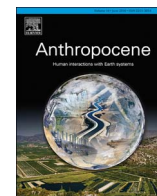




Contents lists available at ScienceDirect

Anthropocene

journal homepage: www.elsevier.com/locate/ancene

Viewpoint

Navigating alternative framings of human-environment interactions: Variations on the theme of ‘Finding Nemo’

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ARTICLE INFO

Keywords:

Anthropocene
Eco-modernism
Planetary stewardship
Sustainability pathways
Post-humanism
Responsibility
Ethics

ABSTRACT

Wide agreement exists that the “Anthropocene” demands new forms of engagement and responses to achieve sustainability, but different fields suggest quite different approaches. In this communication, we set out four perspectives that we argue have fundamentally different framings of the “problem” of the Anthropocene, and consequently point to very different responses to achieving sustainability. These four fields include: the eco-modernist perspective, the planetary stewardship paradigm, the pathways to sustainability approach, and the critical post-humanist paradigm. We suggest that a deeper underlying framing which can help integrate aspects of these four perspectives is an understanding of the “Anthropocene as responsibility”. We argue that from this perspective it becomes possible to engage with an ethics of responsibility that comes with being human and acting on the planet, in the face of an uncertain and unknowable future.

1. Introduction

A recent spate of articles has appeared in social media and through other popular channels about the diversely understood concept of the “Anthropocene” (Chin et al., 2016). Proposed by Paul Crutzen as a new “human-dominated, geological epoch” (Crutzen, 2002), the Earth System Science community increasingly accepts the notion of the “Anthropocene”, and Maslin and Lewis (2015: 111) argue “the evidence for humans being a major geological power has been accepted and the paradigm shift has occurred”. However, as the concept has become established (Ruddiman et al., 2015; Steffen et al., 2007; Zalasiewicz et al., 2010), there has been an enriching debate within other fields as to the usefulness of this term (Brondizio et al., 2016; Lövbrand et al., 2015). Much of the debate specifically centers on what the concept of the Anthropocene implies in terms of actions needed to reshape human interactions with the Earth System in order to achieve environmental and social sustainability, and – more controversially – whether it could be possible to conceptualize of a “good” Anthropocene (Bennett et al., 2016).

A set of interesting blogs initiated by the STEPS Centre¹ has furthered this rich debate. Started by Stirling's (2015) provoking blog on “rei (g)ning back” the Anthropocene, a set of assumptions on how the Anthropocene is understood by different academic fields came to light

through other contributors' additions. In this short piece, we respond to Arora and Stirling's (2015) call to take on the responsibility that those of us in our “burgeoning academic anthrospalons” bear as “mediators of concepts that hold concrete material, social and ecological implications”.

In an attempt to help make sense of the different perspectives, we suggest a categorization based on four broad underpinning ontological imageries that characterize current academic discourses about the Anthropocene. We argue that they differ from each other in terms of how the role of human agency is understood and this in turn influences what actions are advocated for addressing the sustainability challenges posed by the Anthropocene, and ultimately, what can be defined as “good” or desirable in terms of insuring sustainable human-environment interactions. Despite the diverse and even conflicting interpretations of what achieving sustainability and a potential “good Anthropocene” should entail, there is agreement that the Anthropocene calls for deeper engagement and responsibility in governing human and environmental futures. We conclude with a discussion of this deeper underlying notion of the “Anthropocene as responsibility” – a call for humans to act with more responsibility towards each other and the planet.

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2. Current approaches framing the "good" Anthropocene

Dory: Have you seen a clown fish swim by? It looks just like him.

Crab: Yeah, I saw him, Bluey, but I'm not telling you where he went, and there's no way you're gonna make me.

(From the film *Finding Nemo*, 2003)

In the animated children's film released by Walt Disney Pictures called *Finding Nemo* (Stanton, 2003), a clown fish named Nemo is abducted by a boat in the Great Barrier Reef and netted up and sent to a dentist's office in Sydney. Marlin (Nemo's father) and Dory (a blue tang fish he met along the way) embark on a mission to find Nemo without the help of a map or any clue as to where he might have gone. The companions have no device with which they can track Nemo or measure their progress in terms of retrieving him. As a result, the task of finding Nemo is actually an impossible one and the only option that Dory and Marlin have is to "just keep swimming", and to navigate unknown territories by learning the language of the signs and sea creatures that mark the new currents and pathways that they encounter. The story of this film serves as an analogy for how navigating the challenges of the Anthropocene also amounts to making decisions and interventions in uncharted territory marked by uncertainty and unforeseeable outcomes.

There is growing agreement amongst scholars that the emergence and use of the term Anthropocene has inspired new avenues of research, sparked critical debates and destabilized conventional scientific dichotomies between humans and nature (Folke and Gunderson, 2010; Folke et al., 2011; Holling, 2001; Lorimer, 2012), between fact and value (Costanza et al., 2014; de Groot et al., 2012; Latour, 2015), and between objective science and science-with-politics (Barry and Born, 2015). Moreover, the concept of the Anthropocene challenges the notion of a homogenous understanding of collective human agency (Chakrabarty, 2012) by exposing the fact that the consequences of human activity can no longer be explained in terms of purely social theories of difference or political economy alone. As Moore (2016) argues, the idea of the Anthropocene suggests that humanity is now undeniably entangled in the natural world through the collective effects of the species as a geological force and that this shift affects the underlying assumptions that scientists make about the nature of reality. Even the notion of time is challenged by the Anthropocene in that traditional perspectives on the future as flowing from the present are undermined and suggests an understanding of the future as being part of and influencing the present (Latour, 2015; Poli, 2010).

A closer conceptual reading of the term "Anthropocene" reveals that although there is agreement that a new engagement with the challenges that characterize this new era is needed (Brondizio et al., 2016; Löwbrand et al., 2015), different fields suggest different ways in which such engagement should occur. We argue that these various responses are based on diverse conceptualizations of the relationship and agency that exists between humans and nature. Through a critical reading of literature, we have identified four prominent conceptual framings of the Anthropocene. We have categorized these framings in terms of the different worldviews that shape conceptualisations of agency, how the notion of human-nature relations are constructed, and how these constellations inform the proposed responses to sustainability challenges and the values related to what could be seen as signifying a "good" Anthropocene (cf. Table 1).

2.1. Eco-modernism/post-environmentalism

Building on the Enlightenment ideals of progress and instrumental rationality (Bauman, 2003; Toulmin, 1992) the eco-modernist position argues that achieving sustainability is possible only on condition that we embrace human development, modernization, and technological innovation (Ellis, 2011). Through a concerted effort of enhanced human

Table 1
Summary of four different prominent framings of human-environment responses to the Anthropocene.

Perspective	Underlying worldview and problem framing	Primary Response to Anthropocene challenges	Strategies for achieving sustainability and a 'Good Anthropocene'	Examples	References
Eco-modernism/post-environmentalism	Enlightenment ideals of progress and instrumental rationality.	Technological innovation needs to address and account for environmental sustainability.	Humans should use their growing social, economic, and technological powers to manage the Earth System, including the climate.	Agricultural intensification, Desalination, Nuclear power, Decoupling strategies	Shellenberger and Nordhaus (2015), Asafu-Adjaye et al. (2015), Ellis (2011)
Biosphere stewardship	Humans are intertwined with and dependent on the functioning of the Earth System.	Biosphere stewardship & reconnecting people to nature.	Maintaining resilient social-ecological systems to sustain human wellbeing.	Earth system governance, Sustainable Development Goals, Ecosystem Goods and Services, Natural Capital Accounting	Folke et al. (2011), Folke et al. (2016), Biermann et al. (2009), Brondizio et al. (2016), Galaz et al. (2012), Rockström et al. (2009), Steffen et al. (2015)
Sustainability pathways	The current world reinforces unequal access to natural resources and marginalises the poorest.	Opening up spaces for multiple perspectives to be engaged.	Reducing inequality and domination of powerful perspectives. Allowing space for diverse realizations of human wellbeing.	Participatory deliberation and contestation, Political Ecology, Social Movements	Leach et al. (2012), Stirling (2015)
Critical post-humanism	Nature, culture, subjects, and objects do not exist independently but arise through their relationships with other entities. Agency emerges through webs of relations in which human exceptionalism is denied.	Agency is not just located in human activity but comes about through multiple collective alliances or collaborative socio-material assemblages.	Enable generative capacities constituted through processes of interconnectedness that cut across the agency of all species, other entities, space and time.	Actor-Network theory, Non-human agency, Relational ethics	Braidotti (2006), Harraway (2016), Latour (2014), Lorimer (2012)

agency, such as the acceleration of decoupling strategies, urbanisation, agricultural intensification, aquaculture, desalination and the development of nuclear power plants as a main source of energy, a balance between human wellbeing and sustainable development can be managed and attained (Shellenberger and Nordhaus, 2015). This view draws on the modernist understanding and asserts that dealing with the challenges of the Anthropocene can only be achieved through better planning approaches that optimize human agency in managing natural systems. It builds on the assumption that humanity is a self-conscious force that can control planetary dynamics (Schellnhuber, 1999). Under this perspective, a “good” Anthropocene will be one in which human progress is linked with more efficient and objective responsible planetary management strategies that would need to be designed and planned by humans using their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world (Asafu-Adjaye et al., 2015).

2.2. Planetary stewardship

Under this perspective, human wellbeing is defined in terms of its structural embeddedness and dependence on the biosphere, while at the same time recognizing that humans are now responsible for shaping the dynamics of the Earth system at the planetary level (Steffen et al., 2015). The notion of planetary stewardship suggests that the best way of navigating the complex interlinked social-ecological nature of the Anthropocene is by supporting and creating interventions that reinforce and clarify humanity’s connectedness to the biosphere (Folke et al., 2011). Planetary stewardship is less about controlling Earth System processes and more about developing and institutionalizing governance systems that can deal with the Earth System-scale challenges that humanity faces (Galaz et al., 2012). Issues of power relations are not explicitly highlighted in this perspective, nor does it actively confront many of the inequalities in human wellbeing, especially between the Global North and Global South. In this perspective, technological innovation alone is seen as an insufficient strategy for addressing the challenges of the Anthropocene (McAlpine et al., 2015). Based on a social-ecological systems perspective, human agency and well-being is understood as being connected to and dependent on natural systems in which all social systems are embedded (Steffen et al., 2011). People are understood as not just interacting with, but being inhabitants of the biosphere together with all other life on Earth (Folke et al., 2016), but garnering a disproportionate share of the Earth’s resources. In this framing, a “good” Anthropocene can only be achieved through adaptive governance strategies that embody and recognize the responsible relationship of humans as being part of and dependent on the biosphere (Folke et al., 2016).

2.3. Pathways to sustainability

The pathways perspective is premised on the need to open up alternative, sometimes more marginalized, pathways to sustainability, in place of dominant ways of doing things that reinforce the status quo (Leach et al., 2010). This perspective is fundamentally concerned with issues of power dynamics and inequalities within the current global system. In contrast to promoting a singular transition towards sustainability, the pathways approach advocates for pluralities and multiplicities that can allow marginalized voices to be heard and expressed – or “culturing plural radical progress” (Stirling, 2014a). This framing is critical towards interventions that rely too strongly on technological and top-down innovations. From the pathways perspective, there can be no single understanding of what “good” means. Human agency is located in emancipatory and social movements that aim to unmask the inherently political nature of the interests and motivations driving dominant forms of governance and patterns of innovation (Leach et al., 2012). Sustainability in the Anthropocene can thus only be achieved through creating more opportunities for participatory deliberation, to

be distilled through processes of contestation and by allowing more perspectives and contexts to be heard and represented so as to share and distribute responsibility (Stirling, 2014a,b).

2.4. Critical post-humanism

Based on a relational ontology of reality, the critical post-humanist paradigm argues that all phenomena are equally related to one another and that distinctions arise due to how phenomena are constituted within an infinite web of relations (Braidotti, 2013; Hayles, 1999). In this worldview, nature, humans, stories, non-human phenomena or events all have agency (Latour, 2014). As Haraway (2016:100) argues, “no species, not even our own arrogant one pretending to be good individuals in so-called modern Western scripts, acts alone; assemblages of organic species and of abiotic actors make history”. Humans do not have special agency, but are seen as just one kind of element in the infinite universal system (Braidotti, 2013). In such a system of active relationally constituted phenomena, subjectivity and otherness are negotiated in relation to the connections, (power) structures and actions (or flows and forces) that exist between actors in any given network. From this perspective, transitioning to sustainable futures does not only pose questions of what humanity can do to save the Earth or to make the Anthropocene more habitable. Transformation to sustainability is an on-going process of simultaneously re-constituting the world and ourselves in a process of becoming that cuts across species, space and time (Braidotti, 2006). In this framing sustainable human-nature responses in the Anthropocene would entail empowering a web of relations and allowing agency on multiple levels of existence. Responsibility is shared between all “earthlings” (human or non-human) and all are held responsible for shaping conditions for “multispecies flourishing” in the face of the Anthropocene (Haraway, 2016).

It is evident from these four framings that identifying responses to address the sustainability challenges associated with the Anthropocene era – and thereby defining what would constitute a desirable Anthropocene – depends on the inherent assumptions underlying the different conceptualizations of how humanity is positioned in relation to nature. Actions and responsibility for achieving sustainability under each framing is defined specifically in relation to how the agency of humans in relation to nature is understood. This in turn informs what is seen as being “good” or appropriate responses and actions within each framing.

From this analysis it becomes clear that appropriate responses to Anthropocene challenges cannot be defined from any objective Archimedean point, but can only be distilled in terms of the normative principles and values that constitute each of the different conceptual frameworks. Defining what responses are “good” or effective becomes a process of navigating how the human-nature relations are understood under different perspectives; hence our reference to the film *Finding Nemo* where the journey to find the lost clown fish called Nemo, teaches onlookers about what it means to be human through the eyes of Nemo’s companions as they encounter new and unknown territories.

3. Anthropocene as responsibility (or re-learning how to “read human”)

Marlin: I can't read human.

Dory: Then we need to find a fish that can read this.

Hey, look! Sharks!

(From the film *Finding Nemo*, 2003)

As Marlin and Dory learn to “read human” during their impossible mission to find Nemo, they discover how agency is related to knowing how to read the signs along the way. Reading the Anthropocene as a sign that humans have become a “planetary-scale geological force” (Steffen et al., 2015), brings about the realization that continuing on

this trajectory will lead to unsustainable futures. The Anthropocene introduces a moment of “crisis and transformation” in human understanding (Clark, 2013). The crisis is marked by the fact that the Anthropocene proposes a rupture between the dominant paradigm of “managing change” through instrumentalist concepts, and the need for new approaches that can engage with the extreme uncertainty that accompanies this new era.

We are living in a contradictory moment marked by both “responsibility and extreme uncertainty” (Clark, 2013), which leads to a significant “element of indecision” (Szerszynski, 2010). We argue that this moment of uncertainty introduces the need to develop an ethic that is appropriate for an era marked by sudden social, political, economic and environmental changes. Such an ethic should be able to justify and inform individual and collective responses appropriate for an era of global social-ecological change. This implies that because “the nature of human action has changed, and, since ethics is concerned with action, it should follow that the changed nature of human action calls for a change of ethics as well” (Jonas, 1984).

This “ethical imperative” (Jonas, 1984) implies that we re-think our responses and actions (Moore and Nelson, 2010) not just with reference to the planet (e.g. planetary stewardship), but also with respect to fellow humans. Human wellbeing and being able to define the notion of appropriate or “good” actions in this context, needs to be defined pluralistically, recognizing that whilst we are the same species, there is no homogenous human grouping, history, identity or set of values that we can rely on to guarantee and pre-define what can be pinned down as being “good” or not. Actions mandated by public policies aiming, for example, to address the complex challenges of the Anthropocene, are likely to also have significant, and possibly negative, consequences for fellow humans – and we need to recognize that the implicated “anthropos” is not “a homogeneous mass, ignoring the many peoples who have lived without fossil fuels and those who never imagined themselves as members of a species named homo sapiens” (Arora and Stirling, 2015).

Some critics of the term argue that this diversity cannot be included in the definition of the Anthropocene (Malm and Hornborg, 2014). In contrast, we argue that there exists a plurality of framings that inform what could be good responses to Anthropocene challenges, and that extending these definitions for contestation between different groups and disciplines can broaden our understanding of potential responses to the challenges the Anthropocene poses, and enhance our possibility to develop more nuanced, socially considerate and credible responses.

Different framings of the Anthropocene challenges help broaden our understanding of the different dimensions of the ethical imperative posed by the Anthropocene as geological epoch. In a sense, the ethical imperative emerges from the affirmation of our entanglements with the larger world that calls for responses that are eco-egalitarian in direction (Connolly and Macdonald, 2015). Engaging with this imperative recognizes that goodness is not defined by following the Enlightenment process of problem definition based on factual certainty resulting in moral clarity. Instead it is instituted in the need for continuous deliberation through a form of agonistic ethics (drawing from Woermann and Cilliers, 2012). This might seem like an impossible way to establish what could be deemed as possibly being “good” or not. However, such an approach is based on the principle of navigating provisional ethical framings that are established through continuous moral contestations, evolving and emerging from diverse human-nature systems in transformation across various scales of entanglement (Biermann et al., 2009).

The notion of the Anthropocene demands that new conceptual and normative constellations be developed that allow us to define agency and responsibility in terms of defining each new territory and by learning the language and signs of who has the power to act and the power to be affected. From this perspective, appropriate actions towards sustainability will be defined in terms of how we allow and co-create emergent spaces of engagement where multiple actors are

enabled to re-imagine and articulate new normative and future orders of autonomy (framed as the power to act, but also to decide how to be affected), solidarity and security that are cognizant of the kinds of injustices that have accompanied the Anthropocene age. Such an imperative acknowledges that a good Anthropocene is marked by a responsibility towards otherness (nature, the marginalized, developing countries, economically vulnerable communities) that is “predicated not on closure, and independence, but on the recognition of vulnerability” (Szerszynski, 2010: 25).

4. Conclusion

If the Anthropocene is to be understood as an era in which humans are a dominant force on the planet – for good or for ill – then returning to a previous age (i.e. the Holocene, when humans were not the dominant force) is not an option; we cannot turn back the clock, but must therefore proceed into navigating the future-as-Anthropocene. How, then, can human-nature interactions be conceptualized to foster and anticipate novel principles, norms and practices resulting in sustainable Anthropocene futures?

In the Anthropocene, knowing what is good or responsible cannot be determined objectively or by weighing calculable risks against known variables, as the crisis of the Anthropocene brings us face to face with the limits of what is calculable of the current systemic configurations that govern human-nature relations. Left to navigate the uncertainties of global social-ecological change processes, the moment of responsibility is revealed in the instant in which we have to find new ways of responding and acting according to our best judgment in the face of uncertainty (or the unknowable), and to engage with the consequences of those actions (Preiser and Cilliers, 2010). Conceptualized as a moment of responsibility, the Anthropocene challenges all to critically reflect on the diverse kinds of agencies we have and exert. It is the experience of the Anthropocene as a concept eliciting “a sense of the fragility of things” (Connolly and Macdonald, 2015) that calls on scholars, decision-makers and activists to think critically about how they constitute their capacities to act and to be affected as human beings and in lieu of their entanglement with the technologies and institutions that shape the Anthropocene. Acknowledging that various framings of human-environment relations inform different understandings and responses of the Anthropocene challenges, call for greater critical and constructive research and engagement from a theoretically informed position that is mindful of the variety in perspectives, but also their similarities as guided by the intention to bring about sustainable human-environment futures.

Acknowledgement

All authors are funded by the Sida-funded GRAID program at the Stockholm Resilience Centre.

References

- Arora, S., Stirling, A.C., 2015. Stoking the Anthropocene. http://www.nomadit.co.uk/east/east_4s2016/panels.php5?PanelID=4027/. (Accessed 13 May 2016).
- Asafu-Adjaye, J., Blomqvist, L., Brand, S., Brook, B., DeFries, R., Ellis, E.C., Foreman, C., Keith, D., Lewis, M., Lynas, M., Nordhaus, T., Pielke, R., Pritzker, R., Roy, J., Sagoff, M., Shellenberger, M., Stone, R., Teague, P., 2015. An Ecomodernist Manifesto. <http://www.ecomodernism.org/>. (Accessed 13 May 2016).
- Barry, A., Born, G., 2015. *Interdisciplinarity: Reconfigurations of the Social and Natural Sciences*. Routledge, London, U.K.
- Bauman, Z., 2003. *Intimations of Postmodernity*. Routledge, London, U.K.
- Bennett, E.M., Solan, M., Biggs, R., McPhearson, T., Norström, A.V., Olsson, P., Xu, J., et al., 2016. Bright spots: seeds of a good Anthropocene. *Front. Ecol. Environ.* 14 (8), 441–448. <http://dx.doi.org/10.1002/fee.1309>.
- Biermann, F., Betsill, M.M., Gupta, J., Kanie, N., Lebel, L., Liverman, D., Schroeder, H., Siebenhüner, B., 2009. *Earth System Governance: People, Places, and the Planet. Science and Implementation Plan of the Earth System Governance Project*. International Human Development Programme (IHDP), Bonn.
- Braidotti, R., 2006. *Transpositions: on Nomadic Ethics*. Polity Press Cambridge, UK, Malden, MA.

- Braidotti, R., 2013. *The Posthuman*. Polity Press Cambridge, UK, Malden, MA.
- Brondizio, E.S., O'Brien, K., Bai, X., Biermann, F., Steffen, W., Berkhout, F., Cudennec, C., Lemos, M.C., Wolfe, A., Palma-Oliveira, J., Chen, C.-T.A., 2016. Re-conceptualizing the Anthropocene: a call for collaboration. *Glob. Environ. Change* 39, 318–327. <http://dx.doi.org/10.1016/j.gloenvcha.2016.02.006>.
- Chakrabarty, D., 2012. Postcolonial studies and the challenge of climate change. *New Lit. Hist.* 43 (1), 1–18. <http://dx.doi.org/10.1353/nlh.2012.0007>.
- Chin, A., Gillson, L., Quiring, S.M., Nelson, D.R., Taylor, M.P., Vanacker, V., Lovegrove, D., 2016. An evolving Anthropocene for science and society. *Anthropocene* 13, 1–3. <http://dx.doi.org/10.1016/j.ancene.2016.05.002>.
- Clark, T., 2013. The deconstructive turn in environmental criticism. *symplokē* 21, 11–26.
- Connolly, W.E., Macdonald, B.J., 2015. Confronting the anthropocene and contesting neoliberalism: an interview with William E. Connolly. *New Polit. Sci.* 37, 259–275. <http://dx.doi.org/10.1080/07393148.2015.1022962>.
- Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. *Glob. Environ. Change* 26, 152–158. <http://dx.doi.org/10.1016/j.gloenvcha.2014.04.002>.
- Crutzen, P.J., 2002. Geology of mankind. *Nature* 415, 23. <http://dx.doi.org/10.1038/415023a>.
- Ellis, E.C., 2011. The planet of No return: human resilience on an artificial earth. *Breakth. J.* 2, 37–44.
- Folke, C., Gunderson, L., 2010. Resilience and global sustainability. *Ecol. Soc.* 15 (4), 43. [online]. <http://www.ecologyandsociety.org/vol15/iss4/art43/>.
- Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S.R., Chapin, F.S., Crépin, A.-S., Daily, G., Danell, K., Ebbesson, J., Elmqvist, T., Galaz, V., Moberg, F., Nilsson, M., Österblom, H., Ostrom, E., Persson, Å., Peterson, G., Polasky, S., Steffen, W., Walker, B., Westley, F., 2011. Reconnecting to the biosphere. *Ambio* 40, 719–738. <http://dx.doi.org/10.1007/s13280-011-0184-y>.
- Folke, C., Biggs, R., Norström, A.V., Reyers, B., Rockström, J., 2016. Social-ecological resilience and biosphere-based sustainability science. *Ecol. Soc.* 21 (3), 41. <http://dx.doi.org/10.5751/ES-08748-210341>.
- Galaz, V., Biermann, F., Crona, B., Lorbach, D., Folke, C., Olsson, P., Nilsson, M., Allouche, J., Persson, Å., Reischl, G., 2012. Planetary boundaries – exploring the challenges for global environmental governance. *Curr. Opin. Environ. Sustain.* 4, 80–87. <http://dx.doi.org/10.1016/j.cosust.2012.01.006>.
- Haraway, D.J., 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. Duke University Press, Durham.
- Hayles, N.K., 1999. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. University of Chicago Press, Chicago, Ill.
- Holling, C.S., 2001. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4, 390–405. <http://dx.doi.org/10.1007/s10021-001-0101-5>.
- Jonas, H., 1984. *The Imperative of Responsibility: in Search of an Ethics for the Technological Age*. University of Chicago Press.
- Lövbrand, E., Beck, S., Chilvers, J., Forsyth, T., Hédren, J., Hulme, M., Lidskog, R., Vasileiadou, E., 2015. Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Glob. Environ. Change* 32, 211–218. <http://dx.doi.org/10.1016/j.gloenvcha.2015.03.012>.
- Latour, B., 2014. Agency at the Time of the Anthropocene. *New Lit. Hist.* 45 (1), 1–18. <http://dx.doi.org/10.1353/nlh.2014.0003>.
- Latour, B., 2015. Telling friends from foes in the time of the anthropocene. In: Hamilton, C., Bonneuil, C., Gemenne, F. (Eds.), *The Anthropocene and the Global Environmental Crisis*. Routledge, London, U.K, pp. 145–155.
- Leach, M., Scoones, I., Stirling, A., 2010. *Dynamic Sustainabilities: Technology, Environment, Social Justice*. Earthscan, London.
- Leach, M., Rockström, J., Raskin, P., Scoones, I., Stirling, A.C., Smith, A., Thompson, J., Millstone, E., Ely, A., Arond, E., Folke, C., Olsson, P., 2012. Transforming innovation for sustainability. *Ecol. Soc.* 17 (2). <http://dx.doi.org/10.5751/ES-04933-170211>.
- Lorimer, J., 2012. Multinatural geographies for the Anthropocene. *Progr. Hum. Geogr.* 36, 593–612. <http://dx.doi.org/10.1177/0309132511435352>.
- Malm, A., Hornborg, A., 2014. The geology of mankind? A critique of the Anthropocene narrative. *Anthropol. Rev.* 1, 62–69. <http://dx.doi.org/10.1177/2053019613516291>.
- Maslin, M.A., Lewis, S.L., 2015. Anthropocene: earth System, geological, philosophical and political paradigm shifts. *Anthropol. Rev.* 2, 108–116. <http://dx.doi.org/10.1177/2053019615588791>.
- McAlpine, C.A., Seabrook, L.M., Ryan, J.G., Feeney, B.J., Ripple, W.J., Ehrlich, A.H., Ehrlich, P.R., 2015. Transformational change: creating a safe operating space for humanity. *Ecol. Soc.* 20 (1), 56. <http://dx.doi.org/10.5751/ES-07181-200156>.
- Moore, K.D., Nelson, M.P., 2010. *Moral Ground: Ethical Action for a Planet in Peril*. Trinity University Press, San Antonio, Texas, USA.
- Moore, A., 2016. Anthropocene anthropology: reconceptualizing contemporary global change. *J. R. Anthropol. Inst.* 22 (1), 27–46. <http://dx.doi.org/10.1111/1467-9655.12332>.
- Poli, R., 2010. An introduction to the ontology of anticipation. *Futures* 42, 769–776. <http://dx.doi.org/10.1016/j.futures.2010.04.028>.
- Preiser, R., Cilliers, P., 2010. Unpacking the Ethics of Complexity: Concluding Reflection. *Complexity, Difference and Identity, Issues in Business Ethics* Vol. 26. pp. 95–111. <http://dx.doi.org/10.1007/978-90-481-9187-1>.
- Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009. A safe operating space for humanity. *Nature* 461 (7263), 472–475.
- Ruddiman, W.F., Ellis, E.C., Kaplan, J.O., Fuller, D.Q., 2015. Defining the epoch we live in. *Science* 80 (348), 38–39. <http://dx.doi.org/10.1126/science.aaa7297>.
- Schellnhuber, H.J., 1999. Earth system analysis and the second Copernican revolution. *Nature* 402 (SUPP), C19–C23.
- Shellenberger, M., Nordhaus, T., 2015. An Ecomodernist Manifesto: From the Death of Environmentalism to the Birth of Ecomodernism. An Ecomodernist Manifesto. [WWW Document]. URL <http://thebreakthrough.org/index.php/voices/michael-shellenberger-and-ted-nordhaus/an>. (Accessed 13 May 2016).
- Stanton (Writer), A., Pixar Animation Studios (Producer), 2003. *Finding Nemo* [Film]. Walt Disney Pictures, USA.
- Steffen, W., Crutzen, P.J., McNeill, J.R., 2007. The Anthropocene: are humans now overwhelming the great forces of Nature? *Ambio* 36, 614–621. [http://dx.doi.org/10.1579/0044-7447\(2007\)36\[614:TAAHNO\]2.0.CO;2](http://dx.doi.org/10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2).
- Steffen, W., Persson, Å., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., et al., 2011. The Anthropocene: from global change to planetary stewardship. *Ambio* 40 (7), 739–761. <http://dx.doi.org/10.1007/s13280-011-0185-x>.
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., Ludwig, C., 2015. The trajectory of the anthropocene: the great acceleration. *Anthropol. Rev.* 2 (1), 81–98. <http://dx.doi.org/10.1177/2053019614564785>.
- Stirling, A., 2014a. Emancipating Transformations: From Controlling 'the Transition' to Culturing Plural Radical Progress. STEPS Working Paper 64. STEPS Centre, Brighton.
- Stirling, A., 2014b. Towards Innovation Democracy? Participation, Responsibility and Precaution in Innovation Governance Vol. 24. [online]. <http://steps-centre.org/publication/innovation-democracy-stirling/>. (Accessed 13 May 2016).
- Stirling, A., 2015. Time to Rei(g)n Back the Anthropocene? <http://steps-centre.org/2015/blog/time-to-reign-back-the-anthropocene>. (Accessed 13 May 2016).
- Szerszynski, B., 2010. Reading and writing the weather: climate technics and the moment of responsibility. *Theory Cult. Soc.* 27, 9–30. <http://dx.doi.org/10.1177/0263276409361915>.
- Toulmin, S.E., 1992. *Cosmopolis: The Hidden Agenda of Modernity*. University of Chicago Press, Chicago, Ill.
- Woermann, M., Cilliers, P., 2012. The ethics of complexity and the complexity of ethics. *S. Afr. J. Philos.* 31, 403–419. http://dx.doi.org/10.1007/978-9-4-007-5131-6_2.
- Zalasiewicz, J., Williams, M., Steffen, W., Crutzen, P., 2010. The new world of the Anthropocene. *Environ. Sci. Technol.* 44, 2228–2231. <http://dx.doi.org/10.1021/es903118j>.
- de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., ten Brink, P., van Beukering, P., 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosyst. Serv.* 1, 50–61. <http://dx.doi.org/10.1016/j.ecoser.2012.07.005>.