Making Evidence in the Future Perfect: Provincialising Climate Impact Science in the Quest for More-Than-Human Liveability

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*Jörg Niewöhner**

Abstract: *»Die Herstellung von Evidenz im Futur II. Klimafolgenforschung provinzialisieren auf der Suche nach mehr-als-menschlicher Lebensfähigkeit.«* At stake in the Anthropocene is more-than-human liveability. What does this mean for anthropology? This contribution develops one possible answer for the context of climate impact and global environmental change research. It argues for situated modelling as a co-laborative practice between anthropology and the natural sciences. In a first section, the paper sets out from an analysis of recent shifts in the field of climate impact research that has culminated in demands for evidence-based democratic deliberation. The analysis demonstrates how this understanding of evidence introduces a new temporality to the debate (future perfect) and how it risks narrowing the notion of evidence. In its main section, the paper outlines situated modelling as a generatively critical way of engaging climate impact science. Situated modelling is committed to opening up scientific method to participation from diverse publics. It rests on ontological anarchy, partial withness and assembled reflexivity. The paper concludes that situated modelling is one way of addressing the infrastructures of global climate impact science co-laboratively in order to widen what is recognized as legitimate forms of expertise and evidence.

Keywords: Ethnography, collaboration, climate change, evidence-based, situated modelling, climate impact science, climate impact research, global research infrastructures, anthropology, natural sciences.

1. More-Than-Human Liveability

What is at stake today is more-than-human liveability on planet Earth (Tsing, Mathews, and Bubandt 2019) – plain and simple. The way we have been living together since the rise of multiple modernities across the world is pushing this planet to its biogeophysical boundaries (Steffen et al. 2015). *We* here refers to the *species we* that is so often evoked in the discourses about planetary

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environmental change. I will address later on the heterogeneity, multiple inequities and multi-speciesness that this *we* so often hides. Governing complex, urgent, and interdependent phenomena such as global warming and the impacts of climate change, species loss, and the rise of zoonotic infectious diseases is becoming increasingly difficult as moral integrity and respect for the force of the better argument struggle to withstand the onslaught of relentless self-interest. Shaping global transformations towards more sustainable forms of living seems unlikely. Instead, the threat of violent transformations looms large. This sleepwalk into disaster is likely to result in severe and prolonged suffering across the globe, across ecosystems, and across species.

I believe the preceding paragraph to be a description of a very likely future. It is easy to write it down. And it is easy to forget about it and what it really means. Yet having the pleasure of serving as the director of a research institute dedicated to the study of global transformations of human-environment systems, I witness every day and increasingly so, particularly among graduate students from across the world, how the "realness" of this paragraph causes anxiety, ecological and sociological grief, frustration and disbelief. So, if the editors of this special issue ask "What role should the social sciences play in society?" my very personal answer is: Whatever role it takes to reduce at least some of the suffering caused by global environmental change now and in the future, here and elsewhere.

In the following paragraphs, I outline my sense of what anthropology can do in these anthropocenic times and how this relates to questions of method(ology), reflexivity, and practices beyond disciplinary cultures. The special issue as a whole will show whether and how my reading of anthropology speaks to its companion disciplines in the social sciences. I should say upfront that I am writing as an anthropologist of human-environment relations who has been trained initially as an environmental scientist. Also, rather than reporting on a single project, I will write across several projects and my everyday experiences of working in, with, and on an institute that brings together natural and social scientists to better understand and help shape transformations of human-environment systems. Hence the empirical basis of this paper is seven years of intense observant participation within an institute and the wider thought collectives of climate impact science and global change research, collective reflection with a number of dear colleagues – often rather agonistically – and a number of specific projects particularly on global land use practices and their transformations under conditions of rapid social-ecological change. I will begin by outlining recent shifts in climate impact science. I then discuss my disconcertment with the notion of *evidence-based democratic deliberation* that currently finds much support in the field and in wider public discourse. In the final section, I set out *situated modelling* as a set of scientific practices that capture what I think anthropology should be doing in this configuration. I close by discussing "co-laborative" ethnography

(Niewöhner 2016) as a form of generative social scientific critique that tries to find a balance between deconstructing thin simplifications (cf. Scott 1998) of climate impacts and caring for the reconstruction of simplifications that are attentive to more-than-human liveability across scales.

1.1 Moving Target: The Climate Impact Sciences from Physics to Fridays for Future

We are witnessing a shift in the climate impact sciences. I use the term climate impact sciences to refer to a large and loosely knit community of practice that addresses social-ecological changes in relation to climate projections. It reaches from climate physics and its global circulation models via earth systems sciences to the study of specific local food-water-energy nexus and their responses to changes in climate. Physics and economics are the dominant disciplines though the community is not organised along disciplinary boundaries. Until about a decade ago, the climate impact sciences have predominantly been focused on the biogeophysical dimensions of global change: climate change, land cover change, planetary boundaries. Physics and mathematics have been dominating the field methodologically. Three aspects characterise this dominant thought style (cf. Heymann, Gramelsberger, and Mahony 2017): First, systems thinking is omnipresent. This entails a topographical understanding of the world out there in terms of agent interactions within system boundaries. Second, systems thinking favours models and simulations, largely quantified, mathematical, mostly non-linear, and computer based. Third, the directionality of this research field is upscaled towards global dynamics and forwarded into futures along, for example, shared socio-economic pathways and representative concentration pathways (IPCC 2014). The latter is commonly achieved through the aggregation and integration of data and sectoral models or the coupling of smaller scale models. Planetary boundaries, global commons, and their interdependencies thus become quantifiable through an ever more complex layering of quantified representations of biogeophysical and socio-economic subsystems of an overarching planetary nature-culture coevolutionary process. This process, impressively organised through the Intergovernmental Panel on Climate Change (IPCC) and its main contributing institutions, unfolds enormous political but also epistemic power as its database and analytical capabilities (both intellectual and in terms of computing power) are unmatched. A comparable alternative global climate research infrastructure (Edwards 2017; Chen 2011) does not exist.

These modelling efforts have been concentrating on understanding the dynamics of the material subsystems of the earth system at a global scale. With the dawn of the Anthropocene, however, human activity is beginning to occupy centre stage. Understanding the impacts of rapid (anthropogenic)

climate change now means understanding the coevolution of natural and social systems as they emerge in complex entanglement. Hence researchers today are trying to get to grips with the interweaving of material and social agency. Modelling the dynamics of such processes reaches from the small scale of agent-based modelling of specific local social-ecological systems (for example, Haider et al. 2019) to the global scale of nature-society coevolution and ambitious attempts at world-earth modelling (for example, Donges et al. 2019). While the gold standard of climate impact science – the integrated assessment model – still largely represents social dynamics in terms of economic parameters, many other initiatives are underway to conceptualise social processes in a more differentiated manner. The focus lies particularly on social tipping points, that is, moments of rapid value, preference, or behavioural change within a significant population, opinion formation, and consumer choice. Importantly, mathematical and physical thinking continues to prevail – not least because it is often the same people that worked on material systems who now work on social systems. Yet while some crude attempts at operationalising "the social" in terms of simple economic actors or preference theories occur, this research field is experiencing a moment of paradigmatic openness and curiosity: The nature and dynamics of sociality are not yet operationalised and institutionalised. This is not to say that pragmatic reductionism (Beck and Niewöhner 2006) does not often reign supreme or that this field is not driven by interests and power/knowledge as much as any other field. Yet it is not locked into one specific operationalisation of social dynamics or how they may be related to material dynamics. This presents an opportunity for social scientific expertise.

In addition to this programmatic shift, two other significant developments have taken place that are shaping the dynamics of climate impact science: Trump and Fridays for Future. The Trump administration – only the most visible of several post-truth governments – made the climate impact community realise how radically a political culture could change in a relatively short space of time and also how quickly science could be side-lined in administration and broad sections of the public. It took many by surprise how little resistance could be and was offered against heads of state obviously lying to build their policy programmes on a reality of their own imagination and narrative construction – with little to no resonance with other realities out there. Democratic means turned out to be blunt instruments against these most disturbing tectonic shifts in political culture. The climate impact science community observed these shifts and quickly learned two lessons: One, scientific reason is in imminent danger of losing its role in informing the development of late liberal societies. Enlightenment turns out not to be part of Euro-American societies' very fabric but can easily be wiped off its surface at least for significant periods of time. Second, the community begins to appreciate that political change and social-ecological transformation is not going to come by

"simply" speaking truth to power. Persuasiveness instead comes from narratives rather than sheer facts. Employing narratives, so climate impact thinking, would have to reflect the scientific state-of-the-art. It is in this context that I first heard the term *evidence-based narratives* articulated in meetings amongst concerned climate scientists. In other words, the climate impact sciences now appreciate that objective knowledge plus policy briefing and science communication does not equal societal change. This insight has prepared the community for the second significant development: the Fridays for Future movement that arose from Greta Thunberg sitting outside her school every Friday to protest the lack of political action against climate change. Scientists (for Future) have quickly shown their support and begun to work in tandem with the youth movement. While this movement has started off with the well-known focus on CO_2 reduction, it has quickly expanded and is now centrally focused on matters of equity and justice. Climate change is only the prism that makes visible the fundamental flaws of a global exchange and governance system based on growth and non-renewable resource exploitation, pushing the planet towards several boundaries, privatising wealth, devaluing the commons, and lacking any empathy for multi-species encounters.

The climate impact sciences have realised that determining climate dynamics in relation to anthropogenic CO_2 emissions is not the end of a long research trajectory, but only the beginning of a planetary social-ecological process within which the role of climate projections is anything but given.

2. Disconcernment: Evidence-Based Democratic Deliberation

These transformations of the climate impact sciences are raising the question within the community what the role of scientific knowledge is and should be in democratic societies. The following quote about the role of planetary boundaries in democratic decision-making from a 2019 report by the *German Advisory Council on the Environment* provides an answer that is widely appreciated and shared beyond the climate impact sciences:

> It is true that in democratically constituted societies, the definition of the limits to be observed during change is the result of open goal-setting processes, especially since it entails considerable political, economic and technological consequences. However, this cannot mean that the setting of limits can be made without regard to scientific facts and can therefore be decided at will. From an earth system science perspective, every decision is associated with concrete, explorable risks that can only be subject to non-scientific disposition to a limited extent. In this way, science, in this case earth system analysis, is a crucial instrument of evidence-based democratic deliberation (SRU 2019, 62; author's translation from German).

Evidence-based democratic deliberation – the intention behind this phrase is clear: Democratic deliberation in late liberal societies such as Germany, which is in principle a formally constrained but substantively wide-open process, ought to be bound by and respect constraints provided by the limits of physical or rather biogeophysical dynamics of the earth system. These limits are known with an increasingly high degree of certainty by the earth system sciences. This is not to say that science knows the future. Nor is it saying that science ought to determine our collective decision-making. The mode of thinking here is scenario-based. If we decide on certain forms of living and running the economy, the possible trajectories that our finite planet may take in response can be assessed in quantitative terms with a specified degree of certainty.

The term *evidence-based* points to a peculiar dynamic of the scenario mode of climate impact science. The evidence of possible constraints of future pathways is not provided after the deliberative process but as its basis: evidence-*based*. This is not a linear process from deliberation to impact assessment. Rather, evidence-based democratic deliberation would be a circular or oscillatory process in which the consequences of potential pathways would be assessed, and the result of the assessment fed into the deliberative process and so on. The impact assessment would become the evidence base. I say *would* because the Advisory Council and many others, myself included, strongly feel that parliamentary debate and governmental decision-making currently does not consider climate impact science to the necessary degree. Rather, the political process with its actors is "not showing face" (Haraway 2008) to the state-of-the-art of scientific knowledge. If it did, justifying the political compromise of even the revised German climate law as the result of politics as that which is feasible (Merkel) would not be considered sufficient legitimation.

The circularity of this evidence-based process marks an issue of temporality that anthropology has been debating over the last few years as the future perfect. "In late liberalism, […] the ethical nature of present action is interpreted from the point of view of a reflexive future horizon and its cognate discourses" (Povinelli 2011, 3). What is considered a "good" decision or action is not interpreted against criteria of the present, but against a future horizon: Will this have been a good decision? The effect of this ethical mode of late liberalism is very tangible in the context of "development" when, for example, large infrastructure projects in poor countries are justified and financed by international bodies not because they benefit the people concerned in the present, but because they will have been useful investments once development has established a modern order within which large infrastructure plays an important role. When this future does not materialise, the ethical dimension of the future perfect becomes obvious: the planet is littered with the ruins of infrastructure projects (Howe et al. 2016) that once seemed sensible

against a modernity yet-to-be (Biehl and Locke 2010). Empty office buildings (Appel 2010), hydroelectric dams that do not work, or roads that lead nowhere attest to these poetics of infrastructure often financed by international development funds (Larkin 2013).

Evidence-based democratic deliberation operates in the future perfect. Climate impact science constantly calculates and objectifies future horizons, which then frame the basis of deliberation and the ethical nature of present action. It is in this context that the notion of evidence in evidence-based democratic deliberation warrants closer attention. Evidence is not the same as scientific truth. Evidence denotes that which is submitted to substantiate a claim or a practice as true or legitimate. The notion has gained prominence in medicine since the early 1990s (Timmermans and Berg 2003). Evidence-based medicine (EBM) demands that any treatment decision be based on the best available scientific information about the efficacy of a given treatment. The development of EBM has led to the establishment of levels of evidence from the gold standard of randomised controlled trials (level 1) to opinions of respected authorities (level 5). While EBM explicitly argues for the integration of clinical experience, patient values, and scientific information, a persistent concern remains that EBM prioritises scientific information and statistical significance over clinical experience and situational concerns. The problem underpinning this concern is important. At one end of the spectrum the human body is considered to be a biological system that is well understood. Interventions into this system ought to be based on scientific knowledge of their effects, their efficacy, and their efficiency in statistically valid terms. At the other end of the spectrum, the focus lies on the incomplete knowledge of the human body and the need for good care to follow a situational ethics that negotiates what is good clinical practice in constant interaction with the patient (Mol, Moser, and Pols 2010; Pols 2015). These positions need not be mutually exclusive. Yet in the actual everyday routines of medical practice framed as they are by time pressure, limited knowledge and uncertainty, insurance concerns, specific doctors, and specific patients, the risk is very real that the decision architecture is biased towards seemingly unambiguous scientific information.

Translating this to the case of evidence-based democratic deliberation in the context of climate impacts raises a similar concern. If the earth system with people in it were an engineered system that we understood perfectly, few people would oppose the use of science to determine action: if you built it, fix it. Yet, of course, it is not. Not only is science far from agreeing on the nature of the dynamics of the coevolution of earth and people, the academic community cannot even agree whether it is useful to consider the earth or people as systems at all, whether coevolution is a useful term for thinking about the entanglement of nature and culture, whether the dominant ontology of the natural sciences is a useful common denominator, or whether

framing transformations in ecological rather than ethical terms is useful or "good" or how those registers might be related to each other constructively. It is not even clear who ought to be involved in responding to these tussles and whether academia is best placed to address them. Thus, when the advisory council writes that planetary boundaries and the assessment of the consequences of human action on our planet are only subject to non-scientific disposition to a limited degree, this is certainly true. Yet they are very much subject to scientific disposition, which includes the question to what extent non-scientific expertise does or ought to enter into scientific knowledge practices.

My point here is first of all that an evidence-base does not mean that democratic deliberation somehow operates within the constraints of given truths. What is submitted as evidence to the deliberative construction of the future horizon against which we then evaluate the ethical nature of our present decision-making is contingent and often highly contested. My disconcertment stems from the concern that "evidence-based" in late liberal societies such as Germany might give rise to the same decision architectural bias towards certain forms of natural scientific knowledge that EBM suffers from. I appreciate that this is a dangerous position in these times of populist post-truth governance. And I also appreciate that the advisory council is far from any uncritical understanding of scientific practice and evidence. Yet I believe a balance must be struck between, on the one hand, protecting scientific practice from undue influence from outside of science (cf. Ravetz 1971). And on the other hand, the appreciation that scientific practice as a set of specific socio-technical practices is always situated in specific historical and social circumstances. Science is not a citadel but entwined with society in an ever-changing string figure (Martin 1997) made more complicated by the global and planetary nature of the subject matter. The very difficult question then is: What constitutes a sensible evidence base for democratic deliberation about more-than-human liveability? I do not know the answer to this. Yet in the following paragraphs I outline what I think the role of anthropology ought to be in contributing to the processes that produce this evidence base.

3. Making Evidence: The Role of Anthropology

For me as an anthropologist, the relationship between social theory and method(ology) is configured – broadly speaking – through my understanding of ethnography. Ethnography marks the ongoing toing-and-froing between theory and empirical material (Knecht 2012). This process does not have a clearly defined start or end point as might be considered the case in more linear research designs that build or test theory. The oscillation for me is usually set in motion by an ethnographic disconcertment (Verran 2001) during

the mise-en-scène of fieldwork. Disconcertment describes the moment of puzzlement and confusion in ethnographic fieldwork, often literally felt in an embodied sense through laughter, anger, or anxiety, that sets in motion a reflexive process trying to understand what lies at the heart of this reaction: In this case the notion of evidence-based democratic deliberation. Trying to "stay true" to this disconcertment (ibid.) and to understand it leads me to critical social theories such as Marxist thinking, critical theory, and post-structuralism. The "evidence base" is obviously a construct with a specific purpose that hides its own construction and with it the decisions, values, priorities, and exclusions that it implies. Deconstructing the evidence base is thus an important task of any critical social inquiry. In its ethnographic variety, it starts from revealing how the field in its everyday routines and socio-material practices reproduces power/knowledge, stabilises inequitable relations of production, and loses sight of the decision- and value-based nature of scientific practice. In the context of climate impact science, this critique has been most forcefully articulated by political ecologists and geographers, largely with a strong Marxist background, yet equally versed in *poststructuralism* and more recent debates in *science and technology studies*. The climate impact sciences have been strongly criticised as emblematic of a post-political and post-democratic style of problematisation and governance (Swyngedouw 2010). This is an important debate. In their attempt to create a sense of urgency about climate change impacts, climate science and its allies have resorted to apocalyptic scenarios (or be they realistic) in order to force a problematisation of climate change and the necessary transformative response that was and often still is entirely focused on a degree target, the CO_2 reductions necessary to achieve this target and the measures necessary to achieve those reductions. This problematisation has unintended consequences: It reinforces nature-society dichotomies, furthers social homogenisation ("humanity") despite increasingly significant differences in a postcolonial world, separates science (evidence) from society (deliberation), focuses on the elites to affect transformation, and thus fails to identify real political subjects enthralled in agonistic struggle (ibid., 221ff.).

I consider this specific critique and other facets of it that are being articulated from the vantage point of critical distance to the field important. Yet when operating as an observant participant within the field, such critique often leads to a simple question: OK, let us assume this is a valid critique. What do we do now? Whether and to what extent critique needs to take responsibility for reconstructing a better world is of course a long-standing debate. I appreciate that critique must be possible without proposing "better" alternatives. Yet the initial disconcertment with evidence-based deliberation has also led me to another – complementary – social theoretical repertoire, namely new materialism, the ontological turn, and the notion of care. This is a repertoire that warrants an involvement with the natural sciences that does

not rely solely on critical distance, but rather develops generative critique (ibid.) and a situated normative stance (Stengers 2005a, 2005b) from different forms of close involvement. Here are three arguments that might warrant such an approach in defining anthropology's role in the Anthropocene:

1. Shared concern and careful analysis: Planetary environmental change is undoubtedly a significant challenge to the possibility of more-than-human liveability. This is a concern that climate impact science and anthropology share. They also share a research question: How can people live together in changing environments and with other species without compromising more-than-human liveability? This, of course, does not readily translate into a shared goal or integrated research agenda as fundamental differences persist with regards to the ontological status of the object of research: Human-environment systems conceive of human and environment as separate but related phenomena. This is very different from the notion of *naturecultures* that conceptualises human nature as a social and ethical phenomenon always already entangled with material agency (Franklin 2003; Haraway 1989; Gesing et al. 2018). These differences may be argued over while maintaining critical distance. Yet the speculative ethics that emanate from anthropological work on care (Bellacasa 2017) suggest that a careful analysis of a research field may also benefit from an ethico-political commitment to that field. This does not imply an uncritical or somehow affirmative position. Instead, it demands that ethnographic research develop its tentative ethical analysis from within the ecology of practices (Stengers 2005b) within which the work is situated rather than holding external ethical commitments or principles up to the field through an analytical movement of critical distancing. Hence the concern that anthropology and natural science share about anthropocenic suffering translates for me into an ethico-political-epistemic commitment to staying with the trouble and the field (Haraway 2016).
2. Symmetrical critique: Social and cultural anthropology and the social sciences at large have long suffered from a certain obliviousness towards things and materiality more generally – a "*Sachvergessenheit*," as Stefan Beck referred to it (Beck 1997). While this has been widely addressed since the 1990s through the rise of science and technology studies, feminist critique, and new materialisms, anthropology retains an asymmetry in its critique. It is quick to criticise the undue reductions that occur in human-environment research when mathematical models and simulations thinly simplify human action and sociality to the rule-based interaction of trivial agents. At the same time, however, anthropology is much less willing to apply the same criticism to the social scientific treatment of material dynamics. If the phenomenon in question is a human-environment or social-ecological system or natureculture one need not buy

into material semiotics to be convinced that the hybridity of material and social dynamics requires an open ontological stance. There is good reason to not insist on a specific ontological position *a priori*.

3. Beyond the human scale: The basic anthropological question of how people live together in groups cannot be answered at "the human scale" only (Niewöhner and Beck 2017). By human scale I refer to the scale of social interaction, of the social situation, and of intersubjectivity. Of course, discourses span epochs and situations are today understood as also synthetic (Knorr Cetina 2009). Yet a conscious decision to centre on the whole subject and its inter/actions remains prevalent in ethnography for many good reasons. What this focus tends to pay less attention to are all dynamics and drivers of *social* action that are not experienced by the human subject. Anthropology has long worried about the ethnos of ethnography and how it is being reconfigured. In the Anthropocene, it has also begun to worry about the anthropos of anthropology (Rees 2018; Ingold 2017). Posthuman (Braidotti 2006) and more-than-human (Tsing et al. 2020) approaches have arisen recently in order to problematise and provincialise the effects of anthropocentrism in ethnography both with respect to the non-universal nature of the human subject and with respect to the enactment of anthropos in material and multi-species worlds. Hence, *how we live together* is significantly shaped by global biogeophysical forces as well as molecular dynamics, both of which exist thoroughly outside of unmediated human experience. Understanding these dynamics requires knowledge production with the help of sophisticated experimental apparatuses. An anthropological engagement with more-than-human liveability and with materiality – or be it always already material-semiotically practiced materiality – thus requires engagement with these apparatuses of knowledge production.

These three arguments – shared concern and careful engagement, the need for symmetrical critique, and agency beyond the human scale – are informed by new materialist thinking, the ontological turn, and the notion of care. They lead to a thought style, stance, and methodology that goes beyond critical distance. In the remainder of this paper, I want to return to my disconcertment with evidence-based democratic deliberation and outline the scientific practices that flow from this stance for anthropology.

4. Situated Modelling: Provincialising Global Research Infrastructures

The call to "provincialize Europe" (Chakrabarty 2000) resounded powerfully through the social sciences and humanities. The core idea was to historicise

the mythical figure of Europe as the centre of modernity and its reception and translation at the margins and outside of Europe. Its twofold effect has been to, first, demonstrate the particularity of Europe's implicit understanding of disenchanted space, progressive and secular time, and sovereignty as a non-relational concept. Second, and more importantly in the context of this paper, this demystification of the figure of modern Europe has fostered a critical reconceptualisation of European modernity from its margins and from the vantage point of other modernities. Embedded within a much broader movement of postcolonial thinking, *provincialising* as an analytical strategy has quickly been joined by a focus on the multiple entanglements of modernities across the globe (for example, Conrad and Randeria 2002). Taking this movement into academia then resulted in the call to decolonise Western histories of thought (for example, Grosfoguel 2007). This analytic reveals the particularity of concepts that within Western thought traditions are considered universal or at least go "unmarked" so as to escape further reflection. It is about inventing and reinventing concepts, perspectives, critique, and, most generally, academic practice outside of and beyond the historical configurations of colonialism and sustained geopolitical asymmetries.

I argue that decolonisation and provincialising needs to include the natural sciences. I have sketched the climate impact sciences' global research infrastructures and their integrative logics above (for more detail, see Edwards 2017). Such infrastructures can only "see" (Scott 1998) in certain ways. As such, they shape how climate change impacts are problematised, what can and cannot be said about them, what counts as true, and what kinds of interventions are considered legitimate. In many ways, this is a good thing. However, any infrastructure is also scripted and a manifestation of a particular social and moral order and knowledge system (Leigh Star and Ruhleder 1996). Thus, infrastructuring research and interventions necessarily produces priorities and exclusions in ways that tend to reproduce existing power asymmetries and symbolic orders.

Provincialising global research infrastructures then is a call to reconfigure these infrastructures from their margins and from beyond their field of vision. This is not about getting rid of them. It is about strengthening them by situating them, that is, by putting them into dialogue with alternatives that are embedded in often fundamentally different natural, moral, and symbolic orders. Situating reveals the contingency and decision-ladenness of hegemonic knowledge infrastructures thus opening them up to critical reflection. Yet it also takes responsibility for reconfiguring them. And it uses this reconfiguration to reflect received analyses of social processes under emergent conditions of planetary boundaries. It is clearly the case that most Western social theory has been developed against infinite resource horizons. Planetary boundaries thus challenge these theories of the social and of society. One anthropological way of responding to this challenge lies in exploring

alternative cosmologies and ontologies to understand how they configure nature culture relations. To do so requires "minor infrastructures" (Niewöhner under review), that is, infrastructures that do not only have the architecture of modernity and Western cosmology scripted into them. Rather, minor infrastructures can accommodate multiple forms of knowledge, of multispecies kinship, and of living together. Minor infrastructures are, of course, hard to imagine let alone construct and maintain in the face of epistemic hegemony of Western epistemology and ontology across the globe. Yet working on and towards such alternative infrastructures is in my view a key role for anthropology today. This is work that needs to be done jointly with the climate impact sciences. The objective is not to produce an *Other* to existing perspectives, but to reconfigure existing knowledge infrastructures. Provincialise global climate science infrastructures such that they may contribute to a more inclusive evidence base; an evidence base that allows for agonism between integration and difference: between planetary boundaries and planetarity, if you will.

And if realising alternatives is hard to fathom, then at least prying open the existing infrastructures such that alternatives become visible and produce the pressure to legitimate the current infrastructures is feasible. Our suggestion at IRI THESys in Berlin to approach this difficult task is to engage in what we have come to refer to as situated modelling (Niewöhner 2019). Situated modelling is a research framework and analytic in the field of human-environment research that tries to link practices of quantification, numerical modelling, and simulating with practices of reflection and contextualisation. I very briefly outline four aspects here that are constitutive of situating modelling.

4.1 Participatory Modelling

I focus on modelling because modelling is the dominant mode of knowledge production in this field. Modelling here means numerical modelling in a broad sense. This involves the representation of a phenomenon in the world, for example, a local social-ecological system, global climate change, or land use change in Latin America, through terms that can be mathematically manipulated in order to arrive at a calculative device that can be fitted to data and that enables projections into the future.

Within modelling communities, models are understood as heuristic devices that relate to reality in specific and controlled ways, but do not (aim to) represent it accurately. It is usually when models travel outside of their creator community that models are treated as if they represent current and possible future states of the world. It is here that the threat looms large that they become reified models *of* the world that then turn into models *for* the world. As any modeller will readily acknowledge, the specific configuration of a model

requires many decisions by the modeller that are highly contingent. They follow methodological criteria but also depend on the modellers preferences and priorities, underlying value system, epistemology and ontology, and objectives: what is included, how are phenomena parameterised, how are cofactors weighted, how are different forms of uncertainty treated, and so on. This decision-ladenness, of course, is true for any representation of the world (Knorr Cetina 1981). In the context of climate impact science, this decision-ladenness is particularly pertinent for at least two reasons: First, most social-ecological systems are very complex with many important dynamics badly understood and not readily quantitatively operationalisable, particularly in the social realm. Second, results from model runs command significant credibility, particularly when the contingencies and uncertainties of their mechanics are lost in translation. Their ability to fast forward into the future make them very attractive aids in political decision-making. Like maps, their suggestive power is substantial – although modellers might disagree as they often feel they are not being heard in the policy-making process.

The vast majority of modellers in social-ecological or human-environment contexts are trained in the natural sciences. Over time, their research object has shifted from purely physical systems to include social and institutional dynamics of various sorts. Some of these modellers have become concerned about their own role and power as sole decision-makers in this process and they have begun to open the modelling process up to participation from social scientists and stakeholders (Krueger, Inman, and Chilvers 2014; Krueger et al. 2012; Pahl-Wostl 2002). The objective here is, first, to broaden the basis of expertise on which the modelling process can draw. Social science contributes knowledge of social processes whereas stakeholders bring in-depth knowledge and practical experience of a social-ecological system as well as judgements about the relative importance of certain aspects of the system and its future. When practiced successfully, participatory modelling thus broadens the knowledge basis upon which the model is based. This may also increase the democratic legitimacy for its use in political decision-making though this depends on the participatory process.

Situated modelling follows this path. In the spirit of coproduction of science and social order (Jasanoff 2004) and codesign of research processes, modelling is opened up to relevant stakeholders and concerned groups. Anthropological involvement in this process is twofold: First, it can help to inquire into the social dynamics of the phenomenon in question. For example, modelling of hydrosocial territories around dams in Colombia might start from the ethnographic record of the areas concerned in order to identify existing natural and moral orders as well as social dynamics. Second, anthropology can operate in the mode of laboratory studies (Latour and Woolgar 1986) helping modellers to make explicit and articulate the contingencies of modelling choices, discuss uncertainties, and make visible alternative representations and

excluded aspects. Situated modelling interweaves a technical artefact and process with embodied social and political choices and moral orders (Niewöhner 2015). Situated modelling in this sense "infrastructures" (ibid.) matters of concern. It goes some way towards a *minor infrastructure* as running the model in a participatory process gives the opportunity to participants to appropriate the model and its output for their own purposes. They can deliberate possible futures through the model, rather than being constrained by an evidence base that they cannot influence. Participatory modelling provides participants with the opportunity to work on and through this evidence base. This approach obviously works best in settings of limited complexity and with a limited number of stakeholders. It does not scale easily.

4.2 Ontological Anarchy

Situated modelling as a way of provincialising hegemonic research infrastructures is primarily concerned with the conceptual dichotomy of social and ecology, nature and culture, human and environment, or material and social. Scientific practice "naturally" relies on the dominant Western ontology that distinguishes clearly between nature and culture and that assigns different epistemic cultures to their study. We may have never been modern (Latour 1993), yet in climate impact science the social and the ecological remain clearly separated spheres that are then linked in systems through processes of interaction or coevolution. This ontology, however, is historically and socially contingent (Tambiah 1990). For example, Western ontology distinguishes sharply the material, biological human body and its counterpart the moral and political subject. While all humans share very similar biological bodies no matter where they live, very different moral and political subjects arise within particular cultural contexts, that is, they exist in multiple forms. Some consensus may be reached around the universality of human rights. Yet this really only proves the legitimate diversity of cultural practices and associated moral and political subjects. Some Euro-Americans might not like multiculturalism, yet ontologically speaking this is what "the West" works with. The deep anthropological record, however, harbours plenty of ethnographic descriptions of alternative ontologies. Most famously perhaps, Eduardo Viveiros de Castro has shown for many peoples of the Amazon how their pronounced perspectivism leads to multinaturalism rather than multiculturalism. In this cosmology, most living beings share the ability to take perspectives (deixis) and in so doing share a spiritual continuity or "culture." This continuity in spirit comes with discontinuity in physical form and the possibility of transubstantiation, that is, shape shifting or the ability of some creatures to take on different bodies understood as bundles of affect (Viveiros de Castro 2012). It essentially presents a form of multinaturalism and uniculturalism that diametrically opposes Western cosmology. Other ontologies

persist across the world, most intensively studied (by Western scholarship) among indigenous groups in Australia and the Americas; yet neither restricted to these places nor indigenous groups.

Such alternative cosmologies and indeed ontologies are hard to comprehend. They require extensive study and submersion into their lived practices where possible. Otherwise, they remain *other* to the outsider (Alberti et al. 2011). This is the main reason why they are currently not reflected well in public and political discourses and indeed global research infrastructures of climate impact science that firmly rest on Western ontology.

The key point here is that research infrastructures are never neutral representations of worldly phenomena nor are they views from nowhere. They are necessarily built within specific ontological assumptions about what is real, what is material and what is not, and what can exist and what cannot. The evidence base for democratic deliberation reflects this Western standpoint. Yet given the planetary concern of climate change impacts, what about those other ontologies? Are we not continuing the epistemicide (Grosfoguel 2013), which early modern European empires started with colonial expansion and the construction of European identity and global capitalism? Instead of assuming Western ontology as universal, situated modelling advocates ontological anarchy (Viveiros de Castro 2019), that is, an openness towards alternative ontologies without an *a priori* hierarchy such as implied in scientific expertise and indigenous knowledge. Two entry points exist for ontological anarchy: reflecting and diffracting differences. First, as advocated by many decolonial scholars, ontological pluralism should be achieved by considering different ontologies symmetrically. In practice, this means that climate impact science may continue as before. Yet its results ought to be reflected next to other understandings and enactments of climate and global environmental change. The place for such reflection might be the floors of international political or scientific advisory bodies. Ontological difference is thus treated as a political and ethical issue, its negotiation as a matter of power. Where compromise cannot be found, because ontologies cannot exist in parallel, a hierarchy needs to be established, but only after understanding and appreciating differences. In such a process, ontological positions need to legitimate themselves after a process of reflection.

A second entry point for ontological anarchy seems epistemically more promising: diffracting ontologies (Barad 2007). Feminist scholarship has identified diffraction as the literary practice of reading one text through another. The same can be done with ontologies through models. If it is correct that all models independent of scale and complexity carry implicit ontological assumptions, it is possible to run models with a different set of ontological assumptions. This is possible *in principle* for all types of models, yet it is most obvious in cases where ontological differences are at stake, for example, social-ecological dynamics.

Such reconfigurations may fail *in practice* thus revealing limits of both models and ontologies. Either way, it offers an interesting way of working different ontologies through each other rather than placing them next to each other. This may seem like an undue imposition to many in the modelling community. Yet it is really no different from what international programmes of ecosystem service assessment, bioeconomic extraction, or environmental protection have been doing for decades if not centuries: forcing peoples on the ground to express their concerns in the language of an outside agent.

4.3 Partial Withness

Critique in 20th century social science and anthropology has relied on critical distance from the object of research. This distance guarantees the sober, unaffected, and reflexive analysis of a field's dynamics through the lens of a theoretical framework largely external to the field itself: critical theory, Marxism, poststructuralism. Critical analysis has been a very powerful tool and I believe that it has been and continues to fulfil an important epistemic and political role. Yet in its ethos it mirrors the modest witness of the early modern natural sciences. Haraway has shown us how gentlemen in the salons of early modern Europe are modest witnesses to nature at work. They become ventriloquists for the object world, as she writes. Their subjectivity is their objectivity (Haraway 1988, 24). In a similar way, the ethnographer needs to return from the mise-en-scène of fieldwork to the reclusivity of the desk in order to reflect upon observations and experiences and narrate and theorise these against the backdrop of the discipline's collective knowledge. The detrimental effects of this understanding of ethnographic writing as a post-fieldwork reflexive exercise are well documented: Fabian's *Time and the Other*, Said's *Orientalism*, and Trouillot's *Savage Slot* all demonstrate how writing as a non-field-based practice positions the research subjects as frozen in time in an imaginary Otherness. The research subjects' agency is regularly written out of ethnographic accounts in the same way that the natural sciences write material agency out of their accounts of the object world. Arguably, the critical social sciences and a post-representational anthropology are still running the risk of doing the same with and to their subjects as they deconstruct them against a preconceived theoretical framework.

Modest withness (Sørensen 2009) has been suggested as the more apt description of what ethnographic fieldwork is actually and ought to be doing today in many instances. Ethnographic research is much more about shared epistemic work than simply observing. Much of anthropological fieldwork is now conducted with fully reflexive research subjects embedded in fields shaped significantly by specialised knowledge. Studying up has become the norm and the relationship between researcher and researched has been adjusted accordingly. It has become more symmetrical and experimental (Marcus

2010). Modest withness thus describes a much more openly constructive relationship between ethnographer and field. I would like to extend this for situated modelling to what one might call *partial withness*. Partial – in the sense of Strathern or Haraway (e.g., Strathern 1991) – refers to both incomplete and biased. Partial withness needs to balance two modes: First, withness means that the fieldworker works together with the field. The approach is collaborative, co-laborative, or experimental (Estalella and Criado 2018; Lassiter 2005; Niewöhner 2016). Second, fieldwork is incompletely attached to the specific modelling community. In many moments, the ethnographer works together with the modellers, for example, to come up with representations of social processes that speak more clearly to the history of social scientific thought. In other moments, the fieldworker moves into critical distance or uses the experience to advance disciplinary thinking. Partial withness requires oscillation and movement on part of the researcher (see reflexivity below). It also requires a commitment to the field. This commitment has been framed as a form of "caring" for the field, that is, being ethico-politically committed to it (Bellacasa 2017). In the case of situated modelling, partial withness then means being committed to knowing more-than-human liveability in different ways. What makes a "good model" or a "good" process of situated modelling is not decided against criteria external to the practice of modelling. It emerges from within an ongoing careful negotiation of alternative orderings (Stengers 2005a; Mol 2008).

4.4 Assembling Reflexivity

Reflexivity is crucial to the process of situated modelling. Importantly, reflexivity must not be treated as a virtue or source of privileged knowledge (Lynch 2000). Instead, it is all about mobility between different researchers, research questions, concepts, literatures, different kinds of empirical material (Hirschauer 2008), and different ways of being-in-the-world mediated by different methods. I would go further to suggest that reflexivity in situated modelling must not be conceived first and foremost as an individual mental activity. Reflecting does not really happen in the individual understood as a disembodied mental agent. Instead, it might be worth exploring reflexivity as a distributed process or assemblage (Bieler et al. 2020; Niewöhner 2021). This introduces three changes in perspective: First, it treats the reflexive person as linked into social practices. As Ludwik Fleck already pointed out in the 1930s (Fleck 1980 [1935]): It is not the individual who thinks, but its social context and thought collective. Second, such thought collectives include all kinds of non-human kin: for example, signature species in ecology, pets and food, and the microbiome helping to keep up bodily functions in the thought collective. Third, reflecting as a collective undertaking involves all kinds of technologies from the low-tech of pen and paper to the high-tech of modelling software or the

hinterland of social-ecological data production in satellite technology. Reflexivity is thus a material-semiotic practice that is distributed across a whole panoply of human and non-human actors.

Reflexivity in this sense does not only help to explicate assumptions that different people bring to the modelling exercise and help to level the playing field between different participants. It also helps to escape the beaten tracks of a reflexive anthropology (Boyer 2015) where reflexivity means two things: It reassures the ethnographers of their own position in the field understood systemically (Hirschauer 2008), and it means that the researchers do not work with preconceived research designs or fixed definitions of terms. Necessary and important as this is, it is all too easy to get stuck in self-similar reflexive loops.

Conceiving of reflexivity as an assemblage means paying attention to the actual everyday practices within which reflecting occurs. And it means paying attention to the panoply of actors that enable the anthropologist to conceive of herself/himself as reflexive. In the case of situated modelling, these actors include the model itself that affords a specific problematisation. For models of social dynamics, it also includes the question whether and how those communities that are being modelled can articulate their concerns. Are social-ecological models taken into the communities and how does this distribute agency differently from desk-based work? Whose ontological assumptions surface in the project and what role do they play? Last but not least, it is worth thinking about what enables Western scientific practices. The year of 2020 has shown how scientists globally are positioned very differently: precarious contracts, vulnerability towards viral infection, technological and financial support. While the pandemic shines a glaring light onto the differential fragility of scientific practices, this really only alerts the scientific community to a configuration that is shaped by forces even larger and more persistent than the pandemic. Considering reflection and scientific work in general as always assembled from a rich network of kin – human, non-human, technological – might lead us to a more inclusive approach to thinking about and attempting to do more-than-human liveability.

5. Conclusion: Co-Laborating in the Making of Evidence

Situated modelling is one way for anthropology to engage the global research infrastructures of climate impact science. Its aim is to reconfigure the basis of evidence for democratic deliberation by introducing differences into a knowledge producing machine entirely geared towards integration. Differences may stem from radically "other" ontologies as briefly discussed in this paper. They may also stem from subaltern enactments of naturecultures, from non-representational epistemologies (Crang and Thrift 2000), or, less

dramatically perhaps, from the enactments of social-ecological relations in the everyday life right on our doorsteps. This approach involves situating modelling practices historically and socially. It also involves constructively contributing to them using a continuous oscillation between de- and reconstruction to reflect on disciplinary comfort zones that cherish social processes on a human scale. From an anthropological perspective, I consider situated modelling a co-laborative practice, that is, temporary, joint epistemic work that is not necessarily predicated upon a shared outcome (Niewöhner 2016). It rests on an ethico-political commitment to working with other disciplines on representations of socio-material dynamics. Yet its outcome is open and can entail a tangible shared outcome as well as separate disciplinary advances. Its basic mode of operation is agonistic-integrative (cf. Barry, Born, and Weszkalnys 2008). It oscillates between attempts to integrate heterogeneous sets of empirical material in single representations on the one hand and, on the other hand, it identifies and preserves differences between representations or alternative performances in order to induce a process of reflecting and mutual learning.

I consider this approach important in order to widen what is considered as evidence in the processes of deliberating social-ecological transformations worldwide and globally. It is a means of provincialising a global climate research infrastructure that is currently struggling to drive important transformations. Reconstructing these infrastructures from their margins and fields beyond their own vision might strengthen the role of scientific knowledge in informing and shaping transformation processes.

References

Alberti, Benjamin, Severin Fowles, Martin Holbraad, Yvonne Marshall, and Christopher Witmore. 2011. Worlds Otherwise. Archaeology, Anthropology, and Ontological Difference. *Current Anthropology* 52 (6): 896-912.

Appel, Hannah. 2010. *The Licit Life of Capitalism*. Durham: Duke University Press.

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

Barry, Andrew, Georgina Born, and Gisa Weszkalnys. 2008. Logics of Interdisciplinarity. *Economy and Society* 37 (1): 20-49.

Beck, Stefan. 1997. *Umgang mit Technik: Kulturelle Praxen und kulturwissenschaftliche Forschungskonzepte*. Berlin: Akademie Verlag.

Beck, Stefan, and Jörg Niewöhner. 2006. Somatographic Investigations Across Levels of Complexity. *BioSocieties* 1 (2): 219-27.

Bellacasa, Maria Puig de la. 2017. *Matters of Care. Speculative Ethics in More than Human Worlds*, ed. Cary Wolfe, Cary, vol. 41. Minnesota: University of Minnesota Press.

Biehl, Joao, and Peter Locke. 2010. Deleuze and the Anthropology of Becoming. *Current Anthropology* 51 (3): 317-51.

Bieler, Patrick, Milena D. Bister, Janine Hauer, Martina Klausner, Jörg Niewöhner, Christine Schmid, and Sebastian von Peter. 2020. Distributing Reflexivity through Co-Laborative Ethnography. *Journal of Contemporary Ethnography*: doi: 10.1177/0891241620968271.

Boyer, Dominic. 2015. Reflexivity Reloaded. From Anthropology of Intellectuals to Critique of Method to Studying Sideways. In *Anthropology Now and Next*, ed. Thomas Hylland Eriksen, Christina Garsten, and Shalini Randeria, 91-110: Berghahn Books.

Braidotti, Rosi. 2006. Posthuman, All Too Human: Towards a New Process Ontology. *Theory Culture Society* 23 (7-8): 197-208.

Chakrabarty, Dipesh. 2000. *Provincializing Europe: Postcolonial Thought and Historical Difference*: Princeton University Press.

Chen, Robert S. 2011. A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming. National Institute of Environmental Health Sciences.

Conrad, Sebastian, and Shalini Randeria. 2002. Geteilte Geschichten–Europa in einer postkolonialen Welt. *Jenseits des Eurozentrismus. Postkoloniale Perspektiven in den Geschichts-und Kulturwissenschaften*: 9-49.

Crang, Michael, and Nigel Thrift. 2000. *Thinking Space*. London: Routledge.

Donges, Jonathan F., Jobst Heitzig, Wolfram Barfuss, Marc Wiedermann, Johannes A. Kassel, Tim Kittel, Jakob J. Kolb, Till Kolster, Finn Müller-Hansen, and Ilona M. Otto. 2019. Earth System Modeling with Endogenous and Dynamic Human Societies: The Copan: CORE open World-Earth modeling framework. *Earth System Dynamics* 11:395-413. doi: 10.5194/esd-11-395-2020.

Edwards, Paul N. 2017. Knowledge Infrastructures for the Anthropocene. *Anthropocene Review* 4 (1): 34-43.

Estalella, Adolfo, and Tomás Sánchez Criado. 2018. *Experimental Collaborations: Ethnography Through Fieldwork Devices*, vol. 34. Oxford, New York: Berghahn Books.

Fleck, Ludwig. 1980 [1935]. *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv. Mit einer Einleitung herausgegeben von Lothar Schäfer und Thomas Schnelle*. (Erstmals Basel 1935: Benno Schwabe & Co.) Frankfurt am Main: Suhrkamp.

Franklin, Sarah. 2003. Re-Thinking Nature-Culture: Anthropology and the New Genetics. *Anthropological Theory* 3 (1): 65–85.

Gesing, Friederike, Michi Knecht, Michael Flitner, and Katrin Amelang. 2018. *NaturenKulturen: Denkräume und Werkzeuge für neue politische Ökologien*, vol. 146. Bielefeld: transcript.

Grosfoguel, Ramón. 2007. The Epistemic Decolonial Turn. *Cultural Studies* 21 (2-3): 211–23.

Grosfoguel, Ramón. 2013. The Structure of Knowledge in Westernised Universities: Epistemic Racism/Sexism and the Four Genocides / Epistemicides. *Human Architecture: Journal of the sociology of self-knowledge* 1 (1): 73-90.

Haider, L. Jamila, Wiebren J. Boonstra, Anzurat Akobirshoeva, and Maja Schlüter. 2019. Effects of Development Interventions on Biocultural Diversity: A Case Study from the Pamir Mountains. *Agriculture and Human Values*: 1-15.

Haraway, Donna. 1988. Situated knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies* 14: 575-99.

Haraway, Donna J. 2016. *Staying with the Trouble: Making Kin in the Chthulucene*: Duke University Press.
Haraway, Donna Jeanne. 1989. *Primate Visions: Gender, Race, and Nature in the World of Modern Science*. New York: Routledge.
Haraway, Donna Jeanne. 2008. *When Species Meet*. Minneapolis: University of Minnesota Press.
Heymann, Matthias, Gabriele Gramelsberger, and Martin Mahony. 2017. *Cultures of Prediction: Epistemic and Cultural Shifts in Computer-Based Atmospheric and Climate Science*. London: Taylor & Francis.
Hirschauer, Stefan. 2008. Die Empiriegeladenheit von Theorien und der Erfindungsreichtum der Praxis. In *Theoretische Empirie: zur Relevanz qualitativer Forschung*, ed. Kalthoff, Herbert, Stefan Hirschauer, and Gesa Lindemann, 165-187. Frankfurt am Main: Suhrkamp.
Howe, Cymene, Jessica Lockrem, Hannah Appel, Edward Hackett, Dominic Boyer, Randal Hall, Matthew Schneider-Mayerson, Albert Pope, Akhil Gupta, Elizabeth Rodwell, Andrea Ballestero, Trevor Durbin, Farès el-Dahdah, Elizabeth Long, and Cyrus Mody. 2016. Paradoxical Infrastructures: Ruins, Retrofit, and Risk. *Science, Technology & Human Values* 41 (3): 547–65.
Ingold, Tim. 2017. Anthropology Contra Ethnography. *HAU: Journal of Ethnographic Theory*. 7 (1): 21-6.
IPCC. 2014. AR5 Synthesis Report: Climate Change 2014. Geneva: Intergovernmental Panel on Climate Change.
Jasanoff, Sheila. 2004. *States of Knowledge: The Co-Production of Science and Social Order*, *International Library of Sociology*. London, New York: Routledge.
Knecht, Michi. 2012. Ethnographische Praxis im Feld der Wissenschafts-, Medizin- und Technikanthropologie. In *Science and Technology Studies. Eine sozialanthropologische Einführung*, ed. Beck, Stefan, Estrid Sørensen, and Jörg Niewöhner, 245-74. Bielefeld: transcript.
Knorr Cetina, Karin. 1981. *The Manufacture of Knowledge - An Essay on the Constructivist and Contextual Nature of Science*. Oxford: Pergamon Press.
Knorr Cetina, Karin. 2009. The Synthetic Situation: Interactionism for a Global World. *Symbolic Interaction* 32 (1): 61-87.
Krueger, Tobias, Alex Inman, and Jason Chilvers. 2014. Learning Outcomes from Oarticipatory Modelling: A Case Study in the Tamar Catchment, UK. *EGUGA*:4377.
Krueger, Tobias, Trevor Page, Klaus Hubacek, Laurence Smith, and Kevin Hiscock. 2012. The Role of Expert Opinion in Environmental Modelling. *Environmental Modelling & Software* 36: 4-18.
Larkin, Brian. 2013. The Politics and Poetics of Infrastructure. *Annual Review of Anthropology* 42: 327–43.
Lassiter, Luke Eric. 2005. Collaborative Ethnography and Public Anthropology. *Current Anthropology* 46 (1): 83-106.
Latour, Bruno. 1993. *We Have Never Been Modern [Nous n'avons jamais été modernes]*. New York: Harvester Wheatsheaf.
Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*, 2nd ed. Princeton: Princeton University Press.
Leigh Star, Susan, and Karen Ruhleder. 1996. Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research* 7 (1): 111-34.

Lynch, Michael. 2000. Against Reflexivity as an Academic Virtue and Source of Privileged Knowledge. *Theory, Culture & Society* 17 (3): 26-54.
Marcus, George E. 2010. Contemporary Fieldwork Aesthetics in Art and Anthropology: Experiments in Collaboration and Intervention. *Visual Anthropology* 23 (4): 263-77.
Martin, Emily. 1997. Anthropology and the Cultural Study of Science: From Citadels to String Figures. In *Anthropological Locations. Boundaries and Grounds of a Filed Science*, ed. Akhil Gupta, and James Ferguson, 131-46. Berkeley: University of California Press.
Mol, Annemarie. 2008. *The Logic of Care. Health and the Problem of Patient Choice.* London: Routledge.
Mol, Annemarie, Ingunn Moser, and Jeannette Pols, eds. 2010. *Care in Practice. On Tinkering in Clinics, Homes and Farms*. Bielefeld: transcript.
Niewöhner, Jörg. 2015. Infrastructures of Society (Anthropology of). In *International Encyclopedia of the Social and Behavioral Sciences,* ed. James D. Wright, vol. 12, 2nd ed., 119-125. Oxford: Elsevier.
Niewöhner, Jörg. 2016. Co-Laborative Anthropology: Crafting Reflexivities Experimentally. In *Etnologinen tulkinta ja analyysi. Kohti avoimempaa tutkimusprosessia,* ed. Jukka Jouhki, and Tytti Steel, 81-124. Helsinki: Ethnos.
Niewöhner, Jörg. 2019. Situierte Modellierung. Ethnographische Ko-Laboration in der Mensch-Umwelt Forschung. In *Zusammen arbeiten. Praktiken der Koordination und Kooperation in kollaborativen Prozessen,* ed. Stefan Groth, and Christian Ritter, 23-50. Zürich: transcript.
Niewöhner, Jörg. 2021. Reflexion als gefügte Praxis. *Berliner Blätter* 83: 107-16.
Niewöhner, Jörg. under review. Infrastructure. Anthropological Perspectives on a Key Mediator in/of the Anthropocene. *Oxford Research Encyclopaedia: Anthropology*.
Niewöhner, Jörg, and Stefan Beck. 2017. Phänomenographie: Sinnvolle Ethnographie jenseits des menschlichen Maßstabs. In *Kulturen der Sinne. Zugänge zur Sensualität der Sozialen Welt*, ed. Karl Braun, Claus-Marco Dieterich, Thomas Hengartner, and Bernhard Tschofen, 78-96. Würzburg: Königshausen & Neumann.
Pahl-Wostl, Claudia. 2002. Participative and Stakeholder-Based Policy Design, Evaluation and Modeling Processes. *Integrated Assessment* 3 (1): 3–14.
Pols, Jeannette. 2015. Towards an Empirical Ethics in Care: Relations with Technologies in Health Care. *Medicine, Health Care and Philosophy* 18 (1): 81-90.
Povinelli, Elizabeth A. 2011. *Economies of Abandonment: Social Belonging and Endurance in Late Liberalism*: Duke University Press.
Ravetz, Jerome. 1971. *Scientific Knowledge and its Social Problems*. Oxford: Clarendon Press.
Rees, Tobias. 2018. *After ethnos*: Duke University Press.
Scott, James C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed, Yale Agrarian Studies*. New Haven: Yale University Press.
Sørensen, Estrid. 2009. *The Materiality of Learning: Technology and Knowledge in Educational Practice, Learning in Doing*. Cambridge: Cambridge University Press.
SRU. 2019. Demokratisch regieren in ökologischen Grenzen–Zur Legitimation von Umweltpolitik. Sondergutachten. Berlin: Sachverständigenrat für Umweltfragen.

Steffen, Will, Katherine Richardson, Johan Rockström, Sarah E. Cornell, Ingo Fetzer, Elena M. Bennett, Reinette Biggs, Stephen R. Carpenter, Wim de Vries, Cynthia A. de Wit, Carl Folke, Dieter Gerten, Jens Heinke, Georgina M. Mace, Linn M. Persson, Veerabhadran Ramanathan, Belinda Reyers, and Sverker Sörlin. 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* (347) 6223.

Stengers, Isabelle. 2005a. The Cosmopolitical Proposal. In *Making Things Public*, ed. Bruno Latour, and Peter Weibel, 994-1003. Cambridge: MIT Press.

Stengers, Isabelle. 2005b. Introductory Notes on an Ecology of Practices. *Cultural Studies Review* 11 (1): 183-96.

Strathern, Marilyn. 1991. *Partial connections*. New York: Altamira Press.

Swyngedouw, Erik. 2010. Apocalypse Forever? Post-political Populism and the Spectre of Climate Change. *Theory Culture & Society* 27 (2-3): 213-32.

Tambiah, Stanley J. 1990. *Magic, Science and Religion and the Scope of Rationality*, vol. 1981. Cambridge: Cambridge University Press.

Timmermans, Stefan, and Marc Berg. 2003. *The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care*. Philadelphia: Temple University Press.

Tsing, Anna L., Jennifer Deger, Alder Saxena Keleman, and Feifei Zhou. 2020. Feral Atlas: The More-Than-Human Anthropocene. http://www.sup.org/books/title/?id=30693 (Accessed March 18, 2021).

Tsing, Anna L., Andrew S. Mathews, and Nils Bubandt. 2019. Patchy Anthropocene: Landscape Structure, Multispecies History, and the Retooling of Anthropology: An Introduction to Supplement 20. *Current Anthropology* 60 (S20): S186-S197.

Verran, Helen. 2001. *Science and an African logic*. Chicago: University of Chicago Press.

Viveiros de Castro, Eduardo. 2012. Cosmological Perspectivism in Amazonia and Elsewhere: Four Lectures Given in the Department of Social Anthropology, Cambridge University, February–March 1998. *Hau Masterclass Series 1*.

Viveiros de Castro, Eduardo. 2019. On Models and Examples: Engineers and Bricoleurs in the Anthropocene. *Current Anthropology* 60 (S20): S296-S308.

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doi: 10.12759/hsr.46.2021.2.186-204

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doi: 10.12759/hsr.46.2021.2.264-286

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