative takes an apocalyptic perspective[8]. For Northcott such narrative represents a "portentous reversal of the Christian apocalyptic" (2015, 107). Yet, it actually deploys only the catastrophic part of it. Catastrophe is pending, and regeneration after its actualization seems hardly meaningful or imaginable, but some social and/or technological *katechon* might push it away. With post-apocalyptic activists such *katechon* arguably lies within their mind, as a drive to accept and live with (or survive in) the catastrophe while mobilizing against it (Cassegård 2024). This introduces in the narrative a sense of urgency that concentrates all the stakes in the now, appearing for this reason at odds with the deep time of planetary dynamics, though remaining faithful to a linear

conception of time. Whatever the future, it lies ahead. Yet, is that really the case?

According to Jeremy Davies, the Anthropocene is geologically defined by "all those changes to the earth that might be discernible in the distant future" (2016, 77). Julia Nordblad notes that this account uses the future perfect tense:

> It places the past and the future in the same category, because from the point of view of the future geologist they are both equally past. This predictive determinism – she continues – is profoundly unfortunate as a political temporality because it blurs the line between past events and events that are still avoidable. (Nordblad 2021, 335)

This does not help to address a situation that is "both open and decisive", occluding the space "for imagining, planning, critically discussing, or deliberating the future" (*ibid.*, 336). In this sense, Nordblad argues, the notion of Anthropocene contrasts with that of climate change, which the IPCC reports articulate in terms of alternative scenarios. The Anthropocene conveys a notion of the future as "a closed temporality that proceeds as unfolding"; climate change of "an open temporality that harbors alternatives and possibilities", which is "a condition for politics, especially democratic politics" (*ibid.*, 341-342). Thus, the Anthropocene framework is depoliticizing, while the climate change one opens a window for political action. More precisely, the IPCC reports present future as a finite resource, corresponding to the remaining carbon budget before climate change processes become unstoppable. The precise amount of this resource is a contentious point, as calculations are fraught with uncertainties related to the complexity of climate dynamics. Yet, Nordblad stresses, the calculation of this quantity is an eminently empirical question. Likewise empirical is therefore the "precise mechanics" by which "the very long term is entangled with our political present" (*ibid.*, 347) – hence the actual decisiveness of the now.

However, it is by no means sure that privileging the notion of climate change over that of the Anthropocene one is beneficial for democratic politics, let alone an effective one. In the light of the discussion above, the problem is not the opposition between closed and open future, but the relation that is established between the two, with a characteristic blurring of, or movement back and forth between, present, future and past. For a start, thinking of the present as a future past, as happens with the notion of Anthropocene, is not per se foreclosing action. Many AI experts describe the present as the past of a future where the "singularity" (e.g., Kurzweil 2005) – the moment when a technological superintelligence starts to self-develop at an uncontrollable pace – has already happened, and yet, or precisely in view of this, they work to make it happen. Second, as Nordblad also notices, some scenarios take into account "negative emissions", that is the removal of carbon dioxide from the atmosphere thanks to technologies yet to be developed, which effectively correspond to "a kind of carbon debt to be paid back later" (Geden 2016, 793). This is not one problem among many, but a clue to the contradictory implications of the way these scenarios are constructed. They aim to keep and explore an open future, but the greater their reliance on negative emissions, the lesser their capacity to obtain such result. Said otherwise, scenarios based on negative emissions follow a preemptive rationale, producing what they are meant to avoid, that is, the continuation or intensification of present emissions as premised on the development of such technologies. Technologies, more-

over, that are fraught with implications hardly ever democratically discussed, such as accident hazards of CO_2 capture and storage plants and the impacts on biodiversity of forestry and farming aimed at maximising carbon dioxide absorption, which make them "an unjust and high-stakes gamble" (Anderson and Peters 2016, 183). Actually, a preemptive rationale underlies not only technological expectations but any expectation concerning the driving factors of emissions (population size, land use patterns, lifestyles...), as specific assumptions about the future society – again, hardly ever democratically debated and moreover included in allegedly value-neutral assessments – lead to equally specific policy indications (Beck and Mahony 2017).

Furthermore, the empirical character of the carbon budget does not prevent it from performing a major governmental effect. The problematic estimation of the proximity of a threshold or irreversibility of climate processes determines a particular relation between the near past of rapidly rising emissions, the near future of urgent decisions and the distant past and future of geological time. Namely, a sort of syncopated rhythm of time compression and dilation develops. The unspecified decisiveness of the now entails a compression of time, yet the effects of any decision rest to an equally unspecified extent on the deep geological past and future. This rhythm is consistent with the reiterative temporality discussed above, which indeed shows a similar dynamic – the vigilant wait for the enemy; the sorties for eliciting it; the rapid responses to its manifestations; the return to a vigilant wait. The governmental outcome of this rhythm is the one already discussed, which ultimately consists in a growing uneven distribution of agency between, on one side, corporate, financial, media, technocratic and political elites, and on the other the rest of the population. In the case of climate politics this outcome becomes especially evident in the psychologically disturbing and politically disempowering effects of being incessantly exposed to claims about the decisiveness of adopting sustainable lifestyles in a context where such adoption appears ever more difficult or illusory (Blühdorn 2017). The unenviable situation in which post-apocalyptic activists find themselves, caught between police repression, public irritation and a likely eventual irrelevance, between feeling of futility and paradoxical hope, is perhaps the most evident clue to the governmental outcomes of this temporal rhythm and, more broadly, to the conservative or reactionary performance of a dispositive that the Anthropocene and cognate concepts and narratives hardly counter, but rather strengthen.

5. Conclusion: Towards Another Time

This conclusion is supported by looking at the political implications Chakrabarty and Latour draw from their take on the Anthropocene and Gaia – more belated in the case of Chakrabarty; more explicit in Latour's. Chakrabarty (2021) hints of the possibility of a global governance of climate, centred on a technocratic evolution of the United Nations, whose remit would be technologically challenging but politically modest: maintaining or bringing human societies, despite and beyond existing unbalances in power and access to resources and well-being[9], within the boundaries that ensure the reproduction of fundamental planetary processes. Latour outlines a kind of networked technocracy that interacts with terrestrial dynamics in a more creative way, though the preservation of the social and political status quo is out of ques-

tion[10]. He talks of a "Gaia 2.0", where the "scientific establishment" leads a "deliberate self-regulation, from personal action to global geoengineering schemes" (Lenton and Latour 2018, 1066). Gaia 2.0, he points out, does not correspond to a traditional technocratic model, where the best solution is known in advance. It rather builds on improving the "quality of the sensors – both instruments and people – that detect shortcomings and the speed with which we rectify the course" (Lenton and Latour 2018, 1068). Thus, if Gaia, as Latour (2017) stresses, is not "a God of totality", it turns out to be a God of preparedness. Gaia, more precisely, is the God of a time that is neither apocalyptic, as some scholar claims (Northcott 2015), nor post-apocalyptic, as Extinction Rebellion and Last Generation activists see it, but reiterative; the God of a liminal state between the end and its aftermath, between catastrophe and regeneration.

One may ask, at this point, whether the dispositive can be challenged, and how. The answer to the first question should be a yes, at least if one sticks to a Foucauldian perspective. For Foucault, there is no power without resistance; no watertight dominative structures. As for the second question, Foucault suggests that a challenge for domination occurs when its modalities are turned against themselves, which sooner or later happens as power and resistance are moulded on each other. This means that, to be effective, oppositional forces should not focus on the vindication of linear time, but rather elaborate a different eschatology, a different interpretation of kairological time.

This possibility is, in some sense, at the centre of Walter Benjamin's *Theses on the Philosphy of History*, to the extent that they contain a reflection on the dominative implications of a progressive conception of history based on a linear conception of time, and the claim that only a qualitative reappraisal of the relation that connects present, past and future can challenge the winners' legitimisation, to which everything and everyone is bent – not only the living, but, as he writes in the Sixth Thesis, even the dead. Regarding our question, especially telling is the Eight Thesis, where Benjamin contrasts a state of emergency that has become rule to the "real" state of emergency that the tradition of the oppressed indicates as a task. And the Second Thesis, where he talks of the past as bound up with the idea of redemption, and of a "secret agreement between past generations and the present one" as "endowed with a weak messianic power to which the past has a claim" (Benjamin 1969, 254).

Another way to make a case for the possibility of another time, neither linear nor locked in a self-fulfilling circularity, is to consider how, faced with the climate threat, the turn of social agency to a conservative or reactionary direction builds on portraying the relationship between geological and historical time in terms of irreconcilable contrast and tactical adaptation. In this regard, Theodor W. Adorno's (2006[1932]) reflections on the idea of natural history may be valuable. His claim is that natural history is to be conceived dialectically, comprehending things and events as natural precisely where they appear most historical, and vice versa[11]. Neither necessary clash between the two times, therefore, nor rapid detection and adaptive response to the planet's swerves, but rather an effort to understand how these temporalities, as qualitatively and not just quantitatively interconnected, can be brought to a consistent beat. Consistent does not mean single. Following Adorno's aversion to any reduction of plurality and diversity to unity and identity, this beat is to be conceived as composed of a multiplicity of beats – "the multiple times immanent to every being in the world" (Bensaude-Vincent 2016, 98). Consistent, moreover, does not mean that nature and history can shift "one magically

into the other", but rather that "they are dialectically mediated in each other" (Hullot-Kentor 2006, 250). Thinking in terms of mediation, instead of contrast or tactical adaptation, may lead to a reopening of time on a very different basis from the endless value extraction with which the modern idea of progress has come to coincide. Said otherwise, time can be reopened only by aiming precisely at the opposite of the current increasingly dominative, or tactically yielding, designs on nature, namely towards what Adorno calls reconciliation.

Do we find concrete traces of these theoretical suggestions? There is no space to elaborate on that. Yet, one can at least mention post-apocalyptic activists' paradoxical persistence in enacting civil disobedience, in spite of increasingly harsh repression and public disapproval. And, of course, one can mention prefigurative activism, that is, that which seeks to enact and embody in the here and now the future it aims for (Monticelli 2022). This often involves reconfiguring not just social relations but also the relationship with places and things (Schlosberg and Coles 2016). Can this social effervescence be regarded as an expression of the "weak messianic power" Benjamin speaks of? Prefigurative mobilizations, just like post-apocalyptic ones, are often tagged as backward-looking, aiming at, announcing or practicing the return to premodern ways of living. On the other hand, an environmentalism is gaining momentum that draws inspiration from far-right imagery of naturalism and organicism, whose practices are often not easily distinguishable from those of emancipatory prefiguration (Dannemann 2023; Bryant and Farrell 2024). This indicates that prefigurative and post-apocalyptic mobilizations need a thorough elaboration of their relationship with the (oppressed) past[12]. Nonetheless, they are for the moment the only serious challenge to the governmental dispositive that rules this historical juncture.

Notes

[1] To this purpose one can also consider "past futures" – how the present was imagined in the past, compared with its actual state. Such an exercise is especially intriguing with regard to technologies (e.g., Bijker 1997).

[2] This system was introduced to modulate circulation restrictions at regional level, according to a risk classification based on the trend of Covid-19 cases registered weekly.

[3] Agamben (2005) notes that in St. Paul's influential account messianic time corresponds to a gathering together, a summary recapitulation of all things: a sort of convergence of the past in the now. Such movement, again, is linear: you cannot go from convergence to a renewed divergence.

[4] After much wavering, the Anthropocene Working Group of the International Commission of Stratigraphy decided in March 2024 not to grant the Anthropocene the status of a geological era for the time being. Of course, the decision is revisable in the light of new evidence, and certainly did not put an end to the diatribe.

[5] Discussions date back at least to Buffon's 1778 essay *Epochs of Nature*. For a discussion see Herringman (2015).

[6] For a recent reiteration of the case for their disentanglement see Asafu-Adjaye et al. (2015).

[7] This happens also with nuclear waste management or cryopreservation. Deep past concerns respectively the geological stability of the sites for repositories and biological evolution; deep future concerns the endurance of waste containment structures and of a suspended, liminal state between life and death.

[8] Again this can be seen also in nuclear and cryopreservation narratives, apocalypticism being implied in liminality (life/death; radioactivity containment/decay). I have not the space to elaborate on this.

[9] Chakrabarty has repeatedly insisted that, although responsibilities and impacts of climate change are unevenly distributed, climate politics has to think in terms of the human species.

[10] In all of Latour's writings on the climate crisis capitalism is hardly ever mentioned as the main, or at least a major, cause, let alone as a possible obstacle to effective responses.

[11] This is hardly an empty philosophical idea. Think, for example, of environmental migrations on the one hand; of the claimed equivalence of "natural" and genetically engineered organisms on the other.

[12] The very notion of prefiguration, for how it is mainly accounted for, focuses on the present and its relation with the future. The past, such as the anarchist and socialist traditions, is usually regarded as an inspirational source or a benchmark (Raekstad 2022), rather than something awaiting redemption. As for post-apocalypticism, the past appears a destiny more than something actionable in the present.

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◆

A Revival of Natural History? Temporal Short-circuits between the 16th and the 21st centuries

Paolo Savoia

1. The Art of Observation

In her masterful book on the matsutake mushroom and its multiple stories, Anna Tsing spoke about a "third nature", which is the subject of her past and present research on assemblages of human and non-human nature, tracked down through what she calls an "art of noticing" and

the gathering of "polyphonic" stories (Tsing 2015, 23). These arts of observation and of listening to stories she sometimes calls "natural history", a complex research practice that must resolutely recognize the fact that traditional progress narratives have become meaningless, or, worse, blinding to possibilities of life in, and resistance to, 21st century capitalism. Let us hear her:

> Imagine "first nature" to mean ecological relations (including humans) and "second nature" to refer to capitalist transformations of the environment [...]. My book then offers "third nature," that is, what manages to live despite capitalism. To even notice third nature, we must evade assumptions that the future is that singular direction ahead. Like virtual particles in a quantum field, multiple futures pop in and out of possibility; third nature emerges within such temporal polyphony. Yet progress stories have blinded us. (Tsing 2015, *viii*).

Tsing shares the criticism that many historians and social scientists – such as, and in very different ways, have directed to the idea of the anthropocene (Malm and Hornborg 2014; Bonneuil and Fressoz 2016; Haraway 2016; Barca 2021; Moore 2017). While earth system sciences are necessary to understand current threats to life on planet earth, they argue, the reference this undifferentiated *antrhopos* as the agent of such catastrophic alterations of nature is at best too vague, and at worse depoliticizing and authoritarian. Many have embraced the term Capitalocene as an alternative, underlining that it is not *homo sapiens* that brought about planetary destruction, but Western capitalism since the early modern globalization. In other words, historians say that history matters, and that we must look at the close threads of the historical record if we want to build narratives of the Anthropocene which are both historically specific and accurate, and politically leaning towards the demands of climate justice.

Tsing shares this view, but with a caveat. She writes that:

> [I]magining the human since the rise of capitalism entangles us with ideas of progress and with the spread of techniques of alienation that turn both humans and other beings into resources. Such techniques have segregated humans and policed identities, obscuring collaborative survival [...] The modern human conceit won't let a description be anything more than a decorative footnote. This "anthropo-" blocks attention to patchy landscapes, multiple temporalities, and shifting assemblages of humans and nonhumans: the very stuff of collaborative survival. (Tsing 2015, 19)

In other words, according to her, the arts of observation, of description and of curiosity are threatened by historical narratives based on the rise of capitalism that are still too monolithic, not enough attuned to the stories that humanists might gather, stories that would reveal the possibility of imagining and practicing other forms of life – human and non-human, together. To this effect, she proposes a method which combines history, ethnography and "natural history". Looking for alliances with biologists describing multi-species cooperation and symbiosis, Tsing calls for "[n]atural history description, rather than mathematical modeling" as "the necessary first step" of a new humanistic enterprise (Tsing 2015, 144).

In a 2018 paper on life among industrial ruins, Tsing, Gan and Sullivan took this evocation of natural history one step further. They wrote that "anthropologists join a related movement

in ecology to restore the professional status of natural history, which has fallen out of regard in the last century", and they describe their method, based on three steps: gathering human and more-than-human stories from local sources; observation of plants and fungi on the ground; consulting with biologists "to verify field-derived species identities" (Tsing et al. 2018, 39).

2. Natural History

According to standard narratives of the history of western science, natural history – a quintessential early modern scientific enterprise – has fallen out of grace since the 19th century, giving way to specialization and the emergence of scientific disciplines as we know them: biology, geology, chemistry, ecology, and so on (Foucault 1966). In fact, this is mostly true, despite the fact that the term "natural history" has followed a different path in Europe and in the US, where it survived to this day indicating, on the one hand, a sort of amateur art of para-scientific observation, perhaps best represented by birdwatching as a hobby; and, on the other hand, the observational fieldwork necessary for botanical classification (Anderson 2013). To be fair, natural history is also present in 20th century literature. For example Italian writers Mario Rigoni Stern and Primo Levi both used the label natural history to title or subtitle some of their works: Levi for his science fiction short stories of the 1960s, and Rigoni Stern for his late 1990s collection of short stories on plants, mountains, and trees. Albeit in very different ways, both Levi and Rigoni Stern choose to refer to such a tradition for their works that claim to blur the distinctions between humans and non-humans (Levi 1966; Rigoni Stern 2008).

As a historian of science, I am very interested in this "revival", if I might call it such, with explicit political overtones, of natural history. Current historiography of early modern natural history is fresh and exciting, mostly focusing on its global and colonial dimensions, and on the exchange, translation (and exploitation) between European natural philosophy and native knowledge across the Atlantic (Curry and Secord 2018). Early modern natural history was itself a revival of ancient natural history, but very different from it at the same time. Pliny the Elder's 1st century *Naturalis historia*, while putting together the histories of humans, plants, and animals, was permeated by a Stoic vision of nature as beneficial to humans, whose meaning was that of serving human's ingenuity, of course guaranteed by the political order of the Roman empire. The nature of ancient natural history was in a way anthropocentric and finalistic, but on the other hand it was also porous and entirely crossed by historical human action. From the late 16th century on, this revival was made possible by the "Columbian exchange", by the new needs of managing objects and information that were not present in the classical Greek, Latin and Arabic sources, and by the new collective empiricism that characterized early modern natural philosophy, well symbolized by the foundations of botanical garden across European universities (Crosby 1972).

But early modern natural history was also based on a cultivation of, sometimes obsessive, curiosity and thirst for information and possession of natural specimens, that had to be collected in museums. The field trip, both local and trans-atlantic, became a staple of the new identity of the early modern naturalist, together with the gathering of stories from European peasants and American natives. Moreover, in works like Ulisse Aldrovandi's, facts carefully

gathered through correspondence and observation were placed side by side with folk-tales and mythology (Findlen 1994). For example, when natural historians described apple trees, they carefully gave an empirical description of the plant together with notes on the analogy on human and tree anatomy, and all the pagan and Christian mythological tales about apples. When Conrad Gessner, perhaps the most important naturalist of the 16th century, described animals he included in the description their names in different languages, cooking methods and medicinal uses by humans, poetic considerations, and so on (Olmi 1992). Early modern natural history has rightly been described as "the art of description", but, in current parlance, surely it was a more-than-human nature being described (Ogilvie 2006).

On the other hand, early modern natural history cannot be separated from the rise of colonial violence and knowledge appropriation, global commerce, and capitalism. In fact, besides the contact with a radically new human and non-human nature, historians have argued that the habit of closely, empirically describing natural things has been modeled upon to commercial practices of describing items to be sold in the global markets. Indeed, colonial and proto-capitalist ways of living shaped cultural attitudes and how material resources were used creatively in a variety of realms (from entertainment to science). The fact that the "scientific revolution" took place in the first age of global commerce should be taken seriously. The emergence of a certain kind of economy has consequences for science. The Renaissance culture of exchange had enormous consequences not only for businesspeople but also for people engaged in understanding nature. In many ways the economic transformations of this age of global commerce placed a high value on descriptive information about objects; in turn, such values shaped priorities for knowing about nature. "Matters of fact" in the realms of medicine and natural history were gathered and exchanged within the sphere of a wide commercial economy. Harold Cooks argued that the objectivity of the new philosophy, derived from commercial exchange and natural history, also provided the intellectual foundations for philosophical materialism, which deeply threatened the political and philosophical establishment (Cook 2007, 1-41).

However, natural history cannot entirely be reduced to the colonial enterprise and to the rise capitalism, even if it obviously was made possible by these broad historical phenomena. There is an ethical and political dilemma in discussing natural history today, well summarized in a recent article by Taylor M. Moore: "Can emancipatory, decolonial histories be coaxed from objects made visible to history through the violence of the colonial archive?" – his answer is not clear-cut, but he proposes the label "(un)natural history" to take into the account this duality (Moore 2023, 473).

3. Early Modern "Third Nature"

Let me just make one example taken for the 16th century of natural history as a mode of reasoning that goes past the dichotomy between nature and culture. One of the most significant examples of the 16th century literature on the lands, gardens, and country lifestyle under the umbrella of natural history is *La villa*, published in 1559 by the Milanese humanist lawyer Bartolomeo Taegio. The author, a devotee of agriculture and the science of stars, sets the context as a series of dialogues taking place at a dinner party in the country villa of the

Milanese gentleman Camillo Porro, where the "gardener" told many "secrets" to the guests. Among the many things discussed in the book with scientific rigor, Taegio recalled the habit of playfully shaping fruits, mainly citrons and pumpkins.

> I am telling you that if you wish to see in pumpkins, in cedars (if you have them) new and strange faces, you should have someone make a crystal jar of the shape you like, and then place them [the fruits] inside these jars when they are still very young, and you will see that the pumpkin will grow up similar to the jar, and the thing should work. (Taegio 1559, 157)

The discussion went on and focused on grafting, in a tone that alternated between technical language and the language of wonder:

> [O]n this pear tree and on this red blackberry bush you can graft oranges, whose sourness you can sweeten by making a hole in the middle of the trunk, thus channeling out the bad humor, to the point that the fruits are well formed, and then you must dress their wound with lotus; from all this you will see a wondrous effect. (Taegio 1559, 157-58)

Taegio was fully aware of the fact that nature changed under the repeated, patient, gradual work of men, because in the most beautiful gardens "one clearly sees that nature gives way to industry, and that it changes its way after a patient work" (Taegio 1559, 55). While describing the marvelous garden at the country villa of a Senator of Milan, Taegio included a passage on the creation of a "third nature" through grafting.

> Here are without end the ingenious grafts that show with great wonder to the world the industry of a wise gardener, who by incorporating art with nature brings forth from both a third nature, which causes the fruits to be more flavorful here than elsewhere. (Taegio 1559, 58)

Taegio was not the only one who brought up the theme of a third nature in the sixteenth century, which bears a striking resemblance to Tsing's 21st century third nature. Indeed, there was a widespread conception of grafting and horticulture as an incorporation of art and nature that was productive, which brought about something new in the world by challenging the traditional natural/artificial distinction (Beck 2002). These writers drew upon Ovidian themes that were ubiquitous in their culture, shaping iconographic programs of "grotesque" hybridizations of the human and the natural.

4. Scalability

Tsing calls her art of recounting natural stories intertwined with cultural stories a method, even a science – a science of contaminated diversity, an analysis of indeterminate encounters. The main issue at the heart of the matter is one of scale: multi-species and more-than-human stories unfold on vastly different spatial and temporal scales, far apart from each other, with broken and interrupted geographies and timeframes. The problem in making space for this

natural-historical way of reasoning is that modern sciences are precisely based on the possibility of infinite expansion of the same research framework – research questions must be applicable on increasingly larger scales while remaining unchanged – and they don't allow for interruptions; in fact, they consider the art of observation and natural history "archaic" precisely because they cannot "scale up" (Tsing 2015, 37-38).

This *scalability* is a trademark not just of modern sciences; in fact, it is typical of the idea of progress itself: expanding projects without changing assumptions, changing scale without altering one's structure. The scalability Tsing talks about requires that the elements of the project – may it be an economic theory or a scientific research program – remain impermeable to encounter and the indeterminacy it brings: only in this way is expansion possible. The effects of scalability have been so powerful that its projects have taken center stage, and whatever resists scalability has become invisible, useless, or an obstacle that needed to be overcome.

The European early modern colonial plantation is the perfect example of scalability, as it consists in a pattern involving: a) isolating the plant (monoculture); and b) exploiting slave labor (naming the labor of slaves isolated and without relationships in the "New World"), abstract workforce considered as autonomous and interchangeable units. Tsing also argued that the model of the 17th century colonial plantation shaped some of the ideas and practices that became central features of narratives of progress, modernity, science and technology that at the core of the idea that human civilization meant emancipating their needs from nature by dominating nature. The early modern period, the period of the triumph of natural history, is still at the center of multiple histories, including those written by earth system scientists Lewis and Maislin, who famously proposed to date the Anthropocene back to the early 17th century (Lewis and Maislin 2018). Tsing writes of the plantation:

> Interchangeability in relation to the project frame [plantation], for both human work and plant commodities, emerged in these historical experiments. It was a success: Great profits were made in Europe, and most Europeans were too far away to see the effects. The project was, for the first time, scalable – or, more accurately, seemingly scalable. Sugarcane plantations expanded and spread across the warm regions of the world. Their contingent components – cloned planting stock, coerced labor, conquered and thus open land – showed how alienation, interchangeability, and expansion could lead to unprecedented profits. This formula shaped the dreams we have come to call progress and modernity. (Tsing 2015, 39-40)

5. Nature and History

In any case, by the early 17th century the word *historia* could mean several things. *Historia* was employed in several disciplines, such as jurisprudence, medicine, and literature, always with reference to individual, singles cases, or stories – or case *histories*. For the physicians, *historiae* were specific descriptions of single organs to highlight their structure and function; for someone like Francis Bacon, they were collections of empirical information on single phenomena; for Ulisse Aldrovandi they were collections of information to be looked for within the whole literature on plants and animals. But what is important here to keep in mind is that

these "stories" were about what we would call nature and culture at the same time, namely they referred to a continuum between nature and culture, they were placed before – or better away from – the separation between nature and culture (Pomata and Siraisi 2005). This legacy is still very clear in the XIX century, when both Charles Darwin and Karl Marx use "natural history" to describe, respectively, the historicity of nature – and nature as technology as well as technology as nature – and to emphasize the features both historical and natural of political economy.In the preface to the first edition of *Capital* Marx wrote: "My standpoint from which the development of the economic formation of society is viewed as a process of natural history" (Marx 1976, 92). And Darwin before him:

> [W]hen we regard every production of nature as one which has had a long history; when we contemplate every complex structure and instinct as the summing up of many contrievances, each useful to the possessor, in the same way as any great mechanical invention is the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen; when we thus view each organic being, how far more interesting – and I speak from experience, – does the study of natural history become! (Darwin 1872, 426).

Moreover, the historical links between 17th and 18th century natural history as a prehistory of anthropology have been explored, but mostly as focusing on humans as a separate field of inquiry with respect to nature (Campbell 1999). The first man to occupy a chair of anthropology in Italy (1869), Paolo Mantegazza, defined his discipline "the natural history of man" (Puccini 2011, 547).

6. Conclusion

The revival of natural history in environmental humanities reflects similar patterns. As I recalled earlier on in this essay, there are two meaning of the label natural history that can be historically specified, and that both enrich the ways in which natural history is being used in the environmental humanities: on the one hand, the combined history of a historical nature and of a history dependent on the materiality of nature; on the other hand, the Anglo-Saxon contemporary meaning of field work or field observation.

Natural history is being used again to underline the interdependence between history and nature, humans and non-humans, or more-than-human history – of course, without the colonial overtones of 19th century anthropology. I would say the natural history is a mode of reasoning that has a long history of cutting through the nature vs history divide, at least since the 16th century. There are in the history of western approaches to nature ways of thinking about nature and history as completely intertwined. Perhaps, the new environmental humanities and social sciences sometime lose sight of such traditions and tend to think that they have a duty to put into question a distinction – that between nature and history, or nature and culture – that is in fact not so old and not so entrenched within a supposedly monolithic Western way of reasoning. I argue that a more fruitful approach consists in looking for temporal short-circuits between the 21st century and early modernity, as they are enabled by inquiring on the tradition of natural history as an epistemic genre.

Capitalocene is a better word than Anthropocene, and I am convinced that we need narratives about the rise of "world-economies" and "world-ecologies" that span large portions of the world. Yet, we also need stories, both for the sake of painting better historical pictures, and for the sake of listening to the little things emerging out of capitalist devastation. And such stories are to be gathered by forming local and specific alliances between the sciences, humanists, lay knowledge, and more-than-human nature. Capitalism – or Capitalocene – is the frame for new natural histories, but it does not determine such histories in advance. Perhaps it is an old problem, older than modernity itself: how to link the individual to the general? In current terms: how to link case histories with Capitalocene?

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Discounting the Future. The Ascendency of a Political Technology

by Liliana Doganova (2024) Princeton (NJ), Zone Books, Princeton University Press, 336 pp.

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Had Karl Marx read the book I am about to review, I like to believe he would have revisited his famous dictum from *The Eighteenth Brumaire* to say: the discounted future of the new generations weighs like a nightmare on the calculative infrastructures of the present.

Climate knowledge has been validated, political calls on system change have been made, targets set and transition pathways traced, renewable solutions developed, publics mobilized. Still, environmental, political, economic, health crises persist and grow in their magnitude, to the point of appearing overwhelming and leaving humans stuck with business as usual. How to deal with such inertia?

Discounting the Future. The Ascendency of a Political Technology by Liliana Doganova suggests turning the eyes from the panoramic view and looking where the devil thrives: the minutiae and the boring details, hidden in plain sight and yet able to expose the whole machinery of a mystery just like Edgar Allan Poe's stolen letter. Doganova – associate professor at the Centre de Sociologie de l'innovation (CSI), Mines-ParisTech, PSL University – invites us to consider how the future is embedded in the very economic instruments used to imagine, control, and extract value from it. In so doing, the book follows the route of the pragmatist tradition of economic sociology and STS looking at the material and discursive assemblage that enact mainstream economics and finance as well as markets (Callon 1998; MacKenzie 2006; Callon et al. 2007). The focus is not on the meaning of economy and what the economy is or is not, but rather on what economics does: how its technologies of calculation actually work; the worlds they perform; the actors they make visible and invisible; and the time horizons disclosed or hindered. By addressing the question "How the future is made valuable?", Doganova traces the connections of economic knowledge and practices in a quest where the mystery to be solved is nothing less than the mystery of the capital. To understand capital, the author argues, we need to explore the political technologies built on the relation between valuation and temporality.

The book engages with a specific mechanism of valuation through which the future and the present have been appropriated and trapped: *discounting*. The author starts exploring discounting as a "general form" (p. 23) enacted by the instrument of the discount rate, a cost-benefit model assuming that the money expected in the future is equivalent to less money today.

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Chapter 1 begins by examining the discount rate, starting with its formalization by economist Irving Fisher in 1906, as an equivalence between future benefits and present costs. Fisher's "coup de maître" (p. 52) makes the value of things derived solely from the future, cutting the future from the present, and purging it from the past. To consider the states of the future less important than the present has huge implications for the way politics, society, finance and innovation are today conceived. First, once projected into the future, the things being valued are themselves transformed into capital flows. Secondly, what counts for determining the value of things is constantly devalued. The future, indeed, is discounted.

Across the book, the reader travels back and forth through a calculative infrastructure made of economic tools and models, textbooks, standards, resource management approaches, organizational narratives. The machinery of discounting, we learn, shapes firm practices and industrial sectors, major infrastructure projects as well as public policies. It applies to a variety of settings across modern history, before and after Fisher's conceptualization, including the laws supporting international arbitrations and global decarbonization strategies. Chapter 2 traces back the origins of discounting to the "Faustmann formula", introduced in forestry management during the nineteenth century to calculate the right moment to cut trees and sell wood, thus turning forests into capital through time. With a leap in time to the publicly traded firms of the 1950s (Chapter 3), we witness the early steps towards the financialization of the economy as discounting is engineered in a specific tool, the Discounted Cash Flow analysis (DCF). DCF has been transformed into a commodity making the life of companies increasingly dependent on their expected value, with managers acting in the interests of investors. The story of discounting continues moving to the biopharmaceutical industry (Chapter 4), dealing with the uncertainty in the valuation mechanism. The author illustrates how the very notion of uncertainty becomes capitalized, and evolves from a simple lack of knowledge into a tool for assessing the value and risks of developing new drugs. Finally, Chapter 5 explores the role of discounting in the public management of Chilean copper mines, an emblematic story that I will detail below.

The valuation processes are linked in the book by a common thread. Describing forest management, firm practices, biopharmaceutical strategies and management of mineral resources, allows the author to expose the theory of value and the theory of action underpinning the machinery of discounting. A theory of value "characterized by its radically future-oriented temporality" and a theory of action where "the value statements that it produces matter not so much as truth statements, but as action triggers" (p. 28). The book shows how discounting operates as a political technology and the future as a political domain where the capacity of action is unevenly distributed.

The author's aim is not to determine whether DCF accurately represents value or not, but rather to explore how it shapes value together with the objects that are valued. Accordingly, the author sharply illustrates how discounting prescribes not only what matters, but also what is deemed worthy of existence, ultimately hindering the capacity to act in the future. In the case of forests, the long-term approach to capitalize on the value of the forests for market and military purposes clashes with the short-term needs of the rural populations for heating and building houses and tools. Likewise, the decision to develop or not a new drug is increasingly taken given investors' concerns. The high discount rates are in competition with the

potential benefits for the patients in defining the value of a drug. By addressing uncertainty not as a neutral lack of knowledge but instrumental to discounting, Doganova finally shows that the future and the present are a contested landscape, "over which some actors claim the right and the ability to act while other actors do not" (p. 126).

One of the key lessons of Doganova's account is that the economy is far too important to be left solely in the hands of economists. The book contributes to adopting a transdisciplinary perspective and method, drawing on historical and economic sociology to engage with economics and enter dialogue with many other disciplines. There are core influences, starting from the abovementioned scholarship of Actor-Network Theory and STS, developed within the Parisian academic milieu and the CSI, where the author is based. Then the book engages with a variety of debates on markets, economy and time, including future and anticipation studies (e.g., Esposito 2011) and history of ideas (e.g., Nordblad 2016; Andersson 2018). The concept of political technologies draws on Foucault's idea of governmentality, which in turn activates more implicit resonances with other contributions I came across. Most notably, the work by Timothy Mitchell in political theory and history and his notion of "economentality", as a form of political reason and calculative practice which "formed the economy as their object and introduced the future into government" (Mitchell 2014, 485). Likewise, the book's section about the Stern/Nordhaus controversy on the discount rate connects me to recent contributions in non-mainstream economics on temporality and time constraints to identify alternative trajectories of decarbonization (Coffman and Scazzieri 2024). These and many other scholarly encounters suggest that a vibrant and important debate is unfolding, one in which I believe *Discounting the Future* plays a crucial role and to which it offers a truly original contribution.

The fifth and final chapter of the book is particularly compelling and stands out as an ideal culmination of Doganova's genealogy of discounting. It examines two opposite approaches to valuation that share a common dilemma: how to determine the price of privately owned natural resources, to provide compensation once they are expropriated by the state? The chapter delves into the history of Chilean copper mines, initially owned by multinational corporations, then nationalized under Salvador Allende's government in 1971, and successively conceded by law to investors by Pinochet's minister of mines José Piñera Echenique, following the 11th of September 1973 military coup. Piñera developed a legislation with the brute force of economic rationality, bringing the future-based mechanism of discounting to its extreme to attract foreign investors. It allowed to neutralize the previous nationalization without changing the constitution, bypassing ownership through valuation. Under Piñera's system of full and indefinite concessions, the investors' expectations would have been met anyway, regardless of how the future unfolded. Allende's nationalization, in contrast, inspired by principles of social justice and compensation, represents a rare instance, where the past resists the future and becomes the source of value itself: the price of mines is given by their initial value when they were first acquired by companies minus the excess profits made by companies over the years. As it turned out, the Allende government would not have needed to pay to nationalize the mines. Instead, the mining companies would theoretically have owed the Chilean state money due to the immense profits generated.

Clearly, discounting played a crucial role in the historical, economic and social stakes of one of the postwar era's most tragic events, and it plays a crucial role today. The story of Chilean

copper mines does not end here. The author follows its various threads to document the shift from an economy based on ownership to one based on valuation until nowadays.

As an STS scholar engaged with climate transformations, not trained in economics but aware of the strong influence of economics on climate action, I felt both rewarded and empowered reading the book. The narrative settings enable both author and reader to walk together as companions in a shared journey throughout the book's exploration of valuation. The style offers effective guidance through economic paradigms and their technicalities, carefully tracing the connections between the tiny instruments and formulas and their large implications. Not only the language of economics is made accessible, but also actionable. The category of time and the situated approach adopted to study valuation, while offering a novel perspective, have also the advantage of creating a shared cultural ground with the reader, stimulating larger reflections on past, present and future, and widening the book's reach beyond academia.

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Face à l'antibiorésistance: Une écologie politique des microbes [*Facing antibiotic resistance: A political ecology of microbes*]

by Charlotte Brives (2022) Paris, Éditions Amsterdam, 340 pp.

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How can we understand the relationship between capitalism, the WHO's urgent warnings about the alarming rise in antibiotic resistance, the structure of clinical trials and the practices of Evidence-Based Medicine? What if bacteriophage viruses – viral particles that infect bacteria (more commonly known as "phages") – provided a privileged access point to grasp how politics, epistemic infrastructures, medical practices, and ecologies are co-produced?

Charlotte Brives publishes *Face à l'antibiorésistance* as the fruit of an ethnographic inquiry conducted over several years in laboratories, hospitals and associative milieus in France, Switzerland and Belgium. Moreover, the book builds upon years of reflections on the relationships between humans and microbes. As both a trained biologist and an anthropologist, she has co-directed *With Microbes* (Brives et al. 2021), a pivotal work for the anthropology of microbes, and is currently leading two research projects on the anthropology of phages. In her book *Face à l'antibiorésistance*, Brives follows phages through the multiplicity of assemblages in which they are caught and in which they act. She accompanies and makes visible the deployment of phage therapy as a possible alternative to antibiotic therapy at a time when antibiotic resistance has become the object of scientific and very largely public concern. This anthropology of phages involves meeting many actors, human (patients, scientists, physicians, policy-makers...) and non-human (viruses, bacteria, geopolitical borders, chemicals, languages, guidelines...). It also implies exploring relationships that are always particular and always open to renegotiation; histories and knowledge to be made and remade; and a whole antibiotics infrastructure – which is both politico-economic and epistemic – that, for the time being, tightly conditions the circulation of phages as a possible therapy. Giving special importance to a series of rich interviews, and deeply documented from a historical and biological point of view, the book unfolds in nine chapters, each being an encounter with various modes of phage existence *via* the relationships that bring them into being. By *embedding* her practice on various scales of time and space, Charlotte Brives leads us to question in depth what capitalism is doing to the living, as well as how we have to re-knit our practices and relationships in this context.

STS scholars have been keenly discussing the mutual reconfiguration and tight interweaving of medical practices, politics and the living itself. While the governing of microorganisms

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through technologies and human practices (including medicine) has been analyzed as "microbiopolitical" regimes (Brives and Sariola 2021; Paxson 2008; Paxson and Helmreich 2014), the contemporary "political" that allies ethical subjectivities, health policies, molecularized medical practices and biomedical technologies, has been qualified as a "politics of life itself" (Rose 2007). It is in this context that Brives powerfully demonstrates what is political about microbial ecology. On the one hand, it is the production of knowledge. From the choice of its objects and methods to the sedimentation of certain propositions and what they enable to be put in place, the production of knowledge is entirely traversed by, and acting within, the political. This is nothing new. But Charlotte Brives' work gives substance and bodies, to what today seems to be an obvious statement. Such is the case with André's body, whose encounter opens the book with a bang (Chapter 1, pp. 49-ff.). André's body is caught in a complicated and painful web of chronic infections, legislation, geographical and ontological boundaries, DIY bladder polls, and anger. The crux of the matter appears to be the double border, both geopolitical and ontological, between a chemical substance and a registered drug – a double border that makes the use of phages in Western Europe extremely complicated. To provide a basis for understanding this intricated web, Brives constructs her book around a powerful history of the production and utilization of antibiotics (Chapter 7, pp. 209-ff.), which reveals the infrastructure that these chemical molecules produced and require. By infrastructure, Brives, following Susan Leigh Star, means "a complex system of relations between living beings (human and non-human), things and discourses" (p. 211). The industrialization of antibiotic molecules involves extracting the microorganisms that produce them and putting them to work in standardized ecosystems. It is also the precondition for capitalism's objectification of living organisms on a global scale. Antibiotic molecules have been used on a massive scale as "wonder drugs" in human clinics, facilitating the reproduction of the workforce; however, they have also been used on an even larger scale on farming and livestock farms, first as therapeutics and prophylactics, then as growth promoters. Industrially-produced antibiotic molecules played their part in making possible what Haraway and Tsing have called the "Plantationocene" (Haraway 2015): a global simplification of ecosystems, rendering both gigantic and fragile a system of industrial exploitation and commercial circulation of human and non-human living things. This history also shows how the antibiotic infrastructure constitutes the onto-epistemic milieu in which the whole of biomedicine now inevitably unfolds. Industrial production of antibiotic molecules has grounded the paradigm of evidence-based medicine and the obligatory passage through randomized clinical trials (Chapter 6, pp. 181-ff.), implying *de facto* full powers for the private pharmaceutical industry and its logic of profitability. Antibiotic infrastructure also grounds the binary order of infection and eradication as clinical axiology (Chapter 5, pp. 153-ff.). And if the production of knowledge is a political thing, the writing of history is not to be overlooked. Fully partaking this ethos, Brives not only writes her history of the antibiotic infrastructure, but also puts forward what she calls "alternative histories" (Chapter 2, pp. 71-ff.). That is, those stories that do not build their narrative arc upon the somewhat classical positivist and virile sequence of impotence → discovery (great man) → victory (hegemony of antibiotics). Rather, these "alternative histories" are those that make visible what phages have done since their silent disappearance from European pharmacopoeia in the late 1970s. Through them, we are thus taken back to the USSR during the Cold War, to drug stores and

medical facilities in cities such as Tbilisi, Kiev or Karkov; and also to present-day Georgia, and to those French associative milieus where doctors and patients are fighting to promote the development of phage therapy. These stories show that giving bacteriophage viruses the status of a drug today requires making them completely different, "incommensurable" even, from what they were in the 1970s. The networks of knowledge and techniques, regulations, and geopolitical borders have changed, as have biologies themselves. Therefore, to participate in this new world, phages need to be reinvented. And it is this reinvention, multiple and situated, that Charlotte Brives invites us to witness, better understand and care for.

On the other hand, it is also political, in microbial ecology, how human communities are engaged in complex relationships with communities of microbes. Since the AIDS epidemic, but perhaps on an even larger scale since the COVID-19 epidemic, it is pretty hard to argue that the relationships between human communities and microorganisms are anything but political. While on the one hand human practices and (geo)political power are forces that (dis)organize the circulation of (microbial) life, on the other hand, microorganisms can irrupt in, and disrupt, the (geo)political forces and human practices (Brives and Sariola 2021). In this sense, microbiopolitics is a historical force that shapes our present and future in both a (geo)ecological and political way (Landecker 2016). However, these relationships have been elaborated, thought out, regulated and made political for as long as cheese, beer, and other fermentation processes have existed. They have blossomed in modes of existence far more complex, therefore, than that of the therapeutic or vaccine arms race and Emmanuel Macron's bellicose statement that "we're at war" against the SARS-CoV-2 coronavirus (Brives 2020). Charlotte Brives, not interested in fancy poetic neologisms, but convinced that language has real performativity, proposes the concept of "pluribiosis" to designate this complexity of the living, revealing, through a well-documented detour into the ecology of phages (Chapter 4, pp. 125-ff.), the fact that entities, environments, and relationships are inter-defining and becoming; that they are never fixed, never impermeable. Pluribiosis thus encompasses a processual and relational conception of living things, as well as of the knowledge produced from and within them. Thus, if the various systems for categorizing and fixing the living are useful, even necessary, heuristic elements for any practice, *a fortiori* scientific, they must be conceived as being themselves modulated by the relationships in which they are woven; but the modalities of categorical fixing of the living must also be conceived in their own performativity, in that they too have a real impact on the entities they define. What the living, be it human or non-human, does to itself, in the multiplicity of relationships it weaves, forms so many "microgeohistories" that scientists, when they isolate and purify bacteriophage viruses to then determine their efficacy on a particular bacterium of a particular patient, attempt to suspend, to immobilize in order to objectify them (Chapter 3, pp. 97-ff.). Biological matter is both historical and potential, evolving, resisting, adapting and innovating. The development of antibiotic resistance is a painful demonstration of the "recalcitrance" of living organisms (Chapter 8, pp. 241-ff.) and of the fact that they will always exceed our expectations. It is therefore with humble precaution that we must consider the relationships between human communities and other living beings, and more specifically the current developments in phagotherapy. Within the framework that history has provided for our present, and to a certain extent our future, how can phage therapy be made to exist in a way that is both accessible to

all, and yet always profoundly situated and "individualized"? How can we take into account, therapeutically, particular microgeohistories, without making phage therapy a luxury option, out of pix for it to be profitable? Alternatives do exist, and Brives shows us some of them. There are public laboratories and pharmacies on the bangs of the drug market, where profitability is the only compass. In the final analysis, this is what the political ecology of microbes is all about: the moral and political proposals made by actors on how bacteriophage viruses should be used. And it is to such proposals that Charlotte Brives contributes.

As Bruno Latour notes in his preface to the book, Charlotte Brives had the intelligence to be in the right place at the right time. Everything is yet to be done: "The *politics* [of phages] are wide open for the time being" (p. 1, *italics in original*). Such an actual openness is what makes Brives' work so fascinating, and the questions it raises all the more urgent. We regret, however, that there is as yet no English translation of this work. This is a book that will prove important to many scholars. First, to those interested in the anthropology of microbes, and in reading a smart complexification of the so-called "microbial turn" (Paxson and Helmreich 2014) and to those keen on witnessing "science in action" and the assembly process of "socio-technical networks". Second, it is a book that is relevant to all of those interested in the question of how (and why) we should do STS in the crisis of the capitalist system. What does it mean to be a committed and militant researcher when Gaia bursts in, violently, and in return, the exploitation of the living seems ever more barbaric? As Isabelle Stengers, cited by Brives to open the book, writes: "Fighting against Gaia makes no sense; it's all about dealing with her. Dealing with capitalism makes no sense; it's about fighting against its grip" (Stengers 2013, pp. 64-65).

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The Birth of Computer Vision

by James E. Dobson (2023) Minneapolis (MN), University of Minnesota Press, viii-205 pp.

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The ways in which we engage with computer vision are now plenty and immersed in our everyday lives. For example, we encounter computer vision practices when we are forced to tick all the boxes containing a traffic light so to visit a website, as this is turned into data to train computer vision algorithms to identify objects in pictures. We are also subjected to it when we stand in line at the airport or border controls where real-time face-recognition is deployed to identify us, and when our bodies are, or are not, identified as humans passing the crosswalk by the algorithms of a "self-driving" car. Altogether, this means that the topic of James E. Dobson's book *The Birth of Computer Vision* is very timely. If anything, the relevance of this work has only further increased since the adoption of the Artificial Intelligence (AI) Act by the European Union in March of 2024. The AI Act is one example of how a lot of both scholarly and public debate is dedicated to the opportunities, risks, and development of artificial intelligence, as well as computer vision applications specifically. For example, the question of whether real-time biometric identification of humans, by face recognition in surveillance systems, should be allowed is subject to much discussion. At the same time, Dobson shows that both the technology and the scholarly field that now go by the name of computer vision have a rich and intricate history, starting at least from the 1950s, and drawing from older statistical methods. Computer vision is moreover entangled with certain epistemological and ontological constructs, as Dobson argues: "To understand computer vision is to take on its sense of the world as a particular construct, a particular metaperspective toward reality, one that is shaped by its history" (p. 51).

One of the main goals of *The Birth of Computer Vision* is to "deconstruct the absolute division that has been drawn between accounts of human and machine vision" (pp. 3-4). Initially, the author introduces theories of ways of seeing and ideas about perception, arguing for human perception as a precondition that enables the development of machine vision. Moreover, Dobson situates the study in the fields of critical algorithm studies and the history of ideas. Such a two-fold positioning is due to the fact that the book argues that algorithms should be understood, first and foremost, as ideas. Methodologically, the book is a historical investigation, looking for the genealogies of seeing technologies through historical sources. It does this by focusing on a number of algorithms, models and technologies as case studies.

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The rationale of the case selection is based on including algorithms that have had a great impact in the infancy and formative period of the research field of computer vision and that are still important for contemporary technologies and applications.

The first chapter stresses how the visual culture of the last mid-century enabled the development of image-focused technologies and computer vision. It also discusses how the discourse of computer vision presents the technology as a "neutral extraction of information from data" (pp. 29-30) that is also superior to human vision. Machine vision assumes the world as something that can be separated into different entities, with lines demarcating specific objects and spaces. Furthermore, it builds on knowledge from the past to algorithmically shape current technologies and the culture around them. To a large extent, computer vision also takes shape in military research labs, with the United States (US) Department of Defense as a main funder, and is spurred by the military technologies of the Cold War. One first step towards developing computer vision, described by Dobson, is the making of the Perceptron, a neural network algorithm that psychologist Frank Rosenblatt applied to enable binary classification by supervised learning, as presented in Chapter 2. This algorithm was embodied in The Mark I Perceptron, a machine for image interpretation and pattern recognition. Yet, the book discusses how the binary classification soon posed limitations and after some time, Rosenblatt framed the perceptron as a research model rather than a general system able to perform visual pattern recognition.

In the following Chapters, 3 and 4, Dobson describes how research into pattern recognition and machine learning during the 1960s and 1970s moved away from computer-assisted perception of pixel-based data, and towards analysing "sensed scenes" (pp. 100-101) and high-level symbolic representations. This is the period during which the research field of computer vision was formed. According to Dobson, it was made possible by an altered ontology of the image as consisting of a collection of features. By breaking down pictures into components and parts that could be described, in edges and features, pattern recognition and object detection became what other scholars have called more "doable" problems (e.g., Fujimura 1987). Image segmentation and "blob detection" (p. 85) made it possible to distinguish and demarcate objects. Eventually, it resulted in developments such as the first system for real-time face detection, the Viola-Jones face detector framework, published in 2001. It is comprised by a set of classifiers that look for patterns in pixels and try to match them against object patterns identified as faces (p. 119). However, Dobson emphasises that these types of technologies build on normative assumptions about how an average face should look. As the author notes:

> [C]omputer vision, in its earliest moments and in the present, cannot escape from its reliance on symbolic abstractions and the biases, exclusions, and historicity that such model activity inevitably introduces. (p. 132)

Subsequently, in Chapter 4, Dobson describes the US military-funded Shakey project which aimed to produce "Shakey the robot" (p. 135). As an embodied and mobile robot, it was made to move, or rather roll, around, necessitating the ability to "sense" its environment, walls and objects of interest. In addition, by processing images from an attached camera, it constantly updated its sense of the environment. The project led to the development of the

Hough Transform that is used to detect lines. This technology is still often used as, for example, line detection algorithms are of high importance to keep cars in their lanes in assisted driving and deployed by lane departure warning systems. In the concluding chapter of the book, "Coda", more attention is devoted to the impact that these computer vision technological developments have had, and continue to have, on contemporary applications and research (p. 165). Dobson describes OpenCV, the current main toolkit for computer vision that encompasses over 2,500 algorithms, out of which one is an implementation of Rosenblatt's perceptron. The author argues that the cases genealogically analysed – the perceptron, blob detection, template pattern matching, pictorial structures and the Hough transform – have survived the test of time and are used in current technologies. This is why it is all the more important to know their history and assess how they still impact our everyday lives.

Moreover, Dobson does a great job in showing the entangled history of computer vision and military goals, and the relationships between the aims of seeing machines and surveillance. It was the US military funding which enabled much of the computer vision research, and it was to a great extent with military goals that computer vision was developed, such as to identify enemies' advances in aerial photos, to identify targets, and to ease the work for human military photo interpretations. Yet, some of the researchers, that Dobson portrays, seem less devoted to, or even against, the militarisation of the technology. Even though Shakey the robot was portrayed as harmless, it was with military operations in mind that the research behind it was funded and formed. Dobson also portrays how the military bounds led to a backlash for the research during the protests against the Vietnam War. This is argued to formally have led to universities cutting ties with military research labs, while perhaps not so much changed in terms of research practice as main actors continued to carry out research at both organisations.

Dobson also shows how the objectives and framings have changed since the beginning of what we call computer vision. When the initial goals of recognition of patterns and creating a comprehensive machine understanding of images failed to succeed, the researchers started to break it up into smaller more manageable tasks, into features, lines, and edges. In addition, when full automation proved too hard, computer vision was promoted instead as an enabling decision-support tool helping human interpreters rather than replacing them, which was deemed valid for the subsequent expert systems.

In its entirety, the work presented in *The Birth of Computer Vision* is of relevance to several scholarly conversations in current STS. By focusing on multiple actors, both humans and machines, as well as the human-machine relations, this book relates to multiple research areas in STS. For example, it is in the same vein as the work of Adrian Mackenzie (2017) who casted a light on "machine learners" by offering an archaeology of data practices, and by carrying out a sociology of programmers. Dobson's work provides a very valuable description of the cases of specific researchers and algorithms, which demonstrates and offers deep knowledge and richness in detail. However, it would in some instances have been valuable to more clearly and decisively lift the gaze and inform the reader about the significance of that particular story for later developments and for us to better understand our current technologies.

One of the most valuable aspects of the book is how it discusses computer vision as sightless seeing, that is, as a machine's direct sensing of the environment and ability to elicit knowledge from images without a sense of sight. This is also discussed in relation to ide-

as about the increasing absence of a graphic output in the form of representational image outputs that are visually interpretable for humans. This connects to Jussi Parikka's (2023) analysis of images as data made for machines and algorithms. Both Dobson and Parikka refer to the artist and media theorist Harun Farocki's conceptualization of operational images (e.g., Farocki 2004) and, in particular, how these operational images challenge the generally taken-for-granted ontology of images and vision. Yet, *The Birth of Computer Vision* demonstrates the highly material aspects of computer vision. For example, by the embodiment of algorithms into the Mark I Perceptron machine, the robot Shakey or the sociomaterial impact of computer vision technologies. This materiality puts into question whether it is really valid to refer to algorithms as being foremost ideas.

The Birth of Computer Vision is of high relevance for those STS scholars focusing on analysing current digital technologies. The book succeeds in its mission to show the intricate relationship between human and machine vision, and how the latter still is dependent on the former by human labelling and descriptions of images as training data for algorithms and as some algorithms working to support human vision rather than being able to replace it. As computer vision shares much history with artificial intelligence, the book offers a much-needed deepening of the historical perspectives on AI and computer vision's development. It provides a thorough empirical account to be combined with scholarship on the sociotechnical assemblages and impacts of AI, such as Kate Crawford's (2021) *Atlas of AI*. As Dobson puts great effort into describing the military influence on computer vision research, as well as the backlash that the research received due to its military ties, the book is also of interest to those researchers studying science-technology-military relationships, the impact of research funders, and political debates about universities' connections with military operations. The book's greatest contribution is, however, the insights it provides of the intense historicity that is built into our present-day highly impactful algorithms and digital applications.

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Curious Kin in Fictions of Posthuman Care

by Amelia DeFalco (2023) Oxford (UK), Oxford University Press, 212 pp.

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Author Amelia DeFalco is Professor of Contemporary Literature at the University of Leeds, but it is her broader interdisciplinary background in medical humanities, literary fiction, feminism, science and technology studies (STS) and the biopolitics of care that is well represented in *Curious Kin in Fictions of Posthuman Care* (referred to as *Curious Kin*). In the book's four chapters, Introduction and Conclusion, DeFalco takes readers on an exciting journey through the landscapes of posthumanism, both real and imagined. Here, she concentrates on the excluded places and abandoned forms of life that congregate to create new modes of survival and vitality.

Throughout *Curious Kin* DeFalco lines up the tenets of humanism against their posthumanist critiques in the contexts and ethics of care. Historically, humanism has a double legacy. While liberating scientific inquiry, economic enterprise and the potential of "mankind" from the bonds of theological feudalism, humanism also legitimized the Eurowestern division, domination and "civilization" of the world's peoples and cultures (Braidotti 2019). Against this legacy, DeFalco posits posthumanism as a "shorthand for a wide range of critical perspectives united by their skepticism toward anthropocentric humanist taxonomies and the gendered, racialized, bounded individualized 'Man' they have begot" (p. 18). As such, posthumanism in this book provides an alternative and inclusive vision of non-human, more-than-human, inhuman and hybridized lives, whose recognition overturns humanist binaries between "Man"/other, nature/culture, mind/body and life/non-life.

In pursuit of this vision, DeFalco has written a boundary-challenging book, extending her core arguments about relationality to the pathologized and toxic badlands of dystopian modernity. In support, DeFalco frequently cites Karen Barad, Donna Haraway, Anna Lowenhaupt Tsing, Elizabeth Povinelli and other posthumanist thinkers who have aligned their theoretical work to disability, queer, environmental, decolonial and feminist movements. STS scholars will find many parallels between the book and posthumanist approaches to STS in Maria Puig de la Bellacasa's *Matters of Care. Speculative Ethics in More than Human Worlds* (2017). However, the "shorthand" of posthumanism can be difficult to understand because it is neither a unified theory nor a philosophy, but a pooling of various ideas from the work of Gilles Deleuze, affect theory, non-representational geography, Indigenous Knowledges,

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STS and materiality studies, the post-humanities, feminist-ecology and more. In my view, a unifying way of characterizing the many components of posthumanism would as a thought space or a "style of thought" as elaborated by sociologist Nikolas Rose. For Rose, a style of thought is a sense-making modality that emerges within assemblages of expertise, fields, crises and trends that is "not just about certain forms of explanation, about what it is to explain, but about what there is to explain" (2007, 12).

Curious Kin posits that a posthumanist style of thought can reclaim the relationship between kin and care in ways that disturb humanist, colonialist and capitalist orders. DeFalco, as other feminist posthumanists do, theorizes kin beyond traditional biological and reproductive designations in order to imagine "who and what we are" (p. 11). When care is added to this view of kin, then ethical principles of reciprocity, interdependency, responsibility and vulnerability become obvious priorities. This entanglement of kin and care has featured in other philosophies and cultures, but here DeFalco's posthumanist slant deconstructs anthropocentric hierarchies and recomposes them into their horizontal and relational components. Each of the book's substantive chapters accomplishes this task by looking at examples of literary and media fiction to explore posthuman dilemmas of kin and care through the remarkable experiences of fictional characters. This is where *Curious Kin* shines with originality and liveliness, offering a perspective from the critical humanities and literary studies to enrich debates in STS and affiliated sub-fields about human, non-human and technological relationships.

Chapter 1, "Care Robots and Affective Legitimacy" is about care robots. Since the commercial appearance of baby-seal pet robot Paro in 2004, the therapeutic pet robot industry has grown significantly. However, so have criticisms concerning their simulated "care", especially for impaired older adults. Still, robots set off important questions about the meaning and labors of care as they are configured by non-reciprocal human biases about givers and recipients of care. To explore the problematic nature of care, DeFalco reviews the movie "Robot and Frank" (2012), the TV series "Real Humans" (2012-14) and Louisa Hall's novel *Speak* (2015). Each exposes tensions of intimacy between human and machine while remaining cautious about a future relying on robotic care. These fictions also reflect current problems in a globalized health economy that "suggest a provocative affinity between diverse vulnerable bodies – old, young, female, and mechanical" (p. 53). Even as robots become more human-like, and the boundary between carbon and silicon more blurred, the care roles that these robots perform (traditionally female) ultimately represent the exploitative relationships by which care work is structured and devalued. I am convinced by DeFalco that we should take robot stories seriously for what they reveal about the everyday ethics of deciding who is (and who is not) deserving of care. My quibble with this chapter, however, is that the fictional examples are somewhat dated given the rapid development of robotics since their time and the radical incursion of Artificial Intelligence (AI) in active care, monitoring and assistive technologies.

Chapter 2, "Feral Touch", is a fascinating discussion of posthuman care practices "as haptic phenomena" (p. 62). The human body, or all bodies for that matter, are a core focus for posthumanism because they are conduits of non-anthropocentric relationships. Touch is a particularly powerful inter-affective capacity by which life embraces and cares for itself: we are touched, in multiple ways, by what we touch. DeFalco selects two texts about feral children "that engage embodied porousness and 'touchability' in all of its caring potential and mortal

risk" (p. 69). Cases of feral children, whether authentic or fantastical, are famous for shocking moral sensibilities about human development and sociality. Beginning with Eva Hornung's novel *Dog Boy* (2009), DeFalco examines the fictionalized story of Ivan Mishukov, the Moscow child who survived on the city streets with dogs, who are also homeless. The boy does not only eat and sleep with the dogs but is also part of their abandoned "fleshy" world, sharing the warmth, tastes, smells and textures of their bodies. Similarly, Banhu Kapil's *Humanimal: A Project for Future Children* (2009), is based on the story of the two wolf girls of Midnapore (India) in the 1920s. DeFalco again pulls from the text the ecology of animal tactility and sensuality, encouraging readers to try to *feel* the entanglements of a human/non-human world. As with the dog boy, the feral wolf girls have to be rescued to restore the normative boundaries of humanity itself, since stories of rescued feral children satisfy the moral narrative that care in human society means the regulation of animalistic wildness.

DeFalco's adds to this chapter the science fiction novel *Under the Skin* (2000) (also a film) by Michael Faber. This is a story about human and alien contact seen from the alien perspective (humans are called "vodsels"). Human men are hunted and killed for their disposable bio-materials, making their skin and bodies permeable to extraction and human/non-human touch zones porous and intensified. While the traditional human male is taken apart as alien matter, the main female alien character becomes more human, entering into a different set of affective relationships. As with Chapter 1, I am intrigued by DeFalco's insightful interpretations of the material lives of fictional characters and how they become opportunities to defamiliarize and shake up fundamental ontological assumptions. At the same time, I find myself asking two questions. First, do the texts and their interpretations give us a true ethological sense of animal life, of how dogs or wolves actually behave, or are they still characterized by a wildness that risks reinstating human limits? Second, are caring, touching and surviving necessarily complementary practices, even in extraordinary posthuman contexts, since the chapter tends to slide between them often without distinction?

These questions surface in different ways in Chapter 3 on "Care and Disposable Bodies". Here the author asks "how one can care for and about the more-than-humans", but "without belittling the ongoing battle for recognition by marginalized humans" (p. 103). In response, DeFalco selects the books *Never Let Me Go* (2005) by Kazuo Ishiguro and Margaret Atwood's speculative fictional trilogy *Oryx and Crake* (2003), *Year of the Flood* (2009) and *MaddAddam* (2013). These fictions explore the lives of hybridized, bio/techno/human/non-human beings in unsettling conditions of waste that certainly create "curious" kinships. As abandoned beings, they come to matter because even "discarded matter, human or otherwise, can be a form of radical attention, a defiance of the binary colonial cultural logic that produces significant versus insignificant bodies" (p. 109). The texts also conjure up the anthropocenic calamities of global wasteland dumps and toxic dead zones. As with the book's other chapters, the premise here is that a posthumanist ethic of care, based on reciprocity and co-existence must be inclusive of inhuman and disposable lives.

Chapter 4, "Decolonizing Posthuman Care", continues in this vein by exploring impoverished wastelands, with a focus on posthumanist critique as an anti-racist style of thought. In her reading of the novel *Salvage the Bones* (2011) by Jesmyn Ward, DeFalco describes its portrayal of a desperate abandoned American landscape (the pit) in which a southern

African-American community tries to survive before and after a Hurricane Katrina-like catastrophe. As the people struggle for recognition and livability against the neglect, violence and poverty imposed by white racist America, they also create kinship with each other and the wasted and discarded objects around them that refuse their disposable and dehumanized status. DeFalco's interpretation makes the point that posthumanist theory often fails to recognize racism (as well as "disabled and queer lives") (p. 138). This may be a larger problem suggesting a tendency in uncritical posthumanism that leaves the conventional human unaltered, along with the afterimage of its hierarchies and exclusions.

The book's Conclusion: "Care beyond Life – Imagining Posthumous Relations", addresses further gaps in posthumanist thought, including in *Curious Kin*, that overlook Indigenous and non-Anglo-European ontologies. DeFalco treads a path along "posthumous" relations that denote "existents" after life, associated with Povinelli's argument (2016) that not all existence, especially excluded existence, falls within the dominion of "life" (and its life sciences). By way of illustration, DeFalco reads Louise Erdrich's wonderful story "The Stone" (2019), about the comforting and lively relationship a girl has with her stone. The link to Indigenous ways of knowing is that the animation of existing things, like stones, became disconnected through colonial domination. Decolonizing kin and de-individualizing care, in various ways, are deeply implicated in Indigenous traditions and resurgence advocacy (Grande 2018; Hulko et al. 2019), where land-based identities, healing landscapes, spiritual temporalities, community resources and ecological affinity seem to complement posthumanist ethics. But is Indigenous Knowledge a posthuman style of thought? And what are the risks to Indigenous scholarship of celebrating it as such?

These are questions for a much larger discussion, but they are posed here because of the reflexive turn DeFalco takes at the book's end. There, she wonders "[w]hat might a society that acknowledges and values embodied vulnerability in more-than-human worlds look like?" (p. 171). I think part of the answer lies in how vulnerability, kin and care are framed as relatable and expressed as such in thought and writing, for which *Critical Kin* is a great example. In fact, as I began reading the book as a typical reviewer, I found instances of repeated ideas, sometimes rephrased in different vocabularies, and several dense and lengthy footnotes that would fit better into the text itself. But as I read it to completion, I sensed a kind of kin-making of its own inspired by DeFalco's hopefulness distilled from her exemplary fictional worlds about the possibilities of posthumanist life. Perhaps *Curious Kin* is a book that cares for its author too, so that repetitive language or dense footnotes or other lacunae are there to ensure that DeFalco's attentive empathy, respect for detail, critical curiosity and intellectual brilliance succeed in embracing a collaborative imagination between author, reader and text. I learned a great deal from reading *Curious Kin* and I expect many others will too.

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European Objects: The Troubled Dreams of Harmonization

by Brice Laurent (2022) Cambridge (MA), MIT Press, 280 pp.

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In *European objects: The troubled dreams of harmonization*, Brice Laurent engages with "European objects" – i.e., the range of entities governed by European policies. The book's central argument is that making such objects has become a dominant mode of European policymaking. Europe's "regulatory machinery", Laurent (2022, 9) observes, "functions on a flurry of material and immaterial objects, some transformed by European policies, others created by them". Consequently, European objects have become ubiquitous in the daily lives of European citizens. However, in public discourse, they typically only emerge when politicians skeptical of the European integration project point to the tangible consequences of these regulations to simultaneously denounce their absurdity and contest the legitimacy of European interventions. Laurent's book disentangles European objects from the populist politics of denunciation. Its central objective is to take European objects seriously.

Brice Laurent is a senior researcher at Mines Paris Tech's "Centre de Sociologie de l'Innovation" (CSI) and Director of the Social Sciences, Economy and Society Department of the French National Agency for Environmental, Food and Occupational Health & Safety. The pragmatist spirit of "CSI Paris" is palpable throughout the book. It is firmly grounded in Science and Technology Studies (STS) methodologies, particularly those developed to follow around scientific and technological objects as they become matters of concern to develop a better understanding of democracies (e.g., Callon et al. 2009) as well as more recent ones developed to better understand markets. Taking European objects seriously – and, consequently, the reasoning and practices of the actors, experts, and authorities they bring together as well as the objects' materiality – is the book's central objective *and* methodology. The book builds on and draws together insights from several research projects – some conducted with colleagues – and a thorough reading of secondary literature.

Across 204 pages of text (followed by more than thirty pages of endnotes and twenty pages of references in small print), Laurent traces an impressive number of objects. The objects Laurent attends to are very diverse. They include construction materials, chemicals, financial devices, food products, drinking water, or occupational environments. He follows all of them to "sites of problematization" (p. 12), i.e., sites in which these emerge as a matter of concern, thus further developing a methodology he had described in his previous book, "Democratic

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Experiments" (Laurent 2017). Laurent uses sites of problematization as an empirical entry point to explore how, why, and with what consequences policymakers in Europe attempt to transform diverse entities into European objects. He asks: "For the sake of what collective order are European objects problematized?" (p. 15). He unpacks the envisioned collective orders and analyzes the power, authority, and legitimacy that these problematizations rely on. He also draws attention to the undesirable and (un)democratic consequences of European objects and asks whether European objects might be "crucial for envisioning and perhaps rethinking what a desirable Europe might be" (p. 5).

Throughout the book, Laurent shows that interventions on European objects are both the effects of the European objective of harmonization – i.e., the objective of creating a unified regulatory framework across the European Union's member states to facilitate European integration – and the dominant instrument with which policymakers seek to pursue this objective in practice. Laurent approaches harmonization as a socio-technical imaginary with a "dreamlike quality", i.e., a "project not always well articulated and at best imperfectly realized by existing practices" (p. 16). He discusses two versions of the dream of harmonization in more detail: a first one involving the creation of markets, in which objects are expected to circulate, and a second one involving science, expertise, and objectivity to exclude some entities from European markets.

Chapters two, three, and four discuss European interventions involving the coproduction of European markets and those European objects allowed to circulate within these markets – both successful as well as unsuccessful ones. Drawing on Michel Foucault's (2008) work on ordoliberalism, Laurent reminds readers that the vision of creating collective orders through the making of markets gained salience in post-war Europe, eventually shaping the emergence of antecedents to what has now developed into the European Union. Chapter Two focuses on standards for production products, noting that the dominant, though not uncontested, understanding of the appropriate nature of such standards produces an imaginary of a market as an "economy without qualities" (p. 32).

Moreover, Laurent shows these standards to be connected to what he discusses as a twofold "power to disentangle" – a concept that also serves as the title of Chapter Two. On the one hand, this power involves standards that disentangle production products from local sites of production, transforming them into (CE-marked) market objects that can circulate within an economy without quality. On the other hand, this power entails disentangling a sphere imagined as a purely technical matter of market organization from a sphere of political negotiations. Laurent notes that the very legitimacy of European interventions is rooted in the power to disentangle the market from politics and the European Commission's (EC) "ability to distinguish between the two [spheres]" (p. 39).

Chapters three and four engage with objects such as food products and energy to show that while the European power to act relies on standardizing objects that circulate on harmonized markets, the markets are not necessarily markets without qualities. Harmonizing objects can also endow them with qualities that resonate with people's needs, expectations, and concerns. Drawing on a notion developed by Susi Geiger and colleagues (2016), Laurent notes that markets can also be "concerned markets" (p. 65), which can reconnect economic exchanges with collective concerns. Laurent discusses food products whose geographic origins are protected or tobacco products to illustrate that harmonizing objects can also pursue policy

objectives that go beyond market integration, such as the development of rural areas or the protection of consumers from particularly obnoxious cigarettes; however, making markets and standards for objects allowed to circulate in these markets is a requirement for extending the power of European institutions. Creating markets through objects is the European *modus governandi*, yet, a mode which makes space for variations.

The following chapters, five, six, seven, and eight, follow objects such as the Euro, chemicals, and nuclear power plants to engage with the second "dream of harmonization", which involves the ability of European institutions to describe European objects in scientific terms. This ability is at stake when particular entities are excluded from European markets. Laurent asks: are European institutions able to produce facts "deemed scientifically robust and politically legitimate" (p. 94)? Consistent with the first part of the book, Laurent gives nuanced answers to this question.

Building on and extending recent historians of science and STS scholars' work, Laurent describes different configurations of objectivity at work in Europe. Objectivity in the form of the "view from nowhere", as theorized by philosopher of science Thomas Nagel (1989), certainly exists as a pervasive ideal – or dream – of what good European policymakers should strive to enable (as Laurent shows in Chapter Eight, in which he discusses stress-testing banks and nuclear power stations). In practice, however, such a configuration of objectivity can barely be encountered in Europe, with the European Central Bank being perhaps an exception to the European norm. In Europe, objectivity tends to take the shape of an "'interested objectivity' which grounds both the production of technical advice and the representation of interested parties, be they member states or concerned stakeholders" (p. 106).

Laurent describes several modes of European interventions involving such an interested objectivity. In Chapter Six, he engages with the regulation of chemicals, "regulatory precaution", and the multiplication of regulatory categories and sites for collective discussion regulatory precaution entails. Chapter Seven discusses the government of European environments by thresholds – "another mode of European intervention whereby [...] the market is not the vehicle for action but [...] the force that has to be kept in check" (p. 148). Laurent asks whether the interested objectivity, which these modes of intervention rely on, could make space for crafting European policies that are "both democratically satisfactory and environmentally meaningful" (p. 159); or is an "interested objectivity" doomed to amplify the voices of those with more power?

In the concluding chapter, Laurent returns to a question he raised at the book's beginning, drawing together thoughts and reflections that he left in the empirical chapters' endings. Could European objects also be used to reimagine European integration? Could they be made by different modes of interventions? Drawing on Sheila Jasanoff's (2011) writings to reframe the stakes of European objects and European democracy, he argues that answering these questions requires the raising of "constitutional questions", which involve how European institutions "define the conditions of their legitimacy" (p. 186) or how they imagine the nature of European citizens and publics. Would it be possible to rethink European policymaking in such a way that it might still involve the making of markets, without, however, striving to keep the politics of market-making at bay? Laurent's answers to these questions seem to be a "perhaps" and "it depends". He suggests that rethinking European organizations around "European objects that matter" (p. 199) that circulate in "concerned markets"

(p. 191) could help to address these questions affirmatively. However, such a rethinking would involve institutional work through which matters of concern could be identified and dealt with and power asymmetries could be addressed.

Laurent's book is a remarkable engagement with policymaking in contemporary Europe. It uses a diversity of European objects to elucidate the major tenets of the European integration project in action, approaching Europe as a particularly interesting case of contemporary liberal democracies, and the dreams, paradoxes, and contradictions of their *modus governandi*. The sheer scope of the objects the book covers and the breadth and seriousness with which Laurent follows them are impressive. Laurent engages with some of the tension in contemporary European liberal democracy, while also suggesting that these might help us to reimagine European integration – and European democracy – from within. The book is firmly grounded in STS; however, it also engages with insights from other fields of inquiry, such as legal studies or political science. The scope of objects and bodies of literature that Laurent covers sometimes comes at a price; in some moments, I was not sure if I could follow all his arguments. I did not find the book always easy to digest; yet, I took a lot of food for thought from reading it.

What I found particularly remarkable was Laurent's very own mode of intervention – or his mode of representing and intervening in European interventions on objects. The book exemplifies that STS methodologies are helpful tools for exploring the envisioning, making, and contestations of collective orders – and their consequences. It belongs neither to the literature genre, which tells us that we are hopelessly captured and lost, nor to those books that envision scripts for building entirely different worlds. It draws attention to the ambivalence of modes of intervention to start to rethink liberal democracies from within. And it exemplifies a place that scholarship could have in such a project.

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The Atomic Archipelago. US Nuclear Submarines and Technopolitics of Risk in Cold War Italy

by Davide Orsini (2022) Pittsburgh, University of Pittsburgh Press, xiii-313 pp.

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As a Sardinian, the issue of the militarization of my island is challenging. The slaughter of Sardinians in World War I, particularly in the ethnically recruited Sassari Brigade, was the origin of Sardinian political consciousness (*sardismo*) and our contemporary political awareness. Nevertheless, it sparked a flood of militaristic rhetoric, which is not unrelated to the establishment on our island of 60% of Italy's military servitudes today (Esu and Maddanu 2022, 195). This is the same rhetoric that has reinforced the stigma of Sardinians as "violent" and "bandits", characterized by the "culture of the knife" and kidnappings. This has been used to justify, even today, both the re-establishment, starting in the 1980s, of an ethnic brigade sent to the front lines in the so-called Italian "peacekeeping missions" worldwide, and the expansion of the island's militarization, described in Davide Orsini's work, through one of its most significant episodes, the American submarine base installed in the La Maddalena Archipelago between 1972 and 2008.

La Maddalena is an archipelago located between Sardinia and Corsica, on the Strait of Bonifacio, that connects the Tyrrhenian Sea and the Sea of Sardinia, i.e., those two stretches of the Western Mediterranean between the two sister islands and Italy on one side, and the Balearic Islands, Provence, and North Africa on the other. A strategic position, among the most advantageous. Formerly populated only by shepherds, the Archipelago was colonized by the King of Sardinia – a Savoy descent, residing in Turin from which he ruled the Duchy of Savoy – in the 18th century for military purposes and has long been home to fleets and military bases. Today, it seeks an uncertain shift towards tourism.

The opening of the US Submarine Base in 1972 completed the militarization of all of Sardinia, which began in 1956. Unlike other military bases linked to the Italian armed forces, La Maddalena was a US base regulated by a classified *Bilateral Infrastructure Agreement* negotiated by the US and Italy between 1949 and 1954 (Saiu 2014).

The militarization of Sardinia grew in parallel with the policies of development. During the 1960s, a *Piano di Rinascita*, envisaged modernizing the entire island through public capital intervention for the development of the chemical industry, not local resources, as requested by the Autonomous Region. It was not the first attempt at top-down modernization. Even during the liberal (1861-1921) and fascist periods (1922-1945), there were modernization

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efforts, including the eradication of malaria managed by the Americans, but they were not extended to every area of Sardinian society. Following the popular uprising of Pratobello in Orgòsolo (1969), which blocked a military settlement, an anti-military bases movement developed. It had had anti-militarist, ecological, and self-determinist connotations (Esu 2023). Therefore, alongside opposition to militarization, opposition to top-down modernization also grew, together with politically, independence movements.

This is the period Orsini deals with in his historiographic and ethnographic investigation.

Orsini studies the case of La Maddalena adopting an approach embedded in the work of Gabrielle Hecht (2000). Notably, he leverages Hecht's concepts of *technopolitics* and an interest in studying *nuclearity* as a characteristic that connects a set of entities. As such, this approach differs from other STS analyses of nuclear programs. For instance, Donald Mackenzie (1996) focuses on the importance of their construction and the role of tacit knowledge within them. On the contrary, in Orsini's work, nuclearity does not seem to configure a real infrastructure connected in all its parts by standards but rather describes a convergence of heterogeneous elements, among which the discursive element also emerges, having a technopolitical impact on the receiving context.

In *The Atomic Archipelago*, nuclear technology is not treated as a black box; rather, it is central to an analysis that encompasses the militarization of Sardinia. He extracts this story from the sole domain of political and military history, delving into the sociotechnical aspects not as peripheral but as essential for formulating a comprehensive interpretation. Nuclear technology is not viewed as a secondary effect of political games. Instead, within it – in its material, discursive, and collective features – all mobilized elements are found, including location, policies, effects on health and the environment, relationship with epistemic cultures, narratives, collective mobilizations, as well as the colonial dimension of Sardinia.

The book unfolds in three parts and seven chapters.

In the first part ("A Strategic Naval Outpost: History, Identity, and the Military-Industrial Complex", pp. 33-77), Orsini analyses the role of the La Maddalena Base in the American fleet deployment policy in the Mediterranean, and the particular role of the islands (also addressed in Esu and Maddanu 2022). The nuclear nature of the La Maddalena base introduced a technoscientific element that radically changed the status of the military presence in the Archipelago. In the second part ("Technopolitics of Risk: Bureaucracy, and the Production of Ignorance", pp. 78-143), by analysing political, technoscientific, and hybrid controversies, Orsini conceptualizes the role that secrecy, the active removal of knowledge, and data sequestration have had in conditioning them, up to theorizing how crucial the *production of ignorance* are in practices of dominance, both military and administrative. In the final part ("Risk, Accidents, and Political Mobilization", pp. 144-201), the outcome of this process is connected to the contingencies caused by an unreported nuclear submarine accident and the collapse of the base's legitimacy. In two chapters, the strengthening of a shared interpretation of risk as a field of problematization of the phenomenon by most actors is presented, as well as the growing importance of anti-base movements and their connection with community experts, and the mediatization of the risk itself.

The hybrid process described in this book highlights the technopolitical focus it has assumed, in the connection that has formed between the controversy over the presence of nuclear waste in the environment of La Maddalena, the contestation of the lack of anti-nuclear protection measures, and the political opposition to the presence of the U.S. military in Italy.

In fact, various expert groups have discussed the similarity between nuclear submarines and land-based nuclear facilities, considering their different visibility and mobility, and the possible applicability of onshore safety laws at sea, which are stringent in Italy.

The most important transitional moments of the process analysed are linked to the transformative bond between the movement against the bases in Sardinia and the controversy over the presence of radioactive elements, and in particular the shift from the debate over the presence of radioactive elements to the risk of future nuclear disaster.

Among the actors involved in the process described by Orsini, the role of lay experts is significant. They are contrasted with a set of entitled experts from different background, linked to different epistemic cultures and professional groups, or hinged in different organizations. Initially, the most relevant group of experts consisted of those from Sardinian and Italian academic institutions, particularly Italian radioprotectionists and radioecologists, linked to the State apparatuses. Italian entitled experts, especially those from Sardinian universities, consistently opposed any alarmism (p. 134). They meticulously applied "established practices relying on disciplinary assumptions that excluded, *de facto*, the contribution of nuclear submarines to the archipelago's radiation levels" (p. 200). The role of monitoring technicians, administrative experts, community or civic experts differed. After the growth of protest movements, local institutions linked to the Province of Sassari and the Autonomous Region of Sardinia (through the newly established National Health System) set up small monitoring and sample analysis structures. These were facilities with minimal equipment but run by operators with precarious institutional status, initially very active in enabling the potential impact of monitoring (p. 130). Following the 1986 Čornobyl' accident, an independent laboratory established in neighbouring France to measure fallout from that incident, detected an unusual concentration of thorium-234 in seaweed at the Corsican borders of La Maddalena archipelago, never investigated on the Sardinian side of the border. Experts from the field of marine geology were added upon the request of the local community, thus introducing a comparative research method which also addressed the presence of plutonium and radioactive caesium.

Differences between epistemic cultures, investigation methods, relevance of different substances, connections with other events, etc., led to a deconstruction of the relationship between politics and expertise. Disagreements among the experts, along with local elites' lack of leadership capacity, particularly in confronting the state, became a problem.

The dominant model practiced in Italy for public understanding of science, based on the deficit model, did not work. Developing a stance became impossible because both scientific and political positions were internally diversified. The attempts of the political class to convene formal conferences dominated by incomprehensible official communications produced a communicative boomerang effect (p. 150). This left the field open for a bold media operation in 1976, linked to three cases of cranioschisis (deformations or absence of cranial bones), connected by the Sardinian press to the presence of the American base (p. 104).

This was the only episode in which the American authorities were concerned about the crisis of consensus around the base's presence, so accommodating was the local ruling class (p. 127). Social anti-base movements, which – as mentioned before – elsewhere in Sardinia began to mark opposition to militarization from 1969, had little traction in La Maddalena. Here, organized parties were either in favour of the base or indifferent to monitoring

(pp. 133-134), or, else, their mobilization took only in an anti-American stance (Esu 2023). Only the public intervention of the most famous activist magistrate, Judge Gianfranco Amendola, who, as early as 1974, in his work *Basi infette* ("Infected Bases"), denounced the risk of nuclear contamination of the archipelago, broke the traditional silence and disinterest with Sardinian problems in the Italian public debate (p. 146).

Finally, both the political and technical debates found their turning point in the problem of safety and risk linked to the presence of the base. The question of Sardinian political choices was not raised, and technical discussions veered towards a debate on the scant evidence of a radioactive presence and thus its risk. Thinking about risk always involves shifting the discourse towards the future, on potential future consequences, and is a way to distance the discussion from the analysis of the present (p. 160). Risk is a concept on which experts and non-experts, technicians, politicians, and activists can easily converge, through processes that render it objective, eliminating uncertainty and producing consensus (p. 152). Around this interpretive convergence, Orsini observes how expert and non-expert epistemologies are contemporary phenomena that interact entirely and in portions without barriers, circulating among politicians, activists, scientists, technicians, and military personnel, to the point of being used at every level (p. 175).

According to Orsini, the definitive role of risk also rests on the "production of ignorance" and military secrecy practices. This is a combination "involving silence, deception, duplicity, opacity, ambiguity, and the proliferation of bureaucratic apparatuses" (p. 122). In Sardinia, the *production of ignorance* as a policy of the ruling classes is relevant and productive, akin to the invisible aspects of a discursive order, within which certain things are unthinkable, such as Sardinian self-determination, and others are implied, such as their Sardinians' backwardness, up to elements of their racialization.

What brought this debate to an end was the accident of the U.S. submarine Hartford, which occurred off Cagliari in October 2003. News of it came to Sardinia through a local American newspaper leak, published in the town that was home to that class of submarines in the US. No one bothered to communicate it in any form to La Maddalena people, which caused total distrust of the authorities. The distrust also extended to the scientific credibility of the entitled experts (p. 201). In those same years there was still a climate that saw nuclear power as an exceptional and, after Černobyl', negative technopolitical category.

Despite the fact that the Italian Constitutional Court had blocked an advisory referendum in Sardinia on the presence of American bases by the in 1983, an Italian-wide referendum in 1987 excluded the use of civilian nuclear power. This change has created a contradiction with the presence of the nuclear base in La Maddalena. In addition, starting in the 1980s, many local Sardinian governments began adopting a Sardist political agenda, particularly those led by Mario Melis (1982 and 1984-1989) and Renato Soru (2004-2009), eventually leading, under Soru's presidency, to the closure of the La Maddalena Base (2008).

One of the merits of this book is that it allows us to understand how the discourse of modernization – also used to legitimize militarization – conceals the colonization of Sardinia, particularly by Italy and its allies, through the recruitment of local elites, who present themselves as "modernizers" or, in this case, militarizers. However, this aspect is underexplored and is only part of the author's conclusions (p. 211), as though it were an accessory point. The colonial nature of the in-between could have enriched the approach used throughout the analysis and

not just appeared at the end as an almost exotic curiosity. He seems lost in the political culture of the Island, for instance in the confusion between Sardist autonomism and independence movements, a political culture that arose in parallel with the critique of external modernization, which also includes militarization (p. 140). Sardinian independence movements reconnect with reflections about the South by Sardinian political thinker Antonio Gramsci, who did not see our problems as stemming from backwardness (as in autonomist and "Sardist" thought), but in the power imbalance between territories, made possible only by the alliance of the dominant groups of the North of Italy with the backward strata of the South itself.

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Residual Governance. How South Africa Foretells Planetary Futures

by Gabrielle Hecht (2023) Durham, Duke University Press, 288 pp.

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It is rather unusual for an academic book to display a title which is extremely evocative and yet able to fully capture its original theoretical contribution. *Residual Governance* by Gabrielle Hecht is a marvelous book which focuses on the strategies used by mining companies and South Africa's governments to (not) manage the various kinds of waste and hazardous substances produced by mining activities. Historically entangled with apartheid and its correlated urban and political development, residual governance emerges throughout the book both as a technopolitical strategy of modern racial capitalism and as an accelerant of the Anthropocene, hence providing a strong conceptual framework for addressing contemporary planetary dynamics. Professor of History at Stanford University and President of the Society for the History of Technology, Gabrielle Hecht has extensively written on mining waste, radioactive residues and pollution in Africa. These long-standing research interests are well reflected in the book, which draws on an astonishing set of different sources. Interviews with scientists, community leaders, activists, journalists, urban planners and artists are combined with the archival work and fieldwork conducted by Hecht in South Africa over the last two decades. Moreover, pictures, graphs, images and maps pop up throughout the chapters to enrich and substantiate Hecht's analysis. The book is divided into five thematically articulated chapters, which also allow Hecht to piece together the history of South African mines and their residues, from the late 19th century until the most recent attempts to deal with waste dumps.

Chapter One moves across several perspectives, from planetary history and hominids' technical skills and settlements to the evolution of racial legislation and the current state of Johannesburg piles of rocks, where southern African women and men are engaged in artisanal mining. In doing this, the chapter introduces the theoretical lines which are further developed in the following chapters. Hecht emphasizes how the common characteristics of residues (accretion, irreversibility, unruliness) as well as the size of the piles, the extent of the dams and the volume of the voids created by extraction make mining waste a "super-wicked problem" (Levin et al. 2012), one which requires multiple scales and entry points. She hence describes the concept of residual governance as a conceptual tool bringing together three different dynamics: 1) the managing of discarded materials; 2) governance as a residual activity

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which deploys simplification, ignorance and delay as tactics; 3) the treatment of people and places as waste. Additionally, the chapter highlights how the labor practices and infrastructures developed by the mining industry from the late 19th century set the ground for the racist legislation of the following decades and for the "apartheid algorithm" (Mpofu-Walsh 2021) which still shapes South African society. The chapter ends by illustrating the deep entanglement between gold, uranium and radon contained in a block of Rand rock. While the former represented the reasons of the shifting but persisting interests around the Rand, the radioactive elements contained in them and then dispersed in the water, in the air and in the dust caused several kinds of hazards to the citizens living in the area.

Chapter Two describes the scientific, political and legislative problems caused by the drainage of acid mine wastes into the region's water source. Particularly, when the poisonous materials (arsenic, lead, mercury) and toxic residues contained in the water started to affect farmers' fields and animals, studies commissioned by mining companies and governmental bodies revealed the health and environmental harms caused by water pollution and uranium contamination. However, the production and circulation of reliable knowledge about water pollution was one of the major issues faced by citizens. On the one hand, mining companies relied upon one of the core strategies of residual governance, manufactured ignorance, to keep secret the results of those studies, or to generate scientific uncertainty about them. On the other hand, the complexity of contamination required scientists and activists to look for answers and for knowledge which was not available yet. Particularly, what emerged through the studies was the specificity of each ecosystem which, due to its history, characteristics, and human relationships, had to be studied on its own terms. Accountability was another thorny issue. By the time the hazards were recognized, most of the mines had shut down, leaving the new democratic government to deal with the toxic residues and with crucial questions: who had to be held responsible? Who had to pay for the remediation plan? Within this context, regulatory standards, guidelines and best practices became increasingly urgent, but also another field influenced by the interests of corporations.

Chapter Three shifts the focus from water and cavities to dust, sand and dumps. Often compared to pyramids or mountains, dumps had their own, faster temporality of erosion, which made dust difficult to control but also posed a politically complex heritage issue. The management of the dumps, however, reflected the financial interest of the mining companies: at first, dumps were grassed and mine lands used for residential or urban purposes; later they began to be seen as piles of cheap uranium. The chapter touches upon another relevant point, the spatial character of residual governance. In this regard, the unwholesome entanglement of corporations' minimalist management, racist urban planning and untamable toxic material is superbly described in one of the first pages of the chapter:

> Aboveground dust, mine companies hoped, would simply dissipate into the air. But with hundreds of thousands of miners working the seams, the mountains rose so rapidly that the winds couldn't disperse the residues fast enough, or far enough. Dumps dominated the landscape and defined the contours of city planning: Black housing downwind, white housing upwind. (p. 86)

Chapter Four outlines the history of struggle and resistance of inhabitants of "temporary" settlements around mine shafts against residual governance. Hecht documents the lack of basic forms of governmental support, housing, and employment that affected township communities both before and after the attempts at reconstruction of the post-Apartheid era. An absence that left communities to deal with poverty, pollution and violence on their own. The scientific compartmentalization of accumulated measurements made it difficult for scientists to produce the necessary evidence to move governmental and industrial agencies to address the exposure risks of shaft settlements. The lack of access to education made it hard for locals to engage with scientific results, turning the case into a matter of international alliance with external experts. When the situation became an international case, struggles ensued between inhabitants, police and governmental agencies. Regulatory frameworks ultimately left to individuals to enforce their own protection from exposure, moving tailings posed considerable hazards, and forced relocations did little to improve the lives of workers, transforming the struggle into "a battle of repetition and attrition" (p. 161). Against the compartmentalization of science and the multiplication of corporate subsidiaries to stall progress and deflect responsibility claims, the protests did not distinguish demands for decent housing, clean water and healthy food. It was the entanglement of soil, water, buildings, and bodies that, after all, produced the hazards experienced by the population.

Chapter Five presents some of the "toxic afterlives of South Africa's zombie mines" (p. 164) in the context of post-Apartheid land remediation and housing projects. It weaves data that display land injustice with the bureaucratic and legal struggles to address it, alongside photographic projects that represent and problematize informal mining activities around closed mine sites. Dreams of remediating land injustice through housing programs were hampered by the industrial secrecy of geological data and the confusing complexity of environmental legislation. These residual combinations threatened to reproduce Apartheid-era marginalizations of poorer communities into toxic lands. The studies by the Gauteng City-Region Observatory, a social science think tank founded in 2008 that was supposed to help in the strategic governance of mine lands around Johannesburg, further showed the lack of public engagement by leaders of megaprojects in housing and water treatment. The chapter thus calls into question the meaning and methods of democratic participation under capitalist regimes and the blindness of future-oriented projects to existing systemic inequalities.

Hecht's *Residual Governance* engages with long-standing STS debates: racial technopolitics (Cumming 2018), the intersection of chemicals, technical expertise and regulations (Boudia et al. 2022), the strategic production and circulation of ignorance (McGoey 2012). This last topic is especially relevant, as Hecht highlights how various forms of ignorance have contributed to maintain and reproduce corporations' minimalist approach to mine residues, but also how citizens and activists struggled to obtain the knowledge needed to support their claims. In recent years, ignorance studies have shown the generative and intentional production of ignorance across different domains and have highlighted the different forms of ignorance (Roberts 2015). In this regard, the book provides an exceptional variety of types of manufactured ignorance: reports disappearing or put under embargo and contested for using supposedly unrecognized methodologies; recommendations for action not shared with municipal authorities. Even more importantly, the book illustrates what ignorance *does* (Mica et al. 2021) and how it shapes technopolitical action but also people's possibilities of resistance.

STS scholars might find *Residual Governance* precious and highly inspiring for at least two main reasons. First, Hecht concludes the book by highlighting how the notion of residual governance can be scaled up to address global, planetary futures. Far from being unique, the localized dynamics so carefully described by Hecht are conceptually relevant for enquiring about the broader processes that have been shaping the Anthropocene and the environmental and racial impacts of technopolitics around the planet. Second, the book is methodologically and stylistically inspiring. Theoretical analysis and detailed historical reconstruction are punctuated with the voices, actions and artworks of the people who fought against the violent nature of residual governance. Some chapters are written in a style reminiscent of investigative journalism, assembling a heterogeneous variety of materials and sources that try to build a coherent narrative. Their connections to residual governance might therefore appear uneven at times. This aspect raises methodological questions about the inherent tensions between descriptive vividness and theoretical robustness that are hard to avoid, especially in projects of this scope and magnitude.

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Guerre di confine. Autorità epistemiche e società in transizione [*Border wars. Epistemic authorities and societies in transition*]

by Sinapsi (Giuseppe Tipaldo, Flavio Ceravolo, Valentina Moiso, Nico Pitrelli, Mariacristina Sciannamblo and Mariachiara Tallacchini) (eds.) (2023) Milano, Meltemi, pp. 217.

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The opening publication of the series *Sinapsi – Intelligenze e conflitti in rete* (in English: *Synapses – Networked intelligence and conflict*) dedicated to studies on technoscience, politics, media and society, offers a new reading of five essays, regarded as milestones in the Science and Technology Studies tradition, translated for Italian-speaking readers. Each essay is accompanied by as many critical introductions framing its relevance and meaning in the contemporary historical and cultural context, characterised by conflicts and misalignments that affect the institutional boundaries and social reliability of scientific knowledge, relating to media and politics.

In the Introduction, the editors provide a clear contextualisation and rationale for the collection. Covid-19 pandemic, the war in Ukraine and the spread of regional conflicts, the increasingly devastating manifestations of the climate crisis, exacerbated the perception of future insecurity, highlighting instability as a macro feature for societies. Even areas that had for decades enjoyed better conditions of wealth, industrial development and social guarantees are facing daily manifestations of economic risk, everyday violence and environmental disruption. Such factors outline the traits of transition societies where a general crisis of meaning, widespread risk perception, and the cognitive and psycho-social challenges it poses, become defining factors of everyday life and the public sphere. Scientific production and its applicative results have not only acquired a hypertrophic dimension but have also been more than ever exposed to public attention, thus sparking off narratives with strong evaluative connotations. The margins of contestation for epistemic authorities in the public sphere (institutions, organisations, professionals) are widening. The conflict lines between the recognition of official epistemic sources of technoscience and expert knowledge, and the mushrooming of heterodox scientific sources (traditional know-hows, popular beliefs and anti-scientific practices) are being multiplied. The former's difficulties in providing rapid, unambiguous and effective solutions to emerging problems are compounded by the latter's reaction in consolidating sense communities driven by sentiments of diffidence or open defiance towards technoscience's institutional boundaries and practices, sometimes claiming alternative epistemic authorities (and political representation).

These epistemic conflicts are framed through cultural, media, and political dimensions. The "cyberbalkanisation of knowledge" (p. 12) refers to the multiple polarisation of public

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debate on socially relevant facts. This is characterised by phenomena of homophily and radicalisation of contrasts, flanked by rhetorical violence, simplifications and spectacularisations of media representations. Furthermore, the assertion of authority of the political agenda based on the soundness of expert knowledge contrasts with the contemporary exposure of its abuses and failures, highlighting its conventional, socially constructed nature, and exposing it to controversies and contestations.

Editors argue that appropriate education about the dynamics underlying the construction of scientific knowledge as a social institution constitutes a fundamental condition for a deeper awareness of the necessary plurality of rationality forms interacting in the public communication field of expert knowledge, without undermining its interactions. This approach constitutes an antidote to the tendency of reducing the field of knowledge production and social reception to a confrontation between scientistic and anti-scientific stances. Such a dynamic progressively deteriorates the relationship between science and everyday life, by eroding both the public's willingness to place trust in scientific institutions and the capability of exerting a critical reception of discourses conveyed through media and political arenas.

Among the STS critical conceptual tools, editors identify the co-production method, which allows one to consider the concurrence between science and other systems that contribute to defining the structures of social cohabitation and recognizes the entanglements between descriptive and normative dimensions intervening in the establishment of the epistemic order. Furthermore, they emphasise reflexivity. Such approach encompasses the perspective of social research itself in examining the performative nature of scientific activity and its capacity to co-create the worlds it observes, and questions empiricist realism towards an "ontological multiplicity" conception.

In the selection of essays, curators express renunciation of indulging in recentism and sensationalism (as in current AI debates), while turning towards consolidated critical tools, revealing their relevance with regard to the urgencies raised by the aforementioned context for the sociology of science and technology.

In Boulding's re-reading (Chapter 3) of "Science: Our Common Heritage" (1980), introduced by Tipaldo's commentary (Chapter 2), the evolution of science is read as related to the noogenetic bifurcation in human evolution. Learning aptitudes (tools, techniques, etc.) and the ethical and cultural mutations they entailed, have generated an ethos specific to scientific culture, based on the combination of logical faculties and imagination, the empirical verification as a selective factor, and the truthfulness-trust relationship. Threats to science's legitimacy, Boulding argues, occur from potential tensions between the perceived image of the scientific community and the social environment surrounding and sustaining it (including political power). Such tensions, he shows, often emerge from internal contradictions, including a forced generalisation of techniques and methodologies, repetition of truisms, and epistemologically inappropriate impositions of taxonomies and disciplinary boundaries. Yet, they are influenced by exogenous processes, such as the increasingly dense entanglement between science and technological applications, and the economic implications of the products of scientific activity, that bring cost-benefit assessment to become a core element of the perceived and effective legitimacy of science. These circumstances are made particularly evident by ecological and military threats related to technological deployment.

In Jasanoff's essay (Chapter 5) "Technologies of Humilities: Citizen Participation in Governing Science" (2003) the historical and epistemological foundations of a "kind science", as outlined in Pitrelli and Tallacchini's introduction to the translation (Chapter 4), are discussed. Jasanoff anticipated issues that have become particularly urgent in the face of the pandemic, such as the need for a different conjugation between science and democracy, characterised by the capacity for dialogue, listening, openness to criticism, reasonableness and transparency, and the acknowledgement of uncertainties and limitations in cognitive and practical terms.

Accidents, catastrophes and other unforeseen events generated as consequences of techno-scientific applications stress crisis points in the predictive and management capacities within socio-technical systems. This calls into question the accountability of experts and decision-makers, not just regarding the consequences but also the aims of scientific activity. The crisis of the post-war "social contract" of science gave rise to the introduction and refinement of increasingly sophisticated systems for monitoring and evaluating scientific activity, reintroducing predictive analyses and objectivity claims as the basis for legitimate scientific institutions and their funding. Jasanoff looks at pitfalls of such "technologies of *hybris*" (p. 78): peripheral blindness to uncertainty, political neutralisation of predictive analysis, and limited capacity to internalise external challenges to their framing. She also offers a reflection around four focuses for reliable and socially integrated civic epistemology: theoretical framing of problems, involvement in defining vulnerability in social terms, distributional consequences across global societies and markets, and learning socialisation as the purpose of civic deliberation. Thereby, her proposal integrates the operational potential of science and engineering with ethical and political demands in decision-making, enhancing the focus on participation and transparency.

The re-reading of Star's essay (Chapter 7) "Power, Technology and the Phenomenology of Conventions: On Being Allergic to Onions" (1990) is particularly wide-ranging and dense. Pointed macro-themes revolve around certain questions raised by Actor-Network Theory, addressing the power issues in the observation of techno-scientific networks (research and development projects and institutions). In her introduction (Chapter 6), Sciannamblo posits the epistemological and methodological significance of situating analyses in those "high-tension zones" where maladjustments, resistances, and conflicts towards standards emerge. This approach enables a comparative examination of alternative possibilities in techno-scientific deployment. The observation no longer focuses on the heroic narrative of the man-scientist protagonist at the centre of the network, but on actors placed on the margins: those irreducible to purification and standards, paying the cost of ambiguity and adaptation resulting from belonging to different worlds. Indeed, Star argues for placing at the core of social enquiry the concerns of multiple memberships, cultural dualities, hybrid and heterogeneous statuses and identities, which characterise the potential of marginal positions in socio-technical systems' evolution. Regarding the dialectic between production and reproduction, Star looks at the invisibilised labour, pertaining to multiple figures conventionally considered marginal in techno-scientific networks (technicians, laboratory caretakers, administrative staff, wives), considering their functions in transduction and enrolment processes. She highlights how subjects that participate in invisibilised work manage to negotiate the trade-offs, partial involvements and encounters, which constitute the very factuality of scientific enterprise.

Godechot's essay (Chapter 9) "Le bazar de la rationalité. Vers une sociologie des formes concrètes de raisonnement" (2000), resumes one of the earliest ethnographic works on the world of financial trading practitioners. The reasoning and actions of the participants involved in the study, including the uses of certain techniques (e.g., reading charts), devices (e.g., mathematical formulas and press reviews), and disciplined knowledge (e.g., economics, mathematics), result from the combination of cultural and educational resources (family background, education type and degree), acquired knowledge, beliefs, and the power and prestige of the various organisational positions, understood as *habitus* in Bourdieuan sense. Drawing on empirical study of the concurrence of causes that determine economic rationality and the practices that define it, Godechot deconstructs the ideal type of the *homo oeconomicus* of neoclassical economics, shedding light on its heterogeneity and ambivalence. In Moiso's commentary (Chapter 8), the contestation of the univocity of the rationality notion and the enhancement of STS approach, regarding knowledge construction processes, is underlined. Moiso notes how the rationality that guides action within certain organisations and contexts is probed through the inclusion of other social research tools that embrace different dimensions: power positions, economic inequalities, reference culture and socialisation processes. Such analysis results a useful tool to de-naturalise instrumental rationality as the absolute orientation of economic choices, presented and legitimised as a technical, neutral and depoliticised solution, focusing instead on economic inequalities, the corporeal and emotional dimension and cultural differences.

Jenkins' essay (Chapter 11) "School science, citizenship and the public understanding of science" (1999) and Ceravolo's introduction (Chapter 10) discuss the role of scientific education in the redefinition of educational policies and programmes. If scientific knowledge is a constitutive element of the very citizenship rights – namely, the exercise of critique and effective control over public and private choices involving sciences – what kind of scientific teaching should be offered to school students in order to foster their awareness and empower their agency? Jenkins' intervention belongs to a long-running international debate on the effectiveness of educational strategies for scientific knowledge introduced in school curricula, still relevant and unsolved. The remarkable display of the scientific debate during the pandemic stressed pivotal controversies arising from both the claims of official science prescriptions and compelled consent toward results. This deteriorated public trust in scientific activity, already compromised by the insufficient dissemination of adequate tools for reception and understanding of the functioning dynamics of scientific construction and consequent generalised disorientation. Jenkins critiques the inadequacy of science education based on theoretical and manualistic transmission of notions. This form results unable to stimulate interest and instil critical awareness of scientific problems related to everyday life experiences. He points out the importance of prioritising knowledge of scientific activity as a human endeavour, through an approach that facilitates the understanding of its meanings and procedures. Furthermore, he criticises the transmission of a positivistic and thaumaturgic image of science and its institutions, as an obstacle to the formation of a real scientific culture, advocating for a prudent and critical representation of it.

This collection offers reasoned insights into how tools and approaches from the STS can address specific epistemological and social demands regarding knowledge and public educational institutions, as summarised in Saracco's Afterword: "From the engineering of humanity to the humanisation of engineering". These include the reaffirmation of critical thinking

as a tool for participation in public life; the tailoring of the role of universities to current issues (social and ecological justice, psychological well-being); the critique of hyper-specialisation, of disciplinary segregation between techno-scientific and humanistic knowledge, and of the determinism of social engineering, in favour of interdisciplinary contamination and dialectics between complementary or competing visions, approaches and methods. Such an open *episteme* would involve techno-scientists and humanists, manage the confrontation with policy-makers, and integrate wider society (even across media and educational institutions).

The reading of this anthology provides a toolbox, for scholars and students alike, that summarises the indispensable contribution that STS represent for understanding the mediations and conflicts between technoscience, politics and society. The essays' collection and the editors' commentaries provide a historicised actualisation of problems, methods and concepts, as well as revitalising their reception in Italian. Indeed, the book interprets the conflicts between the epistemological boundaries of the techno-sciences not only as a subject for specialists but as a social issue affecting the public sphere and people's everyday lives.

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