Social Learning in the Anthropocene:

Novel Challenges, Shadow Networks, and Ethical Practices

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Highlights:

• Social learning faces novel challenges in the Anthropocene

• Practices of shadow networks are key to social learning in the Anthropocene

• Social learning in the Anthropocene requires focus on ethical practices

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Abstract:

The Anthropocene presents novel challenges for environmental management. This paper considers the challenges that the Anthropocene poses for social learning techniques in adaptive management. It situates these challenges with respect to how anthropogenic forcing on the Earth system affects the conditions required for social learning with respect to: (1) The cooperative exercises of social learning; (2) The techniques used for assessing the fit of institutions to social-ecological systems; and, (3) The strategies employed for identifying management targets that are transformed by human action. In view of these challenges, the paper then examines how the practices of shadow networks may provide paths for incorporating a broader, more robust suite of social learning practices in the Anthropocene. The paper emphasizes how novel challenges in the Anthropocene demand increased attention to ethical practices, particularly those that establish center-periphery relationships between social learning communities and shadow networks.

1. Introduction

Social learning is a canonical part of adaptive management. Central aspects of adaptive management—learning-by-doing, taking an experimental view toward policy, and conducting *ex*

post evaluations—employ social learning to increase institutional capacity in preparation for the uncertainties and surprises inherent in the management of complex, adaptive systems (Holling 1978, Lee 1993, Gunderson and Holling 2002). Social learning is of particular relevance in view of the prospect that humanity has already, or is now on a trajectory to enter, the Anthropocene (see Waters et al. 2016). The Anthropocene is a "no analogue" situation (Steffen et al. 2004), in which human activity rivals "…some of the great forces of Nature in its impact on the functioning of the Earth system" (Steffen et al. 2011:843). Human transformation of the Earth system presents novel challenges regarding how previous markers of systems change, and previously successful adaptive strategies, are entangled with social-ecological crises (see Homer-Dixon et al. 2015). In terms of social learning, Hamilton et al. (2015: 5) argue the Anthropocene is so novel that no previous modes of "cultural learning or transmission" offer preparatory resources for adapting to this new epoch of geologic coevolution.

This paper responds to Hamilton et al. (2015) by showing how the form of social learning in adaptive management remains relevant to the Anthropocene. It then examines the novel challenges that the Anthropocene poses for social learning. These affect: (1) the difficulties of grounding cooperative experiments, (2) the influence of rapid change on how to assess the fit of institutions with social-ecological systems, and, (3) how adaptive management targets are not only moving, but also morphing under the pressure of anthropogenic forcing. The second half of the paper argues social learning in the Anthropocene sits at a nexus of scientific, social, and ethical considerations. It argues that geological novelty should prompt reflection on how learning communities themselves are understood. The paper contrasts two ways that learning communities have been framed with respect to the Earth system—one emphasizing the perspective of Earth system science in reconnecting to the biosphere and the other emphasizing

how resolving social inequality should center perspectives towards the Earth system. Using this contrast, the paper identifies an alternative in which shadow networks are key to both responding to the novel challenges of the Anthropocene and addressing structural social inequality. This alternative is both consistent with adaptive management's search for an "ethical core" (see Fennel et al 2008) and also presents a path for moving beyond theory to ethical practice. Further, it shows how claims regarding institutional norms must be grounded in communities of practice rather than in philosophical claims that frame the novel, quantitative aspects of the Anthropocene in ways that make a priori assumptions about the qualitative prospects for social learning.

2. The "Nature" of Social Learning

Hamilton et al.'s (2015) rejection of all previous modes of cultural learning in the Anthropocene sits amidst calls to overhaul fields of history, economics, and governance—even university systems generally—given that western thought historically presumed that humans are qualitatively distinct from nature (e.g. Biermann 2014, Brown et al. 2015; Castree et al. 2014, Lövbrand et al. 2015, Rousell 2016). A common assumption in these calls is that Anthropocene eliminates space for any conceptual dualism that separates humans from nature. Yet the implications of rejecting the society/nature dualism are far from agreed upon. For instance, there is considerable debate over how scientific determinations of geology intersect with the histories of social oppression that enabled anthropogenic impacts to accelerate at a geological scale (see Chakrabarty 2014, Lewis and Maslin 2015, Finney and Edwards 2016, Malm 2016). Notwithstanding these debates, the knock-on effect of eliminating the society/nature dualism is that the "normative and ethical underpinning" of environmental management must also be

reconsidered to the extent it relies on this dualism to justify management practices (Schlosberg 2016: 193). Yet, even if society/nature dualisms is jettisoned, Hamilton et al.'s (2015) rejection of all previous modes of cultural learning does not follow since many cultural learning practices did not employ a society/nature dualism in the first place (Schmidt et al. 2016). Adaptive management presents one such case.

C.S. Holling's (1973:21) classic work on resilience contrasted forms of management that seek to "harvest nature's excess production" from those that do not presume to know a priori what constitutes "nature's excess" and instead seek to prepare for the surprise events characteristic of complex, adaptive systems. Since then, cognates of "nature" (i.e. "natural variation") have frequently been mobilized in adaptive management, such as in the Golden Rule of adaptive management to "…strive to retain critical types and ranges of natural variation in ecosystems" (Holling and Meffe 1996: 334). In contrast to dualistic formulations of society and nature, however, Holling and Meffe (1996) followed Leopold's (1966) arguments regarding the interdependence of ecological communities to argue in favor of understanding social-ecological systems as interdependent.

Adaptive management's interdependent view of nature rejects society/nature dualisms in favor of an approach in which shared processes affect, and are affected by, social-ecological systems (Holling and Meffe 1996). Views of nature as process have several antecedents: Hannah Arendt (1958:150) argued that both the Latin and Greek roots of nature have processual elements where what is natural "…come[s] into being without the help of man, and those things are natural which are not 'made' but grow by themselves into whatever they become." Alfred North Whitehead (1957:53) famously refused modern dualisms before claiming that, "nature is a process." In a processual view, "nature" and its cognates refer to processes that operate

independently of human manufacture. In adaptive management, the persistence of such processes is part of what creates the possibility of surprise, such as when relationships transform in non-linear responses to disturbances (Holling 1986). Thus, while social-ecological systems exhibit high-degrees of interdependence, numerous processes persist independent of direct or full human control. A second aspect of adaptive management's processual view of nature is its flexibility regarding alternate social ontologies that refuse society/nature dualisms, such as the incorporation of indigenous knowledge regarding social-ecological dynamics like fire (Berkes 1999, Berkes et al. 2000, Aramatas et al. 2016). Of course, the fit of adaptive management with indigenous knowledge is neither straightforward nor uncontested given the historical, structural, and political dynamics of knowledge production (see Nadasdy 2005, Cameron 2012). These difficulties, however, are not due to a society/nature dualism per se.

A processual view best explains three aspects adaptive management's approach to nature and its cognates. First, a processual view both rejects society/nature dualisms and maintains that complex, adaptive systems are characterized by change—processes can operate independently of, and be affected by, human activity (Holling 1986). Second, a processual view befits resilience-based approaches to ecology by connecting social and ecological systems through processes that affect interdependent relationships (Holling 1973). Once seen in processual terms, defining resilience as the capacity of a system to respond to disturbances while still retaining its functions and feedbacks orients attention to the processes that may cease or shift due to human interference (Folke, 2006). Third, processual views approach "nature" empirically, at temporal and spatial scales relevant to experimental approaches to environmental management (Folke, 2003, Folke et al., 2005).

A processual view of nature is also critical to understanding social learning in adaptive management, which began from the premise that, "…however intensively and extensively data are collected, however much we know of how the system functions, the domain of our knowledge of specific ecological and social systems is small when compared to that of our ignorance" (Holling 1978:7). As Walters (1986:8) argued, social learning is an iterative ideal that, "…probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity." Indeed, identifying the mismatch between the known and the unknown has been a constitutive aspect of how adaptive management distanced itself from 'command-and-control' approaches to resource management and their: (1) dualistic treatments of society from nature; (2) separate, often exclusive strategies employed for controlling resources; and, (3) assumptions that ecological systems respond in linear fashion to disturbances (Folke et al. 2002). By contrast, social learning in adaptive management is both an iterative process that seeks to understand the processes affecting social-ecological systems and an interrogative exercise that seeks an experimental basis for decision-making (Walters and Holling 1990).

3.1 Social Learning and Anthropocene Challenges

Adaptive management's processual view of "nature" avoids critiques of society/nature dualisms, but social learning in the Anthropocene still faces challenges due to the novel ways that anthropogenic forcing affects processes at the scale of the Earth system (Steffen et al. 2015a, 2015b). Indeed, the Anthropocene troubles the very notion of "natural variation" whenever planetary boundaries are surpassed in ways that potentially transform key processes of the Earth system (Rockström et al. 2009). As developed below, when processual views of nature are

affected by anthropogenic forcing on the Earth system, social learning must extend to consider how the feedbacks between experimental management techniques and social-ecological systems are understood.

Broadly, social learning encompasses the varying scales of agency, competence, time, and resources available to decision makers (Gunderson et al. 1995). Typically, social learning is understood through three distinct but related registers: (1) Single-loop learning, which targets routine mistakes made in resource management; (2) Double-loop learning, which includes the above but also extends to an examination of the rules, norms, and underlying values that legitimate management institutions; (3) Triple-loop learning, which includes both of the above and also examines governance structures and design constraints on institutions and decision making (Pahl-Wostl et al. 2007, Armitage et al. 2008). Historically, adaptive management faced criticism regarding how to navigate specialized languages of different disciplines, different institutional cultures, and entrenched power relations (McLain and Lee 1996). And although resilience has moved from metaphor to a measured dimension of ecosystem function such that social learning is increasingly able to be oriented to the outcomes of management experiments (Carpenter et al. 2001), ambiguities remain regarding "if, who, how, when and what type of learning actually occurs" (Armitage et al. 2008:87).

Cundill and Rodela (2012) recently reviewed the evolution of social learning in adaptive management and its subsequent elaboration under adaptive co-management. Their assessment echoed others who argue that sustained deliberation, combined with improved institutional structures, are key to social learning (i.e. Norton 2005). Cundill and Rodela's (2012) review, however, did not consider the two predominant theoretical dispositions toward social learning: the systems perspective of Senge (2006) and the psychological perspective toward individual

learning and "communities of practice" (Bandura 1977, Wenger 1998). These different dispositions are critical for situating social learning in the Anthropocene because they bear on how processes themselves are conceptualized within and across social-ecological systems.

From the systems perspective (i.e. Senge 2006), adaptive, learning organizations increase capacity to affect their futures by relying on deeply embedded goals and values. This perspective relies on broadly held norms, cultural practices, and other social facts (e.g. land tenure systems) maintained by a community to test social learning hypotheses (see Folke et al. 2005, Berkes 2009). From the psychological perspective, social learning is concerned with how individuals observe, symbolize, communicate, and effectively learn from the external environment (Bandura 1977). This individualized focus was criticized, however, for not recognizing how humans learn socially (Pahl-Wostl and Hare 2004). Subsequently, Wenger's (1998) "communities of practice" considered how social rules affect learning; a focus that fits with emphases on collective learning, institutional memory, and the reciprocal processes affecting complex systems and governance structures (Ohlsson et al. 2004, Sinclair et al. 2008, Wyborn 2015).

Both systems and psychological approaches to social learning face new challenges in the Anthropocene because the expected ranges and variability of social-ecological systems present novel conditions. These challenges are not simply variants of the "wicked problems" that arise due to the intersubjective and interdependent dynamics of complex problems. For Rittel and Webber (1973), "wicked problems" demanded extended argumentation to reach plausible judgments because rational problem formations (i.e. a general theory of planning) were not available. But this solution to wicked problems presumes upon stable conditions for reaching judgments over time, while environmental management in the Anthropocene does not have this luxury. Rather, social learning challenges in the Anthropocene are more like puzzles, or "super

wicked problems" (Lazarus 2009, Levin et al. 2012), because the conditions for addressing management challenges emerge through the practices used to simultaneously frame and delimit the problem-solving domain. As the examples below show, this requires a constructive ethic that can foster new practices of collaboration under novel conditions (see Montuori 2011).

3.2 Cooperation

Cooperative deliberation is central to social learning because individuals, organizations, and groups frequently differ not only in their attitudes, but also in their practices for understanding complex systems and in envisioning possible futures (Robinson 2003). Power relations inflect how these differences are understood and, in turn, affect deliberative forums for social learning (Parkins and Sinclair 2014, Berbés-Blázquez et al. 2016). Stakeholders with the ability to set agendas or guide collaborative discussions, for instance, have the power to frame issues and procedures to their advantage (Ottinger 2013). Without downplaying issues of power, it is also important to also consider how, within adaptive management, focal issues are expected to "emerge from negotiation among participants in the planning process" and, in so doing, define the system of interest in social learning exercises (Peterson et al. 2003:361). Typically, these types of negotiations assume agreement on background levels of natural variation. That is, the enabling condition for cooperation is that participants hold some system or set of variables constant enough to cooperate regarding the aims or options of a particular policy. For example, a condition of collaborative watershed planning is agreement regarding expected natural variation of spring freshets, which allows focal issues regarding flood plain management to emerge from cooperative exercises (see Sabatier et al 2005). Stable ranges of variability are part of the

conditions for compromise and negotiation because they allow ideas to be tested based on the assumption that, should they not succeed, alternative proposals can be tried.

In the Anthropocene, however, fundamental assumptions about the speed and scale of changes affecting a system or set of variables cannot be held constant. The natural variation of spring freshets, for instance, may no longer function as a premise that participants can presume upon if the processes affecting hydrological variation are put in flux by climate change. As Milly et al. (2008) argue, anthropological forcing on the global water system undermines a key assumption of hydrology regarding the outer limits of natural variability—stationarity—which has historically been relied on to estimate the probability and range of water events, such as 500- or 1000-year flood events. In this case, without the background assumption of hydrological stability, social learning exercises cannot assume that focal issues will emerge from negotiations in a way that allows for ideas to be tested over time. This is not because cooperative negotiations stop working, but because the conditions for such negotiations have fundamentally changed.

Second, although cooperation seems an intuitive way to define spatial or temporal boundaries for social learning experiments in the Anthropocene, it may have the counterintuitive result of reproducing the problems of command-and-control management adaptive management seeks to avoid. To continue with the water example: In deliberative exercises, water planners often cannot decide how to incorporate large-scale uncertainties like climate change into future scenarios (Schmidt 2014). If in an effort to do so, however, planners choose to focus on one or a small set of variables as a proxy indicator for climate change, this could come at the expense of learning about system change. In this case, cooperatively agreed upon proxies may reproduce problems structurally similar to ‘command-and-control’ management regimes wherein management targets are selected based on norms and values that may or may not reflect system

dynamics. To be sure, complex social-ecological systems are inevitably simplified in any management exercise, whether through forms of representative participation that reduce the number of participants or choices regarding which dynamics of ecological systems factor into decisions. Simplification, however, is only part of the challenge. In the Anthropocene, the lack of a natural framework for cooperation—reliable processes for estimating "natural variability"—presents a puzzle regarding how to establish the conditions for judging how to simplify complex systems in management exercises.

3.3 Institutional Fit

A second puzzle for social learning in the Anthropocene relates to how ecological systems are continually changing as part of co-evolutionary processes. From this premise, adaptive management has often inferred that social learning requires multiple iterations of experimentation to determine the scale of ecological changes and that flexible institutions are those that are good at identifying signals of change (Holling 1996). So, notwithstanding present uncertainties, the way forward in social learning is to find a way to choose between the various hypotheses that could explain the gap between observations and reality while recognizing that developing techniques to this end takes time (Walters and Holling 1990). There is considerable work on "institutional fit" as a way to match institutions to the temporal, spatial, and social scales of management problems (e.g. Epstein et al 2015, Cumming et al 2013). As Bromley (2012) argues, however, social learning is not necessarily coincidental with revisions to either management institutions or the science used to identify problems, but rather with how "rules to live by" are crafted, tested, and revised through experience. Here another puzzle arises.

In the Anthropocene, it is not as though we cannot make or test claims, update our beliefs, or transition to new institutional formations. Rather, it is that testing "rules to live by" lacks normative warrant for establishing "fit" between management institutions and social-ecological systems to the extent that novel scales and speeds of change generate new kinds of misalignments. Consider another example from hydrology, where initial climate change models predicted larger rainfall events due to the increased water storage of a warmer atmosphere. Yet, for several decades, observations didn't match expectations. In this case, however, the late arrival of intense rainfall events was not the result of a natural 'lag' in climate-hydrology dynamics but the outcome of human injected aerosols in the atmosphere initially buffering against heavy rainfall events. As aerosols fell out of the atmosphere in the decades following air pollution regulations in the 1980s, rainfall patterns came into line with climate change predictions (Wu et al 2013). This produces a new kind of misalignment for making decisions because the gap between management institutions and social-ecological systems not only has to account for different interacting scales of surprise and uncertainty, (such as for estimating rainfall intensity in preparation for local flooding), but also with how the outer bounds of natural variability are affected by anthropogenic forces.

The problem of institutional fit in the Anthropocene is that it is unclear when to update beliefs versus when to hold onto existing beliefs or institutions. Such matters are issues of judgment—a dynamic already reflected by contests over what constitutes "good" versus "bad" outcomes in the Anthropocene (Dalby 2016). But the issue here is not about the normative implications of the epoch as a whole, but with what short- or medium-term lessons might imply for the prospects of long-term resilience. Surprise and uncertainty at the scale of the Earth system undermines the basis for conceptualizing "fit" as a technical process of experimental testing over

time. As the second half of the paper considers in closer detail, the place of judgment in social learning consequently places increased emphasis on how normative decisions are reached.

3.4 Morphing Targets

A third puzzle for social learning in the Anthropocene begins from the insight of adaptive management that carving out a particular scale for problem solving is often successful for narrow concerns but that this can complicate the management of larger systems (Holling and Meffe 1996). For example, management practices aimed at maximizing timber production may complicate the management of forest ecosystems (Langston 1995). Accordingly, learning from management experiments must likewise consider both positive steps to enhance resilience and negative considerations that avoid management criteria that may limit future adaptation given that social-ecological systems are moving, sometimes unpredictable targets (Carpenter et al. 2002). In the Anthropocene, however, the distinction between positive and negative effects is blurred, in part, because social-ecological systems are not only moving in response to human and non-human disturbances but also *morphing* as coevolution takes place within an Earth system subject to anthropogenic forcing.

Morphing social-ecological systems create concerns distinct from wicked problems—where inter-subjective differences arise over a putatively objective "nature." This is because challenges are not only epistemological differences about problem definition but also ontological: having to do with the kind of system social learning aims to understand. In particular, the Anthropocene challenges social learning's reliance on counterfactual scenarios regarding what might have taken place if no intervention, or some other intervention, were tested

in a management experiment (see Booth et al. 2009). Indeed, the Anthropocene challenges the assumption that there are any counterfactual scenarios in which anthropogenic activities do not affect social-ecological systems. In this sense, social-ecological systems in the Anthropocene are not only moving targets that, if undisturbed by human interference, can be expected to evolve within the ranges of variability typical of the Holocene. Imagine, for instance, a management experiment that involves leaving one area of a forest undisturbed and undertaking experimental activities in an adjacent plot. In the Anthropocene, both the experimental plot and the 'control' area are over-determined by human impacts on the Earth system, which blurs assessments of whether any particular intervention should be considered positive or negative to the extent that human impacts beyond the temporal or spatial scale of the social learning experiment cannot be eliminated or easily predicted. The creation of new categories to classify human-dominated landscapes, such as "novel ecosystems," provides a first step towards rethinking what kinds of social-ecological systems exist in the Anthropocene (Hobbs et al. 2013). The general challenge, however, is that counterfactual claims regarding what might have happened in the absence of a specific intervention gain limited purchase because social-ecological systems are not only moving, but also morphing under the pressures of an Earth system operating at the margins of, or outside, the bounds of natural variation.

3.5 Puzzles, Power, and Post-Normal Times

Social learning in the Anthropocene faces challenges regarding how to understand social learning with respect to cooperation, institutional fit, and the morphing nature of managerial targets. Further, the challenges for social learning in the Anthropocene often intersect in complex

ways, such that the solution for one area of concern often invokes the techniques of another. For instance, it at first appears promising to solve dilemmas of cooperation via institutional rules that work to shore up a shared basis for negotiation, but institutional fit is not straightforward either. In this sense, the Anthropocene fits with diagnoses of 'post-normal' times generally—times in which 'normal' working assumptions for understanding chaos, complexity, and contradictions have limited purchase (Sardar 2010, 2015).

Implicit in the foregoing discussion was how issues of power operate in the transitions associated with social learning in an era of global environmental change. Indeed, the choice to pursue experimental forms of adaptive management and social learning is saturated by discourses regarding how issues of complexity, uncertainty, and resilience should be understood given cultural differences and historical aspects of human-environment relations (cf. Nadasdy 2007). The remainder of the paper considers how these implicit power dynamics might be given explicit consideration through closer attention to the practices of communities at the periphery of the dominant networks affecting social-ecological systems. For many peripheral communities, the Anthropocene compounds the "post-normal" conditions that were initially created not by global environmental change, but by hegemonic communities whose political, social, and environmental practices disrupted customary ways of life.

4.1 Shadow Networks and Social learning in Anthropocene

How should the 'Golden Rule' of adaptive management be pursued given social learning challenges in the Anthropocene? This section contrasts two framings of learning communities with respect to the Earth system—one employing Earth system science to reconnect with the

biosphere, the other mobilizing different social perspectives towards the Earth system given social inequality. Using this contrast, it shows how the search for an "ethical core" for adaptive co-management must shift from a theoretical exercise to an empirical focus on ethical practices. The latter offers opportunities for understanding how the practices of non-hegemonic communities—shadow networks—bear on the challenges of social learning in the Anthropocene.

The quantitative novelty of the Anthropocene has prompted contrasting views regarding what this new epoch implies for understanding human-environment interactions. One view forwards "reconnecting with the biosphere," using Earth system sciences as an empirical point of departure (e.g. Folke et al. 2011, Rockström and Klum 2015). How to 'reconnect' varies: from calls for democratic, polycentric forms of governance to eco-socialist reorganization (Galaz et al. 2012, Biermann 2014, Angus 2016). It is not immediately obvious, however, that "reconnecting with the biosphere" provides a solution to the challenges raised above given that the production of knowledge associated with Earth system science may marginalize the practices of some communities regarding how the biosphere is to be connected to (Uhrqvist and Lövbrand 2014, Carruth and Marzec 2014). Cameron (2012), for instance, shows how colonialism continues to mute the struggles of Arctic indigenous peoples regarding climate change by rendering political concerns into technical terms that are amenable to forms of management that do not challenge structural injustices. Similar challenges exist in many development contexts (Li 2007). So, while reconnecting with the biosphere is a desirable end, there are many forms of disconnection and multiple pathways through which reconnection may proceed.

Escobar (2012) offers a second framework for connecting the Anthropocene to human-environment interactions by arguing that connecting scientific assessments of the Earth system to social policy should explicitly engage the contested narratives of "sustainability" previously used

to integrate environment and development. Yet this view also faces difficulties. For instance, Escobar approvingly cites Berry's (1999) arguments regarding the need to pursue a mutually enhancing "ecozoic" period of human-environment relations to confront prevailing "technozoic" norms that rely on human ingenuity to control and solve Earth system dilemmas. Yet, as Sideris (2015) has compellingly argued, efforts to craft new narratives of the Earth system often leave fundamental questions unanswered, such as whether these narratives actually matter for individual actions, or if they ultimately affect the practices through which individuals or groups make decisions. Because such practices are salient to social learning, gathering social inequalities under large narratives ought not be conflated with the cultivation of practices actually required for narratives to affect decisions. For instance, broad concepts like sustainability are shaped by social conflicts and global North-South politics where it is unlikely that any single framework will find uncontested consensus (Conca 2015).

Contrasting framings of learning communities in the Anthropocene raise questions for the search for an "ethical core" in adaptive co-management, which Fennel et al (2008) have previously conceived of through orientations to western philosophies regarding duties, existential responsibility, and the pursuit of teleological ends. Others have argued social learning fits the norms of American pragmatism regarding deliberative democracy and procedural fairness (Norton 2005). As Schmidt et al. (2016) argue, however, a focus on western ethical theories in the Anthropocene can marginalize social and scientific practices through which alternate norms are produced. As such, and in keeping with adaptive management's long association with Leopold (1966), an alternate is to return once more to the question of how the learning community is understood. Here, one alternative is to explore a less widely emphasized aspect of social learning associated with Wenger's (1998) communities of practice. Elsewhere, Lave and

Wenger (1991) examined the situated learning that takes place on the peripheries of hegemonic communities in order to understand how forms of peripheral learning condition both the manner in which entrance is gained to hegemonic communities (if entrance is gained) and the subsequent reorientation of social relationships once new actors and ideas are accepted. Attending to shadow networks does not attempt to subsume social learning communities in the Anthropocene wholly to those who must 'reconnect to the biosphere' under social conditions they may contest, nor does it require wholesale replacement of environmental narratives. Rather, it begins with how the production of hegemonic-periphery relationships are structurally entangled with social-ecological systems and then constructively creates space to understand how learning within shadow networks has previously taken place under the novel, if unequal disruptions to communities of practice that established and maintained hegemonic-periphery relationships.

4.1.1 Social Learning and Shadow Networks

Social learning in the Anthropocene can be approached in a manner similar to how peripheral learning communities operate in "shadow spaces," where efforts to enhance adaptive capacity are constrained by existing, hegemonic institutions and their social and political inertia (Pelling et al. 2008). Olsson et al. (2006) explored how "shadow networks" may provide fertile ground for new ideas and practices due to their relative freedom from the constraints faced by dominant institutions. Yet it remains unclear how or why these networks persist, falter, or flourish. That is, it is unclear what makes "shadow networks" a reliable alternative. Recently, Ingram et al. (2015) have argued for the importance of place-based narratives in understanding how 'shadow' communities establish, sustain, and learn about human, non-human, and ecological relationships

in the Anthropocene (cf. Lejano et al 2013). Their work attends to the alternate, subaltern social practices that make connections to the biosphere through the specific histories and struggles these networks draw upon—often in ways that contest the disturbances and injustices visited upon them (intentionally or not) by hegemonic networks.

Are there "shadow spaces" from which peripheral communities and learning practices may contribute to enhancing resilience in the Anthropocene? If so, how may these practices and the substantive goods held by communities now at the periphery be respected? Such questions highlight the deep social and political challenge of learning not only within the Anthropocene, but also with respect to the histories and power relationships that inflect relationships of hegemonic and peripheral networks. These concerns resonate with those Lövbrand et al (2010) identified regarding Anthropocene governance and normative choices regarding: (1) the societies *for whom* the Earth system is governed; (2) the distributive ethics and social relations of power through which different authorities undertake governance tasks; and, (3) the scientific contests regarding the degree to which it is either desirable or defensible to "manage" the Earth.

Incorporating the social learning practices of shadow networks requires a reconsideration, and extension, of communities of practice. It also necessitates recognition of how structural aspects of social-ecological systems can reinforce power inequalities between hegemonic and peripheral networks. Ostrom (2010) argued the challenges of global environmental change demanded a shift from exclusive focus on hegemonic institutions to increased attention on the polycentric, multi-scalar practices employed to cope with large-scale uncertainties. In order to make this step, it is necessary to see how multiple speeds of human domination inflect the Anthropocene; It is not only acceleration that matters but also the slower forms of violence that have accumulated historically (Nixon 2011). Explicit incorporation of multiple scales of harm

also enables work on ecohealth to connect hegemonic and shadow communities to the uneven power relationships that affect social learning (Berbés-Blázquez et al. 2014).

For example, in her landmark study of the Bhopal disaster, Fortun (2001) identified how different speeds of ecological effects were articulated by hegemonic versus peripheral communities. In the Bhopal case, hegemonic communities were (and remain) determined to use stakeholder models to address concerns through existing social, political, and legal institutions. These stakeholder models fit with hegemonic, 'epistemic communities' whose values, causal beliefs, and perspectives towards the validity of knowledge claims fit with those institutions (see Haas 1992). By contrast, Fortun (2001: 13) identifies the peripheral, 'enunciatory communities' that exist in the shadows and which are "both subjects of, and subject to" changes beyond their control. That is, peripheral communities are those on the weak side of power differentials for whom acute disturbances are set in the context of their chronic position at the periphery. Further, the experiences of these communities do not align with, and are not adequately accounted for by, the stakeholder models of the hegemonic group. A key practice of enunciatory communities identified by Fortun (2001), therefore, has been to articulate the effects of both ecological events and decision-making by hegemonic groups in ways that expose the highly variable and unequal contexts in which decisions are made and through which stakeholder models identify lessons learned. In so doing, enunciatory communities connect acute and chronic dynamics in ways that retain political cogency despite efforts to translate them into technical discourses.

The Bhopal example is one of many that highlight how enunciatory communities are critical for understanding how slow and accelerating human impacts shape institutions and networks at multiple scales, from local air pollution to international mining law (e.g. Ottinger 2013, Kirsch 2014). Here, the metaphor of the "shadow" has a dual role. The shadow is not only

cast by an improved scientific understanding of epistemic communities arguing for reconnection with the biosphere, but is also cast by structures of inequality that enabled forms of acceleration to capitalize on histories of social domination and to push enunciatory communities to the periphery. The challenge of social learning in the Anthropocene, then, is to revisit the very notion of community. Indeed, this recalls Holling and Meffe's (1996) appeal to Leopold (1966), and his call to extend moral consideration beyond hegemonic human communities in appreciation of the interdependence of ecological systems. The challenge in the Anthropocene, however, is that there are multiple ways in which communities of practice may pursue social-ecological care. As such, there are critical implications of pursuing any hegemonic view of normativity—such as those that prioritize western ethical theories—at the expense of communities on the periphery. To take seriously these multiple practices is precisely to learn about the full range of social-ecological challenges in the Anthropocene in a context where the processual basis for understanding natural variability are uncertain.

5. Conclusion

Social learning in the Anthropocene must expand to consider how social structures condition and shape hegemonic and peripheral communities of practice. As many scholars have shown, scientific practices intersect in complicated ways with social order (Jasanoff 2004, Seidl et al. 2013, Lövbrand et al. 2015). The challenge in the Anthropocene is to seek out communities of practice that have been marginalized and to collaboratively reconcile learning practices in ways that co-create the conditions for social learning in a just manner (cf. Bennett et al 2016). This requires allocating the resources of constructive engagement to techniques that align the

creativity demanded by the novelty of the Anthropocene with practices that address inequality. This is not only valuable because it provides additional resources for dealing with novelty. It also anchors the normative core of adaptive co-management in practice; it respects the practices already navigating uneven landscapes in which slow and accelerated violence cumulatively affect the Earth system. In so doing, it allows the reconsideration of the "normative and ethical underpinnings" of environmental management (Schlosberg 2016) to address the conditions required for social learning. This allows social learning to heed the warning of Bernard Williams (1985:172) regarding the limits of ethical theorizing—that even a society emphasizing 'experiments in living' does not necessarily increase "the chances of living in the best way. It is one sort of society rather than another, and there are various forms of living that it rules out; indeed, those ruled out could include those most worth living."

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