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## Books Forum Introduction

### After the Science Wars: Clash and reconciliation of environmental knowledge, politics and myth

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Since the Science Wars of the 1990s, the heated dispute over anthropogenic climate change has posed the greatest theoretical and political challenge to Science and Technology Studies (STS). When oil industry lobbyists and conservative politicians pointed to the socially constructed and controversial nature of science to undermine a naive realist belief in ‘the facts’, for example, of global warming, their strategy bore an uncanny resemblance with the sociology and anthropology of science of the 1980s and 1990s. Suddenly two decades of social–scientific work that had analysed the uncertainty pervading our ‘ecology of ignorance’ and radicalized a post-positivist philosophy of science that highlights the underdetermination of scientific theories by evidence appeared to provide the intellectual accompaniment for a public disinformation campaign. Scepticism *vis-à-vis* the objectivity of scientific knowledge and an egalitarian representation of a multiplicity of contingent perspectives, including those marginalized by the scientific establishment, may well have helped to block environmental policies that would have imposed stricter regulations on industry.

Against this backdrop, Naomi Oreskes and Erik Conway wrote *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* – a historical account, which breaks with the sceptic and constructivist tendencies that have come to dominate STS.

In his review, Reiner Grundmann mobilizes some of the most powerful arguments developed in STS scholarship to challenge the seeming nonchalance with which Oreskes and Conway brush aside many lessons learned by students of science and technology. For example, the authors consistently breach the so-called principle of symmetry, which requires equal methodological treatment of both sides of a controversy when they explain the positions of climate change deniers in terms of cultural biases while the results of their opponents’ good scientific work appear unaffected by the latter’s political views. Grundmann’s review raises the broader question of what is at stake in this backlash against constructivism.

The rest of the Books Forum is less about war than peace – or at least conflict negotiation. Shiho Satsuka discusses how conceptions and practices of translation figure in three books on the politics of environmental knowledge. In different ways, Tim Choy’s *Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*, Tim Forsyth and Andrew Walker’s *Forest Guardians, Forest Destroyers: The Politics of Environmental Knowledge in Northern Thailand*, and Andrew Mathews’ *Instituting Nature: Authority, Expertise, and Power in Mexican Forests*, examine what happens when local understandings of the environment meet national policies and international activism. Whereas *Merchants of Doubt* presented the climate change controversy as a confrontation between true knowledge and false belief, the concept of translation allows these authors to examine how differences between local and expert knowledge, between indigenous and state interests and between human and non-human actors are negotiated and bridged despite or maybe because of the entanglements of values and facts.

In Michel Serres’s *Biogea*, John Law finds an optimistic way of writing about the fusion of the biosphere and the geological, most noticeable in anthropogenic climate change. This literary form reconciles myth and the knowledge of the new life and earth sciences, replacing the grand narratives of Western philosophy by weaving together little stories that are simultaneously personal, historical and mythical. In the face of large-scale environmental destruction, Law understands this reframing as a political intervention, but worries that Serres did not identify specific targets.

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As a whole, this Books Forum should make us think about whether such reconciliation and translation – both as theoretical framework and as acts of practiced diplomacy – could help to resolve scientific–political standoffs such as the one over

climate change, or whether they obfuscate that it is neither the job of either natural nor of social scientists to serve as ambassadors and that some bodies of knowledge are more valid than others.

## Books Forum

### Debunking sceptical propaganda

Naomi Oreskes and Erik M. Conway  
*Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming.* Bloomsbury Press, New York, 2011, US\$ 13.23, ISBN: 978-1608193943

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Naomi Oreskes and Erik Conway's much acclaimed *Merchants of Doubt*, published in 2010, is an extremely well written book. It tells the story of *How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. The authors are historians but the book does not aim to offer a 'balanced account' of the issues it deals with. It provides a partisan account of scientific controversies embedded in policy disputes. It is written as an attack on the *Merchants of Doubt*, justified by the importance of the issues at stake and the alleged influence of the protagonists. The book traces the activities of some key players, nearly all of them in the United States, above all Fred Singer and Fred Seitz, through case studies of acid rain, tobacco smoking, global warming and pesticides. As far as historical reconstructions go, the analysis of the acid rain controversy is the most persuasive, the chapter on global warming the least.

The plot of the book is simple: we would have made more progress in policymaking had not a bunch of contrarian self-stylized experts tried to undermine faith in the knowledge base for regulation. Their motivation was a belief in free market principles with a dose of anti-communism. They have combined both motives to reject government intervention, to promote the freedom of enterprise and to attack environmentalists as 'socialists in disguise'. This ideological influence made them blind to the facts, in fact led them to 'deny the science'. The US media, following a professional norm of journalistic balance, have amplified the false truths propagated by the contrarians. Nearly all of the elements of this plot are axioms or shared beliefs of environmentalists and some climate scientists. The partisan account provided here thus merits special scrutiny.

Much of the book documents how scientific assessments have become the battleground for political quarrel and how protagonists sought to influence the central message for policymakers. This is best demonstrated in the case of acid rain. The authors show in great detail how a small group of people (especially Fred Singer) re-interpreted the findings of a scientific panel to make it more palatable to the US government. The findings of the 'Acid Rain Peer Review Panel' were diluted and re-arranged for a report by the Office of Science and Technology Policy. A great deal of historical documentation supports the narrative.

Oreskes and Conway invest much energy to demonstrate what 'the facts' say. This leads them to overstate the factual basis on which regulations should be based. And it leads them to neglect the logic and dynamics of political decision-making and the policy process. The book relies for large parts on pre-theoretical knowledge about the science-policy interface (for example, we all know that emphasis of uncertainty will delay political action) and only the

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concluding chapter refers to some relevant, yet still extremely limited social science literature.

The storyline of the book follows the simple pattern of accusing the contrarian protagonists of foul play without realizing that the logic of a politics of knowledge induces all sides of argument to employ similar tactics. A section headline in chapter 3, 'Manipulating peer review', refers to contrarian strategies in the acid rain debate. One does not find a similar section in the chapter on climate change, despite the fact that, in the so-called Climategate affair, this has been a prominent issue for the other side as well.

The authors seem to think policymakers rely on the quality and evidence of scientific research for environmental regulation. This exemplifies a technocratic approach to policymaking, which has largely fallen out of favour in science and technology studies. It is therefore curious to see two historians of science embrace this kind of thinking and getting much praise for it. It may have to do with the polarized debate under consideration in the book and the penchant of the authors to identify good guys and bad guys in a clear-cut fashion. This does not mean that I doubt in any way their characterization of the contrarians as free market fundamentalists who tried to oppose environmental regulations through interventions into the advisory process and public debate, thus effectively operating as a vocal lobby group, claiming to speak with scientific authority. The book documents this rather well. What is problematic in this account is the crude scheme, which exposes cultural bias but sees it only as a problem for one side of the debate. The reader searches in vain for sociological studies, which have shown how cultural bias operates across different social groups, and within science, including the 'good' scientists.

Oreskes and Conway seem to have adopted a tacit justification for this. They quote the contrarians' characterization of the environmentalists as 'disguised socialists' and concede that this may apply to some environmentalists. However, they are adamant it does not apply to many scientists, and that 'even if all environmentalists were socialists, it does not follow that global warming is a myth'. This is to say that there may be cultural bias at work across the board but the environmentalists have the advantage of being scientifically correct, and therefore such cultural analysis is not relevant.

This poses a serious problem for the logic of their argument, especially if it were the case that scientists had such sympathies. To count as a socialist in the eyes of the contrarians does not require radical left-wing politics – a pro regulatory position is sufficient. Oreskes and Conway are well aware that policymakers

and citizens rarely scrutinize the knowledge base for regulation. They trust some experts while they mistrust others. But if scientists can be portrayed as biased, the trustworthiness can no longer be taken for granted. This leads to the now common standoff between 'sceptics' and 'alarmists', or between catastrophists and cornucopians who believe in technological solutions for all problems associated with population growth and environmental destruction. Science becomes the *Ersatzkrieg* between these two political orientations.

Oreskes and Conway espouse a considerable political naivety about the political process and the role played by scientific research in this. They believe that regulatory progress has been delayed, hindered or blocked by the fabricated impression of uncertainty. For Oreskes and Conway, the science is clear and justifies, or even demands, government interventions. But because a 'handful of well-funded contrarians' is able to spread doubt, we don't make any headway (or only after a long wait).

The public relations-savvy contrarians have been given much space to express their views in the media. This aspect is worrisome for Oreskes and Conway. It is also the most alarming part of their story. The freedom of modern journalism allows for such false representations of scientific knowledge and the authors suggest they should not be presented in the media because they failed to gain acceptance in the scientific literature: 'Many of the claims of our contrarians had already been vetted in the halls of science and failed to pass the test of peer review. At that point, their claims could not really be considered scientific, and our protagonists should have moved to other things. In a sense they were poor losers. The umpires had made their call, but our contrarians refused to accept it' (p. 270).

Oreskes and Conway stop short of calling for press censorship and they acknowledge, in a last minute return to common sense and social science, that 'scientists have no special purchase on moral or ethical decisions ... . In some cases lay people may have relevant experiences scientists can learn from' (p. 273). But this comes at the very end of a book that is full with assertions about the centrality of scientific opinion, properly understood.

Another shortcoming of the book is its lack of conceptual differentiation of different kinds of knowledge and the consequences for policy analysis. Not only is the science/policy interface underdeveloped, the nature of knowledge that is at stake is never analysed in appropriate terms. The whole account gets muddled as a result.

The confusion arises because Oreskes and Conway do not see that there are different reasons for

policymakers to enact regulations; scientific knowledge is only one component and arguably not the most compelling. Political scientists usually list salience, credibility and legitimacy, or economic, administrative and political viability as key determinants for policy-making (Hall, 1989; Cash *et al.*, 2003). Coalition building and public support are essential levers to advance a case, not scientific research. Scientific knowledge can never be certain in the sense of providing 'positive truth'. The authors acknowledge this (in some places they say it is a matter of judgement of how to weigh the evidence). But they swiftly replace scientific Truth with scientific consensus as ultimate arbiter in environmental policy disputes. However, it is one thing to produce knowledge, which is practical, that is effective in practice. It is another thing to have a detailed scientific agreement about an issue as a necessary precedent for action (Grundmann and Stehr, 2012). Scientists and policymakers who frame their case in terms of consensual science invite criticism aiming at a deconstruction of their scientific claims. It is simple: if you present science as the reason for action those opposed to action will start dissecting the science. To get out of this conundrum, Oreskes and Conway call into question the legitimacy of their contrarian protagonists to do so. Meanwhile, nothing has been achieved in terms of developing a policy that could win the support of voters and powerful actors.

On the other hand Oreskes and Conway realize that scientific theories and practical action are different indeed: 'in scientific research there is always doubt. In a lawsuit, we ask: Is it *reasonable* doubt?' (p. 31). They recognize, for example, that the causal link between smoking and cancer is not straightforward ('current science does not allow us to say with certainty that any one particular person's lung cancer – no matter how much she smoked – was caused by smoking', p. 31). This gave industry spokespersons an argument to oppose government intervention as Oreskes and Conway acknowledge: 'One reason the industry's campaigns were successful is that not everyone who smokes gets cancer. In fact, most people who smoke will not get lung cancer' (p. 33). Believe it or not, on the same page the authors assert that 'the tobacco industry was never able to support its claims with evidence, which is why they had to resort to obfuscation'.

The role of non-scientific actors is largely absent from the book. There is no recognition of the fact that – apart from the tobacco industry – many smokers had an interest to fend off government anti-smoking policies. And there were other reasons apart from concerns about cancer that drove anti-smoking campaigns. Ambient air quality is a powerful reason to ban indoor smoking, no matter what the science says about

tobacco as a cause of cancer. In the story about the ozone layer the authors admit in passing that American consumers had switched to CFC-free products even before regulations kicked in or the science was settled.

In the stories about acid rain and global warming the authors do not discuss the abatement costs from fossil fuel burning and how this affects competitive advantage among industries and nations. Yet such considerations are powerful motives for policymakers to embrace or shun regulatory proposals.

The book's main weaknesses come to the fore in the chapter on global warming. It starts with a complaint that the US public does not seem to have a good grasp of the essential scientific facts about global warming (in 2006, only 56 per cent thought global average temperatures had risen) and that the public perceived a 'lot of debate among climate scientists'. As one would expect, the contrarians' campaigns and the media attention are to blame for this state of affairs. And, crucially, the authors seem to believe that in the absence of such contrarian misinformation, we would have made much more progress. The way the story is presented makes one wonder just how much progress could have been made by now and how countries with different domestic politics would perform (neither Germany nor the United Kingdom, despite their 'progressive' climate policies, have met the modest targets of greenhouse gas (GHG) reductions set in Kyoto 1997, if one accounts for their offshored manufacturing to countries such as China).

But the problem is more nuanced than this. The public perception of scientific debate about climate change is entirely accurate, how else would one explain the rising number of publications in the scientific literature? Oreskes and Conway would probably point out that these are merely refinements of scientific detail and that the fundamentals have been agreed upon.

Oreskes and Conway construct an analogy between someone proclaiming that the Sun rotates around the Earth and someone proclaiming global warming as 'not real'. They suggest that it is plain that the Sun-rotating-the-Earth nonsense would not be published in a scientific journal and that there could be no place for someone to suggest 'global warming was not real'. But this phrase hides the all-important nuances. It is unspecific as regards the precise knowledge claim. The analogy breaks down because in contrast to global warming, the heliocentric model is quite specific and can be tested quickly. In climate science it is not clear what would count as falsification. What is more, most climate sceptics agree with the official temperature record; they also agree with basic physical principles

(such as carbon dioxide being a GHG and rising emissions leading to more warming). The disputes are about how much future warming can be assumed and how much warming in the past can be attributed to past GHG emissions. These issues about climate sensitivity and attribution raise questions about the quality and predictive validity of climate models. These questions are not sufficiently addressed in the book but they become more urgent as it becomes evident that global temperatures have remained flat over the past decade (see Hansen *et al.*, 2013).

The storyline of the book seems to suggest that any criticism of mainstream climate science would come from contrarians who are well-funded by powerful business companies. This is alluded to when Steve McIntyre is described as ‘a Canadian geologist with links to the mining industry’. In fact, McIntyre is an expert in statistics who tried to replicate the famous ‘hockey stick’ and set up a widely read blog, *Climateaudit*. It is misleading to suggest he would sing the praise for fossil fuel companies because he used to work as a prospector for mining firms.<sup>1</sup> It will be interesting to see how Oreskes and Conway interpret emerging critical voices, which have thematized temperature records and sensitivity. Maybe the deadline for the book meant that such developments could not be included.

I am curious if the Climategate affair occurred too late to still be taken into account. It would have provided a contrasting case to examine not only with regard to the issues of scientific ethics but with regard to the politics of knowledge (Grundmann, 2012). The selection and stage management of scientific papers and reports for the Intergovernmental Panel on Climate Change (IPCC) would come very close to the lobbying practices described by Oreskes and Conway. Climate scientists have been accused of emphasizing specific information while leaving out inconvenient data (for example in the practice known as ‘Mike’s Nature trick’ of ‘hiding the decline’ of decreasing temperature records from a set of historical tree ring data and refusing the release of data under the Freedom of Information Act, FOIA).

The only recognition of this affair can be found in the conclusion, which refers to Michael Mann, who was ‘harassed’ by Steve McIntyre (their term for noting his request for data and code under FOIA). Oreskes and Conway comment that FOI ‘was designed to enable citizens to know what their own government was up to, not to help foreigners harass our own scientists’. It looks as if the authors

unreservedly side with beleaguered climate scientists when stating that the data are freely available anyway so ‘there is no need for FOIA’.

But the authors should have been aware of at least one more recent development in the scholarly literature, especially as it goes to the heart of their claims about ‘false balance’ in the US media reporting on climate change. This term originates from a study by Max and Jules Boykoff from 2004, which examined the US press from 1988 to 2002 (Boykoff and Boykoff, 2004). However, Max Boykoff in a follow up study from 2007 (under the title ‘Flogging a dead norm’) did not find confirmation for his earlier claim, suggesting that the US press in 2005 and 2006 did no longer apply the journalistic norm of ‘balanced reporting’ (Boykoff, 2007; see Grundmann and Scott, 2012, for the scarce visibility of sceptical voices in the newspaper coverage of climate change).

For all these reasons I think this is a problematic book. It is disappointing to see professional historians reduce the complexity to a black and white affair where it goes without saying what the preferred colour is. The social science literature relevant to the understanding of policymaking in the face of uncertainty is largely absent. The authors mention just one study, about rational decision theory, which is probably cited because it supports the authors’ claim that scientific uncertainty helps to prevent or delay political action. They missed the opportunity to confront their historical material with approaches that have examined the same case studies but did not come to the same conclusions. Reading *Merchants of Doubt* gives the impression that no such work exists. This raises the question of what epistemological status it can claim. Its authors have been critical of the scientific credentials of the contrarians, quoting the lack of peer review or selective use of information. This book has all the hallmarks of science (there are many footnotes) and perhaps it was even peer-reviewed. But it is what the title and subtitle suggest: less a scholarly work than a passionate attack on a group of scientists turned lobbyists – and thus itself a partial account. I wonder if it does not do a disservice to the cause it is advocating.

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1 See my analysis of ‘Climategate’ in which McIntyre’s dispute with established climate scientists is explained in greater detail (Grundmann, 2012).

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## Politics of environmental knowledge translation

Tim Choy

*Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*. Duke University Press, Durham, NC, 2011, \$19.12, ISBN: 978-0822349525

Tim Forsyth and Andrew Walker

*Forest Guardians, Forest Destroyers: The Politics of Environmental Knowledge in Northern Thailand*. University of Washington Press, Seattle, WA, 2008, \$25.00, ISBN: 978-0295988221

Andrew Mathews

*Instituting Nature: Authority, Expertise, and Power in Mexican Forests*. The MIT Press, Cambridge, MA, 2011, \$23.57, ISBN: 978-0262516440

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Attention to the politics of environmental knowledge has grown among social scientists. As the 'environment' becomes a key issue in global politics, there is a heightened interest in how people living in various places understand their environments. How is their knowledge of environmental issues shaped by specific social, political and economic concerns? What happens when competing understandings of environment come into contact? What kinds of contestation and negotiation take place in the encounter of cosmopolitan expert knowledges and lay understandings of specific landscapes?

To explore these questions, recent critical studies of environmentalism and environmental science in anthropology and political ecology have been in dialogue with science and technology studies (STS), offering interesting analyses of how expert environmental knowledge is produced and circulated. Much of this literature gains insights from the STS notion of 'translation' (Callon, 1986; Star and Griesemer, 1989; Latour, 1993), examining how various human and non-human actors are enrolled in the process of making and legitimating scientific knowledge, and giving it authority in policy-making and implementation. In turn, these studies highlight inequalities and asymmetrical power relations among actors, and demonstrate the political nature of scientific expert knowledge making. Interestingly, as Goldman and Turner (2011) point out, although environmental issues have become a global concern, 'messy' 'field-based' environmental scientific work', such as ecology, forestry and agronomy have been relatively understudied in the field of science studies (p. 14; but see Kuklick and Kohler, 1996). Yet, such

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field-based sciences would provide prime sites for examining politics among expert scientific knowledge and other forms of knowledge, as local residents form rich knowledges about specific environments in their everyday activities and experiences.

This review discusses three books that apply the STS notion of 'translation' in their critical analyses of environmental expert knowledges – one co-written by a political ecologist and an anthropologist and two books by anthropologists. Each book, in its own way, demonstrates the entanglements of politics and environmental knowledge: Forsyth and Walker analyse the proliferating environmental discourses that influence forestry and agricultural policies in northern Thailand; Mathews examines the performative construction of expert knowledge in the forest bureaucracy in Mexico; Choy documents the articulation of environmentalism in Hong Kong in the political context of its handover from Britain to China.

## Entanglements of Environment and Politics

Forsyth and Walker critically examine commonly held explanations of environmental problems in northern Thailand. They call these discourses circulated in media, bureaucracy and popular debate 'environmental narratives' and argue that such narratives are misleading and oversimplified, consisting of 'selectively chosen elements of both scientific and local knowledge' (p. 18). The authors assert that environmental narratives 'frequently impose meanings that are acceptable to their creators and users, but which may contain unwelcome implications for other social actors' (p. 17). These narratives have shaped the view that upland 'hill tribes' are problematic, based on the stereotypical understanding of their agricultural activities as 'shifting cultivation'.

The book introduces the region as one of the most heavily researched areas in Southeast Asia: it has drawn international attention for its mountainous landscape inhabited by diverse ethnic groups, as well for the region's specific history as a 'political frontier' and site of frequent government military action against communist insurgencies. Given these security concerns, the region became the recipient of various aid and development programmes. The authors describe how these concerns influence debates about forest and watershed protection, biodiversity conservation, agricultural management, soil erosion and ethnic conflicts. Environmental narratives in these debates often take two competing approaches: a 'nature-oriented' conservationist approach and

a 'people-oriented' strategy for effective natural resource management. In particular, the Hmong have been stigmatized as villains of forest degradation, due to their image as cultivators of opium and its cash-crop substitutes, such as cabbage and potato. Their agricultural practices are labelled as 'pioneering shifting cultivation', constantly moving on to clear new fields, making them the target of a relocation campaign by lowland Thai. In contrast, the Karen have been romanticized as environmental 'heroes' (p. 76). Their careful site selection, short cultivation periods with long fallow periods, control of burning and maintenance of large tree stumps are considered to be ecologically sustainable, causing minimal soil disturbance and limited erosion.

The authors critique both of these narrative approaches because each embodies the problematic assumption that the primary causes and solutions to environmental problems should be located in the practices of upland farmers. Against this assumption, they provide research results that suggest that water shortages should not only be attributed to upland deforestation, as high water demand from lowland agriculture may also be contributing. They identify the source of the problem of environmental narratives as their naïve application of scientific models developed elsewhere, and the transfer of ideas without considering the specific local context. In particular, the authors critique the relevance of using the US-developed Universal Soil Loss Equation for assessing environmental problems. They provide a variety of research results that reveals uncertainties in the applicability of the model to the landscape of northern Thailand.

By providing ample evidence that counters dominant explanations of environmental crisis, Forsyth and Walker forcefully argue that environmental science is not politically neutral, and 'the production of environmental knowledge both reflects and reinforces social structures' (p. 15). Concerning the 'accuracy' of environmental knowledge and the political effects that could unnecessarily restrict the livelihood of residents, the authors ask, 'What can be done to overcome these influences? Can environmental knowledge be generated more critically, transparently, and inclusively?' (p. 237). The authors suggest that instead of assuming the universal applicability of scientific knowledge and thus foreclosing the problem's definition, it is necessary to diversify definitions of the problem by paying closer attention to the particular social and natural environment of northern Thailand, and to contextualize the problem by incorporating the various perspectives and circumstances of different social actors.

Here, although the book's diagnosis of the problem of simplified environmental narratives is powerful and convincing, there seems to be a tension between the author's analytic approach of critical discursive analysis and their interests in making political interventions to mobilize 'accuracy' and 'transparency' in policymaking. If scientific knowledge is not neutral, but constructed by selective generalization and inevitably influenced by the social and political context of knowledge production, what exactly do 'accuracy' and 'transparency' mean? Clearly, this political ecology book's concern is macro-level politics within the framework of existing national and international politics. Thus, an analysis of the micropolitics of knowledge – why and how norms of 'accuracy' and 'transparency' have been constructed in specific historical and social contexts to privilege a certain epistemological framework and suppress others – may not be within its scope, and it would be fair to leave it for other projects.

Yet, questions linger: how and why do the environmental narratives maintain their stability and strong influence in spite of ample counter evidence? This is related to the way the book treats knowledge translation and the formation of 'actor networks' almost as synonyms for 'governmentality' or 'the achievement of political ends by locating decisions in apparently neutral science and expert institutions that remove discussion from the public domain' (p. 22). If we do not want to naturalize the formation of dominant environmental discourses and their governing power, how do we analyse their ignorance toward counter evidence? One potential approach is to pay attention to the practices and motivations of the actors. Why and how do the bureaucrats and experts evade this evidence? How do the upland farmers themselves make sense of and respond to these narratives and how do their responses influence the expert knowledge? Although the book compellingly demonstrates how the knowledge about natural ecology is inseparable from the politics and social ecology of knowledge production, what the book leaves out are the dynamics among subjective experiences of the actors.

## Performance and Gaps in Translation

Mathews offers quite a different understanding of expert knowledge and its technical implementation by highlighting the performative aspect of knowledge

translation. Instead of assuming the transparency of expert knowledge, Mathews argues that transparency is achieved by the acrobatic performances of state officials who have to deal with the tensions between the state's knowledge claims and the local people's experiential understanding of the concrete landscape. His rich ethnography of Ixtlán, a model forest community, demonstrates that the state officials performing authority about their knowledge are 'haunted by a sense of vulnerability' (p. 4).

The history of the development of the Mexican forest bureaucracy and the indigenous community forest in Oaxaca provide the ground for Mathews to interrogate the 'uncertain authority' (ibid.) of state expert knowledge. The forest bureaucracy developed out of the Mexican Revolution in 1910–1920. The state redistributed vast lands owned by great estates to newly formed peasant and indigenous communities. Forestry science was introduced by translating European silviculture, in order to make the land legible to the state for managing timber production with scientific rationality. In this context, document making became an important technology for covering staff shortages and extending the state's administrative reach to remote places. The forest service has continuously tried to assert authoritative knowledge by producing documents such as scientific forest management plans, statistical data, and logging and fire permissions.

In this process, agropastoral burning posed a significant challenge to the forest bureaucrats. Although officials framed fire as a potential threat to timber production, burning was a widespread practice for swidden agriculture throughout Mexico. Moreover, the imported forest theory did not suit the pines that dominate forests in Oaxaca because, as a pilot species, pines require disturbance for regeneration and are well adapted to the landscape created by local burning practices.

Rather than depicting the implementation of fire regulation as the exercise of a unitary and oppressive state power, Mathews offers more complex dynamics among various human and non-human actors. For example, Mathews explains how, with the introduction of industrial logging in the mid-twentieth century, community members creatively reworked their fire-fighting practices by combining traditional fire control measures with new knowledge by adopting official fire discourse. Along with the transformation of firefighting, community members successfully reconfigured their position from users to fighters of fire. By so doing, they also shifted the state discourse of forest degradation and forced it to accept that the

source of forest degradation was the predatory practices of the logging companies, instead of the community's usage of fire. This led to the state cancelling logging concessions in the 1980s, putting the forest under community control.

Mathews suggests that while documents are important tools for the bureaucrats to perform their authority, the enormous amount of documentation also put them in vulnerable positions. For example, the data required for burning permissions is considered to be 'unrealistic' for farmers to provide in advance due to changing weather and other conditions. The enforcement of 'unrealistic' requirements could trigger resistance and accusations from the community, endangering the officers' jobs. Therefore, the officials have to simultaneously produce transparency in their paperwork and obscure the fire and logging activities in the community by ignoring them. Ironically, the more the state tries to make the forest legible through these documents, the more it makes the local practices illegible. Yet, the chains of paperwork produced by various levels of officials present Ixtlán as a successful example of an indigenous forest community, enabling the state to seek funding from the World Bank.

Translation for Mathews not only enlists actors and consolidates expert knowledge, but also opens up a gap between knowledges. He states, 'This gap was a space for a tactics of making alternative knowledges and of opposing or remaking forestry institutions' (p. 236). Translation also fosters transformation. His examples suggest that despite its universal claim, expert knowledge is 'never applied without transformation and translation in local contexts of use; scientific theories are transformed in the making of technologies' (p. 229). Translation stages the performances of actors who try to deal with the gap by diverse strategies and by responding to their particular positions in the natural and social ecology, formed by the web of relations among various actors – both human and non-human, such as pines.

## Affective Translation of Universal and Particular

The tension between universal and particular is the implicit theme in both Forsyth and Walker's and Mathews' analyses of translation. Forsyth and Walker critique the assumption of universal applicability of expert scientific knowledge, thus problematizing translation as an act of transferring certain knowledge to a foreign context that often results in marginalizing

other knowledges despite the uncertainty of the scientific knowledge claim. In contrast, Mathews sees the gap opened up in the practice of translating expert knowledge in a particular place serving as a site of political negotiation. Rather than placing the universal and the particular in opposition, Choy illustrates how universality and particularity form a paired condition for expert knowledge to claim its authority. Expert knowledge needs to concurrently perform its ability to be universally circulated and appropriated in a particular context. Moreover, Choy's ethnographic accounts suggest the significance of affective aspects of universal-particular articulations. Translation not only transfers the instrumentality of knowledge – how people use their cognition and information in livelihood strategies – but also informs their worldviews, sensibilities and senses of belonging. In turn, translators' aspirations and desires shape the way they move knowledge.

Choy focuses on how the universal and the particular play out in environmental activism and coalition making in Hong Kong. With the historical background of the region's handover from British rule to Chinese governance in the late 1990s, Choy describes how environmental issues are entangled with social concerns about Hong Kong's uncertain future in the rhetoric of 'endangerment', the fear of losing its unique existence. Choy offers a variety of episodes as examples: the protection of the pink dolphin as a mascot of Hong Kong, heightened popularity and attention to the old fishing village of Tai-O, interpretation of the relationship between orchid species in Hong Kong and China, and various measures to express people's concerns about Hong Kong's air pollution. Through these examples, Choy demonstrates how people constantly translate scientific concepts and frameworks, conservation strategies, evaluation measures, lifestyles and ethics developed elsewhere and brought to Hong Kong, and how people make comparisons between their specific conduct of life in Hong Kong and that in other places. The universal circulation of these knowledges allows people to reflect and produce local knowledge about the particularity of their situation.

Choy illustrates the significant role of translators in circulating knowledge and making environmental coalitions. For example, Chapter 4 describes how a Hong Kong Greenpeace activist interpreted an American chemist's expert knowledge to villagers and journalists in a town meeting and convinced them to form a coalition against a municipal plan to build a waste incinerator. By repeating the chemist's speech in Cantonese, mimicking his gestures, volume and

pitch, as well as filling in knowledge gaps, the activist generated metapragmatic effects; he staged the authority of the original speaker. Choy argues that this kind of translation is key for articulating environmentalism, stating that translation is a 'technology that makes knowledge move and come to matter as expertise... [It] performs transportation' (p. 92). Translation mobilizes various stakeholders and enables the making of allies.

Then, in Chapter 5, Choy discusses how translators' own subjectivities as environmental activists are shaped by their interpretations of environmental ethics encountered and imagined through the experiences of travel and living overseas. By comparing themselves and other Hong Kongers, as well as Hong Kong and other places, they shape their desires for cosmopolitan belonging, and their sensibilities towards environment 'within local and translocal ecologies of gender and expertise' (p. 14). Thus, Choy's ethnography of Hong Kong environmentalists attests to the entanglement of not only natural and social ecologies, but also mental ecology, or affective human relations that shape the particular subjectivities of people.

Although Choy's beautifully crafted prose illustrates his informants' subjective experiences and suggests the importance of the affective aspects of knowledge translation, the book left me with a set of questions: Is environmentalism in Hong Kong only articulated in a Greenpeace style – a form of international activism that explicitly challenges the state and industrial practices and an oppositional politics that aims to correct capitalist resource extraction? In other words, is environmentalism articulated only among speaking subjects, or those with cosmopolitan aspirations or investments in international coalitions? Moreover, would it be possible to mobilize environmental causes in other forms, more compatible with local residents' knowledge traditions and worldviews? What is the role of Chinese intellectual legacies in environmentalism?

Right after describing coalition making among the Greenpeace activists, the American chemist and indigenous villagers, Choy discusses 'the moments of unarticulated knowledge' (p. 100) or 'the outsiders' of articulated environmentalism (p. 81). The neighbouring non-indigenous community was excluded from the coalition because the village head refused to publicly speak against the incinerator project, although he and his fellow villagers obviously had many complaints about waste problems. They refrained from articulating their concerns in the form proposed in the town meeting. Choy's explanation of

these moments of exclusion points to the issue of 'indigeneity' in Hong Kong, and the histories of political-economic inequality among villages. However, I wonder if there were also other cultural politics, such as disputes over the meanings of problems, contestations among different epistemological frameworks with which people generate the knowledge about the issue and conflicts regarding what kind of subjectivity such knowledge requires. Although I respect Choy's focus on the translation of forms, a critical analysis of semiotic translation may add to his insights. By foregrounding the negotiation of meanings in the encounters among different knowledge systems, this might help us to understand how environmentalism in Hong Kong is not an example of the domination of Western knowledge, but a product of constant translation and negotiation of various knowledges. In Chapter 6, Choy introduces various perceptions of air that shape people's concerns about air quality by drawing from diverse sources including scientific index and accounts of the traditional Chinese understanding of wind and body. Would it highlight the uniqueness of environmentalism in Hong Kong if the book foregrounded the way these various knowledge traditions are translated in environmental activism?

## Translation of Three Ecologies

By closely examining the translation of environmental knowledges and environmentalism in non-Western societies, the above books demonstrate how environmental scientific knowledge is transported and circulated, shaped into bureaucratic expert knowledge and/or articulated in knowledge oppositional to state environmental policies. Read together, these three books illuminate a promising future direction that the cross-disciplinary dialogue among STS, anthropology and political ecology could offer: close examination of the process of translation is integral to understanding the knowledge politics about the environment and ethnographic attention to people's concrete everyday practice is essential for rendering visible the texture of knowledge politics.

Forsyth and Walker's astute critique of environmental narratives reminds us of how expert knowledge is politically implemented while suppressing the uncertainty of its truth claim, further underprivileging marginalized people. Mathews's rich ethnography illustrates the performative construction of expert knowledge that constantly needs to bridge the gaps

between claimed transparency and what it actually evades and does not know; it directs us to open our analytic sensibility towards the everyday political negotiations among bureaucrats and local people who skilfully learn how to deal with the bureaucracy. Choy's analysis of subjective experiences of environmentalists suggests that environmental knowledge is not only about instrumental understandings of how to use and manage natural resources, but that it is also central to the construction of subjectivity – how people position themselves in the world, both in relation to other people in the society as well as to other beings in the natural world. My combined reading of these three books reminds me of Guattari's (2008) argument for 'ecosophy', or an ethico-political articulation between three ecological registers – the environment, social relations and human subjectivity (p. 19–20). Guattari argues that, in order to respond to environmental issues, we need to reshape the way we produce material and immaterial assets politically, socially and culturally. Such reshaping requires taking into account not only 'visible relations of force on a grand scale', but also 'molecular domains of sensibility, intelligence and desire' (p. 20). In other words, we face the challenge of considering three ecologies – natural, social and affective mental ecologies – simultaneously.

How can the politics regarding affective aspects of human subjectivity be effectively incorporated into the picture without falling into culturalist explanations and essentializing preconceived cultural differences among various knowledge traditions? This challenge resonates with the recent call in social studies of science to incorporate post-colonial per-

spectives to take cultural politics seriously (for example, Anderson, 2002; Harding, 2011). The accounts of Forsyth and Walker, Mathews and Choy all suggest that critical analyses of translation processes of environmental knowledge have much to offer to this call.

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## ***Biogea: Love, hate and the murmurings of the world***

Michel Serres

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The world explodes, begins, expands; I can recount its Grand Narrative from the beginning, at the big bang, to its end – predictable? – called the big crunch. How boring, this dull duration, unfolding in billions of years. (p. 153)

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So there will be no big stories, perhaps because they are dreary, monotonous and mind numbing. However, what makes them this way? Are we simply in the grip of a particular aesthetic? Is it a matter of being repelled by narratives that come in big slabs? The answer is, perhaps, but there's something else going on too. A few pages after this declaration of faith Serres tells us that 'The private short stories of encounters run away from the public hell of power and glory'. (p. 161). He's telling us that they escape the great force fields of uniformity and domination. He also tells us that mostly it's not the trajectories that are important. Rather, it is what happens along the way. Hence, this book, *Biogea*, is a web of little stories: ancient and modern; historical, mythical and personal; philosophical and mundane. It is a collection of stories and meditations about the earth. It talks about how to know and care for the earth.

Ettore Majorana, Italian engineer and physicist, worked on atomic spectroscopy with Fermi and subsequently with Heisenberg. He posited the existence of neutrons (though he didn't publish about it) and wrote about neutrinos too. Possessed of 'that global intuition that only belongs to the great names cited two or three times a century' (p. 55), he wasn't in the slightest bit bothered about fame or recognition. Not for him that public hell of power and glory. Perhaps he wasn't very stable, and he was probably depressed. Serres tells us (others have said the same) that what weighed him down were the consequences of nuclear physics: he knew this would end in a Hiroshima. This was 'the original sin of nuclear physics' (p. 58). Majorana disappeared while sailing from Palermo to Naples in 1938. No one knows what happened to him. Suicide? Some form of escape? It's unclear. Before he disappeared, however, he wrote: 'Physics has taken a bad path'. (p. 54) Why? Serres plays with the hypothesis that Majorana did not want to and could not follow this bad path. Instead he preferred to vanish.

This small story about a big man is one example of Serres' mode of story telling. He does not simply tell about the earth, but also about encounters with unpredictable outcomes. The stories are often elemental too: earth, air, fire and water, all of these feature large in *Biogea*. Majorana belongs to fire, or perhaps to water. Empedocles, creator of the ancient Western scheme of the four elements is here as well – he belongs to fire, embraced by the caldera of Mount Etna. Moreover, Archimedes, the third Sicilian character in Serres' book, belongs to water but also to fire. He belongs to fire because he focused the rays of the sun to incinerate the Roman fleet, and to water

because he lay in his bath worrying about Hiero's crown and realized that a body floating in water displaces its own weight of water. The rest, as they say, is history unless you happen to think that its myth. At any rate, for Serres it's also parable because, as he puts it, if you plunge 'into authentic life or into direct and courageous learning' then you receive back an equivalent force that will lead to discovery (p. 65). Encounters, small encounters, and lots of displacements, these are what is important.

Hence, big stories aren't just boring, though they are indeed boring. It's not simply that they are saturated by power and glory, though once again Serres is clear that they are. It's also that they don't catch what is going on. Grand Narratives and specialist ways of thinking singularly fail to obtain purchase on the non-words of *Biogea*. The lesson is that we need to find ways of learning to *listen*. We need to be willing to learn and we need to learn not to want to impose our own codes. In short, we need to be willing to be shaped by our learning, by the earth, and by *Biogea*, the generative space that lies between the biological and the geological. Like Empedocles, we need make ourselves vulnerable and accept its embrace. Hence, many of the stories, most of them perhaps, are stories of vulnerability, about encounters that change.

Often the encounter is with water. Think, for instance, of the Garonne. A mighty river, sometimes it floods and breaks its banks, washing everything before it. This is a story told by the young Michel Serres. Raised on its banks, he worked first as a boy and a young man on a cable ferry. Calm most of the time, this was a job that brought terror when the river started to flood. When this happened the river showed its power. Animals, haystacks, trees, branches, stumps, bushes, people dead or alive, furniture, whole parts of houses, these would be washed away, swept downstream and get entangled in the cables. This was the moment when the work became a matter of life and death. The flotsam had to be cut loose or else the cable stays would be swept away. On one occasion they retrieved a human body, a murder victim and laid him out in the bottom of the boat. We learn, then, that Serres was born with the power of water. He was born from Garonne and the river was his lover. 'Never stop making love to the Garonne', he writes (p. 24).

Vulnerability, encounter, and the need to listen and to change in the encounter with the earth, these are the *leitmotifs*. Therefore, the book starts with Noah – or 'old Taciturn'. He built his absurd boat before taking his young kinsman, the narrator, to look first at the ocean, and then to listen to the rumblings of the

earth. A thin spit of earth stands between the ocean and the pastures. 'As far as the eye could see, plowed fields, cherry orchards, meadows ...' (p. 4). All of this is at risk. However, what of the rumblings? 'Listen to its voice', says old Taciturn. 'Our earth is speaking; you feel it; it's recounting something to us ... it's saying what it knows. What?' (p. 5). And then, later, comes the flood anticipated by the reader, the story of the ark and the planting, afterwards, of the vines, which leads to the creation of that early biotechnology, the making of wine. We need to find ways of listening to the earth, and what we are doing to the earth.

Hence, this is a book about knowing the earth. However, there's something wrong with how we do this. We're too specific, too specialist. We're good at our 'isms' and our 'ologies', and as a part of this, we're too concerned with our particular narratives, more or less grand, with their accounts of particular origins and particular causes. 'How boring, this dull duration'. Boring, vainglorious, but, and more important, also beside the point. Serres wants to tell us that it's not particular causes that are important. Who killed the murdered man they fished from the Garonne that day? The answer is that it isn't important. Serres goes out of his way to say that individual crimes may matter, but the problem of evil is collective. It's nowhere in particular, or everywhere, like God or the nuclear physics that was to lead to the incandescent obscenity of Hiroshima. However, most of us are not like Majorana because most of us do not walk away. Most of us remain attached to our own specialist grand narratives, narratives that do not begin to address the problem of evil because, vainglorious instead, we are too busy squabbling.

*Egodicy*: sometimes guilty, often innocent.  
*Theodicy*: undecidable sentence. *Sociodicy*: always guilty. Political thanatocracy, human and collective thanatomania. (p. 22)

Hence, the stories that Serres tells lead us, such as old Taciturn, to places of encounter. They lead us to places of overlap with the indeterminacy and fragile creativity of *Biogea*. We are shown its power, and exposed to its rumblings. The issue is one of dissolution and resolution, of movement between that which is definite and, more important, that which is not. We are in a world of encounters with the earth, encounters that are generative but in which we are also destroying the earth. Can we hear the rumblings? Are we able to attend to them? That is the question. Are we open enough to attend to *Biogea*, this fusion of the

biosphere and the geological? Are we able to attend to the pagan places of the soil where we are, or where we were born? Are we able to attend to this vaginal fissure between earth and flesh? Or have we closed ourselves off?

There's a moment when Serres sets up a pair of oppositions:

'We will never', he tells us, 'attain a deontology of our knowledge and actions without thinking the subjective, the objective, the collective, and the cognitive all together simultaneously'. (p. 71)

The deontological reference is partly to Empedocles, he of Mount Etna. The point being that for Empedocles the elemental realities of earth, air, fire and water, were linked to the principles for assembling or distinguishing them. Those principles? Love on the one hand, and hate on the other. Hate does the cutting, the destroying, the analyzing, the separating and the killing (this is a near quote from p. 70), while love is the tie, the force, that 'joins, unites, mixes, combines, constructs'. Love leads to birth, growth and joy. Note that term, joy. In this archaic metaphysics, love and hate are not just subjective emotions, but form part of the world as well. It makes no sense to separate goods and bads from the world – which, however, is what we have been doing, us in the West, for over 2000 years. Myths and nature, we've been in the habit of separating these, that's the story. It's a bit of grand narrative. However, now, looking forward, there is a ray of hope. The sciences are starting to point the way. The specialist business of cutting everything up is beginning to come apart at the seams. Perhaps for the first time in two and a half millennia we are in a position to attend again to the rumblings of *Biogea*, the inchoate voices from this space between earth and life. Myth and knowledge can be put back together again. Perhaps we can find wisdom or virtue in new sciences that are simultaneously subjective and objective, and collective and cognitive. Instead of an analytical hate in which we cut everything up, we can finally aspire to something better:

Difficult, global and connected, the life and Earth sciences presuppose communications, interferences, translations, distributions and passages. Love.' (p. 76)

Wisdom and knowledge can join, and we can begin to attend again, to the creative rumblings of the world

Gaping Mother earth: whether of body or of silt, a gaping opening yawns in the middle of the *Biogea*, at the weld between Bio and Gea, from which our origin and my book springs up. (p. 46)

Or, indeed, between information and the plenitude of the spiritual. (p. 195)

And for an appreciation, what do I say?

First, this is the book of an old man. Old but brilliant. Old *and* brilliant. Michel Serres was born in 1930. Hence, the Garonne is there; the years of service in the navy; the École Normale Supérieure; the Hermès series; the astonishing and brilliant command of classical Western philosophy; the interface between the striated and the turbulent; the eddies, the currents and the vortices. And the body is there too, beautiful, energetic, passionate, engaged and erotic, caught up in its own vortices and self-referential, indeed unashamedly so. The man and his body are there in the small stories and small encounters, refusing the inevitability of the grand narrative, which would tell of a lifetime, which began in a small bang, proceeded in linear fashion, and will end in a small crunch. Serres is refusing the boredom of that narrative, dodging and feinting through the specificities of encounters as his body approaches the crunch. He is searching, making or remaking the possibility of a return to enchantment, perhaps to the enchantment of spiritual, and at any rate to the undifferentiated. I write these words more easily because I, too, am nearly an old man. If they imply condescension, then that condescension rains down on my head as well. That said, if we are lucky old age no doubt also brings its privileges: a willingness to let go of specificity, not to mention the vainglorious trappings of pomp and power. Serres is in this place of privilege and it would be wise to attend to his wisdom.

Second, the book is also a cry of pain. Its author is an old man in a hurry. However, even if this is true, to say this is also cheap, indeed far too cheap. For if Serres is urgent, then it is because he is also crying out in pain for the planet, this *Biogea*, this place between earth and life, that is the wellspring of us all. The issue is: how to attend to that place and listen to the rumblings? How to connect with its distress, and to do so before it is too late? How to make ourselves vulnerable, not to the hateful cutting of specialist analytical logics, but rather to the melting and the fluidities that grow in and emerge from the *Biogea*, flows that come from the mother earth who is also a lover. How to attend to urgent but non-punctual responsibilities before it is too late? I touched on the

argument above. Egodicity is easily dealt with but it mostly doesn't matter. It's the sociodicities that we need think about. I am less optimistic, but perhaps Serres is right. Perhaps the joining of earth and life sciences is a way through what he elsewhere talks of as a narrow door (p. 195). Perhaps they can bring the tools we humans need, to know how to converse with the *Biogea*, if necessary (the tension is Serres' own) in silence as we move 'from the nothing of meaning to its plenitude'. (p. 195)

And then, third, I want to think about the issue of parochialism in three different ways.

First, though I've underplayed this here, the imaginaries in this book are male in a very particular way. Mother and lover, these two tropes are woven into the fabric of its pages. In the encounters retold by Serres this is *Biogea* as woman, often enough. This isn't, so to speak, necessarily wrong. On the one hand, a long line of feminist spirituality celebrates the fecundity of mother earth (Starhawk, 1989). In addition, on the other, the male imaginary is not necessarily without its own virtues. Though we might want to pick these over and discuss them. Perhaps something is starting to shift if the lover is no longer a body to be mastered. An open question.

Second, the vision is mostly Western, though there's one moment when it isn't. Along the way Serres does a very nice job on the notion of 'sustainable development', which, he writes, is 'advertising for [our economic systems] ... to finish the plundering'. (p. 192) Yes, this needs to be said. However, where have I heard it before? The answer is: by first nations faced with the demands, or the bribes, or the violences, of corporate capitalism in Quebec, in Ecuador or in Australia (Verran 1998; Feit 2004; de la Cadena 2010). To say this is not to detract from Serres' point, but rather to throw the Biogean framing into relief, and in particular to note that it is struggling with Western philosophy and Western metaphysics. For, looked at in one way, Serres is saying that we need to unlearn large parts of this. I think this is right, but the project is also parochial. No doubt the Chinese are making a mess of their part of the planet, but classic Chinese philosophy certainly doesn't distinguish between the world on the one hand, and virtue on the other (Hall and Ames, 1995). Neither has it made separations either between the collective and the cognitive, or the subjective and the objective. All of which is a way of saying that there are other resources out there for thinking *Biogea*. Chakrabarty (2000) was right: Europe is in need of provincializing.

And third, the imaginary at work here is that of the intellectual, which brings its own form

of parochialism. Marx (1970) wrote, and it's been cited so often it has achieved the status of cliché, that: 'The philosophers have only *interpreted* the world, in various ways; the point is to *change* it' (p. 123). I don't want to go reductionist here. I have spent much of my life struggling against those who prefer direct action including direct intellectual action, and who therefore think that indirect action is no action at all. Surely this is wrong: reframing imaginaries is a way of intervening that is simultaneously intellectual *and* political. Add to this that Serres knows perfectly well that we live in a global world with a particular and ruthlessly exploitative economic system. But. But. Here's the but. Reframing needs its points of leverage; it needs its sites of interference. Moreover, it is the intellectual's form of parochialism to imagine that truth, as it were, talks by itself, everywhere. So it is with Serres' cry of pain. It would be good, in the end, good to know *where* the interventions might take place, and then to think about the *forms* that they might take.

So to my final words. I appreciate this book. It is not without its faults, but then again, we all have our faults. So I want to say that: it is beautiful and powerful, and it deserves our attention. Yes, we are wrecking the planet and we do not know how to listen to it. It is crucial to find ways of knowing it better. Serres' message is that it is urgent to abandon the analytics of hate and turn to the creativity of joy. He tells us that love leads to birth, to growth and to joy.

'Joy: the matter from which the *Biogea* is made' (p. 200). These are the words with which he leaves us at the end of this moving book: it has become important, nay vital, to appreciate the earth by listening to it.

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