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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