Accepted: 11 March 2019
DOI: 10.1111/tran.12308

REGULAR PAPER

The moral geography of the Earth system

Jeremy J. Schmidt

Department of Geography, Durham University, Durham, UK

Correspondence
Jeremy J. Schmidt
Email: jeremy.schmidt@durham.ac.uk

Funding information
Social Sciences and Humanities Research Council of Canada

Human impacts on the Earth system have profound moral consequences. The uneven generation and distribution of harms, and the acceleration of human forces now altering how the Earth system functions, also trouble moral accounts of belonging. This article shows how moral geography can be renewed in this context. It begins by identifying how human impacts on the Earth system are shifting global norms of sustainability, such as in calls to enhance planetary stewardship and to transform social values. These shifts are important in themselves, but also reveal a deeper challenge to moral geography and the counterfactual heuristics traditionally relied on to understand belonging. In response, many critical scholars have rethought the terms and conditions of belonging in the Anthropocene in reference to considerations of novelty, time, ontology, and agency. I argue that these strategies face difficulties that are not only analytical, but which also arise from new practices of belonging that accept critiques yet reach markedly different conclusions. I examine two cases of this kind. The first treats human forces as a geological sphere: the technosphere. The second incorporates the planetary boundaries framework of Earth system science as the basis for a *grundnorm* (a norm basic to all others) in international programmes of environmental law and governance. Examining these two practices within the broader context of shifts in sustainability reveals a new politics of naturalisation unperturbed by critical scholarship on the Anthropocene. By contrast, a renewed moral geography can identify how earlier norms of sustainable development, especially the promotion of economic instruments to secure environmental relief, now structure the incorporation of Earth system science in sustainability transitions. Retaining the structure of sustainability and accepting critiques of the Anthropocene are now giving rise to a new form of neoliberalism without nature.

KEYWORDS
Anthropocene, grundnorm, moral, sustainability, technosphere

1 | INTRODUCTION

Chapter one, line one, of the World Commission on Environment and Development report, *Our Common Future*, reads: "The Earth is one but the world is not" (1987, p. 39). It was and remains a remarkable statement that consolidates global environmental challenges and naturalises the normative trajectory of sustainable development: the convergence of multiple social worlds on a single Earth. This article examines how the norms of sustainability are shifting in the Anthropocene in ways that demand a renewal of moral geography. The shift is evident in global governance, such as the Sustainable

Development Goals (SDGs), when Earth system science is used as rationale to both constrain development within planetary boundaries and to compel social values, such as stewardship (e.g., Sachs, 2015; Steffen et al., 2015a). For instance, Steffen et al.'s (2018) landmark article showed how the planet could become "Hothouse Earth" if human impacts on the Earth system cross climate thresholds – a key planetary boundary – beyond which reductions of greenhouse gas emissions would not prevent climate destabilisation and would lead to average temperatures higher than any of the past 1.2 million years. Steffen et al. (2018, p. 8254) then argued preventing climate destabilisation and achieving the SDGs requires "deliberate and sustained" efforts to enhance stewardship across the biosphere, climate, and societies – a task that requires a transformation of social values. Beyond its stark warning, the argument of Steffen et al. (2018) shifts sustainability along three areas of concern to moral geography (cf. Smith, 1997): First, it *describes* practices that have moral dimensions because they lead to harms or goods. In this case, actions leading to climate destabilisation. Second, it makes *normative* claims regarding what should be done: stewardship ought to be enhanced across the biosphere, climate, and societies. Third, it develops a *meta-ethical* argument regarding how to think differently about moral obligations in light of existing or expected conditions; an epoch in which humans alter the function and trajectory of the Earth system – the Anthropocene – requires transforming values (cf. Steffen et al., 2011, 2015b; Waters et al., 2016).

Descriptive, normative, and meta-ethical arguments regarding the Anthropocene are not usually referenced to moral geography.[1] As Section 2 shows, part of this can be traced to how critical scholarship on the Anthropocene unsettles moral geography and the counterfactual heuristics that use "other" spaces, places, or landscapes to challenge naturalised notions of belonging. A second reason, however, is that critical scholars often use the Anthropocene to recast notions of belonging in reference to considerations of novelty, time, ontology, and agency. This strategy has limits that are not only analytical. As Section 3 shows, critical scholars often have targets to the side of practices already shifting norms of sustainability, and notions of belonging, in the Anthropocene. I examine two such cases: one treats humanity's life support system as a geologic sphere, the technosphere, an idea circulating among Anthropocene Working Group members to assess the spatial and scalar burden of humans on the Earth system. The second uses planetary boundaries to establish a *grundnorm* (a norm basic to all others) in international environmental law and to provide a rational and empirical basis for the SDGs.

In light of new practices of belonging that are unperturbed by critical scholarship on the Anthropocene, Section 4 argues that a renewed moral geography must attend to a new politics of naturalisation now taking shape. This form of naturalisation does not presume that the integration of "many worlds" to one Earth is value-neutral, an idea long-rejected given that every view of the Earth is situated in a social world. Instead, this form of naturalisation treats human–Earth integration as empirical fact, not normative aim. It accepts critical rejections of nature as a non-social sphere. It agrees Anthropocene novelty generates a mismatch between human and geological time, and that non-human agency inflects the multi-causal account of human impacts on the Earth system. It is from these propositions, in fact, that the new politics of naturalisation combines descriptive, normative, and meta-ethical claims into a moral geography of the Earth system. This new politics of naturalisation, evident in the technosphere and an emerging *grundnorm*, raise concerns resonant with those over how "systems thinking" frames social or biophysical integration (MacKinnon & Derickson, 2013). But the new politics of naturalisation does more than frame integration. It begins with the proposition that integration has happened. This proves both impetus and catalyst for shifting sustainability from seeking integration through market instruments – so called "green neoliberalism" – to a form of neoliberalism without nature. A renewed moral geography must engage with the politics that structure how new practices of belonging naturalise, and further capitalise on, Earth system processes.

2 | ANTHROPOCENE CHALLENGES TO MORAL GEOGRAPHY

At the turn of the millennium, Schellnhuber (1999) argued a Second Copernican revolution was underway. It was a revolution unlike the first. Its aim was not to put Earth, and humans upon it, in correct astrophysical context, but to evoke a cognitive shift that "will enable us to look back on our planet to perceive one single, complex, dissipative, dynamic entity, far from thermodynamic equilibrium – the 'Earth System'" (Schellnhuber, 1999, p. C20). Echoing Schellnhuber's argument that the idea of the Earth system also required recasting sustainable development, Crutzen and Stoermer's (2000) call to recognise the Anthropocene came with an argument to enhance environmental management and engineering for sustainability. For critical scholars, however, interpreting Earth system science as a new "Copernican revolution" tacitly repositioned moral possibilities between poles of enhanced control (e.g., geoengineering) versus reflexive humility in view of a system too complex to control (Lövbrand et al., 2010). Castree (2016) amplified the stakes of this shift by arguing that global change research is itself value-based. The timbre of such critiques is that one must not conflate what is with what ought to be. That is, the geologic forces wielded by humans do not naturally set moral options on an axis between enhanced control and humble retreat.

Revolution or not, the Anthropocene challenges moral geography, particularly the idea that "certain people, things and practices belong in certain spaces, places and landscapes and not in others" (Cresswell, 2005, p. 128). Typically, these "other" spaces, places, and landscapes are important to how moral geography examines differences regarding the production, maintenance, and contests over belonging(s) (Proctor, 1998; Sack, 1997; Smith, 2000a, 2000b, 2001). *Prima facie*, the Anthropocene appears to close off appeals to "other" spaces, places, or landscapes owing to how all forms of belonging are now subject to an Earth system functionally altered through social actions. This challenge is not over how the environment is or has been used to naturalise intersecting issues of race, gender, or class (Harvey, 1996; Livingstone, 1991; Merchant, 2004). Nor is it about the orientation of moral geography to western philosophy, which has been criticised for the Eurocentric assumption that "other" forms of belonging can or should be fairly made legible to western ethics (Preston, 2003, 2009; Tuck & McKenzie, 2015). Those concerns remain, as do those regarding the elevation of idealised accounts of injustice over spatially explicit accounts (Barnett, 2018). Added to these is a methodological concern over the loss of counterfactual heuristics that use "other" spaces, places, and landscapes to hold open possibilities for different forms of belonging. Counterfactual reasoning orients difference among possible forms of belonging to what has not happened or is not necessarily the case – to "other" spaces, places, or landscapes. Counterfactuals are used, for instance, to reject environmental determinism (using the environment to explain social difference) through appeals to "other" forms of belonging in similar environments or similar forms of belonging in "other" environments. The Anthropocene, however, appears to create conditions where the social alteration of how the Earth system functions overdetermines "other" forms of belonging to space, place, or landscapes.

These concerns underwrite two related challenges. First, authors within and beyond geography argue that Eurocentric notions of "nature" must be rejected. The quantitative evidence of human impacts on the Earth system compound qualitative arguments that reject the separation of "nature" from human action (Clark, 2012; Lorimer, 2015; Moore, 2015; Purdy, 2015; Yusoff, 2013). The upshot is that accounts premised on nature as a non-social ground on which "other" forms of belonging take shape require renovation to incorporate the actions, forces, and processes of humans and non-humans (Adams, 2016; Bennett, 2010; Johnson et al., 2014; Lorimer, 2017). Second, accounts of "anthropogenic" forcing on the Earth system that employ universal notions of the "human" (*qua* species) are rejected (Castree et al., 2014; Malm & Hornborg, 2014). Here, the "other" histories, agencies, and worlds mobilised to challenge the largely capitalist pathways structuring human impacts on the Earth system are not consigned to reproduce Orientalism (cf. Said, 1978). Rather, differences among human or non-human "others" premised on fixed or transcendental categories are rejected for immanent explanations of social and geological phenomena co-produced across different life worlds (Danowski & Viveiros de Castro, 2017; Haraway, 2016; Tsing, 2015; Weston, 2017).

Tandem rejections of nature and naturalised "others" are not blind to uneven geographies nor to their study. Ghosh (2016) argues the counterfactual contrast of a stable Holocene versus an unstable Anthropocene betrays bourgeois ideals of stability that those forced to hazardous environmental margins have never enjoyed. Feminist scholars confront intersecting forms of oppression in the Anthropocene based in race, gender, class, and colonialism to articulate new possibilities for solidarity, care, and belonging within and beyond human communities (Gibson-Graham, 2011; Grusin, 2017; Hird, 2017; Tolia-Kelly, 2016). These insights challenge the easy affiliation of attachment to place – belonging – with moral consideration by pointing out that detachment also matters morally (Ginn, 2014). Moral considerations may extend, as Hale (2016) put it, even to the wicked parts of the wild. The methodological implications prompt Lorimer and Driessen (2014) to rethink inquiry in the Anthropocene as "wild experiments" that cannot be configured through fixed or transcendent categories that demarcate "other" landscapes. Likewise, Matless (2017) argues new vocabularies are now needed to articulate belonging, landscapes, and time in the Anthropocene. Below, I consider four overlapping themes frequently used to rethink the terms and conditions of belonging after the rejection of nature and naturalised "others." The goal is not complete coverage but to consider how the limits of novelty, time, ontology, and agency operate across descriptive, normative, and metaethical concerns in ways that demand a renewed moral geography.

2.1 | Novelty

Echoing claims of a "Second Copernican revolution," numerous scholars claim the Anthropocene is novel – a new Earth of human making (Hamilton & Grinevald, 2015; Nicholson & Jinnah, 2016; Parr, 2018). Novelty is often both descriptive and normative, such as when the "no analogue" state of the Earth system provides rationale to claim a "no analogue" state for normative reasoning about what ought to be done (cf. Steffen et al., 2004). For instance, Hamilton et al. (2015, pp. 5, 8) argue the Anthropocene renders previous moral frameworks inadequate because there has been "no biological adaption and no cultural learning" sufficient to guide action under such novel conditions; as they put it, "Talk of ethics renders banal a

transition that belongs to *deep time*, one that is literally Earth-shattering." This categorical rejection has been critiqued for dismissing all cultural learning, especially non-Western knowledge and norms, by fiat (Schmidt et al., 2016). There is another facet, however, to how Hamilton links novelty to morality. The link is not metaphorical; it is unlike arguments that use geology to reimagine morality in ways philosophically unfamiliar to geologists (e.g., Yusoff, 2017).[2] Rather, Hamilton claims Earth system science provides for moral experiences previously unavailable in human history.

Rejecting Holocene morality, Hamilton argues that only a new anthropocentrism will allow humans to take "responsibility" for their geological actions as "*the central agent in a new kind of Earth*" (2017, p. 49, original emphasis). Claiming earlier forms of anthropocentrism were "not anthropocentric enough," Hamilton (2017, p. 53) argues the empirical descriptions of Earth system science require reimagining belonging to a transformed planet. He distinguishes his position from those who critique the Anthropocene without attending to how it is only through Earth system science that knowledge of human impacts on the Earth system is possible. Principal among Hamilton's (2017, p. 92) targets is Haraway (2016), whose notions of the Chtulucene, Capitalocene, or Plantationocene are dismissed as "terminological incontinence."[3] Haraway is not Hamilton's only target, but a foil for those he claims compromise on the full implications of Earth system science. By contrast, Hamilton holds that humans must embrace "the blunt truth of the Anthropocene … in the book of life, man *is* the greatest story ever told" (2017, p. 91, original emphasis).

Hamilton's account faces challenges. First, Hamilton contradicts his rejection of Holocene norms by reviving anthropocentrism. Apparently, some Holocene morals are worth keeping, yet Hamilton supplies no satisfactory argument explaining which ones or why. Second, Hamilton's (2017) call for more anthropocentrism is structurally analogous to the "compromise of liberal environmentalism" of sustainable development in the 1990s. At that time, economics gained legitimacy on the premise that markets would efficiently provide environmental relief and development opportunities, even though economic growth was widely critiqued as generating environmental harms (Bernstein, 2001). Hamilton's (2017) compromise equivocates a key driver of ecological malaise, anthropocentrism, with neoliberal terms of responsibility that are the outcome of "blunt truth" as he puts it (cf. Brown, 2015). Third, Hamilton's (2017) anthropocentrism is all too ethnocentric. He offers no substantive engagement with notions of relationship, reciprocity, or obligation in other socio-cultural practices. Finally, as Sideris (2017) argues, eliding scientific and moral novelty ignores the importance of experience and place in everyday life. Global accounts of the type Hamilton offers often reveal more about the re-enchantment of science-as-narrative than they do about changing conditions for new forms of belonging. Nevertheless, Hamilton's use of novelty upends counterfactual heuristics that imagine a place "outside" the Earth system in the new time of the Anthropocene.

2.2 | Time

The historian Martin Rudwick (2007) offered a penetrating assessment of how geology "burst the limits of time" by extending history to scales beyond human existence. For Chakrabarty (2009), however, the Anthropocene raises new questions of time because it requires linking temporal scales of geology, planetary science, and human history. Attempts to bridge different temporal scales produces rifts, Chakrabarty (2014, 2017) argues, owing to the incommensurable times used in accounts of geology and human history required to explain human impacts on the Earth system. The consequence, for Chakrabarty, is that the Anthropocene is never "completely separated from moral concerns" (2018, p. 8). Rather, the new "geology of morals" requires that belonging be configured amid incommensurate temporal scales (Chakrabarty, 2016). In one sense, "rifts" over different notions of lived versus scientific time between the social and natural sciences are not new, as the famous showdown between Bergson and Einstein made clear a century ago (Canales, 2015). What occupies Chakrabarty (2017, 2018), however, is not what approach to time is superior but how to navigate different notions of time once human actions puncture the Holocene and, with it, the possibility of parsing human from non-human time.

Chakrabarty's assertion of temporal rifts in Anthropocene time is not easy to defend. Coen claims accepting incommensurability leaves us "paralyzed in the face of ethical questions that cannot be put off" and also doesn't account for the contingent, social aspects of spatial and temporal imaginations, which imply that there is no "fixed meaning to the 'human scale' that could be set in opposition to 'the planetary'" (2016, p. 308). In addition, Chakrabarty does not examine the configuration of time within Earth system science itself. It was the work of Ilya Prigogine on non-equilibrium systems that, to recall Schellnhuber, allowed the Earth system to be understood as a "single, complex, dissipative, dynamic entity, far from thermodynamic equilibrium" (1999, p. C20). Moreover, time was foundational to Prigogine's work. For his account of time, he did not look only to physics but to the works of Bergson and Whitehead, among others (Prigogine, 1997; Prigogine & Stengers, 1984). In short, Prigogine entrained time into the physics of Earth system science in ways sophisticated and challenging, but not incommensurate with respect to human accounts of time. None of this implies Chakrabarty is wrong to identify challenges of time in the Anthropocene. It reveals, however, that moral geography must be attentive to how notions

of belonging are often entangled with judgements about temporal categories – ontologies – across human and physical sciences.

2.3 | Ontology

Central to many appraisals of the Anthropocene is the rejection of fixed or transcendental categories of being and relations. A common aim is to exorcise dualisms between society and nature and to dethrone human exceptionalism (Braun & Whatmore, 2010). Once on flat ontological footing with other beings, forces, and processes, the agency of humans and non-humans provide scope for new, immanent forms of belonging (Coole & Frost, 2010; Tsing et al., 2017). Before considering these, one exemplar of why ontology matters morally can be highlighted in the uptake of object-oriented ontology (OOO) in geography. OOO is a realist view that takes the Kantian gap between things and their phenomenal appearance to human subjects and generalises it to all objects (Harman, 2013). Morton (2013) employs OOO to argue that the Anthropocene is marked by hyperobjects, like plastics and climate change, that are so vastly distributed in space and time that they are incommensurate with the subject–object correlation through which phenomena are experienced. Hyperobjects are real entities that cannot be known directly, a trait they share with all objects in OOO, the truths about which are allusive and only indirectly known (Harman, 2013). Morton argues that, as a consequence of thinking without nature and without the Kantian subject, morality must be oriented to "collectivity, not community" (2010, p. 127; 2017).

Mitchell (2015) applies OOO to locate the Anthropocene mismatch between moral act and moral responsibility in a hyperobject: plastic. Plastics, on Mitchell's account, are geological markers of human impacts on the planet that transgress liberal, cosmopolitan norms that imagine the moral community as a "circle" that delineates those within as deserving of moral consideration and what is outside as morally relevant only with respect to those within it. Plastics, for Mitchell (2015), outpace liberal cosmopolitanism because they create relations and harms of such scope and duration that there is no place "outside" the moral circle; no counterfactual "nature" is available for circumscribing the moral community. Once plastics are distributed throughout terrestrial and marine ecosystems, and insinuated into the bodies of multiple species, the limits of modernity's encircled moral geography are exposed. As a hyperobject, the harms of plastic undermine the imagined moral geography of liberal, cosmopolitan ethics and trespass its presumed boundaries of moral consideration. The upshot is that the new ontological class of harms created by plastics requires an alternate account of moral obligations.

Mitchell (2015) makes several undefended moves, some of which are tied to deeper problems with OOO. First, if hyperobjects exist and are morally relevant, then we are owed an account of the moral truths entailed by them. Yet, as with other truths in OOO, these would be allusive and indirect. Such truths provide little guidance for action.[4] Second, OOO's claim of incommensurability between objects and experience is suspect. Rejecting the Kantian subject does not warrant claims about humanity writ large. Many Indigenous communities have notions of subjectivity with (more than) sufficient resources to situate two and half centuries of anthropogenic climate change – a reputed hyperobject – in their moral communities (Watt-Cloutier, 2015; Whyte, 2017). So do western societies. If the goods plastic provides can be situated in our experiences, such as in packaging for emergency food, water, or medicine, then why not harms? As Masco (2015) shows, nuclear fallout is already socially placed in the moral imagination of the United States. So, even though nuclear fallout meets the criteria of a hyperobject (Masco doesn't treat it this way), it is not the "thing" that renders it incommensurable but an ontological commitment that may or may not reflect social or cultural practices, imaginations, or categories.

2.4 | Agency

Where is agency in the Anthropocene? Slugs, plastics, and hydrological processes are just a few non-human agents in the work of critical scholars that reference Latour's (1993) arguments that "things" act in ways that refuse the society/nature binary.[5] Latour himself, however, rejects critical scholarship. Instead of establishing critical distance by showing how "matters of fact" depend on actions of both humans and non-humans, Latour (2004) pursues empiricism to get "closer" to how scientific facts and the things that affect them together produce matters of concern. For Latour (2017), this entails that morality cannot be projected against "nature" in the Anthropocene but must reckon with how agency is distributed by multiple human and non-human actants. Here, Latour (2017) mobilises Lovelock's Gaia Hypothesis of Earth as a self-organising system. Far from a stable site to reconvene "nature" under even a provisional holism, Latour's Gaia emerges much as Stengers (2017) also envisions: a cacophony of agents, forces, and processes that have only misaligned, if any, ends. With this notion of Gaia in hand, Latour (2014, 2017) contrasts his much-maligned "moderns" with those he calls earthbound. To be earthbound, Latour argues, is to reckon the distributed agency of Gaia. The modern/earthbound contrast provides the

basis of, and a foil for, a new moral geography. Following Sloterdijk (2014), Latour argues that earthbound individuals do not (as do moderns) seek immunity from nature on the "other" side of the society/nature binary. Instead, the earthbound face Gaia's gifts, uncertainties, and dangers. Latour then appeals to Schmitt's (2007) distinction between friends and enemies as the normative basis for politics to argue that because "moderns" constituted themselves without respect to Gaia there has never been an ecological politics. Now, however, "moderns" are confronted by "earthbound" enemies who reject consensus on the society/nature binary and demand land and territory for themselves (Latour, 2015) – an earthbound moral geography.

Latour's (2017) claim that "moderns" had non-ecological politics ignores violent geographies of modernity. The proposed Anthropocene start date of 1610 – marked by the "Orbis spike" of carbon sequestration that attended biomass regrowth in the Americas after millions of Indigenous peoples were killed through diseases and warfare – is just one piece of evidence (Lewis & Maslin, 2018). As Davis and Todd (2017) argue, a defensible ethical position in the Anthropocene must confront colonial violence against Indigenous peoples. So, when Latour claims "there is no cure for the condition of belonging to the world" (2017, p. 13), that may be true. But an account of belonging cannot ignore the modern, often violent co-production of territory and ecology itself (Anker, 2001) or the genealogies of colonial thought that anticipate the Anthropocene (Bonneuil & Fressoz, 2016). Even if we accept Latour's peculiar Gaia for the sake of argument, an evolutionary account would still distribute agency more widely across socio-cultural practices than what some moderns "discover" as the basis for being earthbound (see Kohn, 2013). There are sympathetic engagements with Latour that seek to bridge between the worlds of the moderns and "others" (e.g., Cadena, 2015). Nevertheless, the onus remains on Latour to give an account that reckons not only with Gaia, but also with the moral violence that his newly christened "earthbound" agents are premised on.

There are more lines of inquiry into belonging in the Anthropocene than those of novelty, time, ontology, and agency. Malm (2017), for instance, rejects many of the positions advanced above for a Marxist realism that retains the society/nature binary. What Malm's polemic shares with others, however, is an analytical target to the side of practices already taking shape without nature or naturalised "others." The forms of belonging considered below accept the need to grapple with novelty, temporality, ontology, and multiple human and non-human forces. In short, they accept many of the points critical scholars of the Anthropocene make and are using them to shift practices and norms of belonging in global sustainability.

3 | THE TECHNOSPHERE, *GRUNDNORM*, AND GOALS

Earth system science is already being used to shift norms of sustainability and to shape new forms of belonging in the Anthropocene. This section examines two such cases. The first is the treatment of humanity's life support apparatus as a technosphere, a geologic sphere like any other (i.e., the hydrosphere, atmosphere, lithosphere, or biosphere). The second is the return of Kantian ethics via a *grundnorm* that uses planetary boundaries for the Earth system to ground international law and notions of "governing through goals." Whereas critical scholars counter forms of naturalisation with new lines of inquiry, new practices of belonging in the Anthropocene suggest a new politics of naturalisation that leverages the end of "nature" into new descriptions, norms, and ways of thinking: into a moral geography of the Earth system.

3.1 | The technosphere

Hannah Arendt (1958) once remarked that, from the perspective of the universe, automobiles might look like a biological mutation in which humans develop steel shells. Echoing attempts to take this Archimedean view, Earth system scientists, including members of the Anthropocene Working Group such as Peter Haff, have treated the technological apparatus that supports human life as a technosphere in order to gain a more "detached view of an emerging geological process that has entrained humans as essential components that support its dynamics" (Haff, 2014, p. 302). According to Haff, the technosphere enables one to "adopt a non-anthropocentric view that technology is a global phenomenon that follows its own dynamics, representing something truly new in the world – the opening phase of a new paradigm of Earth history. In this sense, one might say that technology is the next biology" (2014, p. 302).

The technosphere should not be placed on a spectrum between the eco-modernist embrace of technology (Schellenberger & Nordhaus, 2011), the reputed "good Anthropocene" (Dalby, 2016), or appeals to abandon technological mastery for an "ecozoic" view of mutually enhancing human–Earth relationships (Berry, 1999). Rather, the technosphere is premised on treating humanity's technological apparatus geologically. Haff provides a definition worth quoting at length:

> The proliferation of technology across the globe defines the technosphere – the set of large-scale networked technologies that underlie and make possible rapid extraction from the Earth of large quantities of free energy and subsequent power generation, long-distance, nearly instantaneous communication, rapid long-distance energy and mass transport, the existence and operation of modern governmental and other bureaucracies, high-intensity industrial and manufacturing operations including regional, continental and global distribution of food and other goods, and a myriad additional 'artificial' or 'non-natural' processes without which modern civilization and its present 7×10^9 human constituents could not exist. (2014, p. 301)

For Haff (2014), humans are to the technosphere what water is to the hydrosphere – part of a physical system. Along with other members of the Anthropocene Working Group, Haff contributed to special issues of the journal *The Anthropocene Review* that mapped the spatial area and physical extent of the technosphere. According to the calculations of Zalasiewicz et al. (2017), the technosphere tips the scales at 30 trillion tonnes of cement, steel, reservoirs, farmland, and resources trawled from the sea floor, all of which support a human enterprise that demands 81.83 (10^6) km^2 of urban and rural space. Such calculations enable the technosphere to be measured alongside other geologic spheres and allows for the study of possibilities for affecting its behaviour as one might another physical system. In addition to the implications of configuring the human geography of the Earth system in this version of non-anthropocentrism, it is notable that the technosphere is not "immunised" from other geologic spheres but rather integrated with them.

The reception of the technosphere has not been uniformly positive. While some apply it to urban studies or inter-planetary arguments (Otter, 2017; Szerszynski, 2017), others identify challenges. Donges et al. (2017) argue Haff's conception of the technosphere restricts human agency and intention in ways counterproductive to understanding the co-evolutionary dynamics of humans and non-humans, and that it ignores the peopled, political discourses of sustainability. In short, the technosphere is a physical system, but it is not only physical. Incidentally, responding to this objection can illuminate how the technosphere evades critiques of universal notions of "the human" in Earth system science. To the contrary, the technosphere appraises human *capacities* for affecting the Earth system as one would other geological spheres, where the capacities (or affordances) of complex systems have long replaced essentialist ideas of nature. Focus on capacities, it may be argued, provides scope for ascertaining the physical possibilities of sustainability without undercutting the politics or agency of how those possibilities are subsequently navigated. This rejoinder, however, has moral implications. As Carruth and Marzec (2014) argue, measurement tools and instrumental interpretations are not free of judgements. Other theorists are more dismissive, arguing the "unruly technosphere responsible for the Anthropocene" is immoral because it configures machine-driven forms of industrialism with information-driven networks of capital accumulation (Pasquinelli, 2017, p. 312).

Provocatively, Haff's (2017) subsequent development of the technosphere mutes several lines of criticism by accepting the point that the intentions of human agents are at risk in the technosphere. Arguing that the global population is dependent on the technosphere, Haff (2017) claims that, from a geological perspective, the concern is that the technosphere might seek efficiencies that co-opt or constrain human activity, such as through algorithms designed to pursue efficiency but to which human well-being is incidental. Haff worries that not only may humans overwhelm the forces of nature but that humans may be "in the process themselves of being overwhelmed by novel forces of an evolving earth" (2017, p. 108). Advances in synthetic biology and nanotechnology, as Preston (2018) argues, create new moral terrain at scales that exceed many standard treatments of ethical action. Indeed, agreeing with critical appraisals of the Anthropocene, Haff (2017) grants it is irrational to treat humans as exceptional. Yet, he doesn't think this is grounds for rejecting human exceptionalism; instead, Haff (2017) celebrates irrationality and advances it as a basis for confronting dehumanising forces of the technosphere. The danger of not doing so, he argues, is that geological processes may diminish humanity's "own status as essential components of an efficiency-driven technosphere" (Haff, 2017, p. 108).

Viewed through the technosphere, the moral geography of the Earth system naturalises interconnections of energy, information, and materials. Recently, Lenton and Latour (2018) have argued the technosphere is part of a new Gaia – Gaia 2.0 – that operates with some level of self-awareness owing to how humans can set planetary goals with the weight of geologic force behind them. Setting aside that this seems more a reboot of the noösphere,[6] it is worth considering Lenton and Latour's ethical conclusion, that "any attempt to tamper with the sensors or slow down the reaction to errors jeopardizes the chance to learn from Gaia how to close the loops that would enable Gaia 2.0 to better sustain the human population than the present world" (2018, p. 1068). Here, Latour makes good on his effort to get "closer" to the facts through empiricism, but to do so he naturalises the technosphere. Technology does not come from nowhere. Its components are mined, refined, assembled, exchanged, and maintained through relationships, social structures, and political economies that may justifiably prompt moral responses of slowdown or stoppage. Such power-blind techno-ethics, like Haff's embrace of irrationality, do

not suffice as moral reasons. As the next section considers, this is also not the route being developed in Earth system governance, where new forms of rationality buttress goals for belonging.

3.2 | *Grundnorms* and goals

The technosphere treats the human enterprise geologically, but how might that conglomerate be steered? This question is increasingly answered in Earth system governance in reference to "governing through goals." Goals augment the contingencies and uncertainties of deep time with time-bound, metric-driven agendas, such as the SDGs (see Kanie & Biermann, 2017). Goals also shift sustainability from norms focused on "setting the rules" for markets designed to provide environmental relief – so-called "green" neoliberalism (Bakker, 2010) – and instead direct economic activity towards chosen, revisable ends (Young, 2017). As Dryzek (2016) argues, Anthropocene institutions require reflexivity across market, non-market, and Earth system feedbacks. Goals steer an already integrated economic and environmental system in two respects that structure this section. First, goals are increasingly referenced to the planetary boundaries of the Earth system and naturalised according to a *grundnorm*: a norm basic to all others. Second, goals are used to interpolate empirical claims regarding the "safe operating space" provided by the planetary boundaries framework into normative constraints on human development (see Rockström et al., 2009). Together, *grundnorms* and goals naturalise human–Earth integration as empirical fact, not normative aim, and employ planetary boundaries to provide an empirical and rational basis for new practices of belonging.

Kelsen's (1945) positive legal theory held that law is a system of rules set between normative validity, on the one hand, and empirical facts on the other. This formulation, like others that operate "between facts and norms" in the Kantian tradition, seeks a non-metaphysical foundation for rational validity and political legitimacy (Habermas, 1996). Whereas Habermas (1996) sought this basis in empirical facts regarding communicative rationality and the reputed power of the better argument, scholars of environmental law turn towards empirical accounts of the Earth system. Here, Kelsen's notion of a *grundnorm* is given empirical expression through facts about the function and trajectory of the Earth system as it is disclosed through Earth system science (e.g., Rockström et al., 2009; Steffen et al., 2018). This maintains fidelity to the Kantian tradition but replaces Habermas's notion of a community of truth seekers – where norms are derived from rational consensus achieved by overcoming social or political difference – with norms rationally derived from the state of the Earth system.

Kim and Bosselmann (2013) provide one of the most robust arguments for deriving a *grundnorm* from planetary boundaries. The planetary boundaries framework, on this account, provides a basis for international environmental agreements because anthropogenic projects that do not respect planetary boundaries with respect to freshwater, climate, or any of the nine interacting components of the Earth system, will (ultimately) fail empirically. Well before that, they will reveal the irrationality of agreements that are not premised on how the Earth system functions. As a *grundnorm*, the planetary boundaries framework offers a rational and empirical basis of normative validity without metaphysical or culturally specific appeals to "nature." Kim (2016) argues such a *grundnorm* should also be incorporated into multilateral frameworks, such as those regarding the SDGs, in order to meet both social and environmental obligations. For Brandi (2015), there is an ethical imperative to establish an SDG for the Earth system since its functioning provides the basis for achieving all of the others. Häyhä et al. (2016) develop a similar idea, arguing that in order to connect the SDGs to the Earth system it is imperative to incorporate ethics as a distinct sphere of decision-making. In their account, moral judgements come in a sequence that begins with biophysical determinations of the Earth system before moving to assessments of socio-economic connections across scales and sectors of planetary dynamics. Then, in a third step, ethical principles are applied to achieve equity and justice. In short: with the Earth system as a *grundnorm*, and the facts of socio-political connections between people and planet in hand, moral geography finds a hierarchy not naturalised to nature, but to how Earth system science discloses human–Earth integration.

One challenge for Earth system governance and sustainability is to operationalise the notion of ecological integrity that underpins planetary boundaries at the scale of the Earth system (Kim & Bosselmann, 2015). To this end, the novel use of "goal-setting" by the United Nations, such as in the SDGs, provides opportunity to incorporate empirical facts about human–Earth integration into political and economic agendas (Biermann et al., 2017; cf. Biermann, 2014). This might be done by, for instance, down-scaling from the Earth system and up-scaling from human needs to calculate "a good life within planetary boundaries" (O'Neill et al., 2018). When goals are used for governance, they contrast with the rule-based norms of neoliberalism in earlier iterations of sustainable development, where states were expected to set the rules for markets and stakeholders, and where normative legitimacy arose from fair procedures and institutions for economic and political allocation of resources (Young, 2017). In place of rules putatively designed for free competition, goals become sites

where uncertainty and complexity provide warrant to actively steer intractably entangled political and economic processes (Kanie & Biermann, 2017).

The aim of "governing through goals" is not to integrate "many worlds" to one Earth. Instead, the fact of integration means that previous norms of sustainability, such as the rules for re-regulating markets under earlier programmes of sustainable development, must be fortified by actively directing economies and polities to stay within the constraints of the Earth system. The temporal horizons of political goals, such as the 2030 SDGs, may be arbitrary from the perspective of the planet, but in the context of existential risks to human flourishing they entail ethical value assessments about possible futures (cf. Bostrom, 2013). These are judgements at the intersection of economics and environments that don't naturalise moral orders to natural ones. Instead, they project a hierarchical order of normative integration (a *grundnorm* at the base of all others) onto a non-hierarchical Earth system that is characterised by cross-scale feedbacks and non-linear dynamics (Steffen et al., 2004, 2018). As with the technosphere, this is a politics of naturalisation that proceeds through the means of doing without nature.

4 | NEOLIBERALISM WITHOUT NATURE

Why emphasise the moral geography of the Earth system, not that of the Anthropocene? In part, this distinction highlights that there are more than just meta-ethical stakes about how to think about the epoch as a whole. A broader concern, however, is how the loss of "others" affects new forms of belonging (cf. Elliott, 2018). In this regard, the technosphere, a *grundnorm*, and goals perform naturalising work that does not truck in natural laws or transcendent categories. They immanently render new descriptions of a physical system, new norms on which to proceed, and new ways to think about the moral ends of governance; a moral geography of the Earth system. Examining these practices requires tools moral geography can offer, and which can identify a new politics of naturalisation taking shape. This politics begins with human–Earth integration as an accomplished event, albeit not on the terms of sustainable development where market forces were dispatched to meet the needs of one generation without compromising the ability of future generations to meet their own needs. Rather, the new politics of naturalisation anticipates a form of neoliberalism without nature; a neoliberalism that retains the structure of sustainable development but sheds the assumption that nature provides a stable backdrop for fulfilling human needs from one generation to the next.

The idea of the Earth system reinforces the place of "system" as a – possibly the – master modality for knowledge in modernity (cf. Siskin, 2016). The Earth system operates, in this sense, as *explanandum* and *explanans*: a way to describe phenomena to be explained and a way to order the knowledge explaining those phenomena. Yet it doesn't naturalise phenomena to an external "order of nature." Instead, it is used to moralise the means of doing without nature. To recall: the moral imperative is to not hinder the technological means through which Gaia 2.0 is known (Lenton & Latour, 2018), while a *grundnorm* frames empirical possibilities for the good life even though frames are not reasons (Hale, 2016). Likewise, using "goals" to correct for the limits of neoliberal integration of economics and environment under sustainable development anticipates forms of belonging after the end of (western) nature. Neoliberal structures of governance, however, are left in place on such accounts when the political economy of the technosphere vanishes, or when a *grundnorm* is advanced without reparation for the uneven geographies now pressing planetary boundaries. Neoliberalism without nature is consistent with, but not yet considered in, accounts of neoliberalism (e.g., McCarthy & Prudham, 2004).

Neoliberalism without nature has been gestured at in accounts of: the rise of neoliberal governmentality alongside the incorporation of resilience and complex systems theory in finance and valuation (Chiapello, 2015; Cooper, 2011; Walker & Cooper, 2011), the integrated, "causal architecture" connecting environmental and economic crises (Homer-Dixon et al., 2015), and the "naturalization of process" that connects geologic agency to liberal modes of environmental governance and sustainability (Schmidt, 2017, p. 197). Here I do not seek to unpack what neoliberalism without nature entails, but to name a phenomenon that a renewed moral geography can identify in combinations of descriptive, normative, and meta-ethical claims now taking shape in accounts of human impacts on the Earth system. The use of planetary boundaries to set goals that direct international financial practices, such as the 2030 SDGs, provides a non-contingent timeline for resource valuation and risk calculation without nature and amid uncertainties over human impacts on the planet (e.g., Sachs, 2015). Perhaps most striking, however, is the moral act of calling for value transformation. Such calls demand an account of the moral geography of the Earth system that underpins them, especially given that calls for transformation are themselves premised on values, such as planetary stewardship, that have long been used by actors in the Global North to describe biological and geological resources of the Global South as of "world" significance and to then justify political intervention and

(often) capital accumulation (Black, 2018; Macekura, 2015). Sustainability has never been value-neutral. Calls for value transformation structured through global programmes of neoliberalism without nature also sharpen contrasts with non-systemic, relational forms of life underpinning other socio-cultural forms of life that merit dignity. And they do so at a critical moment: when decisions taken will affect the trajectory of social and Earth system evolution for millennia.

There is currently a missing account of how forms of belonging are being shaped as sustainability works without nature yet retains the form of integration achieved under neoliberalism. Renewing moral geography in this context provides an opportunity to examine forms of belonging taking shape without nature or naturalised "others." It can identify naturalising impulses in both transcendental and immanent accounts of belonging. A renewed moral geography must retain its orientation to difference and its commitment not to impose external categories of description, norms, or meta-ethical concepts on social practices. This pluralistic approach can and should, however, also be trained on new politics of naturalisation in which belonging proceeds both with or (through the means of doing) without nature. This requires renewing commitments across geographic scholarship, such as in fields engaged with science and technology studies or social studies of finance. The moral dimensions of these fields are frequently implied, yet often not explicitly engaged across descriptive, normative, or meta-ethical concerns. Likewise, geographic work on human–environment relations, global change research, and global governance might expand from recognition that the Earth system is too complex to govern in toto and examine how accounts of human–Earth integration developed in light of this fact – as a physical system, in reference to planetary boundaries, as a basis for goals – are shaping calls for value transformation and shifting the norms of sustainability in the Anthropocene.

ACKNOWLEDGEMENTS

I thank Gavin Bridge, Sohini Kar, Simon Naylor, and the anonymous reviewers who provided thoughtful direction to this article. All defects are mine. The Social Sciences and Humanities Research Council of Canada provided support.

ENDNOTES

[1] Moral geography, for its part, often only indirectly engages the Anthropocene. See Olson's (2018) progress reports.

[2] Baker (1999), for example, engages geology through the semiotics of Charles Peirce.

[3] Hornborg (2017) makes similar critiques of Haraway (2016), Tsing (2015), and Moore (2015).

[4] It is unclear if adherents of OOO are also metanormative realists who hold that moral truths exist independently (Enoch, 2010). If so, an account of those allusive truths is also required.

[5] Respectively: Ginn (2014), Mitchell (2015), Lorimer and Driessen (2014).

[6] Teilhard de Chardin's notion of the noösphere explains consciousness in bio-evolutionary terms to suggest self-awareness is a new step in planetary evolution (see Sideris, 2017). Arguably, Lenton and Latour (2018) reboot the idea with technology rather than only biology affecting evolutionary self-awareness.

ORCID


Jeremy J. Schmidt https://orcid.org/0000-0002-9155-1777

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How to cite this article: Schmidt JJ. The moral geography of the Earth system. *Trans Inst Br Geogr*. 2019;44:721–734. https://doi.org/10.1111/tran.12308