indicators such as investment patterns and corporate practice, combined with their three lenses, to interpret the actual and potential effect of TCCG on climate change. This includes the contribution of TCCG to increased efficiencies, the way in which TCCG initiatives might scale up or catalyze further responses, and how they might change the terms of debate for action on climate change.

In terms of the contribution of TCCG to climate governance, the authors show that the normativity of TCCG initiatives has significant suasion on the practices and activities designed to respond to climate change; just as much as interstate governance. The authors claim this is almost certainly so in the case of cities, energy technologies, and carbon markets. The interactions between TCCG initiatives and state governance are also important. For instance, the Climate Registry's GHG reporting standards have influenced the design of state standards. Carbon offset initiatives have influenced certification within the Clean Development Mechanism and some city networks are recognized by the United Nations Framework Convention on Climate Change.[4]

The book's final chapter concludes the discussion by looking beyond TCCG. In particular, the authors relate their research on TCCG initiatives to existing and potential research agendas in transnational relations, climate change, and environmental governance. They end on a positive note by highlighting the new opportunities TCCG may present, not as a panacea or even a substitute for state action, but as an emerging normative framework and set of practices that are likely to continue to grow.

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Global Environmental Governance, Technology and Politics: The Anthropocene Gap,
by Victor Galaz
Edward Elgar, 2014, 208 pp, £70 hb, ISBN 9781781955543

Earth has entered a new geological epoch known as the Anthropocene that is characterized by rapid nonlinear global environmental change.[5] What is unique about this new epoch is that, for the first time in Earth's history, a single species has

[4] New York, NY (US), 9 May 1992, in force 21 Mar. 1994, available at: http://unfccc.int.

[5] See, e.g., P.J. Crutzen, 'Geology of Mankind' (2002) 415(6867) *Nature*, p. 23; W. Steffen et al., *Global Change and the Earth System: A Planet under Pressure* (IGBP Secretariat, 2004); W. Steffen, P.J. Crutzen & J.R. McNeill, 'The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?' (2007) 36(8) *Ambio*, pp. 614–21; W. Steffen et al., 'The Anthropocene: From Global Change to Planetary Stewardship' (2011) 40(7) *Ambio*, pp. 739–61; W. Steffen, J. Grinevald, P. Crutzen & J. McNeill, 'The Anthropocene: Conceptual and Historical Perspectives' (2011) 369(1938) *Philosophical Transactions of the Royal Society A*, pp. 842–67.

become a major geophysical force that drives the change. We have posed extreme risks to the biosphere on unprecedented spatial and temporal scales, which in turn have put us in danger. In *Global Environmental Governance, Technology and Politics: The Anthropocene Gap*, Victor Galaz presents an authoritative view on how we might sensibly approach Earth system complexity and navigate safely through the Anthropocene.

A key argument in Galaz's book is that we are currently in what he calls the Anthropocene gap – a time when we are struggling to comprehend, analyze, and respond to the major implications of humanity's transgression into the new epoch. Here, our mental models are being challenged by the complexity, scale, and speed of global environmental change (the cognitive gap). Our analytical approaches are increasingly failing us as we gain insights into Earth system dynamics (the analytical gap). Our political institutions are unable to respond effectively to novel risks and opportunities induced by the advancements in technology (the political gap).

The realization of these cognitive, analytical, and political gaps leads to three key governance puzzles that run through the book. They are, firstly, what might characterize the ability of international institutions to detect and respond to global human-environmental surprises of great importance to human well-being? Secondly, are international institutions able to address complex Earth system interactions, or should we instead put our faith in the emergence of polycentric approaches? Thirdly, is a governance setting possible that is strong enough to 'weed out' technologies that carry considerable ecological risk, but still allow for novelty, fail-safe experimentation, and continuous learning?

These questions are explored in the book through a resilience lens. This particular analytical lens is suggested to be most appropriate for the purpose because non-linearity, scale, politics, and technology make current discussions about governance in the Anthropocene different from conventional sustainability discourses such as the limits to growth. Galaz argues that, in a complex human-dominated world, the narrow focus on the need to reduce the pressure on natural resources by, for example, minimizing waste is inappropriate. The emerging discourse of the Anthropocene rather requires us to treat the Earth system as a complex adaptive system and steer away from interacting planetary tipping points. Such an analytical approach has wide implications for managing the challenges that characterize the Anthropocene. For political scientists like Galaz, it allows one to identify a governance configuration best suited for experimentation, learning, and change – thereby enhancing the resilience of social-ecological systems at all levels.

The book proposes two intertwined tasks as a possible way forward to enhance the ability of institutions to deal with Earth system complexity. One is to address the 'problem of fit', as conceptualized by Oran Young and others,[6] by exploring the

[6] See, e.g., O.R. Young, *The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale* (The MIT Press, 2002); V. Galaz et al., 'The Problem of Fit among Biophysical Systems, Environmental and Resource Regimes, and Broader Governance Systems: Insights and Emerging Challenges', in O.R. Young, L.A. King & H. Schroeder (eds), *Institutions and Environmental Change: Principal Findings, Applications, and Research Frontiers* (The MIT Press, 2008), pp. 147–82.

underlying and multidimensional institutional architecture and its ability to 'fit' the behaviour of a complex Earth system. The other is to explore the role, potential, and limitations of polycentric order and international actor collaboration processes in coping with the complexity. Polycentricity is the keyword here. It seems that, through this work, Galaz wanted to empirically test whether polycentric approaches, as put forward by Elinor Ostrom and others,[7] are the answers to complex problems of the Anthropocene. In the end, Galaz provides theoretical insights related to the ability of governance (including institutions and networks at multiple levels) to cope with human-environmental complexity and connectivity on multiple spatial and temporal scales.

Overall, Galaz concludes that a governance setting that allows fail-safe experimentation and continuous learning is conceivable if complemented by ingenuity, recognition of the socially contested nature of emerging technologies and international experimentation with 'natural' systems, and a governance focus on polycentricity. He finds that polycentric approaches entail a number of properties that can help to overcome institutional fragmentation and segmentation, which is a legacy of environmental reductionism that still prevails in our mental models. For example, polycentric systems can support communication across sectors and levels; help to coordinate action which builds adaptive capacities; and provide a setting for experimentation and learning. However, polycentricity is not presented as a panacea. Galaz observes that polycentric approaches face problems if causal beliefs are contested, issues become conflictive as a result of diverging interests, or political circumstances change. Therefore, 'polycentric approaches cannot replace, but rather complement international institutions in important ways' (p. 142).

In terms of the structure of the book, Galaz proceeds as follows. The introductory chapter provides an overview of the scientifically and politically contested Anthropocene debate. To Galaz, what is critical is not whether the Anthropocene strictly qualifies as a new geological epoch or not, but how this new Anthropocene debate affects political discussions about global change, sustainability, and governance, and how to analytically engage with the institutional and political challenges in the Anthropocene era. In support of this exploration, Chapter 2 delves into the nature of the governance challenges posed by complexity using three key characteristics of complex systems – namely thresholds, surprises, and cascading effects. Chapters 3 to 6 present case studies of governance of four different complex systems. Chapter 3 focuses on the challenges posed by the interlinked tipping elements in the Earth system, and how we can come to grips with Earth system complexity from an analytical perspective. Chapter 4, on epidemics and supernetworks, focuses on detecting and responding to 'surprises' in a timely and adaptive manner. In Chapter 5, Galaz explores regulatory gaps and the complex actor constellations in geoengineering, and the poorly understood trade-off between

[7] See, e.g., E. Ostrom, 'Coping with Tragedies of the Commons' (1999) 2 *Annual Review of Political Science*, pp. 493–535; T. Dietz, E. Ostrom & P.C. Stern, 'The Struggle to Govern the Commons' (2003) 302(5652) *Science*, pp. 1907–12; E. Ostrom, *Understanding Institutional Diversity* (Princeton University Press, 2005); E. Ostrom, 'Polycentric Systems for Coping with Collective Action and Global Environmental Change' (2010) 20(4) *Global Environmental Change*, pp. 550–7.

innovation and precaution in a new setting characterized by rapid and non-linear environmental and technological change. Chapter 6 explores another emerging technology with implications for our ability to govern global change in the Anthropocene – that is, algorithmic trade in commodity markets. Galaz concludes the book in Chapter 7 by revisiting each of the three dimensions of the Anthropocene gap (cognitive, analytical, and political) and the three governance puzzles.

Global Environmental Governance, Technology and Politics: The Anthropocene Gap eloquently links theory with rigorous analysis based on empirical evidence. Galaz makes effective use of real-world examples to capture the interest of the reader and aid understanding. The book certainly makes a significant contribution to ongoing debates about how humanity is to navigate through the Anthropocene. It provides food for thought for transnational environmental law scholars who are concerned about their potential role in relation to the broader framework of Earth system governance. As he powerfully demonstrates, the 'time is ripe for a very different discussion' (p. 146).

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