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Transcending Ontological Schisms in Relationships with Earth, Water, Air, and Ice

SIRI VELAND

Institute at Brown for Environment and Society, Brown University, Providence, Rhode Island, and Macquarie University, Sydney, New South Wales, Australia

ABSTRACT

Ontological separations made between earth, water, air, and ice can surreptitiously produce high-risk outcomes in environmental policy processes. Where legislation, risk assessments, land rights, or governance is based on unacknowledged schisms between Earth elements, they produce epistemological blind spots that unwittingly prevent asking critical questions of policy processes and render important connections invisible. This paper investigates a series of cases in which ontological schisms within Earth materials and knowledge systems have or may produce surreptitious outcomes. The article considers a diverse array of examples including managing environmental change in Australia, negotiating mining leases in Papua New Guinea, governing the ice edge in Norway, and climate change in the United States. Each case is presented as an illustration that unsettling ontological boundaries between Earth materials, that is, making their identification and definition an explicit component of land and sea policy and governance, lowers the risk of policy failure. The paper finishes by asking how environmental management might be shaped by relational ontologies. Some possibilities offered through transdisciplinary and adaptive management approaches are promising for intercultural collaboration, but this paper suggests a transformation is needed in how we consider our relations with each other and with Earth systems under rapid change. A new method or framework may be insufficient, and new ways of relating may be required. Acknowledging uncertainties in fundamental categorizations and structures can open discussions to ask novel questions of our relationships with Earth systems and imagine solutions to environmental crises and injustices.

1. Introduction

Why consider ontologies of Earth systems? The concept of ontology belongs to philosophy as the "logic of being," to metaphysics, and perhaps to other more abstract and theoretical discussions than those concerning Earth systems. The work that inspires the topic of this paper—considering relations between humans and earth/Earth[1]—requires recognition that Earth does not present itself passively to our attention. Hugh Brody (2001) showed that as we move through childhood and adult life, the world we come to know results from a dialectic between the things we experience and the words and stories we learn about them. We come to assume that our understandings of time, space, and place are variable and changing expressions of a secure set of underlying phenomena that present themselves to human observation impartially and universally. The separate nature of earth, water, air, and ice appear to come from the very creation of the world for those raised in such traditions (Brody 2001), rendering alternative understandings seemingly illogical, misguided, invisible, or at least abstracted. We derive a foundational sense of security from having our understanding of how the world works confirmed and justified in the unfolding of the world, a sense Anthony Giddens (1984) speaks of as ontological security. We defend the stories of our experience, even in the face of unsurmountable evidence (Beck 2009). Yet as a now well-established body of work shows (Haraway 1988; Mol 1999; Brody 2001; Nagar 2003; Law 2004; Howitt and Suchet-Pearson 2006; Ingold 2006; Barad 2007; Coole and Frost 2010; Bennett 2009), insisting on possessing an understanding of natural processes free of human subjectivity is hubris. Our

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[1] For the purposes of this special issue, I distinguish Earth and earth as planet and element, respectively.

Corresponding author: Siri Veland, siri_veland@brown.edu

concepts and vocabulary might claim to describe the world "as it is," its ontology, but they are equally epistemic, our means by which to explore, discover, and act in the world (Barad 2007). As this insight has been rehearsed in research on cross-cultural, gendered, interspecies, and technological relations over the past decades, the key insight is not that we need to respect and make room for alternative worldviews and the more than human, although of course that continues to be both a driver and outcome of that research. Rather, the key lesson of such work has been the need to understand how diverse practices emerge, entangle, and engage Earth systems (Barad 2007; Yates et al. 2017; Brondizio et al. 2016).

Ontological schisms are moments at which assumedly secure ontological categories become incommensurate across practices, or they fail to find purchase in the world. They occur where the expectation of clearly defined concepts describing a world of stable phenomena falls short. In the meeting between unfamiliar social customs, culturally contingent concepts and definitions might come together in messy and unpredictable ways (Howitt and Suchet-Pearson 2006; Law 2004; Howitt et al. 2013), or researchers and policy-makers might employ conceptual tools that fail to describe the world in a way that permits safe and sustainable decision-making (Veland and Lynch 2017). In thinking the earth, assumedly secure understandings of the nature, presence, and behavior of Earth materials are inextricably linked to their leasing, purchase, management, and study. Increasing attention to surreptitious risks resulting from such assumptions reveals shortfalls in efforts to treat exposures to hazards, achieve justice, or develop comanagement in diverse settings. It is becoming clear that assuming a common understanding of Earth system building blocks and processes compounds risks (Howitt et al. 2012; Veland et al. 2013).

What might rethinking Earth and rethinking the earth entail for resource and environmental policy in the twenty-first century? In this paper, I work from the epistemological role of discourse. I highlight ontological schisms, but with the aim of suggesting that bringing attention to such schisms opens opportunities for coexistence between knowledge systems and practices, and lowers the risk of failed or unjust policies (Howitt et al. 2013). Such effort counters epistemological bias, which in research and policy risks failure if unchecked, and in cross-cultural contexts results in deep colonizing—the perpetuation of cultural erasure under ostensibly liberating ideologies (Rose 2004). Based on ethnographic field work and literature review, in this paper I examine "earth" in several guises—as the geomorphology of climatic change in northern Australia, as

distinct from water in the Aboriginal Land Rights (Northern Territory) Act of 1976, as a polygon on a cadastral map of Papua New Guinea mining leases, as solid ice in Norwegian ice edge jurisdictions, and as a dynamic element of loose conglomerate permafrost, ice, and sea on the Alaskan North Slope. The concern of each case is the Giddensian ontological security assumed by decision-makers, local residents, and researchers as they seek to weave their interests and identities into Earth processes. To conclude, I explore how resource and environmental policy processes work through relational ontologies of Earth—taking its nature not as predefined but as relationships to be shaped and engaged though research and policy process.

2. Earth and water "Dreaming"

Inalienable freehold title secured through the landmark Aboriginal Land Rights (Northern Territory) Act of 1976 recognizes the prior presence and rights of Aboriginal peoples on ancestral lands in the Northern Territory of Australia. In securing these rights, what has become known as the Woodward Commission recommended in 1974 that Aboriginal reserve land in the country's Northern Territory should be handed over to "traditional owners" (Rowse 2000). The ensuing Land Rights Act of 1976 then ensured other land could be claimed if there was evidence for the continuity of Indigenous Australian culture. The following engagements with anthropologists to help build cases for land rights cases, and to help mining companies negotiate with traditional owners, opened the doors for a new era of academic, public, and corporate engagement with Australia's First Peoples (Howitt 2001). In the translation into English concepts of space, time, and place, much meaning needs to be negotiated. For instance, the idea of Dreaming, the space–time of Indigenous creation myth, has been critiqued as a poor translation, which drives Stanner (2009) to suggest *everywhen* may be more appropriate, though it is not in wide use. The concept of dreaming invokes processes occurring in sleep or altered consciousness, but the creation invoked in Dreaming is an ever-present and ongoing process (Rose 2004). Similarly, in an effort to better work across cultures in natural resource management, the approach of "caring for country" became part of government policy in 1996 (Altman and Whitehead 2003; Zander et al. 2013). The idea of "country" is in this context not just the physical features of a landscape, but a cosmological space in which relationships with Earth are engaged according to Indigenous laws and traditions (Rose 2004).

In European tradition, property rights are recognized down to the high-water mark. The separation between

land and water is the Dreaming of Australian common law, Allen (1994) argues, inherited from Abrahamic traditions in which God separated land and water on the third day—a divide originating in the very making of the world (Muller 2008). This understanding of Earth is so assumed and unquestioned that anthropologists working in the Northern Territory from 1921 to 1977 all failed to recognize that their research partners did not separate the earth and sea (Peterson and Arthur 2005). Allen (1994, p. 58) writes ''the absence of any exclusive, private property in running water and the sea is constructed not merely as a convenient social rule: it is seen as originating in the law of nature, it stemmed from the inherent character of the worlds and the elements of creation.''

One way to understand this lack of separation is to consider that the low topography of Australia's ''top end'' contributes to vast tidal plains, and that wet season rainfall inundates immense swaths of savannah woodlands each year. Additionally, sea level rise since the end of the last ice age 10 000 years ago has caused kilometers of coastal areas to be inundated. These changes appear to be recorded in Dreaming trails, stories of creation, kinship, and law that follow the path of ancestors across the coast of northern Australia. These trails continue to follow the topography of terrain now extending tens of meters below current sea level (Flood 1983; Veland et al. 2013; Nunn and Reid 2015). In the canons of Earth science, it can be said that the daily, annual, and millennial inundation of Australia's top end finds expression in a cosmology that does not separate earth and water (Muller 2008; Jackson et al. 2005; Allen 1994). Engagements with and responsibilities for these places continue to form intrinsic parts of living identities across northern Australia. In following Eurocentric ontologies, the Land Rights Act perpetuates an epistemological bias in the legislation that continues to render invisible Aboriginal engagements with diurnal, seasonal, and millennial changes to the morphologies of Australia's north (Muller 2008).

Making some concession, the Australian High Court in 2008 ruled in favor of Yolngu claimants in the Blue Mud Bay case (Gawirrin Gumana and Ors v. Northern Territory 2008). The Court affirmed that Aboriginal traditional owners possess exclusive title to the intertidal zone and its resources, providing a first step toward recognizing Indigenous relationships with marine environments (Veland et al. 2013). Because this decision affects all Aboriginal lands, 80% of the Northern Territory intertidal zone is now under the control of Aboriginal Land Councils. This constitutes perhaps the greatest advance in Aboriginal rights since the 1994 Mabo Decision (Mabo v. Queensland 1994) that ended

the doctrine of *terra nullius* (empty land). While the Mabo case has ''moved very slowly without upsetting the status quo with respect to water rights'' (Poirier and Schartmueller 2012, p. 323), the Blue Mud Bay court decision stepped beyond the affirmation of the prior existence of Indigenous rights to ancestral territories: it also respected Aboriginal cosmologies and their alternative ontologies of Earth processes. While only extending down to the low-tide mark, this landmark legislation shows that reconsidering fundamental categories of Earth systems to accommodate ex-Eurocentric experience, and to reflect these in law, can be achieved.

3. Geomorphologies of climate change in northern Australia

The challenge of seeing, hearing, and attending to ontological pluralism (Howitt and Suchet-Pearson 2006) arises most acutely in situations where the aim is to reduce risks of negative impacts from perceived hazards (Veland et al. 2010; Howitt et al. 2012). Responding to climate-related hazards through climate science, adaptation, and emergency management has been a key concern for federal and territory governments for a decade. In the urgency to respond to threats, apparently intangible perceptions of risk may recede to the background of concern, whether in the mind of scientists, emergency responders, or persons of particular religious or cultural orientation (Veland et al. 2010, 2013; Howitt et al. 2012). This section draws on my own ethnographic research on climate-related hazards in northern Australia, where attention to change adaptation and emergency management might compound socioeconomic and cultural risks (Veland et al. 2013).

In a call for research in the region, a Northern Territory shire highlights the precariousness of remote Indigenous living under climate change, questioning the viability of some communities (S. Gamble 2011, personal communication). The IPCC (2007) similarly stresses the particular vulnerability of Indigenous communities because of their remoteness, low adaptive capacity, and early onset and irreversibility of environmental changes. Preparing for my visit to the Northern Territory coast, I had spent six months researching peoples ''on the frontline of our changing climate'' (Ford 2007, p. 42). I had learned of expected impacts to often dilapidated community infrastructures along low-lying coastal areas, and exposed to extreme climate-related weather events such as hurricanes and storm surges (IPCC 2007). I assumed that my arrival, as a researcher interested in the topic, would be a later development in these peoples' encounter with climate change. I expected that climate change as an empirical

phenomenon might be a point of conversation over which we could arrive at a cross-cultural understanding of how to treat climate-related hazards, to illustrate the need to act on climate change globally. Having sought out a location that from the point of view of the IPCC's (2007) vulnerability indicators defined vulnerability to climate change—Indigenous coastal settlements along remote, low-lying, and eroding shorelines, exposed to intense and frequent tropical cyclones, and exhibiting low socioeconomic performance—I was wholly unprepared for the experience of bringing the climate change story to the population. The assumption that climate-related risks in the canons of science would be immediately observable to persons in remote Indigenous communities did not hold. I had, however, prepared a reflexive methodology, and so I turned to challenging conventions of what environmental change is, and how it should be managed.

This lesson came immediately after landing on my first visit to Warruwi (or Goulburn Island) in 2007, located about 200 km northwest of Darwin, in the Arafura Sea off Arnhem, Northern Territory. As I sat down with the Traditional Owner, his first question to me was, "So, this climate change, what's up with that?" I was surprised. I had not been prepared to explain climate change, but I introduced my project and outlined why I was visiting. I mentioned the region's vulnerability to climate, drawing on the IPCC indicators set out above, and outlined my interest in understanding changes from their perspective, and my concern to influence how the government and emergency services might plan for future risks. He appeared taken aback by my weaving the climate change story into this place. He smiled and said that climate change was happening in the Arctic, but that I might be able to speak with Elders about climatic changes they had seen on the island. In open-ended interviews, participants spoke of some changes to the seasonal calendar and retreating shorelines. The fieldwork turned from attending only to the impacts of a predefined process of climate change, to collaborating with people on Goulburn Island to map out the cultural contingency of climate change—who defines it, with what perception of risk, and for what purpose.

The ontological schisms between my scientific understanding of climate change, and the hybrid ontologies in which Aboriginal people there live, became apparent during field visits. While visiting a bay in which reefs had been growing and limiting access by boat at low tide, my collaborators pointed to a spit to the west and told me of a sandbank that had disappeared some years earlier. As I asked about this place, they explained that it had a strong and secret Dreaming concerning merfolk, which continued to shape the morphology of the spit. Having heard researchers such as Josephine Flood (1983) linking such Dreaming with climate change since the last ice age, I immediately wondered if this story might represent sea level rise, coastal erosion, changing currents, or more broadly millennial climate change. My naïve question was met with an explanation that while these geomorphic processes might be present and relevant, the Dreaming is not a metaphor for climate change or other environmental science concepts. The changes associated with that place were simultaneously driven by climate change and by Dreaming. One cannot be discussed or managed without the other.

During another conversation, as an Elder drew environmental changes she had observed on a laminated satellite map, she pointed out one of her Dreaming sites as lying some 25 m below the sea. Again, this reminded me of Flood's (1983) accounts, and I asked whether she might agree her Dreaming could be an example of ice age geographies remembered in her story, as a metaphor representing sea level rise inundating the ancestral lands of the Arafura region over millennia. My interlocutor answered with a cautioning that while she appreciated my perspective, this was not what this place was. The Dreaming that narrates the dynamic processes shaping this location is not a metaphor of millennial climate change. The Dreaming is "really real," ongoing, and irreducible to myth. Yet her account did not subtract from recognition of, and interest in, the processes of rapid environmental change narrated by environmental science and environmental history. As I was taught, I learned the need to understand and incorporate such ontologies of environmental change.

"Seeing with both eyes" (Veland et al. 2014, p. 303) across the sciences and Indigenous cosmologies is familiar to persons in Aboriginal communities. Through schooling, work, bureaucracy, and healthcare, most have learned to work with "Balanda," or Western ways. The challenging recognition for professionals trained in Western science is that processes and expressions of environmental change exist within a cosmologically hybrid hazards context. It is hybrid because while there is a sense of "grafting" Indigenous cosmologies to the sciences, there is a sterility to the effort that perpetuates ontological schisms by continually repeating the need to insert Indigeneity into Western knowledge structures. Hence, as a Western researcher, the challenge of learning to see with both eyes was present only to myself, not to my research partners on Warruwi. A similar observation made by anthropologist Deborah Bird Rose (1996, p. 41) is that "virtually anything can be accommodated [in Aboriginal cosmologies], from tin cans to Toyotas," but, she cautions "everything must be accommodated according to the logic of country." The story of coastal

erosion from rising sea level and changing ocean currents can be accepted as "real," but it in no way negates other stories of environmental change. Correspondingly, scientific accounts of environmental change can incorporate the values of Aboriginal Dreaming, but only according to the logics of scientific inquiry. Science demands a single authoritative history that necessarily relegates Dreaming as folklore or "culture"—metaphors and imagery of what are "really" the science of Earth system processes of change. The schism ensues.

When mobilizing ontological categories unquestioningly into policy, the slow disaster of colonialism is perpetuated (Howitt et al. 2012; Veland et al. 2013). For instance, if adapting only to climate-related hazards, moving people out of the way of environmental risks may expose them instead to existential risks by severing cosmological relations with Dreaming. Colonialism is the process by which the thriving agency of the "more than human," however defined, within preexisting and ongoing cosmologies and forms of governance are excluded, marginalized, or denied in policy processes, in favor of agency that is condoned within imposed ways of seeing, knowing, and doing. The impacts of this denied relationship are then expressed as ill health, unemployment, low school completion, and other indicators of dysfunctional social relationships; here we come full circle, for these are mistaken for fundamental drivers of climate change vulnerability (Howitt et al. 2012). In the process of managing environmental risks, therefore, taking such vulnerability indicators as "really real" perpetuates colonialism by mistaking the symptoms for the cause. To simultaneously address environmental change and colonialism, planners must relate with the coexistence of multiple, dynamic, and juxtaposing cosmological contexts that challenge and transcend academic boundaries of knowledge production about morphological changes to coastal areas. The climate change story I brought to Warruwi found purchase in their observation and interpretation of Dreaming and changes to the morphology of the earth, and engaged attention to rapid Earth system change. Permitting Dreaming to engage in fertile exchange with science and governance presents a much greater, if not insurmountable challenge.

4. Air, ore, and Earth in Papua New Guinea

Self-determination and land rights have driven industrial and government investment in improved cross-cultural understanding (Howitt 2001). In finding the need to negotiate mining leases with Indigenous land holders, mining companies such as Rio Tinto and ConocoPhillips have developed particular skills in engaging Aboriginal Australian Traditional Owners, as part

of gaining access to resources [e.g., the West Arnhem Land Fire Abatement Project (WALFA) in 2006; Doohan 2013]. For instance, Rio Tinto's agreement with the traditional owners of the Argyle Diamond Mine in the East Kimberleys of Australia involves traditional smoking ceremonies for the Barramundi Dreaming that is the mine, cross-cultural training, and culturally sensitive work contracts (Doohan 2013). Such engagement remains to be achieved more equitably in Australia and in other nations (Imbun 2007). This section turns to existing literature on events leading up to the Bougainville Rebellion in Papua New Guinea and the handing over of sovereignty of the territory from Australia to the newly formed government around 1970, and cross-cultural miscues over the nature and significance of leasing the earth.

As the handing over of sovereignty to Papua New Guineans drew near, Australian government representatives and Papua New Guinea administrators were on a tight time schedule to set up the systems of the new government. In this same time frame, the Panguna mine lease was also being negotiated between land holders and Rio Tinto. Rio Tinto negotiators used maps to determine the extent of copper ore around the township of Bougainville, and to make agreements with town representatives over royalties, lease costs, and the lease term (Howitt 2001). The lease appeared progressive for its time, being among the first to engage directly with Indigenous landowners rather than colonial or national government interests. The mine was to share 0.5%–1.25% of total revenue with Bougainvilleans, while providing 40% of the nation's exports (Filer 1990). Rio Tinto began operations in 1972, but closed in 1989, and it has not reopened. In 2016, Rio Tinto forfeited the lease, despite its remaining 5.3 million tons of copper (out of 8.3 million tons) and 19.3 million ounces of gold (out of 28.6 million ounces) (Smyth 2016). With the autonomous Bougainville government receiving 68% of Rio Tinto's shares, and the Papua New Guinean (PNG) government receiving the remaining 32%, the PNG and Bougainville governments both have equal shares in Bougainville Copper, and now discuss reopening the mine (Smyth 2016).

The mine's closure in 1989 has been linked directly with what has become known as the Bougainville Rebellion, ensuing from the considerable pollution and other environmentally destructive practices of the open-pit mine, but Howitt (2001) argues that the causes of the conflict can be found in the relationships that were engaged in the much earlier lease agreement. This is not to say a misunderstanding of the content, but rather to suggest a similar challenge to that identified by Curry and Koczberski (2009). They show that cross-cultural

miscues in leasing do not arise primarily from their different understandings of land use rights; rather, they relate to "conceptions of how land use rights are discursively produced in the first place" (p. 103). Local leaders had a clear expectation of the relationships the mining lease would engage, based on customary institutions for the leasing of fruit trees. Allen (1985) explains that food gardens are "cultivated on a usufructory basis" (p. 234), where the lessee has rights to harvest and will return the trees at the termination of the lease (Howitt 2001; R. Howitt 2016, personal communication). In entering into the lease, the relationship pertains to a set of rights that only has validity so long as there is "continued participation in indigenous (gift) exchange and fulfilling other obligations" (Curry and Koczberski 2009, p. 103). Such relations are reset when trees die and need replanting, Curry and Koczberski (2009) write, producing "potential rupture points in the web of social and generational relationships underpinning resource access, because it is at these points that old patterns of social relationships partially dissolve to resolidify as new webs of social relationships" (p. 105). Herein lies the rupture. The assumption was shared by both parties in contract that the land would be returned after the lease ended.

Negotiations between Rio Tinto and Bougainville had debated the meaning of the word "lease," but the short time frame left little time for careful deliberations, leading to a catastrophic miscue. Over the first decade of operations, the assumed shared understanding of its meaning slowly eroded as the excavation of the open-pit mine began to encroach on the township of Bougainville. This town, situated on the edge of the mining site and overlooking the developments, saw the earth materials loaded onto cargo ships and to processing plants overseas. The removed earth, as perhaps the death of a fruit tree, might otherwise have produced a rupture point in the web of social relationships, but it became clear that neither customary understandings of returned goods after ended lease nor this renegotiation of relationships would be possible.

To better understand the ensuing disagreement, it is necessary to acknowledge that contracts in Eurocentric cultural traditions are understood as legally binding for the duration of the agreement and difficult to renegotiate once engaged. It is also necessary to examine how Eurocentric traditions conceive of land rights. Dating back to Roman law, subsurface rights remain with the state. This means that cadastral maps limit nonstate ownership of Earth surfaces to a near two-dimensional plane (Gocht et al. 1988). This ontological leap is interesting where extractive surface industries are concerned: two-dimensional land is leased for three-dimensional activity. From a corporate perspective, the

land lease was no different from similar operations in the United States and Canada. Hence, no contradiction was recognized as the subsurface material was excavated, replaced by air in the mining pit, remolding the catchment, and directing pollution downstream. These were considered ontologically distinct from the two-dimensional earth as it was delineated before leasing, allowing Rio Tinto to assume no breach of the agreement had occurred. At the intersection of these cosmologies, the living engagement of customary relationships with the fertile harvest from Earth was reduced to a two-dimensional surface from which depth was erased. As Bougainvilleans realized this schism, and the irreversible destruction it produced, unprecedented and extreme social disruption ensued.

As in the example from Australia above, there has been a confounding of symptoms and causes that has led observers to conclude the Bougainville Rebellion was "a unique blemish on the body politic of Papua New Guinea" (Filer 1990, p. 16). Filer instead suggests such cultural miscues characterize "certain types of economic development" (Filer 1990, p. 16), but Howitt (2001) suggest these miscues emerged surreptitiously. In Panguna, the assumed mutual understanding of leased earth elided discussions that could have led to clearer expectations and agreements (Howitt 2001). Compounding these early miscues, the Bougainville community over the period of the mining operations found they received insufficient royalties and compensation for environmental destruction (Filer 1990; Howitt 2001). Filer (1990) suggests some explanation for missing royalties can be found in there being no customary system of rent distribution, meaning there was no established way of sharing the wealth. Reflecting on similar challenges in the management of palm oil plantations in Papua New Guinea 30 years later, Curry and Koczberski (2009) write,

> Many outsiders discursively construct their dealings in land with customary landowners as market transactions, that is, cash payments for land where land is conceived of as an alienable commodity. These outsiders attempt to locate land claims in a market rationality (commodity transactions—see below [sic]) that draws on notions of modernity and national development. Such attempts to construct land dealings discursively as commodity transactions may stem from their experience as migrants growing up on the [Land Settlement Schemes], where land is held under individually owned State agricultural leases. The legitimacy of these leases is grounded in modern notions of development and land legislation rather than in customary principles of land tenure (p. 103).

While Australian consultants had taught methods of governance and rent distribution, they did not replace

the importance and existence of prior customary institutions. As the European understanding of leasing did not transfer and thus failed, so too the European tradition of rent sharing was not adopted. It may be tempting to attribute the disagreement to a strongly cross-cultural setting in both Papua New Guinea and Australia, but the tendency to attribute destructive social processes to the preexisting tensions between local and colonized peoples is highlighted by Filer (1990) as unhelpful and incomplete. More constructively, Howitt (2001) and Curry and Koczberski (2009) argue, the tensions result from relationships that are not engaged in a mutually patient and situated (Howitt and Suchet-Pearson 2006) manner. Situatedness is here borrowed from Haraway (1988, p. 584), who argued that seeing "from below is a problem requiring at least as much skill with body language, with the mediations of vision, as the 'highest' techno-scientific visualizations." Underestimating the need for this skill produces a procedural vulnerability (Veland et al. 2013), where presumptions of meaning, identity, or culture as taking on particular pathways of change elide conversations about the nature and role of phenomena as they appear. Avoiding tendencies toward either relativizing or totalizing knowledge in cross-cultural meetings, Haraway (1988, p. 584) argues, is found in "solidarity in politics and shared conversations in epistemology." As the three-dimensional land of the Panguna mine was shipped away, Rio Tinto's expectation of a mutual and fixed lease agreement of a two-dimensional surface elided renegotiation of relationships, rents, gift giving, and leasing, with a catastrophic outcome.

The capacity to treat procedural vulnerabilities is hampered in many ways, including short time frames, tight budgets, juxtaposed demands between cultures of practice and the complexity of competing and often urgent tasks. In our current age, urgencies from global processes of change appear to be accelerating, and the time to sit down and discuss ontological schisms might appear luxurious. But it has never been more urgent to reach better understanding of how distinct understandings of Earth processes emerge, interact, and impact societies (Brondizio et al. 2016; Yates et al. 2017). In the following section, I draw the discussion outside the cross-cultural spaces that have been engaged so far, to show that such ontological assumptions are also expressed in the science-driven spaces of Norwegian offshore governance near the sensitive marine ecosystems at Arctic ice edge. Preventing and managing social disruptions and environmental disasters require examining how such miscues in ontological determination arise, and finding means of better understanding their nature.

5. Delineating the Norwegian ice edge

The anticipation of a seasonally ice-free Arctic that permits expanding shipping and extractive industries over coming years is driving broadscale geopolitical moves to delineate Arctic boundaries and regulate associated industries. Key to this challenge is defining the ice edge; the boundary where ice meets the open ocean unsettles clear divisions between earth and water. Ice behaves unlike earth or water, and the changing dynamics of Arctic seasonal freeze and thaw cycles renders fraught the necessary determination of vast national and international zones as either solid or liquid. Ice dynamics challenge legal frameworks governing national and industrial activities, mathematical models for forecasting and delineation, and the skills of technological and logistical engineers. As industry invests in the engineering of new ice-capable technologies, the United Nations Law of the Seas (UNCLOS) and the International Marine Organization are working to update their legal frameworks to more accurately govern ice. Yet in 2016, these international governing bodies still administer this region using the ambiguous "presence of ice" as delineator. Similarly, leading policy publications, such as *Polar Geopolitics?* (Powell and Dodds 2014) and *Diplomacy on Ice* (Pincus 2015), as well as Young (1998), in *Creating Regimes*, discuss "ice" vaguely as thinning, disappearing, and melting (Veland and Lynch 2017). Meanwhile, the Norwegian government has opened new drilling leases in the Barents Sea, the cruise ship *Crystal Serenity* has been able to visit Alaska's North Slope, and the northern sea route is reducing shipping distance by thousands of kilometers for an increasing number of ships between Europe and Asia. Petroleum industries can afford the risk associated with seasonal ice: costs of Arctic exploratory ventures can be offset amid more secure investments in other regions. Meanwhile, fisheries and conservation industries are concerned that poor scientific and engineering understandings of ice dynamics constrain the technologies and logistics for response to inevitable oil spills.

The precise nature and presence of ice is key for national and international governance and pollution prevention. Why is ice difficult to model? Neither liquid nor solid, neither Earth nor air nor ocean, its dynamic properties challenge science, engineering, and decision-making. Because it does not behave like Newtonian liquids or solids (for which there are accurate mathematical expressions), representation of its physical properties, movement, and change has long been the domain of metaphor, approximation, and innovation (Veland and Lynch 2017). In physical models, for instance, ice has been represented as "viscous-plastic"

(Hibler 1979), a "cavitating fluid" (fluid with air pockets; Flato and Hibler 1992), and "elastic-viscous-plastic" (Hunke and Dukowicz 1997). Each of these has enabled forecasters and researchers to achieve some predictive capacity in their mathematical models, but they have so far severely underestimated the rate of sea ice melt in the Arctic. The two key methods for representing ice dynamics, statistical and physical models, are poorly equipped to project novel behavior, such as northward retreat, and researchers have yet to successfully integrate ice–ocean models with ice–air models. Thus, while models can represent long-term averages in relationship with climatic changes, and ice forecasters can project daily variations due to wind and wave conditions, the operational horizon of years to decades has poor predictability. Indeed, Walsh et al. (2011) warn that for physical models, "the levels of uncertainty and inter-model divergences with increasing time-spans and levels of complexity should be troubling for any decision-maker who has to plan for the future based on such data" (p. 20). They remind the reader that physical models "are not 'truth-machines', but general guideposts" (Walsh et al. 2011, p. 20).

The elusive mathematics of ice makes room for much ambiguity in determining the ontological status of the ice edge, and thence in regulating industry presence. Nevertheless, the unique and rich biodiversity of the ice edge prompts Norwegian policy makers to treat this zone as a fixed regulatory boundary for industry. To set this boundary, the ice edge has been represented by an average value of minimum extent of ice observed over a number of years. Until January 2015, the Polar Institute drew the ice edge based on the average seasonal maximum extent of 15% ice cover, measured in observational data from 1967 to 1985. Until January 2015 and the opening of the 23rd licensing round for petroleum deposits, this boundary extended south of the protected Bear Island south of Svalbard. On the day of the leases opening, the Polar Institute revised the ice edge delineation, drawing on statistical models made by National Ice Center satellite data from 1985 to 2014. In the hours before opening the 23rd concession round, therefore, the ice edge, petroleum leases, and potentially associated industry all moved northward. The timing for this move seemed opportunistic and threw the scientific process of ice edge delineation into a strong public debate over the ambiguity of ice edge ontology: a national newspaper satirically declared "the Polar Institute has found the ice edge" (Blindheim 2014). This boundary may shift farther north if Norway decides to follow the International Maritime Organization (IMO) definition as 10% ice cover for regular ships and 20% for trained personnel.

At the intersection of solid, liquid, and air and of science, policy, and opinion, there is much room for discursive ambiguities to accommodate diverse interests. For instance, while Norway mapped a northward ice edge retreat that benefitted industry, Canada mapped a southward trend that ensured sovereignty over the Northwest Passage, parts of which a northward retreat would open for international traffic (Steinberg and Kristoffersen 2017). While not explicitly driving the science behind such redefinitions, UNCLOS appears to be an implicit influence in both instances. Ice-free ocean outside the exclusive economic zone (EEZ) is governed as international waters, and where ice is present most of the year within the EEC, states are permitted to enact laws regulating activities. Ensuring increasing industry presence near the ice edge does not produce damage to ecosystems will require innovations that can more accurately represent the role of ice as neither earth (as solid), air (as shaped and moved by weather), nor water (as liquid), while sharing some of the behaviors of all. While sea ice modelers and climate scientists have contributed to the assumption that future Arctic navigability will improve, the success of Arctic operations will depend on a much more nuanced and specific understanding of ice ontology. In the Alaskan Arctic, this nuanced understanding is urgently needed as melting ice redefines land, water, weather, and the livelihoods that depend on them.

6. "Thinking the earth" of Alaska's North Slope

Long-term trends, seasonal variations, and immediate change along the Alaskan Arctic coast renders "earth" a dynamic and shifting domain of ice, glacial conglomerate, permafrost, and water. Over recent decades, rapid sea ice retreat and melting permafrost have come to the forefront of local, regional, and global concerns. The melting permafrost, eroding shorelines, and dependent human and natural systems have become a go-to for researchers and activists from across the world wishing to alert diverse publics of the urgent need to act on climate change. Images of coastal towns such as Shishmaref, Alaska, and accompanying stories of highly vulnerable Indigenous populations have become the charismatic examples of potentially devastating global climate change. With sea ice retreat and the melting of permafrost, the ice-free summer and fall seasons expose melted shorelines of loose conglomerates and glacial silts to greater wave power (Brunner and Lynch 2010). Storm events in the 1960s and 1990s took out several structures in Barrow, Alaska, and a 2015 storm severely eroded the shoreline and endangered the town water resources. The highly dynamic nature of North Slope earth is not

recent—the shoreline has been retreating since the end of the last ice age. However, the new exposure resulting from a combination of valuable and fixed infrastructure in which power, sewers, and water supplies have been laid underground, in conjunction with the new hazards from increased storms and retreating shorelines, is creating a perfect storm of risks to North Slope coastal communities. For instance, in 2016 the U.S. administration invested in the resettlement of select settlements, but Barrow was not settled on a plan to secure its infrastructure.

While the dynamic earth of the North Slope is presenting unprecedented challenges for fixed infrastructure, the social structures that have developed in tandem with centuries of dynamic change are still bolstering the resilience of Inuit livelihoods. North Slope communities have for centuries been sustained by their ability to keep up with shoreline retreat and to read and predict ice edge conditions—skills that have offered a platform for relationships with wider national and geopolitical interests since the 1800s (Lovecraft and Eicken 2011). As part of a traditional and ongoing subsistence diet, the ice edge is a region from which to hunt whales, seals, polar bears, and walrus. As explorers and whalers from across the United States and northern Europe began venturing into Arctic waters, the Alaskan North Slope became a place of interaction with European and U.S. territorial and trade expansion.[2] Trading baleen, whale oil, and skins with ships arriving in the seasonal thaw became a new industry, funding improved infrastructures for living and traveling. When frequent disasters saw Yankee whalers shipwrecked on sea ice around the time of the Second World War, and petroleum became the preferred energy source, whale trade in this area saw its demise. Military researchers interested in the dynamics of the Arctic replaced the presence of traders until a new "oil age" came with petroleum resources (Reiss 2012). The infrastructures of old whaling settlements, such as that of Barrow, became centers of oil trade. To ensure access to these resources, Native leaders negotiated land rights in order to access benefits from the national push to develop oil fields. While there are ongoing and considerable challenges to well-being in many Native communities, Inuit governance institutions have proved as dynamic and adaptive as the earth on which their communities have been sustained.

[2] Showing the growing interest in Arctic matters, the Svalbard Treaty of 1920 was signed by 14 nations, including Norway; the United States; Denmark; France; Italy; Japan; the Netherlands; Great Britain, Ireland, and the British overseas dominions; and Sweden.

Nevertheless, an ongoing narrative on Indigenous lives and livelihoods across the world, and particularly across the Arctic, is of a highly vulnerable population strongly dependent on a particular constellation of earth processes. Their vulnerability has been the object of widespread attention by academic research, in magazines, and activist advertising materials, rendering a worldwide association of climate change with Arctic change (see, for instance, the section on Warruwi in northern Australia above). The role of Arctic peoples has been as victim of the force majeure that is anthropogenic climate change and a reason to reduce global greenhouse gas emissions. As a result, the anticipatory politics of Arctic industrial expansion is seen as an "Arctic paradox" (Gabrielsen 2005). Yet here it is not the case that a well-known climate change is affecting all Arctic communities disastrously. The social and environmental changes that have been ongoing since Inuit arrived in the Arctic, and that have accelerated since the arrival of Yankee whalers at the end of the nineteenth century, tie in with current rapid change in both Earth systems and in industrial economies—changes that Inuit governance has proved skilled at navigating.

Anthony Giddens (1984) speaks of the expectation that identity and belonging will be sustained as ontological security. In the dynamic Arctic region, part of this security is found in the ability to "let go." As part of a research visit to Barrow, conversations with residents suggested this inherent sense allowing change was tied to the historic loss of infrastructures along the retreating shorelines and the seasonal loss of sea ice. Since the last ice age, sea level rise has inundated the Beringia land bridge that once connected the Eurasian and North American continents (Mann et al. 2015), and continues to encroach on the coastline (Barnhart et al. 2014). This retreat, hence, has accompanied human settlements on the North Slope since the first people arrived there at least 10 000 years ago. The Barrow Heritage Museum reports that all ice age sites are now under water. Many settlements have been abandoned over that period, and many more will need to be abandoned in the future as shoreline retreat accelerates (from $6.8 \, \mathrm{m \, yr^{-1}}$ for 1955–79 to $13.6 \, \mathrm{m \, yr^{-1}}$ in 2002–07; Barnhart et al. 2014). In summarizing *Siku: Knowing Our Ice*, Bravo (2010) urges that policy and research recognize the social ontology of sea ice. Perhaps this entails a letting go. The Arctic continues to warm more rapidly than other regions of the world (Screen 2014). February 2016 saw temperatures 30° above normal, and the North Pole experienced above-freezing temperatures midwinter. A long history of interacting with a dynamic and changing Earth renders Inuit knowledge key to securing Arctic futures. In the negotiations over North Slope futures, therefore, a

careful navigation between sea ice knowledge, risks to subsistence hunting, investments in exploration infrastructures, and retaining a seat at the negotiating table with national and international decision-making bodies will require a carefully storied account of future hopes and goals, present risks, and ongoing traditions. What may the path forward demand that we let go of?

The rapid melting, erosion, and increasing industrial activity puts unprecedented pressures on the adaptive capacity of Inuit communities, but as in the Papua New Guinean and Australian cases, the stressors cannot be reduced to a set of problematic cultural relations. There are many who successfully transcend such boundaries. Instead, the risks are found in reified schisms where assumedly secure understandings of earth, water, ice, and air, and our relations with them (personal, cultural, technological, scientific, political), fail to find purchase in the world and limit adaptive relationships with their interchanging and transformational dynamics.

7. Concluding reflections on "thinking the earth/Earth"

Scholars, artists, students and professionals who met during the Thinking the Earth event (April 2015) were challenged to consider recurring themes—cultural ontologies and epistemologies, knowledge and power—as requiring a rethinking of politics, custodianship, and stewardship of Earth. Ground-proofing this perhaps rather lofty conception of the purpose of our meeting, the Administrator of the Rhode Island Environmental Protection Agency, Curt Spalding, spoke of the need to rethink our relationships with each other and with what we conceive of as "nature." With one bureaucrat practicing a rethinking of environmental policy, he is part of bringing Rhode Island to rival European counterparts in its climate change mitigation strategy and in ushering improvements in environmental quality. While federal U.S. politicians and ministries seem unable to accept climate science, such examples give hope that larger changes are possible.

In this paper I have examined a series of tensions between and within Aboriginal and Eurocentric conceptions of change in Earth systems. The aim of presenting these cases is not simply that we need to respect cultures other than our own, although of course that is a basic requirement of any practice. The aim is to recognize the need to understand how diverse ontologies emerge, entangle, and produce outcomes as we strive to understand and work with earth, water, air, and ice. Providing some insight as to a healthy acknowledgment of contradiction and incoherence, many Aboriginal cosmologies have greater acceptance for hybrid and

relational ontologies of Earth than do the Western sciences. Sociologist J. Law (2004) observes the many Dreaming sites making up Uluru in central Australia as overlapping, contradicting, and representing rock features in ways that prevent telling a single coherent history of how its features came to be. Law suggests Eurocentric traditions can and must learn from such narrative epistemologies (Veland and Lynch 2017) in order not only to confront colonial legacies but also to better understand the phenomena we research, manage, and govern. That Law's (2004) book centers on his own seemingly distant field of medical research on alcoholic liver disease only speaks to the epistemic entrapment Western science is suffering under more broadly. Enabling such insights, authors such as Mario Blaser, Noah Theriault, Igor Krupnik, Elizabeth Povinelli, Marisol de la Cadena, Julie Cruikshank, Lesley Green, Helen Verran, Zoe Todd, and many others have produced a theoretically intensive body of literature, but their findings can be inaccessible to physical scientists. Our lack of ability to act on climate change underscores the urgency to transform our ways of thinking, seeing, and doing (Howitt 2001; see also El Khoury 2015).

The issue here is not that there are too many schisms or that there should be fewer. Rather, the issue is with how we navigate the schisms or incompatibilities between cosmologies in propositional (El Khoury 2015) or agonistic (Barry et al. 2008) ways, instead of trying to integrate and harmonize them into one coherent whole. There is a rising ground swell of promising processes that engage in what Yates et al. (2017) term *ontological conjunctures*—places of "networked dialogue among multiple ... ontologies" (p. 1). Drawing on Indigenous language in British Columbia, they present *En'owkin* (or *En'owkinwixw*) as a frame of ontological conjuncture that "refers to a process of consensus-making dialogue" (p. 1). Similarly, the idea of "ethno-geomorphology" (Wilcock et al. 2013) encapsulates the many and varied ways in which dynamic and shifting Earth processes can be storied culturally. Drawing on "concepts of emergence, connectivity and space-time relationality," this "situated, non-relativist response to people–landscape connections" (Wilcock et al. 2013, p. 573) considers interactions with dynamic earth processes as moments of possible convergence across knowledge systems. In risk research, it has long been recognized that "environmental" problems are really social problems that concern the distribution of goods between social groups (Hewitt 2014, 1995). Similar recognition in environmental policy says we are not really managing Earth systems, but rather human relationships. Drawing on the 2015 Papal Encyclical, Veland and Lynch (2017) agree, "we cannot renew our

relationship with nature without renewing our relationship with each other ... the 'natural' world is created by, through and with the same human concepts, ideas and emotions that create the 'social'" (p. 7). A relational approach to natural resource management is one where Earth is recognized as the confluence of human values and perspectives, not made of a priori given categories that are then "managed" (Howitt and Suchet-Pearson 2006).

Yet how might these lessons from bridging ontological schisms between knowledge systems be brought into a critical self-reflection within the physical sciences? This fascinating discussion is under development by, for instance, Tadaki et al. (2015), who encourage critical practices in physical geography to examine "ways in which our environmental objects could be assembled differently" (p. 160). Many of our seemingly intractable global change problems stem from unquestioned and broad brush assumptions about Earth system processes. In the urgency to respond to global change, ideas of planetary boundaries (Rockström et al. 2009) and an Anthropocene Era (Crutzen 2006) make it seem as though Earth and the earth are inherently defined, bounded, and knowable (Veland and Lynch 2017). Helpful as planetary-scale thinking is, my hope is that knowledge production can avoid any reified thinking of what Earth is, and can be. As climate change has narrowed to a particular story line about greenhouse gas emissions, key and important decision-makers have disengaged, perceiving the science as misguided or even conspiratorial. Stories of a "good Anthropocene" are urging forward a grand narrative inciting optimism that human abilities will soon enable us to live in a more harmonious relationship with Earth systems. Taking care to scale these grandest stories back to relations between people, we must keep asking what erasures planetary thinking might entail.

Ontological schisms in thinking the earth and Earth contribute procedural vulnerabilities to policy processes under rapid global change. Each of the cases presented above shows how presumed and assumed knowledge—that earth, water, ice, and air behave and relate as separate knowable elements—can prevent policy and research from discovering innovative responses to global change, from adapting to climate change to forging relations with transnational corporations. Transdisciplinary and adaptive governance approaches make considerable advances toward constructing reflexive and iterative policy and research, and so opening for reconfiguring governance frameworks that relate to, for instance, the Norwegian ice edge, or to Indigenous cosmologies of earth and sea (Yates et al. 2017). In line with Tadaki et al. (2015), the argument made here is to look beyond methods of bridging what we already acknowledge as distinct knowledge systems, to acknowledge and transcend ontological schisms that exist within as well as across knowledge systems. This requires more than attention to methods, and a more fundamental shift toward relational ontoepistemologies (Howitt and Suchet-Pearson 2006) that rediscover and reinvent relationships with spatial and temporal scales of planetary systems. Writing between sociology and economics, Curry and Koczberski (2009) suggest relational approaches have "capacity to reveal how economy and society are co-constituted ... from social relationships, rather than maintaining the conceptual distinction between the economic and the social" (p. 99). This is a pursuit that requires applying lessons from social science and humanities research not just to fight for justice, but to rethink the Earth for resource and environmental policy in the twenty-first century and beyond.

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