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RESEARCH ARTICLE

Experimenting with political materials: environmental infrastructures and ontological transformations

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Wide-ranging research, in science and technology studies (STS), anthropology, environmental and infrastructural studies, and elsewhere, can currently be seen to work out the implications of Latour's evocative but enigmatic call for a parliament of things. What are the political materials that would inhabit such a parliament? What are their demands? And how are social scientists capable of getting them into view? Asking these questions, the paper experiments with political materials in a double sense. Putting into conversation a heterogeneous corpus of empirical materials, the paper examines some ways in which different forms of materiality impinge on politics, and conceptions thereof. Doing so, it also highlights different ways in which different kinds of scholarly materials are able to get political materials into view. Environmental infrastructures, the paper shows, are excellent objects for thinking through the implications of political materials because of the sheer ontological multiplicity of their constituent components. They are cauldrons in which multiple forms of political materials intermingle and through which practical ontologies emerge. Eliciting these, often invisible, processes, the paper aims to enhance the sensitivity of social scientists to the multiplicity of political materials that shape our worlds.

Keywords: anthropology; environment; experiment; infrastructure; ontologies; political materials; STS

In the early 1970s, legal scholar Christopher D. Stone posed the controversial question, *Should Trees Have Standing?* (Stone 1974). He asked this legal question, which he answered in the affirmative, in the context of increasing recognition of industrial pollution of rivers and forests in the United States; problems that were hard to deal with, in his estimation, because it was impossible to represent trees or bodies of water in courts of law. Stone recognized that his proposal would be viewed as outrageous, and he answered some of the predictable objections head on: 'The fact is, that each time there is a movement to confer rights onto some new "entity", the proposal is bound to sound off or frightening or laughable. This is partly because until the rightless thing receives its rights, we cannot see it as anything but a *thing* for the use of "us" – those who are holding rights at the time' (8). He also dismantled the objection that the proposal would be impossible to implement 'because streams and forests cannot speak', noting that neither can corporations, universities, infants, and states (17). Finally, he did not accept the view that forests only merit legal consideration

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to the extent that they provide profits to its human users. ‘Why’, he asked, ‘should the environment be of importance to us only indirectly, as lost profits to someone else? Why not throw into the balance the cost *to the environment?*’ (27).

In 2010, the cultural anthropologist Marisol de la Cadena posed a question, which is noticeable at once for its similarity to Stone’s and for the fact that asking it is still equally controversial. During her ethnographic work with indigenous movements in Peru, de la Cadena followed protests against a mining project at the Ausangate Mountain. De la Cadena was repulsed by the mine because of its adverse effects on local populations, but, as she found, for her informants this was only part of the problem: ‘Ausangate would get mad, could even kill people’ (2010, 339). As her interlocutors saw it, Ausangate was a non-human entity, a *tirakuna* earth-being, not an inert lump of material. Analogously to Stone she asks: ‘How might Ausangate be brought to bear on Peruvian politics not as an object, a mountain, but as an agent, an earth-being?’

To be sure neither the concerns nor the solutions of Stone and de la Cadena are identical. Stone ultimately argued for a model of guardianship, where natural entities would be legally represented by their ‘friends’ such as the Sierra Club or other environmental organizations. In contrast, de la Cadena draws on the work of the Belgian philosopher of science Isabelle Stengers and her injunction to ‘slow down reasoning’, a notion that also inspired Bruno Latour’s *Politics of Nature* (2004). For de la Cadena, bringing earth-beings to parliament requires inventive alliances between a motley crew of actants, capable of troubling ‘the monopoly of science to define “Nature”’ (de la Cadena 2010, 346).

Nevertheless, the issue in both cases concerns how to bring non-human entities into politics and law and, reversely, how to bring politics and law into nature. Whichever direction is implied, what is required is an expansion or reconfiguration of what kinds of things politics and law are, and how they operate, due to a recognition that the actors that inhabit the world for which policies and laws are made are themselves much more diverse and divergent than allowed by humanist or liberal theory. What is required is recognition of multiple forms of political materials.

Political materials

The current surge of interest in the politics of things, Latour’s *ding-politik*, draws on diverse, though related, threads of scholarship. Eminent precursors include Gilles Deleuze and Felix Guattari, whose collaborative work posited people as living in and through assemblages of materials, from language and organizations to metals and chemical compounds. Their attack on psychoanalysis in *Anti-Oedipus* (1983) focused on its privileging of purely human relations, disabling understanding of multiple other kinds of ‘productive forces’ that shape modern subjectivities. Emphasizing the shaping of human consciousness by its non-human surrounds, *A Thousand Plateaus* redefined Nietzsche’s genealogy of morals as the *geology* of morals (Deleuze and Guattari 1987, 39–75).

Inspired by Deleuze and by Michel Serres’s new natural contract (1995) in equal measure, the hallmark of actor-network theory has also been insistence upon the intimate, mutual shaping of people and things. Latour’s collection *Making Things Public* (Latour and Weibel 2005) and his recent work on ‘Gaia’ (Latour 2008) explore the implications the liveliness of non-human forces might have for politics. The work on material politics by Noortje Marres (2012), Andrew Barry (2013), and others is directly inspired by these ideas.

In a slightly different vein, the work of Jane Bennett, also in conversation with Deleuze and Latour, considers whether non-human entities might provide an entry-point for re-enchanting nature. In her view, Max Weber’s view of nature, as a controllable and

mechanized space, led to a disenchanting view not only of nature but also of politics, which came to be seen as wholly rationalized and bureaucratized (Bennett 2001, 57–65). Bennett's rubrics of enchantment and wonder, however, are arguably too one-sided. After all, non-human entities are not only wondrous but also dangerous. Inasmuch as everything, from floods in the United Kingdom to droughts in Australia and melting icecaps north and south, just to mention a few dramatic instances, continuously impinges on human affairs, then materials of various kinds must indeed be given voices in politics, but those voices are more varied than the notions of wonder and enchantment allow.

Though usually averse to grand conceptual statements, broadly similar sentiments also lie behind certain forms of environmental history (e.g. Biggs 2012; Cronon 1995; Drayton 2000). Carefully describing human endeavours to harness material forces for political and economic gains, in places as diverse as Chicago and the Mekong Delta, this body of scholarship elicits the regular failures and unforeseen consequences of such attempts as due to the fact that environmental forces are often both too complex and too powerful for people to comprehend and control. That recognition – that nature is fully capable of *striking back* at culture, and in fact may well hit harder than anyone had cared to imagine – also feeds a lot of current debate around climate change.

In conjunction, these bodies of work can be seen to work out the implications of Latour's evocative but enigmatic call for a parliament of things (1993). That concept literalized the idea that materials of all kinds are political while insisting that their political qualities have not been given due recognition: hence the necessity of creating a 'parliament' for and of non-human entities. The parliament of things, Isabelle Stengers has argued, 'provokes an immediately operative "deformation" of the present under the effect of a future whose demands are without limits' (Stengers 2000, 152). It obliges recognition of varied practices and actors, 'to the degree in which they make representatives proliferate, always more varied and demanding' (152). The parliament of things thus acts as a 'lure for feeling' in support of imagining what politics might look like if it was to bring into focus these always more varied demands. The present paper explores just how varied the materials making such demands are.

That exploration, finally, ties in with issues of ontology. Presently much debated in anthropology (e.g. Holbraad, Pedersen, and Viveiros de Castro 2014), the interest in practical ontologies in fact emerged long ago in STS (see Jensen 2004), and this in direct consequence of the observation of varied material capacities. As early as 1991, Joan Fujimura suggested that Michel Callon and Bruno Latour were 'explicating a new ontology' (Fujimura 1991, 220). Only slightly later, Andrew Pickering's *The Mangle of Practice* (1995) argued for a decentred social theory, in which people and things engaged in an open-ended and unpredictable 'dance of agency', redoing ontologies through their encounters and interactions. Along similar lines, Annemarie Mol examined how bodies, discourses, and medical tools together enacted specific versions of the world that embedded different forms of ontological politics (Mol 1999). Dances of agency, enactments, assemblies of people and materials: Each of these conceptual foci highlights the unpredictable, world-transforming, and experimental consequences of things doing things to – and with – people. They also oblige rethinking of the relations between materials and politics.

In one sense, the sketch of inspirations I have just outlined indicates that such rethinking is already occurring and, indeed, has been going on for a good while. It is also the case, however, that discussions taking place in STS, anthropology, environmental history, infrastructure studies, and elsewhere often run in parallel and rarely meet. Additionally, I suggest that the corpus of scholarly materials pertaining to such rethinking is even broader than suggested by the literature so far surveyed.

Accordingly, the following discussion engages with political materials in a double sense. The paper puts into conversation a heterogeneous corpus of materials all of which speaks to the need for rethinking the materials of environmental politics. In that sense, the paper examines some ways in which *different forms of materiality* impinge on environmental politics, and conceptions thereof. Doing so, however, it also highlights different ways in which *different kinds of scholarly materials* are able to get political materials into view.

In order to contain this discussion, I focus in particular on scholarship that can be seen to examine the composition and transformation of *environmental infrastructures*. Environmental infrastructures are excellent objects for thinking through the implications of political materials because of the sheer (ontological) multiplicity of their constituent components; a multiplicity I shall attempt to amplify in what follows. However, the notion that environmental infrastructures both contain and produce ontological multiplicity is unlikely to be immediately obvious to the reader, and thus some preliminary words of explanation are required.

It is common to recognize standard examples of infrastructures such as roads or sewers as material (consisting of gravel or pipes, for example) but also social (due to planned interventions). In conjunction this produces a conventional view of infrastructures as ‘second nature’ (Bowker 1995), consisting of technical, social, and institutional *additions* to ‘first nature’ – the presumed pristine foundation of earth, stone, water, and trees. Yet, the materials drawn together here challenge that distinction. For one thing, they suggest that infrastructures are not necessarily either quite natural or quite social. They may be composed of entities as diverse as ancestor spirits, computer models, and apple trees. Indeed, I aim to illustrate that environmental infrastructures are something like *cauldrons* in which multiple forms of materials intermingle. What we like to call the natural and the social are *redone* through such processes. The outcomes are transformed practical ontologies (Jensen 2004).

Most of the time the political import of these processes goes unnoticed by social scientists. They largely unfold as a sub-politics, which silently changes worlds, while people deliberate and argue about other matters. Even so, in our times, getting such world-shaping processes into view, learning how describe and analyse the multiplicity of materials that quietly or violently shape the conditions of human lives and planetary well-being seem increasingly urgent. The following discussion thus aims to enhance the sensitivity of social scientists to the multiplicity of political materials that shape our infrastructures and thus our worlds.

Rivers material and fantastic

Marshall Sahlins reminded us, in his article ‘Infrastructuralism’, that Lévi-Strauss located anthropological concerns at the level of what Marx called superstructure, defined in opposition to the economic ‘base’ (Sahlins 2010, 372). Sahlins continued to obviate that distinction by encompassing praxis in culture. ‘Rather than a discontinuity, temporal as well as ontological, wherein culture appears as the symbolic afterthought of a material practice that has its own rationality’, he wrote, ‘what is entailed in infrastructuralism is the realization of encompassing conceptual schemes in the particular material function of provisioning the society. Economy, we might even say, is the objectification of cosmology’ (Sahlins 2010, 374–5; see also Tambiah 1977).

Interesting as it is, Sahlins’s argument creates its own problems. For if culture is not the symbolic afterthought of a material practice, his scheme is more prone to rendering

materiality as the practical afterthought of conceptual schemes. The consequence is that the political *materials* of infrastructure fade from view.

To begin *adding to* this set of materials, rather than subtracting from it, we can turn to Hugh Raffles's book *In Amazonia* (2002). This book offers a compelling depiction of the Amazonian Rio Guariba as an environmental infrastructure, though Raffles does not use the term. Even so, one of his enduring messages is that 'trees and people create each other', so that 'the histories produced in nature are biographical, unpredictable and deeply affective' all at once (8). The very shape of the Rio Guariba is the product of relations of commerce, such as timber trade, sugar plantations, and the trade in acai berries. The river has been formed throughout history by people looking for opportunities and by the labour they put into cutting streams, digging channels, diverting water (5). Raffles's account of these river histories is premised on the simultaneous existence of the river's 'blatant physicality and its enduring imaginaries' (3). As in the literary genre of magical realism the landscape is 'at once material and fantastic' (4). In Raffles's depiction, natural history thus entails recognition that 'nature is both a dynamic actor and a decisive ground in the contemporary politics of place-making and in the ongoing struggle over everyday life' (68). The fantastic aspect of natural history is elicited as what he calls 'histories of creativity' involving multiple agencies (34).

Yet, even as Raffles offers a compelling depiction of the Rio Guariba as a socio-material infrastructure, I want to dwell a bit on the particular way in which he relates riverine and social histories. For although their entwinement is his analytical premise, the two also continue to separate from one another. If, as Raffles writes, the landscape is at once material and fantastic, his narration relies on an opposition according to which the material as such does not seem to be, or perhaps cannot be, fantastic. It is material and *also* fantastic, but the fantastic is elicited through the creative practices of local people as they work the river. The river and the forest thus come into view as political materials predominantly through the imaginative capacities and practical efforts of *humans*.

Now Raffles begins with an aerial image of the Rio Guariba, itself a product of global military infrastructures. That image provides the basic contrast to Raffles's story, for, as he shows, peoples' lives were not determined by either state concerns or military preoccupations. Instead they were engaged in practices of 'ontological self-determination' (Viveiros de Castro 2011), fully capable of 'making new worlds on their own' (Raffles 2002, 2).

But while this image offers a counterpoint to Raffles's story, in STS the reasons for *its* existence and the manner of its construction might well have been topics in their own right. Indeed, the field has paid much attention to the difficult processes of creating global information infrastructures, in support of both military and environmental projects. Whereas Raffles sticks closely to local practices, Paul Edwards's (2010) work on climate modelling elucidates the difficulties of making global environmental infrastructures. *Certain kinds* of political materials are rendered with far more liveliness in this account.

Global climate models

Climate scientists have no option of making controlled experiments since no 'control earth' exists (Edwards 2010, 140). Their question thus revolves around finding ways of *modelling* climate behaviour in a way that sufficiently takes into account its complexity and scale. Present climate modelling grids form rectangles with sides that are between 100 and 500 kilometres in length, and vertical dimensions up to 20 km (146). Within these grids various physical properties and their interactions are modelled, and the outcome is predictions of climate behaviour, such as weather patterns. But the relation between the behaviour

of atmosphere and the models is recursive. To create good models, experimenters rely on ‘meteorological experience with the actual atmosphere’ (152). The persistent ‘bootstrapping problem’ is that models are needed in the first place because existing empirical data are too historically scarce and spatially patchy.

To determine whether a simulation model is good, one needs to figure out whether it looks like the reality it simulates (Edwards 2010, 183). But to do that one needs a reliable picture of reality. Yet, the lack of that picture is what propels the need for the model in the first place. Thus, global climate models have literally created data for areas of the world where no actual observations exist. ‘Virtually everything we now call “global data” is not simply collected; it is checked, filtered, interpreted, and integrated by computer models’ (188). Together these socio-technical processes produce the infrastructure of global climate models, which Edwards describes as ‘a vast machine’.

Where the ‘real weather’ stops, infrastructure begins, and models enter the scene is thus fundamentally ambiguous. Indeed, the efficacy of the vast machine is premised on an on-going, mutual transformation, which fundamentally destabilizes the notion that infrastructure ‘sits on top of’ an underlying substratum of ‘first nature’. Thus, global climate modelling vividly illustrates the argument that *‘Raw Data’ is an Oxymoron* (Gitelman 2013; see also Walford 2013). It is turtles all the way down.

In Edwards’s fascinating account of the travails of climate modellers, the political qualities of materials are not exclusively parsed through the creativity of people. Undoubtedly, global climate infrastructure is a gigantic cybernetic dream machine for environmental scientists, policy-makers, and military strategists alike. However, their varied dreams are not *extant* to the models. Within the vast machine, satellites, grids, images, and calculations *produce and transform* political visions, agendas, and plans. In this story, political materials thus take the predominant form of scientific models and technological practice.

But here we can pause. In Edwards’s story, the complex machineries of modern technology and its relations to scientific and political institutions are shown in vivid detail. Yet the trees, mountains, and rivers which held the attention of Stone and de la Cadena fade from view. Raffles’s local populations are also gone. Or, rather, the presence of these ‘entities’ is wholly indirect, elicited and represented through modelling grids and parameters. If this story excels at getting into view the political materials of global climate infrastructures, it simultaneously conceals the fact that people, trees, and water act in other capacities than as numerical input to such models.

Yet, there are other possibilities for bringing out what ‘natural entities’¹ do, how they do it, to whom, and to which effect. To explore some alternatives, I turn to examples from environmental history and journalism.

Nature’s capacities

It is not at all common for social scientists to try to describe the viewpoint of natural entities. After all, according to Latour’s (1993) modern constitution, this is precisely the domain of natural, not cultural, inquiry. Still, we might turn to histories of the environment for explorations of this issue.

Consider, first, Richard White’s short but excellent *The Organic Machine: The Remaking of the Columbia River* (1995). White views the river as an ‘organic machine, as an energy system which, although modified by human interventions, maintains its natural, its “unmade” qualities’ (xviii). ‘The flow of the river is energy’, he says, but so is the electricity that is eventually extracted from it, the human labour applied to change the river, and the fat stored by salmon in preparation for their upstream journey. The riverine

transformation depicted by White is not one in which untouched nature is gradually given cultural, infrastructural form. From the beginning, the river was an interactive system, in which flows of water, movements of fish, and the work of Indians entwined.

But the relations that made up this system changed. White settlers began competing with Indians, then with each other, over natural resources. Whereas travelling the river used to be a life-and-death contest, it became easy, as boats become more powerful, dams were built, and large-scale industrial and bureaucratic efforts to 'control nature' (McPhee 1989) set in. As salmon depleted, electricity production soared. The energy exchanges of nature and culture took new form. Over the years, the river turned into what we would readily recognize as conventional infrastructure, rather than natural system. The river became a cyborg, an entity at once organic and machine.

Changing river infrastructures turned out to be machines for redistributing wealth, power, capacity, and vulnerability. That is one good reason to think of them as composed of political materials. On Raffles's Rio Guariba, river communities became increasingly dependent on trade with urban centres, craving supplies of acai berries. White's story of the Columbia River describes the displacement of Indians, the introduction of Chinese labourers and their subsequent eviction, the gradual decline of salmon populations due to overfishing, the collapse of the fishing communities altogether, and the building of electricity-generating dams, feeding factories that polluted the river in turn. Salmon, people, and water were indeed highly consequential political materials *for one another*.

Michael Pollan's (2002) *The Botany of Desire: A Plant's-Eye View of the World* offers another evocative illustration of what it might mean to get nature's capacities into view. Like White, Pollan is also concerned with describing changing relations between 'nature' and 'culture' in a way that does not presuppose humans as the central actors. *The Botany of Desire* contains chapters on four human desires: for sweetness, beauty, intoxication, and control. The emergence of each of these desires, in specific histories and places, is documented with reference to particular plants that gave rise to them. Thus, the American desire for sweetness was emergent and consequent upon the travels and tribulations of apples. Earlier, the beauty of tulips was an obsession for the Dutch. Marijuana and the desire for intoxication have been inseparable in the United States, Europe, and elsewhere. And the potato was affiliated with a desire for control. I like to think of the book as an exploration in 'planthropology'.

For Pollan, plants, like apples and marijuana, and humans 'are partners in a coevolutionary relationship' (Pollan 2002, xii) in which both need each other for divergent ends. Plants care not a whit about human desires, but only about their own genetic propagation. But the way in which they ensure this propagation is by 'playing on the animal's desires, conscious or otherwise' (xiii). And no animal is more creative in finding ways to gratify its desires than the human. About 10,000 years ago, Pollan writes, the event happened that we 'somewhat self-centeredly' call 'the invention of agriculture' (xix). However, this supposedly human invention can also be seen as the effect of *plant strategies* to get 'us to move and think for them' (xix). Gradually, plants evolved, so 'compelling and useful and tasty they would inspire human beings to seed, transport, extol, and even write books about them'. And they changed the very landscapes and infrastructures through and in which they live.

In his history of American apples, for example, Pollan describes how they 'helped remake the New World landscape in a more familiar image, in the process of contributing to an ecological transformation of America the magnitude of which we've just begun to appreciate' (Pollan 2002, 45). That reshaping involved transportation systems, the creation of settlements that turned to towns, liquor production and legislation against it, and a

gradual reconceptualization of the apple as a symbol of moral Americanness itself – as American as apple pie, as the saying goes.

In the stories of White and Pollan, neither people nor technologies are the central protagonists. Instead the main figures are rivers, salmon, apples, and tulips, engaging in complex dances of agency, mutually modifying human and non-human worlds. In these stories people are located on the inside of nature, for there is no outside.² But if there is no outside, how can apples and tulips be political materials? If the world consists of flows of energy or gene populations there can be at most a ‘naturalized politics’, hardly an appealing prospect.

Aside from its lack of appeal, the problem with ‘naturalized politics’ is that it is wrong. For though energy and co-evolution function marvellously as expository devices, helping White’s and Pollan’s narratives and getting into view the activities of salmon, river flows, and potatoes, they are nevertheless metaphors or concepts, not the things themselves. More specifically, they are *scientific concepts*. Just as it is physics that speaks the language of energy, not rivers, so it is also biology that speaks the language of co-evolution, not potatoes. Though I turned to these environmental histories in order to *circumvent* the ventriloquism of global climate models, whereby it is finally Western technoscience that speaks for trees and rivers, the impasse is ultimately similar. In neither case can ‘nature’ be elicited except through a (technoscientific) apparatus of description.

Perhaps the stories of apples and salmon just offered seem less mediated than those of weather patterns modelled by climate science. It appears somehow as if we are closer to the entities as they really are. But this sense of unmediated naturalness should be a cause for concern as much as for celebration. Climate models are so obviously ‘artificial’ that it is impossible to uphold any notion that nature itself is speaking. Correspondingly, it is relatively easy to recognize them as made of political materials. In contrast, by writing as if natural entities themselves speak the language of energy and evolution, White and Pollan effectively *naturalize* nature, fortifying the very distinction that makes it so hard to see non-human agents as political.

Even so, these narratives *also* make it possible to perceive the profound influence apples and salmon have had on people’s lives, their laws, their politics, and their relations. In spite of themselves, as it were, they help us get into view such entities as political materials whose actions can be illuminated, though they are not ultimately determined, by the conceptual schemes of science. In *that* sense, these stories complement and *add to* the understanding of environmental infrastructures produced by scholarship in anthropology and STS. Plants and trees are indeed also doing *other things*.

Spirit rivers

Plants and trees may be doing other things than what can easily be imagined by Western social and natural scientists. But at least they are recognizable *as* entities by them. There are, however, other entities, that are not only difficult to recognize as *political* materials, but hard to accept as being *materials* at all. Even so, they may also be part of environmental infrastructures. And they may be political, in their own ways, too.

From the Milk River, written by the social anthropologist Christine Hugh-Jones (1979), analysed spatial and temporal processes in the Pirá-paraná area in Northwest Amazonia inhabited by Tukanoan groups (6). At a first glance, this work seems to have much less to do with either environmental infrastructures or political materials than anything we have encountered so far.³ Engaging the classical themes of myth and kinship through social-structural analysis, Hugh-Jones noted the correspondence between locations of

habitation along the river and social prestige (25). As in Raffles's much later work, she outlined diverse usages of the river. Much more important, however, was the fact that each 'exogamous group above sib level is derived from an anaconda ancestor' (33). The earth was originally populated at a 'string of sites', referred to as 'people waking-up houses' (34). Ancestral anacondas were 'anacondas in the water but ... whenever they came on land at the waking-up houses, they were transformed into groups of people who danced and performed ritual' (35).

Much of Hugh-Jones's analysis is dedicated to outlining a series of models that account for social practices such as food production and consumption, habitation in the long house, and marriage patterns. For example, she depicts a transformational system, in which movable parts, including the changing human body, anaconda body, and the womb, map onto a set of immovable parts: the house, the broader long-house setting, and the universe at large (Hugh-Jones 1979, 237–8). She also extracts two models of the river systems of the earth, strikingly named the single- and double-anaconda models, both of which are based on the observation that the river and the anaconda 'are treated as analogous systems'. Thus, the river is depicted as a continuous and doubled flow that on the one hand moves water and distributes people downstream and upstream and on the other hand distributes evil forest spirits upstream and ancestors downstream (240–2).

The analysis engages the Milk River from the Tukanoan point of view, as a system in which social relations, practical issues of livelihood, evil spirits, and anaconda ancestors coexist. In my reading, it also encourages yet another broadening, if not transmutation, of the notion of political materials. For conceived as a vastly expanded infrastructure, the materials that make up this river infrastructure encompass at once what we might be inclined to view as 'natural', 'social', and 'spiritual' entities. None are inherently more real or consequential than the others, for they are relationally defined.

This is an imposition, however, for in the final instance Hugh-Jones's own analysis discourages such an interpretation. At the end of the day, she writes: 'people must transpose the system of the universe with its creative processes onto the concrete systems which they are able to control, or at least change, through practical action' (Hugh-Jones 1979, 236). And so, 'whatever people are doing in metaphorical terms, in real terms they are acting within the confines of the longhouse setting ... Thus, when they identify themselves with ancestors, they are actually putting on feather head-dresses, drinking yagé and so on' (236). As metaphors, ancestors and spirit rivers turn out to be really conceptual structures that enable people to act practically. Cosmology and myth are thus rendered as epistemological aids for social action, rather than materials that are integral to establishing the river as a very particular form of infrastructure, no longer 'environmental' (since the Tukanoans do not have an 'environment') but ontological (since they surely have a world). Rather than expanding the set of relevant political materials, everything eventually centres, once again, on human cognition and interpretation.

Nevertheless, if we turn to Peter Gow's (2001) *An Amazonian Myth*, focusing on Piro and Campa people in and around Santa Clara on the Urubamba River, we may identify a perspective congenial to the more expansive view of political materials advanced here. These people also rely extensively on rivers and forests for their sustenance and livelihoods: 'For as long as records exist, Urubamba Piro had been at the centre of a complex network of riverine trading' (199). Gow's concern is with the relation between the histories through which this network formed and transformed and the gradual transformations of indigenous myths used to account for these changes. His study thus elicits the dense relations between infrastructure and cosmology.

Crucially, for Gow the telling of ancient peoples' stories is not detached from Piro experiences with aircrafts, new boats, forms of writing, and other technologies. Instead, these stories *enable* Piro people to grapple with the introduction of new technologies and machines. Correlatively, infrastructural transformation is also 'co-ordinated with a transformation in Piro people's ideas about celestial beings' (Gow 2001, 191). Infrastructure and cosmology are thus part of a mutually defining system of transformations, which simultaneously accords myth with history and infrastructural change with cosmological consequence. What Westerners categorize as technological (airplanes), natural (fish and animals), social (practices of living), or mythical (ancient peoples' stories) is the effect of an open-ended process of ontological transformation.

This is not an explication of indigenous thought per se since, for the Piro, ancient peoples' stories are precisely the 'things that do not change' (Gow 2001, 285). That is why they can provide the ground for everything else that does.⁴ However, just as rivers slowly change their course, Gow elicits almost imperceptible mythological transformations in response to infrastructural and environmental changes. Though occasionally such changes take the form of rupture, mostly they occur as gradual reconfigurations, akin to what Francois Jullien calls silent transformations. *Silent*, he writes: 'since "everything" within it transforms itself, it is never sufficiently differentiated to be perceptible' (Jullien 2011, 8).

Such on-going transformations are the results of continuous recalibrations of relations between entities as diverse as anaconda ancestors and new motorboats, acai berries, virtual salmon, and dams. Having each their own important role in changing the environmental, social, and political worlds (including the work of defining what, if anything, is *seen as* 'environmental', 'social', and 'political' within these worlds), they are political materials. Yet the fact that many of their activities are indeed 'silent', slowly unfolding, hardly noticeable, means that they are often unattended. Usually remaining in the background of social, political, and scholarly concerns, these processes only occasionally give rise to bursts of anger and action, and affiliated attempts to articulate knowledges (Choy 2005) or negotiate ontic differences (Verran 2007).

Writing political materials

What meaning can be given to the notion of political materials? To answer this question, I have explored a wide-ranging and eclectic set of materials, collated from anthropology, STS, infrastructure studies, and environmental history. My aim has been to expand on the set of materials that are perceivable to social scientists and thus available for contemplation and discussion.

Starting with a focus on the political qualities people ascribe to things, I moved on to suggest that climate models, trees and rivers, then apples and salmon, genes and energy flows, and, finally, anaconda ancestors and spirit rivers can all be seen as political materials. But a new question then follows. If we are unable to circumscribe the set of relevant political materials (here, trees; there, genes; over there, spirits; and in there, technological diagrams and policy briefs), then what might be the consequences for *our* descriptive and conceptual experiments?

Commenting on the new ontology she saw explicated by Callon and Latour, Joan Fujimura noted that: 'How we write depends on what we want to accomplish' (1991, 217). Her suggestion was to write in such a way as to retain 'the complexities of situations' while searching for 'ways to include new and diverse perspectives in our studies' (208). Around the same time, John Bowers posed the following question, also inspired by

actor-network theory: 'If there is contingency, creativity and situatedness in human affairs, why can there not be contingency and the rest' in technology (Bowers 1992, 240)? He proceeded to make a strong argument for technological systems, infrastructures, and classifications as being political through and through. Clearly, the notion of political materials has been on the STS agenda for a long while. Even so, there is more to political materials than STS has usually imagined. *Tirakuna*, earth-beings, for example, or trees that need standing in courts of law.

Yet, if both de la Cadena's *tirakuna* and Stone's trees highlight the importance of bringing into our descriptions more diverse forms of political materials, entailing in turn more varied forms of politics, they also raise new questions about how to write about political materials and how to draw out their implications. For example, even as Stone aimed to ensure the standing of trees, he commenced to transfer their guardianship to the Sierra Club. Though that solution was radical in its own way, it hardly seems satisfying once we recognize that trees are also doing things in their own right: even *political things*, like changing the American country-side, inducing regulations against apple cider, and changing consumption patterns and wealth distribution. Though we might accept that trees occasionally have to be represented, the core question is *in which capacity*. Neither the Sierra Club nor anyone else has the general right or ability to make this decision, for trees are part of the future whose demands, as Stengers wrote, are without limits (2000, 152).

The contrast with de la Cadena's analysis of *tirakuna* is illuminating, for it is explicit about the relationship between earth-beings and indigenous movements. As far as indigenous people are concerned, *tirakuna* are not mountains but earth-beings. The idea of innocently representing nature as it is (like the Sierra Club representing 'trees' as they are) evaporates in this story, for whatever nature is (including whether it can be adequately designated nature), it is defined relationally, as part of a political struggle. But this *also* comes with a certain analytical cost. The *agency* of the non-human largely vanishes, and *tirakuna* takes the guise of *peoples'* materialized cosmology.

The problem we face, then, is that discussions of political materials easily settle into the well-worn grooves of familiarly dichotomous explanations. On the one hand, the STS interest in material agency inclines toward a baseline of Western naturalism (whereby spirits and mountains have a much harder time coming into view as political materials than climate models and scientific diagrams). On the other hand, anthropological explorations tend to circle over and around indigenous categories, stories, and myths (whereby the material agency so dear to STS falls by the wayside).

Attempting to elicit environmental infrastructures as assemblages where the 'natural' and the 'social' mix and take new shape, this paper has tried to circumvent the tendency to dichotomize. This has obliged an effort to stay attentive to the rather wildly heterogeneous set of materials that meet in, make up, and transform rivers, forests, roads, databases, and, indeed, *worlds*. Environmental infrastructures, I have argued, are relational systems, in and through which the contingent, creative, and world-shaping implications of a multiplicity of political materials can be elucidated. They are experimental systems for producing social, natural, and political futures. They are arrangements for the unpredictable generation of new ontologies.

More than human and less than ordinary

If I would like to draw one general conclusion, it is thus that all kinds of materials gain political qualities inasmuch as they are elements in unfolding infrastructural experiments that make up new worlds, futures – ontologies.

But though ontology is a term that, recently, has received considerable attention in STS and anthropology, the appositeness of an ‘ontological turn’ is by no means broadly accepted within either. In Michael Lynch’s view, for example, there is a tension between ‘adopting a general philosophical ontology and pursuing empirical studies of particular’ practices (2013, 444). Viewing the turn to ontology as exemplifying a general philosophical position, he compares it with ‘a lecturer’s gesture toward the smudged and faded outlines of a figure that had earlier been erased from the blackboard’ (452). This barely discernible outline is the figure of earlier abstract philosophies claiming the ability to define nature in advance of empirical inquiry. Lynch clearly worries that ontology signals a new scholasticism.

Lynch’s smudged figure is made of straw, rather than chalk. It bears little resemblance to the arguments of Mol, Latour, or others that he criticizes. But if the critique is muddled, his own position is stated with perfect clarity: ontology can make sense only if redefined as an ‘ontography’, avoiding philosophical speculation and centring on elucidation of ordinary action and ‘vernacular categories’ (Lynch 2013, 455).⁵ Strikingly, ontology thus begins to look very much like ethnomethodology!

And yet, the focus on vernacular categories and ordinary action is limiting for efforts to rethink material politics. Rivers and trees change landscapes and livelihoods, and often this happens as silent transformations, underneath the radar of vernacular categories. Climate models, as much as people, transform global politics, and though such models are classification systems, they are also many other things. Even more, beyond ‘ordinary’ action (as conceived by the Western social scientist), earth-beings and anaconda ancestors influence environmental infrastructures and modify ontologies. The political materials involved in these processes are invariably *more than human and less than ordinary*.

In this paper, I have attempted to address a double invisibility: the invisible activities of the materials out of which environmental infrastructures are composed, and the invisibility of forms of action that fall outside the scope of the ordinary and vernacular. Environmental infrastructures are sites where materials meet, engage, and produce new worlds. Such worlds may be incommensurable, or they may be shared. Political clashes may take front-stage in battles over articulating knowledges, but often they are silent transformations of the world’s arrangements. Tracing such transitions and transformations is an effort to outline the contours of emergent ontologies. This offers an agenda for a social science willing to look more attentively at the multiplicity of political materials that change our worlds, and interested in experimenting with the empirical and conceptual resources for getting them into view.

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Notes

1. Are they indeed ‘natural entities’? As de la Cadena reminds us, this is also part of the question, for a crucial part of the struggle she describes revolves around whether Ausangate is a (natural) mountain or an earth-being. The latter force upon us altogether harder questions concerning political materials, since it does not fit into the natural–social dichotomy upon which conventional

environmental politics relies. Thus it for practical purposes only I continue to speak of rivers, forests, and mountains as ‘natural’.

2. Per implication this must extend to the teller of the stories too. If there is no outside, description is the outcome of one ‘piece of the world that is looking at another piece of the world’, as Italo Calvino’s character Mr Palomar formulates it (1994, 102). Mr Palomar wonders if it might even be the case that the ‘the “I”, the ego, is simply the window through which the world looks at the world’. This is not a line taken by Pollan, but it is one to which I return below, picking up on Joan Fujimura’s (1991) observation that how we write depends on what we want to achieve.
3. This section was originally prompted by a question I posed to Eduardo Viveiros de Castro: What would environmental infrastructure look like from an Amerindian point of view? He replied that perhaps the river itself might be the infrastructure. This idea can also be read from Raffles’s *In Amazonia* or White’s *The Organic Machine*. But because the Milk River is not a Western river, in the same sense as Ausangate is not a Western mountain, it opens up for different questions concerning political materials.
4. As Marilyn Strathern observes: ‘this very capacity to think one is perpetuating very old ideas, simply doing again what has been done at other times and in other places before ... is itself a profound engine for change’ (1992, 44).
5. Lynch thought ontography to be his own neologism but found that others had already used it ‘for the very sort of metaphysical position I had hoped to distinguish it from’ (2013, 461n6). He does not cite who these other metaphysicians are. However, it is noteworthy that Martin Holbraad (2012) has recently put the term ontography to creative use in an anthropological context. For Holbraad, as for Mol, Latour, Stengers, de la Cadena, and also for myself, ethnography and conceptualization are not mutually exclusive categories. They do not create a zero-sum game as Lynch imagines when he contrasts general philosophy with empirical inquiry.

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