The Anthropocene: The One, the Many, and the Topological

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Given the many discourses about markers for the Anthropocene, those peripheral to one's academic niche might elicit indifference or even dismissal. Conversely, a shallow pluralism can take root in which any Anthropocene demarcation matters equally as others. I propose a more diplomatic coexistence of ideas regarding the Anthropocene boundary issue. In this perspective, the choice of when to delineate the Anthropocene's start and how to signify its presence is analogous to a modifiable areal unit problem. Boundaries can be drawn from a range of anthropogenic phenomena. Geographic subdisciplines have acquired distinctive ways of sublimating socioecological patterns and processes into a timestamp. Less attention, however, is given to how their respective temporal modes and ensuing markers of anthropogenic change overlap and relate to one another. I show how topology, as invoked in the biophysical sciences and social theory, integrates these temporalities of the Anthropocene. The Anthropocene can be framed as a cusp catastrophe, a folded surface in which different modes of change emerge from and coexist with each other. These trajectories of change, the gradual, the threshold driven, and those exhibiting hysteresis, encapsulate the interdependencies among past, present, and future invoked across different delineations of the Anthropocene. The Anthropocene might be less a fixed point in time as it is a moving window where human and natural processes are folded into one another. An Anthropocene represented as a folded surface rather than a timeline incorporates the importance of unpredictably productive responses to the present Anthropocene moment. *Key Words: Anthropocene, diplomacy, hysteresis, pragmatism, topology.*

From its inception, the concept of the Anthropocene has been a debate about boundaries. Among geographers, these boundaries have often corresponded with subdisciplinary affinities. Critical geographers target the rise of colonialism and global capitalism. Biophysical geographers identify the uptick in the extent of agriculture 10,000 years ago or the peak signature of radioactive fallout from nuclear bomb testing. These and other markers, however, do more than signify academic self. Intent is also implicit to their designation. Any Anthropocene boundary prioritizes a particular view of the past that steers anticipation of a future and the kinds of actions we take in the present (Anderson 2010). Consequently, the choice of an Anthropocene marker can be made to support the perception of the long-term influence of humans. Anthropocene boundary work can make appeals to our ecomodernist hopes for a flourishing of new ways to live on Earth (Ellis 2015). Anthropocene boundaries might even be rejected because they mask underlying social processes and no clear date identifies when humans became geophysical agents (Bauer and Ellis 2018).

In this manner, the concept of Anthropocene allows people to reinforce and perpetuate preferred views about the implications of human interaction with the Earth. As Castree (2017) noted, "What counts as epochal change is a matter of perspective, since it emerges from judgements about when quantitative change morphs from qualitative transformation" (289). The inevitable dichotomies that result, like the good versus a bad Anthropocene, drive conversation toward confusion as individuals argue preferred versions of an Anthropocene concept and its markers. Philosophical and political perspectives become entangled with scientific measures of human impacts and proposed geological stratigraphic units for the start of the Anthropocene (Autin 2016). As the number of demarcations and interpretations of the Anthropocene have grown, perhaps so, too, has the temptation to advocate for one's favored temporal representation of the Anthropocene and the discourse surrounding it.

Following Anderson (2019), I take the position that Anthropocene markers are representations in relation. They are entangled and coevolving rather than isolated. Any individual demarcation of the

Annals of the American Association of Geographers, 0(0) 2020, pp. 1–9 © 2020 by American Association of Geographers
Initial submission, November 2019; revised submission, March 2020; final acceptance, March 2020
Published by Taylor & Francis, LLC.

Anthropocene is lived with in the midst of other events and processes. Accordingly, the pertinent question might not be when the Anthropocene began but how to summarize the relationality of its many demarcations (Castree et al. 2014). Such a pluralistic approach aims for a diplomatic coexistence of boundaries, a negotiation among parties often distrustful of each other (Castree 2015a, 2015b). For example, designating a stratigraphic marker for the Anthropocene has been productive in ways beyond earth science. Initial proposals to reduce the Anthropocene down to a geologic unit fueled wide-ranging debate on the causes and correlates of the Anthropocene. Similarly, knowledge of how racial and class inequities signal the Anthropocene can be useful in ways that do not obviate all of the practices of global change science (Castree 2015a, 2015b). Yet Anthropocene demarcations are often presented as single agential cuts (Barad 2007) along partisan lines of academic identity. As an alternative, Anthropocene boundaries should be conceived as productive insofar as their relational character is foregrounded as difference but not necessarily contradiction. Following Conway (2019), rather than "dissolving all antagonisms, such that a sea of mutuality might then rise," this perspective on the Anthropocene diplomacy seeks "to dispel unnecessary antagonisms so that necessary ones might come to the fore. It explores the folds that are possible so as to enable the cuts that are necessary" (22).

From this point of view, the Anthropocene can be conceived as a temporal analogue of the modifiable areal unit problem (MAUP), a central concept of geography. Yet this is not simply the observation that the Anthropocene began at different times in different places. Instead, having contrasting, even conflicting demarcations of time (and space) to infer the Anthropocene can be viewed as constructive. In this sense, the MAUP and its counterpart in time, the modifiable temporal unit problem, are not just fallacies of interpretation, the usage most geographers associate with this concept. As I have argued (Stallins 2012), these modifiable unit issues encapsulate the topological character of environmental problem solving performed by organisms. Biological life operates through a constant engagement with the modifiable unit challenge of making predictable sense (cuts) out of the shifting boundaries that define its environment. Accordingly, for humans, any single Anthropocene boundary is a local negotiation that reduces environmental pattern and process down to a point or interval on a timeline. Yet it is only through collective negotiation among many different demarcations of the Anthropocene that this boundary work can become more fully productive.

As an example, one proposed marker for the Anthropocene is the Orbis spike of the early 1600s (Lewis and Maslin 2015). This boundary sublimates the economic processes of European colonization into a timestamp of abruptly lowered carbon dioxide concentrations due to forest regrowth after the genocidal depopulation of the Americas. As a biophysical marker, the Orbis spike also signals a start to the colonialist, global-scale transformations of people and landscapes that continues today. That diffuse political and economic processes become less visible in the stratigraphic designations of the Anthropocene underscores the challenge of finding representations of the Anthropocene that accommodate what seem to be subdisciplinary irreconcilabilities. Yet it is not that we do not understand how these environmental signals and economic processes relate (Saldanha 2019). The challenge is linking the geometries of process and form encompassing colonial power and carbon dioxide levels in Antarctic ice cores. Hence, the Anthropocene is also a task of visualization, of cartographic imagination to bring together objects and processes that defy traditional mapping.

In this article, I show how a topological approach inspired by this reformulation of MAUP lessens some of the partisanship of defending any one Anthropocene boundary from among many. Topology provides a means to represent how different temporal modes of environmental and social change jointly contribute to a more continuous form for the Anthropocene. By allowing many perspectives to exist in relation, topology avoids reifying a single Anthropocene boundary as preeminent; that is, as guilty of committing the fallacy version of MAUP. This hews to Castree's (2015a) advice about how the Anthropocene moment should avoid narratives that "risk perpetuating an emaciated conception of reality wherein Earth systems and social systems are seen as knowable and manageable if the 'right' ensemble of expertise is achieved" (1). This topological view emphasizes a diplomatic coexistence or "presence" (Kaika 2018) among the different temporalities of the Anthropocene rather than any final delineation of origin or single best marker.

Topology in the Biophysical Sciences and Social Theory

Formally, topology is a branch of mathematics that studies shapes. Topologists treat shapes as spaces whose coordinates are not necessarily contained within a Cartesian coordinate system. Instead, they are intrinsic to the surface itself. Topologists focus on what aspects of a shape remain constant, such as its dimensionality or number of edges, when the surface is deformed. In topological data analysis, high-dimensional visualizations are created from large data sets of many interacting variables. Analysis of the shape of these data provides insight into the relationships among variables. The shape of this data cloud is abstract, but the surfaces and distances within it convey insights about relationships among real-world processes.

Topology has a long history in the biophysical sciences through the use of ball and cup diagrams and fitness surfaces (Inkpen and Petley 2001). These topological ways of seeing can be mathematically formal as well as descriptive and conceptual (Prager and Reiners 2009). One of the more well-known topological forms invoked in the biophysical and social sciences is the cusp catastrophe (Zeeman 1976; Graf 1979; Thorn and Welford 1994). This shape formalizes how a few variables can interact and create a surface where distances between points on it represent transitions among different states. These transitions can range from gradual to sudden depending on the location on the surface. Studies on lakes, coral reefs, oceans, forests, and arid lands have shown that smooth gradual change can be interrupted by sudden drastic switches to a contrasting state (Scheffer et al. 2001). Anthropocene scholars have invoked these abrupt transitions to suggest that the Earth might irreversibly tip and lock into a degraded state once planetary boundaries are exceeded (Barnosky et al. 2012). It is now recognized, however, that the potential for these large jumps in state is more varied in space and time (Dakos et al. 2015). Gradual and less sudden threshold dynamics can coexist with them.

For social theorists, topology is a way of thinking about relationality, space, and movement without mathematical constraints. Topology in human geography provides a way to map out how people and things change and how they relate without quantification (Martin and Secor 2014). Social theorists have used topology metaphorically to account for how presences and absences no longer correspond to measures of physical proximity. For example, power can extend itself in ways that are nonterritorial in the sense that its reach is present in quieter but more pervasive forms irrespective of traditional measures of proximity (Allen 2016). The social relations of home are topological in that they are a collection of attachments that consist of people, places, ideas, and things that are both near and far (Kallio 2016). In human geography, topology has come to be a shorthand for the contextual, relational constitution of the world that defies physical proximity and spaces defined by absolute distances. Social theorists invoke topology as metaphor and rhetorical construct in accounts of the Anthropocene. Their Plantationocene and the Capitalocene encompass the destructive structural logics of resource depletion and petrochemical dependency embedded in the world system of capitalism (Davis et al. 2019). The Chthulucene is a foil to the Anthropocene, a multispecies unfolding and "tentacularity" connecting disparate realms of life in potentially collaborative and creative webs of kinship (Haraway 2015).

Topology provides a means to integrate the pluralistic and often competing delineations of Anthropocene. The diversity of qualitative and quantitative interpretations of the Anthropocene and the markers for them defy conventional space and time boundary making. Topological approaches, however, can meld temporal perspectives on the Anthropocene in ways that timelines and absolute measures of space and time cannot.

Shapes and Surfaces of the Anthropocene

As a conceptual rather than formal mathematical topology, the Anthropocene can be represented as a cusp catastrophe demarcated by three axes (Figure 1). One axis represents the variable of time. A second axis is ecological malleability. This variable conveys the degree to which ecological systems can become entrained by humans. High ecological malleability denotes a socioecological system in which a subset of nonhuman organisms and processes are readily shaped by humans. Low ecological malleability implies ecological systems

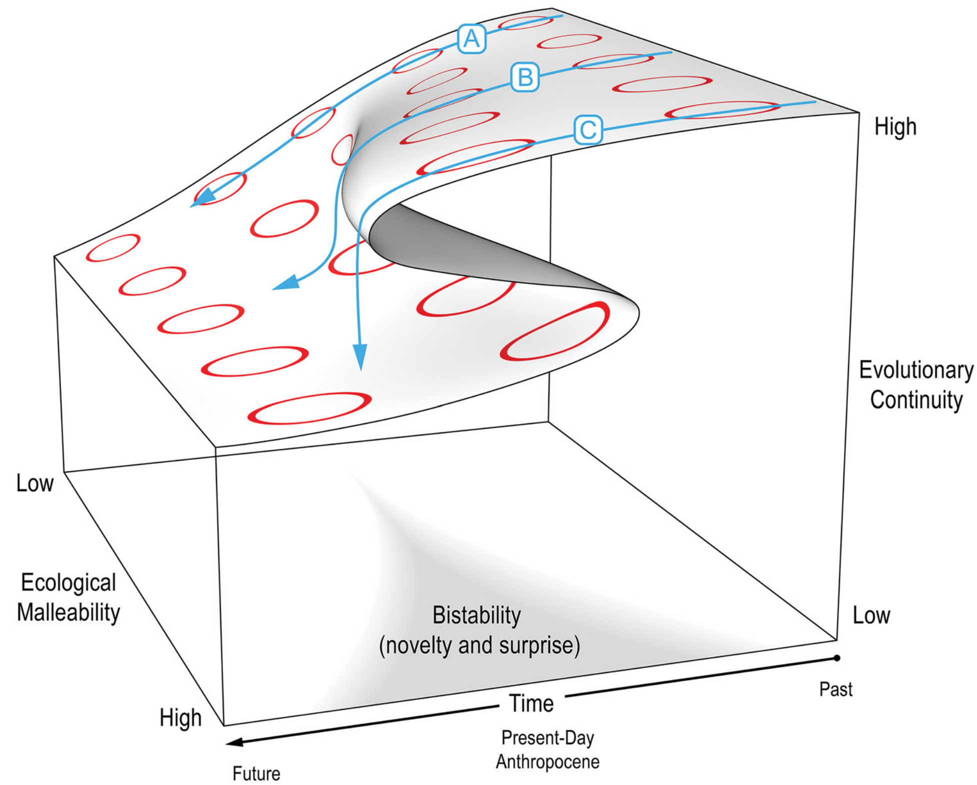

Figure 1. Cusp catastrophe for the Anthropocene with three temporal trajectories: (A) gradual, (B) threshold, and (C) hysteretic. Changes in the shape of the distortion ellipses along each trajectory represent how past, present, and future inform one other. Consistent ellipse shape along a trajectory indicates predictable correlations among past, present, and future. Distortions indicate less predictability of the future based on the past and present. The gray shaded area represents where novelty and surprise arise from bistability and tipping.

with properties that resist human incorporation or domestication, an unruliness of nature. The third axis represents evolutionary continuity. This response variable is a measure of the depth of time comprising evolutionary development in the absence of human impacts. Lower positions on this axis represent a greater divergence from past nonhuman evolutionary context. Higher positions represent systems more temporally continuous with nonhuman environmental change and ecological processes. These three axes demarcate regions on the surface of this fold that parallel a trend of increasing human impacts through time, from the past, to a present-day Anthropocene, and a future.

The movement from an unmodified, evolutionarily conserved past to the ecologies of the humanized present traces multiple paths on this surface. Although many trajectories are possible along the contours of this surface, the three predominant ones shown in Figure 1 range from the gradual, to threshold-driven, and a path that exhibits irreversibility, or hysteresis, associated with sudden changes in state. These three trajectories also possess contrasts in how the past is correlated with present and how they anticipate the future. The changing shapes of the distortion ellipses projected on this surface represent the past, present, and future correlate and inform one another. For example, for a ball moving along a gradual trajectory (A), change is relatively predictable. The unchanged shape of the distortion ellipses conveys a consistent predictability in how the past informs the present and the future through time. With threshold trajectories (B), the past has much less capacity to inform the present and the future, as represented in the shrinking of the distortion ellipse where the surface bends inward in the center. With hysteresis (C), the distortion ellipses stretch more in one direction, indicating how the past can inform the present only within increasingly narrow bounds. Trajectories here become more blind to the future. These three predominant trajectories and their contrasts in how past, present, and future relate to one another give form to the many Anthropocenes that coexist as one.

Gradual Anthropocenes

Although the Anthropocene is often described as sudden, others have argued for a longer run-up to the present. For this trajectory, its low ecological malleability results in greater evolutionary continuity and a stronger correlation of the past with the present and future in the accumulation of human impacts. Early agricultural societies by 3,000 years ago had set in motion the large-scale anthropogenic modification of soil and biota (Jenny et al. 2019; Stephens et al. 2019). Human behavior has been a long-term ecological driver of plant and animal evolution for at least 50,000 years (Sullivan, Bird, and Perry 2017). These gradual trajectories reflect how some environmental and evolutionary constraints have not vanished in the Anthropocene. Aspects of our environment, nonhuman organisms, and human behavior and biology can exhibit a resistance to anthropogenic influences. For example, our mammalian qualities have not suddenly disappeared because we focus more on sociocultural identities and have secured the title of planetary engineer (Laist 2015). In these ways, a gradualist framing of the Anthropocene reinserts nature into the Anthropocene moment. Even the governmental and economic systems operative today remain correlated over a length of time with the past. Their futures are path dependent. As many critical geographers recognize, new envisionings of society do not easily escape the ruts left by old economic orders just because their radically transformative potentials are recognized. The colonial past remains entrenched in different economic and political forms. Defining the Anthropocene as a point on a timeline obscures many biophysical as well as social features of the past that are continuous and predictably correlated with the present and near future (Figures 2A–2B).

Threshold Anthropocenes

Many of the variables of the post–World War II Great Acceleration map as threshold trajectories. For this trajectory, malleability increases and allows greater deviation from historical precedents as axis position shifts toward less evolutionary continuity. These more industrialized Anthropocenes have sharper deviations from long-term trends, as exemplified by rapid increases in the number of humans on Earth, in rates of fossil fuel consumption, and in the pace of environmental change. Consequently,

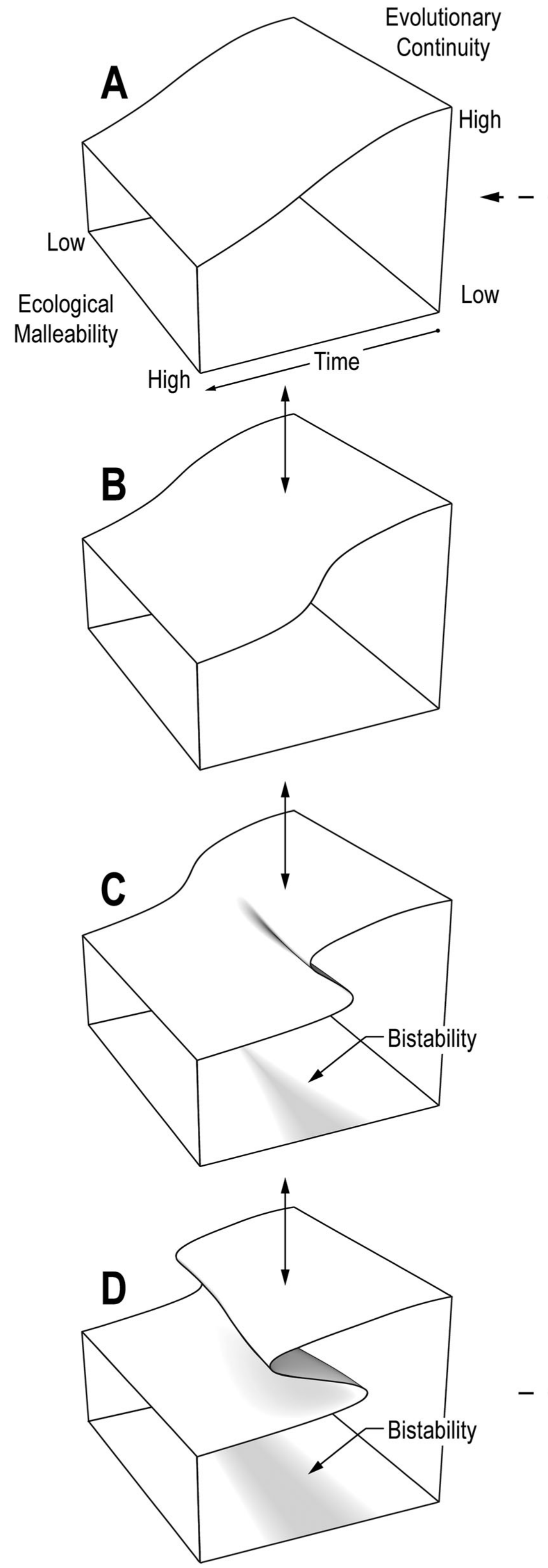

Figure 2. The emergence of the Anthropocene fold: (A) gradual transition surface; (B) initiation of threshold change where malleability is high; (C) hysteresis develops as system is managed for predictability, thereby increasing potential for sudden change in state; (D) with greater folding, more bistability and uncertainty but also greater potential for novelty and surprise. Sequence is not intended to be deterministically developmental.

rainfall, temperature, and river flows no longer have a stable mean around which they predictably fluctuate. This loss of stationarity, an inability to predict the future based on the past, is often taken to be the defining feature of the Anthropocene. The Great Acceleration, however, forms out of the velocity of a gradual past. Its threshold trajectories and loss of stationarity have a dependence on the degree to which the details of past can be resolved. This dependence arises because the accumulation of knowledge and technology that makes this acceleration possible also helps resolve the details of environmental histories extending back millennia. In other words, the more we know about the past, the more we know about the threshold slope leading to the future and what constitutes stationarity.

This dependency of thresholds on the resolution of the gradualist past is not confined to biophysical characterizations of the Anthropocene. With this rapid accumulation of knowledge has come a broadening in awareness of the inequities of the Anthropocene, of who has gained and who has borne the costs of this acceleration not only in the present but also in the past. To imagine a more equitable decolonized political future analogously depends on interpretations of history and awareness of the global present to serve as anticipatory guides. As seen on the Anthropocene surface (Figures 2A–2C), threshold trajectories are continuous with gradualist trajectories of change. Threshold and gradual trajectories inform one another whether they highlight biophysical or social and political interpretations of the Anthropocene.

Hysteretic Anthropocenes

Axis positions for this trajectory signal the capacity of human systems to utilize ecological malleability to the extent that abrupt shifts to novel systems can occur. With hysteresis, threshold change is delayed. Tipping points are eventually reached, resulting in a sudden jump to a historically novel state. These transitions can be irreversible. The tipping metaphor has gained prominence in many fields. Human economic systems can undergo these kinds of critical transitions (Battiston et al. 2016). Climate also has a propensity to tip irreversibly (Steffen et al. 2018). The potential for tipping has been overstated, however, particularly for ecological systems. Tipping might be more variable in space and time than early studies suggested, largely because the experimental designs that informed them downweighted the role of spatial heterogeneity (Kefi et al. 2013). As reflected in Figures 2C–2D, tipping and hysteresis coexist with and emerge from gradual and threshold trajectories of change.

The relationships between past, present, and future are more uncertain on the hysteretic region of the Anthropocene surface. This uncertainty is a trade-off, though, for the generation of novelty. The hysteresis fold demarcates a region where multiple states manifest within the same general conditions. In this bistable region between tipping points, seemingly oppositional states can coexist (Figure 3). The good Anthropocene of the technological optimists and ecomodernists, as achieved through scientific mitigation of human impacts, coexists with the protectionist and cautionary outlook for a bad Anthropocene. Robbins (2020) framed this as a coexistence between the forward-looking ecomodernist's more-is-less world and a skeptic's look backward to a less-is-more world. Similarly, bistability allows for conservation to coexist as preservationist, neoliberal, or decolonialist (Collard, Dempsey, and Sundberg 2015). In this bistable region, the Capitalocene coexists with the Chthulucene. Through the property of bistability, hysteresis can foster a mosaic of contrasting, even seemingly contradictory social and biophysical states despite their proximity on the Anthropocene fold.

Due to its propensity to tip and to allow different states to coexist, the Anthropocene fold produces not only problems but also solutions and new ways for humans to encounter and modify nature. The "Anthropo-scene," according to Lorimer (2017), is unique in that it makes possible novel forms of knowledge and sets the stage for new arrangements for knowledge production to emerge. It is where humans construct their sociocultural niche through constant experimental action and reaction (Ellis 2015). It is on this folded region of the surface that the past coexists with the emergence of new biophysical and sociopolitical entities and unexpected events in ways that generate the ongoing reconfiguration of the world.

This bistable region should not be viewed as the only source of solutions, however. Gradual trajectories lessen the generation of novelty, but they are more likely to provide deeper evolutionary solutions,

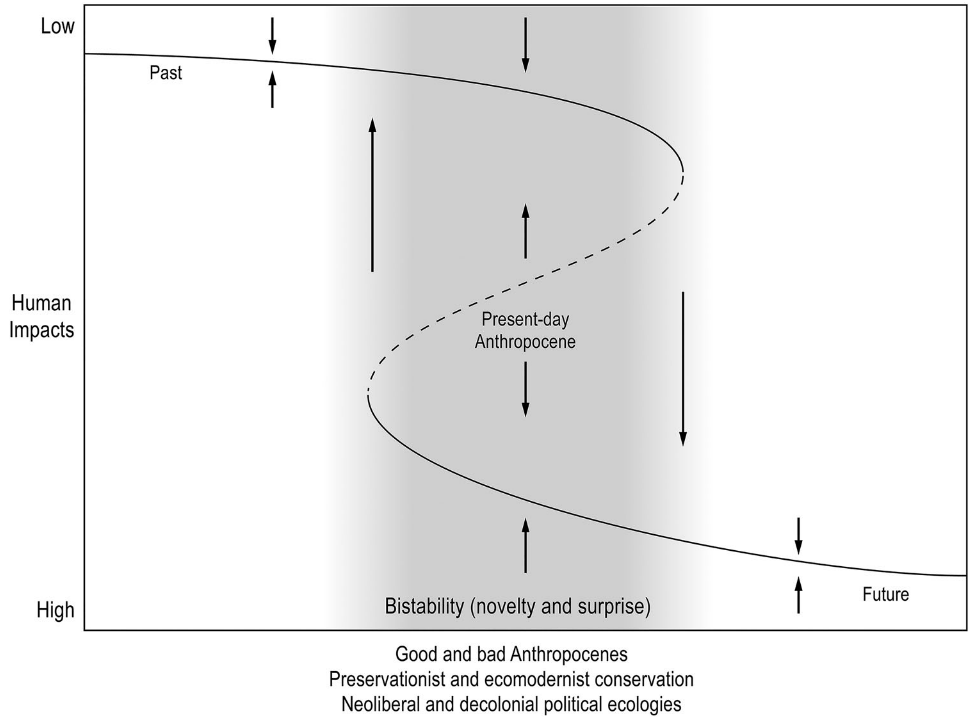

Figure 3. Bistability, novelty, and the tensions of the Anthropocene. Arrows indicate the direction in which the system tends to develop in response to feedbacks. The dashed line indicates a dynamically unfavored region as the feedbacks tend to direct organization to one of two states. Time is along the horizontal axis.

ones that have been recognized by indigenous cultures and conserved through time. In sum, a wide range of solutions, traditional as well as novel, can be present at the same time across this surface (Figure 2C). Too much bistability (Figure 2D) or too little (Figure 2A) would not offer as wide a range of solutions for humans to manage their influence on Earth.

Coda: Topology and Pragmatism

The present-day Anthropocene consists of multiple trajectories of change. It is relational with characteristics of paradox, pluralism, and perspectivism (de la Cadena and Blaser 2018; Wells 2018; Fagan 2019). Instead of a timeline emanating from the past that crosses some threshold, the Anthropocene is an involution, a topological folding over of human and natural processes. This Anthropocene is less a fixed point in time than it is a moving window where the fluxes of nature coexist with the cultures of nature. It is an evolving, propagating boundary where human sociocultural processes shape and are shaped by ecological theory and practice.

This topological interpretation of the Anthropocene is built on more than the truism that boundaries are impermanent and imprecise. Instead, it conveys how the conflicting boundary interpretations that animate the modifiable temporal and areal unit problems are not necessarily fallacies to avoid. They leverage productive differences to negotiate new yet temporary meanings from among antagonisms. As an attempt at diplomacy, topology negotiates among the oneness and manyness of debates over Anthropocene boundaries and signifiers. As for the hazard of reifying any one definition of the Anthropocene and a marker for it, care should also be taken as to how the pluralism of the Anthropocene is construed. Philosophical pragmatists would hold that this pluralism should not be a simplistic celebration of the many, nor the grounds for hardening one's favored belief and discourse. Instead, this pluralism provides "first and foremost a pragmatics, an experimental, exploratory and unpredictably productive response to our present moment" (Savransky 2019, 5).

Acknowledgment

In addition to my anonymous reviewers, my thanks go to William Reihard (https://williamreinhard.

artstation.com/) for providing his skills in the development of the three-dimensional graphics.

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References

Allen, J. 2016. *Topologies of power: Beyond territory and networks*. London and New York: Routledge.

Anderson, B. 2010. Preemption, precaution, preparedness: Anticipatory action and future geographies. *Progress in Human Geography* 34 (6):777–98. doi: 10.1177/0309132510362600.

Anderson, B. 2019. Cultural geography II: The force of representations. *Progress in Human Geography* 43 (6):1120–32. doi: 10.1177/0309132518761431.

Autin, W. J. 2016. Multiple dichotomies of the Anthropocene. *The Anthropocene Review* 3 (3): 218–30. doi: 10.1177/2053019616646133.

Barad, K. M. 2007. *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Durham, NC: Duke University Press.

Barnosky, A. D., E. A. Hadly, J. Bascompte, E. L. Berlow, J. H. Brown, M. Fortelius, W. M. Getz, J. Harte, A. Hastings, P. A. Marquet, et al. 2012. Approaching a state shift in Earth's biosphere. *Nature* 486 (7401): 52–58. doi: 10.1038/nature11018.

Battiston, S., J. D. Farmer, A. Flache, D. Garlaschelli, A. G. Haldane, H. Heesterbeek, C. Hommes, C. Jaeger, R. May, and M. Scheffer. 2016. Complexity theory and financial regulation. *Science* 351 (6275):818–19. doi: 10.1126/science.aad0299.

Bauer, A. M., and E. C. Ellis. 2018. The Anthropocene divide obscuring understanding of social-environmental change. *Current Anthropology* 59 (2):209–27. doi: 10.1086/697198.

Castree, N. 2015a. Geography and global change science: Relationships necessary, absent, and possible. *Geographical Research* 53 (1):1–15. doi: 10.1111/1745-5871.12100.

Castree, N. 2015b. Unfree radicals: Geoscientists, the Anthropocene, and left politics. *Antipode* 49 (Suppl. 1):52–74. doi: 10.1111/anti.12187.

Castree, N. 2017. Anthropocene: Social science misconstrued. *Nature* 541 (7637):289. doi: 10.1038/541289c.

Castree, N., W. M. Adams, J. Barry, D. Brockington, B. Buscher, E. Corbera, D. Demeritt, R. Duffy, U. Felt, K. Neves, et al. 2014. Changing the intellectual climate. *Nature Climate Change* 4 (9):763–68. doi: 10.1038/nclimate2339.

Collard, R. C., J. Dempsey, and J. Sundberg. 2015. A manifesto for abundant futures. *Annals of the Association of American Geographers* 105 (2):322–30. doi: 10.1080/00045608.2014.973007.

Conway, P. R. 2019. The folds of coexistence: Towards a diplomatic political ontology, between difference and contradiction. *Theory Culture & Society* 37 (3):23–47. doi: 10.1177/0263276419885004.

Dakos, V., S. R. Carpenter, E. H. van Nes, and M. Scheffer. 2015. Resilience indicators: Prospects and limitations for early warnings of regime shifts. *Philosophical Transactions of the Royal Society B-Biological Sciences* 370 (1659):10. doi: 10.1098/rstb.2013.0263.

Davis, J., A. A. Moulton, L. Van Sant, and B. Williams. 2019. Anthropocene, Capitalocene, Plantationocene? A manifesto for ecological justice in an age of global crises. *Geography Compass* 13 (5):e12438–15. doi: 10.1111/gec3.12438.

de la Cadena, M., and M. Blaser. 2018. *A world of many worlds*. Durham, NC: Duke University Press.

Ellis, E. C. 2015. Ecology in an anthropogenic biosphere. *Ecological Monographs* 85 (3):287–331. doi: 10.1890/14-2274.1.

Fagan, M. 2019. On the dangers of an Anthropocene epoch: Geological time, political time and post-human politics. *Political Geography* 70:55–63. doi: 10.1016/j.polgeo.2019.01.008.

Graf, W. L. 1979. Catastrophe theory as a model for change in fluvial systems. In *Adjustments of the fluvial system*, ed. D. D. Rhodes and E. J. Williams, 13–32. London: Allen and Unwin.

Haraway, D. 2015. Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making kin. *Environmental Humanities* 6 (1):159–65. doi: 10.1215/22011919-3615934.

Inkpen, R., and D. Petley. 2001. Fitness spaces and their potential for visualizing change in the physical landscape. *Area* 33 (3):242–51. doi: 10.1111/1475-4762.00028.

Jenny, J.-P., S. Koirala, I. Gregory-Eaves, P. Francus, C. Niemann, B. Ahrens, V. Brovkin, A. Baud, A. E. K. Ojala, A. Normandeau, et al. 2019. Human and climate global-scale imprint on sediment transfer during the Holocene. *Proceedings of the National Academy of Sciences* 116 (46):22972–76. doi: 10.1073/pnas.1908179116.

Kaika, M. 2018. Between the frog and the eagle: Claiming a "scholarship of presence" for the Anthropocene. *European Planning Studies* 26 (9): 1714–27. doi: 10.1080/09654313.2018.1484893.

Kallio, K. P. 2016. Living together in the topological home. *Space and Culture* 19 (4):373–89. doi: 10.1177/1206331216631290.

Kefi, S., V. Dakos, M. Scheffer, E. H. Van Nes, and M. Rietkerk. 2013. Early warning signals also precede non-catastrophic transitions. *Oikos* 122 (5):641–48. doi: 10.1111/j.1600-0706.2012.20838.x.

Laist, R. 2015. Why I identify as mammal. *New York Times*, October 24. Accessed October 24, 2019. https://opinionator.blogs.nytimes.com/2015/10/24/why-i-identify-as-mammal/.

Lewis, S. L., and M. A. Maslin. 2015. Defining the Anthropocene. *Nature* 519 (7542):171–80. doi: 10.1038/nature14258.

Lorimer, J. 2017. The Anthropo-scene: A guide for the perplexed. *Social Studies of Science* 47 (1):117–42. doi: 10.1177/0306312716671039.

Martin, L., and A. J. Secor. 2014. Towards a post-mathematical topology. *Progress in Human Geography* 38 (3):420–38. doi: 10.1177/0309132513508209.

Prager, S. D., and W. A. Reiners. 2009. Historical and emerging practices in ecological topology. *Ecological Complexity* 6 (2):160–71. doi: 10.1016/j.ecocom.2008.11.001.

Robbins, P. 2020. Is less more … or is more less? Scaling the political ecologies of the future. *Political Geography* 76:102018. doi: 10.1016/j.polgeo.2019.04.010.

Saldanha, A. 2019. A date with destiny: Racial capitalism and the beginnings of the Anthropocene. *Environment and Planning D-Society & Space* 38 (1):12–34. doi: 10.1177/0263775819871964.

Savransky, M. 2019. The pluralistic problematic: William James and the pragmatics of the pluriverse. *Theory, Culture & Society*. Advance online publication. doi: 10.1177/0263276419848030.

Scheffer, M., S. Carpenter, J. A. Foley, C. Folke, and B. Walker. 2001. Catastrophic shifts in ecosystems. *Nature* 413 (6856):591–96. doi: 10.1038/35098000.

Stallins, J. A. 2012. Scale, causality, and the new organism–environment interaction. *Geoforum* 43 (3):427–41. doi: 10.1016/j.geoforum.2011.10.011.

Steffen, W., J. Rockstrom, K. Richardson, T. M. Lenton, C. Folke, D. Liverman, C. P. Summerhayes, A. D. Barnosky, S. E. Cornell, M. Crucifix, et al. 2018. Trajectories of the Earth system in the Anthropocene. *Proceedings of the National Academy of Sciences* 115 (33):8252–59. doi: 10.1073/pnas.1810141115.

Stephens, L., D. Fuller, N. Boivin, T. Rick, N. Gauthier, A. Kay, B. Marwick, C. Geralda Armstrong, C. Michael Barton, T. Denham, et al. 2019. Archaeological assessment reveals Earth's early transformation through land use. *Science* 365 (6456):897–902. doi: 10.1126/science.aax1192.

Sullivan, A. P., D. W. Bird, and G. H. Perry. 2017. Human behaviour as a long-term ecological driver of non-human evolution. *Nature Ecology & Evolution* 1 (3):1–11. doi: 10.1038/s41559-016-0065.

Thorn, C. E., and M. R. Welford. 1994. The equilibrium concept in geomorphology. *Annals of the Association of American Geographers* 84 (4):666–96. doi: 10.1111/j.1467-8306.1994.tb01882.x.

Wells, J. 2018. Mind the gap: Bridging the two cultures with complex thought. *Ecological Complexity* 35:81–97. doi: 10.1016/j.ecocom.2017.11.001.

Zeeman, E. C. 1976. Catastrophe theory. *Scientific American* 234 (4):65–83. doi: 10.1038/scientificamerican0476-65.

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