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Authors

Mathews, Andrew S
Barnes, Jessica

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1
Prognosis: visions of environmental futures

Q1 Andrew Mathews *University of California, Santa Cruz*

Jessica Barnes *University of South Carolina*

While prognoses about the future are as old as human society, this special issue argues that the proliferation of new ways of modelling, planning, and interpolating the future of resources and environments is an increasing feature of contemporary environmental politics. In our introduction, we draw out two dimensions to this prognostic politics: first, the processes of making predictions about the future; and second, the movement of these predictions through the unstable and messy institutions that act upon the future in the present. We argue that new regimes of environmental forecasting and contests over these prognoses are giving rise to new forms of nature, framings of time and space, and modes of politics.

In the contemporary world, various environmental futures, from the apocalyptic to the utopian, are brought to us by a host of people and institutions. Stories about global climate change, ocean acidification, biodiversity loss, oil depletion, water scarcity, and deforestation conjure a picture of imminent doom, while counter-visions of organic agriculture, solar panels, rehabilitated ecosystems, and green cities vie to suggest more hopeful, alternative futures. Often, proponents of economic or technological change step forward to speak for futures that are, on the one hand, inevitable and desirable, and, on the other hand, in need of care if they are to come into being. Across domains of artistic, technological, and popular culture, efforts to imagine and domesticate these futures proliferate.

Concern about the future is nothing new. Humans have always struggled to imagine and predict what is to come, and future-orientated practices are as old as human society. We could point, for example, to the recourse to augury or oracles in ancient civilizations (Herodotus 1987) or the long traditions of divination in many parts of the world (Evans-Pritchard 1963 [1937]; Holbraad 2012). Modern ways of addressing the future developed alongside the emergence of modern states and conceptions of a demarcation between science, politics, and religion (Shapin & Schaffer 1985), and constructions of the secular and the non-secular (Lilla 2008). Central to modern statecraft, therefore, was

the generation of a set of practices for dealing with the uncertainty that surrounds the future, for instance through statistical modes of reasoning (Desrosières 1991; Hacking 1990) and forms of risk management and social insurance (Beck 1992). Furthermore, just as states have sought to manipulate the past by celebrating some moments in history and silencing others, so, too, they have linked these selected pasts to particular futures. The question of the past, then, if looked at in the right way, has always also been a question about the future.

It is important to remember that religion, too, has been an important source of imagination and action around environmental futures, often by those who redefine or deny altogether the boundaries between the scientific, the political, and the religious. Examples include the visions of environmental futures held by conservative Christian Evangelicals opposed to state-sanctioned climate science in the United States (McCammack 2007) or the futures imagined by indigenous people concerned about the protection of sacred mountains (de la Cadena 2010). While the papers in this volume do not address these non-secular visions of the future, there are numerous examples in the world, and there are likely to be many more as anthropologists probe further the environmental futures imagined by non-scientists.

Within anthropology, there has been a recent upsurge of interest in thinking about the future.[1] With some notable exceptions (e.g. Wallman 1992), much of the earlier anthropological work on temporalities focused on the past and present, and the past in the present, with a relative neglect of the future (Munn 1992: 115-16). A growing number of anthropologists have, however, begun to explore the future as a domain which, like the past, can be brought into the present to do various kinds of political or cultural work (Abram & Weszkalnys 2013; Appadurai 2013; Bear 2014; Ferry & Limbert 2008; Guyer 2007; Holbraad & Pedersen 2013; Maurer 2002; Miyazaki 2006; Rosenberg & Harding 2005). This scholarship has drawn attention to the state of anticipation, as something that 'pervades the way we think about, feel and address our contemporary problems' (Adams, Murphy & Clarke 2009: 248).

Although interest in the future is not novel, we believe that we are seeing the emergence and proliferation of new ways of thinking about the future, and new ways of linking the future with the present or the past. As the essays in this special issue show, modelling, planning, and interpolating the future of resources and environments has become an increasing feature of contemporary environmental politics. Rather than operating alone, these new methods of describing the future are in conversation with pre-existing technical and political arts of imagining and acting upon the future, such as national estimates of water, fisheries, oil, or forests. In the deployment of these environmental futures, we see a reworking of the relationship between states, corporations, and their publics, which opens up new points for opposition or engagement on the part of the people who might be affected by governmental or corporate actions.

In the remainder of this introduction, we draw out two dimensions to this prognostic politics. First, we look at the processes of making predictions about the future. Second, we look at the movement of these predictions through the unstable and messy institutions and publics that act upon the future in the present. These two dimensions are not distinct. As various actors conduct their predictive work, they are haunted by the political implications of their results, and their imaginations are shaped by interactions with different publics. So too, as predictions move, these circulations rework the content of models and the practices of modellers, with multiple interactions

at various stages, and no simple flow from a new future to a new policy. It is not the case, then, that powerful actors disseminate visions of the future to a passive and ignorant society (Wynne 1996). On the contrary, futures are everywhere remade, whether in laboratories by scientists who fear the political influence of an ignorant population (Wynne 2005), or in government offices by officials who are wary of public opinion, or on the streets by activists charting their own visions of what the future could be. Thus in the process of knowing, interpreting, and acting on the future, we see a close interaction between 'expert' and 'popular' domains. Indeed, citizen imaginations of the future may totally transform or constrain scientists' visions and the degree to which their ways of knowing the future gain traction and validity. Popular stories about the future, gossip about the credibility of official predictions, and accounts of conspiracies between officials and multinationals can all sustain or undermine official and scientific visions of environmental futures.

Knowing futures

The future in question may be a presence (e.g. a prospective mineral deposit), an absence (e.g. the end of oil), or a change (e.g. in prices or ice extent). This future may be anticipated, forecast, predicted, projected, prognosticated, divined, speculated, imagined, narrated, promised, revealed, augured, foreseen, or fantasized about. In casual conversation, we use these verbs of knowing the future interchangeably, sometimes switching from one to another without being fully aware of this change ourselves, despite the different implications that these terms carry (Weszkalnys 2014). Prognoses about the future can take place at various spatial and temporal scales, from the imminent to the long term (Guyer 2007). The future can be told as a story, calculated as a probability, or speculated upon as a form of potentially valuable risk. Those who make and interpret modelled futures struggle with ways to qualify it by using adjectives or visual imagery (Liverman 2009). Terms such as 'likely', 'probable', or 'expected' are used, sometimes in very specific technical ways, sometimes in more vernacular ways, and often with a curious slippage between the two by scientists themselves (Lahsen 2005). The future, then, is not one but many, and those who create futures typically seek to narrow down what the future can be to a relatively limited subset of possible registers.

The texture of the future, like other facts, depends on how and by whom it is composed (Latour 2004). Sometimes, the biographies of particular futures affect their reception for an extended period of time. The credibility of futures of abundant and cheap nuclear energy, for example, was powerfully affected by the emergence of atomic energy in association with military research and the Cold War state (Jasanoff & Kim 2009), even as the Cold War also provided the material and ideological basis for studying global environmental change (Masco 2010). It is important, therefore, to look at who produces particular predictions about the future, and the historical contexts and institutional ecologies in which these futures emerged. The actors engaged in creating environmental futures range from computer modellers forecasting global climate patterns (Lahsen 2005), to farmers forecasting seasonal rainfall (Orlove, Chiang & Cane 2002), local residents forecasting the damages associated with an energy project (Howe 2014), and consultants forecasting natural gas prices (Mason 2007). In crafting their predictions, these actors draw both on their political imaginations about institutions and what they might do, and on an array of material engagements. Such material engagements feature in a number of the papers of this volume, from

water dripping off an ice sheet (O'Reilly) to hard disks of data transported around the world (Barnes), rock-core samples stored in wooden boxes (Kneas), or slogans written on a house wall (Chowdhury).

By looking at the process of knowing the future, we hence focus on what kinds of knowledge and non-knowledge about the future are being made, who makes this knowledge (consultants, governments, scientists, computer programmers, 'locals'), how they make it (different calculative technologies, forms of data collection, and standardization practices), and what spatial and temporal scales they seek to grasp (the time periods they model, the landscapes they gather data from). Although in practice there is an enormously diverse range of methods for crafting the future, for the purposes of this volume we distinguish here three main aspects of the predictive process: model-building, the role of scenarios, and methods for dealing with uncertainty or risk.

Models

The emergence of techniques for modelling very complex systems, whether the global climate, ecosystems, economies, or markets, has been fundamental to allowing the proliferation of futures within contemporary environmental politics. These models draw upon vast quantities of empirical data, linking practices of measurement, standardization, and data entry, and connecting distant times and places (Edwards 2006). A 'culture of prediction' has evolved across many research fields, associated with the increasing availability of cheap desktop computing power and scientists' newfound ability to employ simulation models on an everyday basis (Johnson & Lenhard 2011). As the potential grows for models to describe what the environment is and how it is likely to change in the future, so too do demands for governments and other institutions to make themselves responsible for the natural resources, environments, or risks that have been revealed at new scales (Jasanoff 2004*a*; 2004*b*). Such demands translate, also, into critiques of these institutions for their failure to have met this responsibility in the past (Zeiderman, this volume).

Models have different purposes, face different material and infrastructural constraints, and are addressed to different audiences, with very different effects. The most charismatic and obvious of these models today are the general circulation models (GCMs) which simulate global climate patterns and enable the projection of climate change (Edwards 2010). These computer models, and the scientists who write the code and equations that comprise them, might be what first come to mind when we think of charting environmental futures. There are, however, many ways of modelling the future. Kirsten Hastrup (2013), for instance, describes the 'diagrammatic reasoning' that hunters in Greenland employ to comprehend the melting of ice around them. Operating through networks and images rather than concepts and numbers, this modelling is the hunters' way of reading the ice and anticipating both the near and more distant future. The kinds of models that have been built by natural resource managers are different again, relying upon practices of classifying, counting, and calculating the presence and possible growth of the resource in question, in order to plan the amount of the resource to be exploited. Models of tree growth, for example, emerged with the invention of scientific forestry at the end of the eighteenth century (Scott 1998). Such sustained-yield models are as much about performing the rationality and stability of the nation-state as they are about actually predicting and managing forests (Mathews 2011). Modelling, then, is found in many domains, and models can speak in several registers at once, perhaps asserting political authority and the stability of the nation-state, or

perhaps predicting the quantified or non-quantified aspects of the future destiny of that resource.

The practices of modellers are deeply influenced by their political circumstances and biographies, the material resistances that they encounter in their daily work, and the audiences for whom they are building the model. It has long been observed by the scholarship on climate modelling that models are under-constrained, requiring experienced practical judgement and imagination on the part of modellers who convert equations to code and parameterize the models, inserting quantities or simple equations for domains that are too complex to model (Guillemot 2010; Sundberg 2009). Further, a model has to be 'tuned' through a skilled craft of adjusting its components so that it fits modellers' understandings and desires of what a 'good model' looks like. As Paul Edwards notes, 'better' may mean that the result agrees more closely with observations, or that it corresponds more closely to the modeller's judgement of what kind of change is physically plausible (2010: 342). This work of tuning is affected by modellers' disciplinary training and by their engagements with models and the subjects of those models, which are both intimate and technical, as we see in Jessica O'Reilly's paper on the glaciologists who study the future of the West Antarctic Ice Sheet. Modellers' decisions are affected, also, by their sense of the political environment (Lahsen 2009; van der Sluijs, Shackley & Wynne 1998).

Not all models are equally good for all users, and new models must typically be articulated with older models through a process of translation and commensuration which demonstrates the validity of the new model. What travels from one model to another may be quantitative data, or it may be only a sense of the plausible or reasonable limits and constraints that should be imposed upon the new model. Often, models must fit certain restrictions produced by other institutions or actors, such as the rules about how risk models are constructed owing to their effect on stock-market valuations (MacKenzie 2007). In the case of resource estimates, David Kneas's paper shows the manoeuvrings that a mining company has to do to bring its estimates of copper abundance in the Ecuadorian Andes in line with the rules set by the Toronto Stock Exchange.

Scenarios

Scenarios are a specific form of addressing the future which grew out of Cold War military planning, and has since been adopted across many social worlds. Scenarios require modellers to envisage a credible future which is, however, intrinsically impossible to calculate. During the Cold War, such imaginations would have been about the likely responses of enemy military leaders to a particular event or course of action. In the contemporary period, examples include the crafting of disciplined responses to bioterror events (Cooper 2006; Masco 2013), forest loss (Mathews 2015), financial market turns (Cooper 2010), or disease outbreaks (Lakoff 2008; Samimian-Darash 2013). Scenarios introduce a crucial new relation to an uncertain future event. Under scenario planning, a disciplined practice of imagining *plausible* future events enables concrete planning in the present to prepare for such events.

To formulate a scenario, it is necessary to select a set of reference-points, modes of observation, and objects of discourse (Mason 2007). This process is anchored in assessments by scenario planners as to what futures are credible. Like other stories, scenarios do the work of classifying which agents and objects are to be considered, where the story is to begin and end, and what kinds of major narrative structures are to

be employed (Cronon 1992). Scenario planning is therefore a form of subjunctive narration about the future, a speculation of the form of 'What would happen if *x* happened?' We see this, for example, in the policies to reduce greenhouse gas emissions from forest removal, known as REDD (Reduced Emissions from Deforestation and Degradation). In these programmes, forest policies and reimbursements to landowners are justified by a 'reference' or 'business as usual scenario', which would have happened had the policy intervention not taken place (Mathews 2015). These scenarios of landcover change do not replace national statistical estimates of forest cover or growth; rather, they build upon and complement each other. Scenario planning has multiplied into different subfields, sometimes with the goal of optimizing policies (as with many climate change models), at other times with the goal of supporting vision-building or strategic choices (Westhoek, van den Berg & Bakkes 2006).

Scenario planning practices are potentially unstable and subject to contestation, or to slippage between different forms of scenario-making, from vision-building to policy optimization. In Karen Hébert's paper, for instance, she describes the controversy over the mining scenarios that the US Environmental Protection Agency used as the basis of its risk assessment for the Pebble Mine in Alaska. Hébert traces how the language of 'hypothetical mine scenarios' in the initial drafts of the assessment report was replaced with a language of 'realistic mine scenarios' in the final report. Such linguistic changes, she argues, have implications for how the possibility of a deviation from those scenarios is understood.

Risk, uncertainty, and disaster

When looking towards environmental futures, however, there will always be things that we do not and cannot know (although, as pointed out by Nelson, Geltzer & Hilgartner [2008], there are many dimensions of present environments about which we similarly know little). A key distinction in preparing to act upon the future is the difference between addressing *uncertainty*, the probability of an event whose nature is largely known, and *indeterminacy*, an event whose nature is not yet known. Preparations for disaster and risks of various kinds wrestle with both uncertain and indeterminate futures.

The evaluation of the risks that are associated with different environmental futures has come to be a key element in the prognosis process.[2] Risk analysis underlies the majority of modern environmental regulations, with more risky types of hazards being more tightly regulated (Jasanoff 1999). Typically, risk analysis has tried to delimit the type of future event that is calculated and prepared for, often by excluding non-expert visions of risk and causation, as, for example, when experts explain that they are responsible for the facts, and that ordinary citizens may only express ethical values and emotions.Indeed, some methodologies of risk assessment, such as the expert elicitation panels that Jessica O'Reilly discusses in her paper, are predicated on the notion that certain experts are in a position to evaluate future risks in a way that the 'average' person is not. More recently, however, as Karen Hébert's paper documents, there have been efforts to move towards more participatory processes in risk assessment, with mixed results.

When disasters do occur, there is often a reshuffling of systems of measurement, and assessments of causation, so that it becomes clear in retrospect what the nature of the risk was all along (Bond 2013). In other words, state institutions try to make risk tractable and calculable, both prospectively and retrospectively, as a way of demonstrating

their reasonableness and competence. Such demonstrations are powerfully affected by popular understandings of risk and expertise, which can undermine or overthrow institutions at moments of spectacular failure (Jasanoff 2005; Zeiderman, this volume). As with other forms of modelling, then, risk models which seek to calculate quantifiable futures are sustained or undermined by other ways of assessing the future and the past, including collective understandings of the proper way of performing expert knowledge, or of the proper role of the state with regard to its audiences.

In response to the emergence of non-quantifiable forms of risk, the concept of reputational risk has come to the fore in the worlds of business, where the fact of having carried out a risk analysis is used to demonstrate responsibility and due diligence (Power 2007). In many cases, former regimes of statistical prediction have been displaced by risk-management control systems. Risk analysis is used in some measure to inocculate institutions against the environmental futures that they are supposed to anticipate in their management practices, by transforming a disaster from a demonstration of incompetence and lack of preparation, into something which was at least partially prepared for.

Futures in motion

Once environmental futures come into being, they are translated and transformed as they move through different sites. In the process, they produce a range of affective responses. In Gisa Weszkalnys's paper, for example, we see the 'doubtful hope' sparked by the future of oil in São Tomé and Príncipe, as well as the problematization of this affect by various international agencies and their efforts to cultivate an affective response that they deem reasonable. At the same time, these futures are put to work across domains of economic and political life. While it seems commonsensical to note that the present shapes the future, the present can also come to be told and worked on as an effect of the future (Nielsen 2014).

Nation-states have long tried to control environmental and natural resource futures, precisely because nation-states themselves seek to link past to future. Although the literature on nationalism has emphasized the importance of imagination (Anderson 1991), an often-overlooked point is that nationalisms imagine not only pasts and invented traditions, but also futures. The ideal futures of nationalism contain nations that will be properly constituted as a unified territorial unit, with people of like national status and language living in a form of social communion with each other. Nationalisms are future-orientated projects, then, a practice of doing political work in the present in the name of a yet-to-be-fulfilled future. The practices of environmental bureaucracies can also take on this future-orientated quality, as bureaucratic authority is often performed by translating celestial ideals into earthly practices, and by explaining the gap between ideals and reality as the result of human failings or mundane lack of resources (Herzfeld 1992; Mathews 2008). Such celestial ideals can be present-orientated, but they are often linked to ideas of improvement, towards a future that will be better than the present. What such studies reveal is that positioning by powerful actors in relation to the future is one of the ways in which they seek to perform their authority (Mathews 2014).

Another important future-orientated set of discourses are those of development, which is linked to nineteenth-century concepts of the emergence of immanent forces and energies, guided by officials or elites (Cowen & Shenton 1995). State-sponsored projects of modernization often classify people and places in terms of who or what

belongs to the past or to the future (Fabian 1983) – classifications that often have a strong environmental component. From the early development theorists who saw societal progress as a temporal transition from the 'traditional' to the 'modern' (Rostow 1960) to recent efforts at crafting futures through quantitative benchmarks, such as the Millennium and Sustainable Development Goals, the project of development is founded on an imagination about what the future should be.

Visions of environmental futures have also had a powerful effect on environmental policies. Often, the environment has been understood by scientists and state environmental institutions in ways that link some parts of the landscape to particular temporalities. For example, forest services have commonly seen the most undisturbed areas of forest, such as mature high forest, as remnants of a formerly uniform forest cover (Cevasco & Moreno 2013; Fairhead & Leach 2000; Rackham 2006), driving officials to seek to restore landscapes to a desirable, densely forested future. Ecological theories of succession, influential especially in the first half of the twentieth century (Worster 1990), have also assisted forest services in classifying certain landscapes as degraded, the blame for which is frequently assigned to peasants and indigenous peoples (e.g. Siviramakrishnan 1994). In many instances, the temporal classification of a landscape, whether as ancient or as recently disturbed, has been tied to a temporal classification of a people, as in the case of indigenous forest peoples, who have been seen by outsiders as inhabiting another time (Brosius 1997). The temporal and spatial frame that is chosen to classify part of the landscape in turn helps set the stage for future-orientated projects of nature protection, natural resource management, or environmental restoration (Cronon 1992). Frequently, these temporal and spatial ordering practices have deep and enduring colonial roots (Orlove 1993).

Thus visions of different futures and the relationship between present and future are central to political practices both by environmental planners and states, and by counter-movements that might oppose their policies. A prediction may sustain the legitimacy of institutions or infrastructures, and call into being specific policies in the present, or it may call into being opposition which undermines policies. In the case of oil, for instance, both a future with the resource (Weszkalnys 2014) and a future without (Limbert 2010) have profound implications for the cultural and political present. Often, it is the future's partial or complete unknowability that becomes a resource for those who wish to claim political, technical, or financial resources. Futures, then, like pasts, are a place of powerful imaginations on the part of rulers and ordinary people alike. People everywhere seek to make use of these energies in order to establish their legitimacy and authority. One area in which the future is powerfully linked to the routines of daily life is through modernizing projects of infrastructural change in the present, with related material, aesthetic, sensorial, and affective resonances (Larkin 2013).

Underpinning work on the political implications of environmental futures in the present are particular understandings of the state, whether explicitly stated or implicitly held.[3] Vast as the literature on the state is,[4] we could distinguish between Marxist and Weberian visions of the state as a more or less unified structure, and related ideologies of modernization, improvement and development, or environmental degradation (Sivaramakrishnan 1998). James C. Scott (1998), for example, follows what might be called a neo-Weberian approach in tracing the impact of state ideologies of desirable landscapes upon the subjects of rule. Following more Foucauldian approaches, we can see visions of environmental pasts and futures as discursive formations that are internalized by the rulers and the subjects of rule, and used to justify colonial

and postcolonial projects of appropriating natural resources (Fairhead & Leach 2000; Fairhead, Leach & Scoones 2012). Alternatively, following from science and technology studies and related approaches, we can see environmental futures as being produced through technopolitical work (Latour 2004; Latour & Woolgar 1987; Mitchell 2002). The authors of this issue draw variously on these approaches. Collectively, however, they understand the state as being fragile, enacted, and in motion. The state's ability to take a particular future and use it for political ends, therefore, becomes a complicated question. Indeed, like other official forms of knowledge, official and corporate practices of modelling futures seem not to silence opposition, but to produce new and unexpected results, sometimes increasing state control, but in other cases reducing it.

Imagination, also, plays a part in how different people respond to environmental futures. For scholars of science and technology studies, imagination and imaginaries, used more or less interchangeably, have the constitutive power to make facts about the world through material and semiotic relations (Jasanoff & Kim 2009). This makes prognostic politics of interest not only for the more obvious political and economic effects that they might produce, of a dam or a road being built, but also for their power to constitute a particular truth, such as the presence of a mineral deposit. There is, however, a risk that imagination can come to stand for all that holds a cultural field together (Sneath, Holbraad & Pedersen 2009). Instead, we prefer to consider the cognitive and epistemic effects of imagination. Imagined national futures can help stabilize infrastructures in the present, or they can be used to stabilize particular facts about the world.

Circulations and transformations

As particular kinds of knowledge about the future move through everyday sites, their meanings and associations shift through diverse processes of translation (Rudiak-Gould 2012; West 2005). Understanding how people do political and technical work by invoking environmental futures requires particular attention to the question of knowledge transmission and transformation. How does knowledge about these futures move from those producing this knowledge to others? How does this knowledge morph along the way, as it is reworked by different groups in new locations? How is it selectively taken up in contrasting ways in different sites for particular political purposes? From the perspective of those who produce a forecast, this process of dissemination, through which that piece of knowledge about the future travels through different social spaces, opening up possibilities for 'resignification, semantic drift, miscommunication, and trouble' (Taddei 2013: 245), may be a cause of considerable anxiety.

There are different channels through which a prediction may circulate. Some channels may be 'official', such as company press releases or peer-reviewed journal articles. The government-authorized textbooks, national historiographies, and museum exhibits that Mandana Limbert analyses in this volume, for instance, tell a particular story about the past and future of oil in Oman. Others may be less 'official'. Maarten Onneweer (2014) describes, for example, the circulation of rumours in the Kitui district of Kenya about the presence of a resource of questionable existence – red mercury – and the potential profits that resource could bring. Nusrat Chowdhury also draws attention to more informal channels for the transmission of knowledge about the future. In her paper, the future of the Phulbari district in Bangladesh and the coal that lies beneath it circulates through different signs, from activists' graffiti on a wall to a multinational corporation's New Year's greeting card. Key to the circulation of a

prediction is the question of trust. Continual circulation of this knowledge is contingent on those responsible for translating and passing on this knowledge considering it to be valid. To some, the trustworthiness may lie in quantitative or statistical parameters (Porter 1995); to others, it could be linked to the source of transmission (Lomnitz 1995). Indeed, official statistics may be seen as credible by some, the opposite by others (Mathews 2008).

Whatever the origin of a particular piece of knowledge about the future, as that knowledge moves through different sites, it is transformed. Gatekeepers to the circulatory process may emphasize some results over others. In her paper, for example, Jessica Barnes describes how climatic and hydraulic models produce projections of future rainfall and Nile flows that are highly uncertain, but which Egyptian scientists then use to predict an overall decline in the river flow. Such an interpretation may be linked to these scientists' personal and institutional location as well as their awareness of Egypt's vulnerability to declining water availability. At science/policy interfaces, there is often feedback between politicians and their modeller advisers and also a significant effect from modellers' own assessments of their political contexts. Modellers may, for example, express a higher degree of certainty about their predictions when communicating results to policy-makers (Lahsen 2009; Lövbrand 2007; Shackley, Risbey, Stone & Wynne 1999; van der Sluijs *et al.* 1998); in other circumstances, they may emphasize the uncertainty (Brysse, Oreskes, O'Reilly & Oppenheimer 2013; Shackley & Wynne 1996). At the interface between scientists and citizens, too, we see a process of challenge and negotiation, which may shift the nature and terms of the predictive science (Hébert, this volume).

Finally, just as important as thinking about the political work that an environmental prediction does in the present is to think about the political work associated with the *absence* of such a prediction. What happens when there is no prediction, or when the prediction is wrong? These are questions raised in the paper by Austin Zeiderman. He looks at the past failure of the Colombian state to predict a flood in Bogotá and at local residents's efforts to call the state to account for this failure. Avoiding the simple point that prognoses of the future are political when masquerading as technical, Zeiderman shows us how and for whom they become political. What matters is the particular manner in which the future is called upon. The future, then, is a realm of political and technical creativity open not only to states or corporations, but also to ordinary citizens. Here, we move fully from the vision of the future as the domain of state ideology or discourse to the future as something which people can make and do, with different futures proliferating and pulling at each other.

Papers in this volume

The papers in this collection offer ethnographic explorations of some of the new ways of using and addressing the future that are emerging in environmental domains. Some of the papers focus on resources, including water, copper, gold, oil, and coal – resources whose futures are shaped by a range of drivers, from global climate change to technological developments and evaluations of risk. Other papers focus on environmental resources' converse – environmental disasters, such as flooding or rapid sea-level rise.

The first papers in the volume look at ways of knowing the future. In Jessica O'Reilly's paper, she focuses on the future of the West Antarctic Ice Sheet under climate change – a future that holds particular significance owing to the impact of ice melting on global

sea levels. O'Reilly takes us into the day-to-day practices of field science, modelling, and expert elicitation panels through which knowledge about the ice sheet's future emerges. Expertise about the ice sheet and predictions about the likelihood of its disintegration come not only from scientific data and technical knowledge, O'Reilly shows, but also through scientists' embodied experience, sensory engagements with the ice, and informal interactions with one another. Such ways of knowing, she argues, shape the production of knowledge about the future and help fill in the gaps of things that are fundamentally unknowable.

The second paper, by Jessica Barnes, looks at the climatic and hydrological models that scientists use to project the impact of climate change on future Nile flows. These models produce a range of results, which span from the positive – an outlook of increased water supply for Egypt – to the negative – a reduced water supply. Barnes examines how Egyptian and non-Egyptian scientists' presentations of uncertainty about Nile futures and their ability to know, address, and reduce it are tied to their positions in expert networks, particular material things, and the broader political context in which they are working. The paper underscores the importance of probing how scientists in different places – not only in Egypt, but in any political setting – interpret, deal with, respond to, and represent the uncertainty inherent in environmental events that have yet to take place.

The third paper, by David Kneas, looks at a junior mining company that explored for copper in the Intag region of Ecuador in the 2000s. Kneas examines the shifting registers this company employed to talk about the environmental future of this region. He describes, first, the story that the company told to investors on the Toronto Stock Exchange – a story of abundant copper and mineral wealth, which was founded on the use of particular sampling techniques, computer models, and geological theories, and the company's need to classify the deposit in terms that met the stock exchange's rules. He contrasts this imagined future with the future that the company told local communities – a future associated not so much with the profits of mineral wealth as with the removal of another threat: environmental degradation associated with agriculture.

Nusrat Chowdhury's paper draws attention to the role of different kinds of signs in signalling the presence of a resource and a potential environmental future. Her paper looks at a proposed open-pit coal mine in the Phulbari district of northern Bangladesh. This resource was framed by its proponents in terms of potentiality; a projection of prosperity into the future that tied its coal mines inextricably to the prosperity of the nation. Chowdhury draws attention, in particular, to the question of visibility, or, in the case of Phulbari, a lack thereof. The inability to see coal, she argues, demanded evidence in visual form – both for those who wanted its immediate extraction and for those against it. She documents how these actors collectively produced and consumed signs of coal's presence as well as the potential havoc its extraction might wreak for the thousands living above ground.

The second set of papers looks in more detail at the impact that various visions of the future of an environment or resource have on contemporary social worlds. Karen Hébert's paper looks at a proposed gold, copper, and molybdenum mine in the Bristol Bay region of southwest Alaska, which, if built, would be among the largest in North America. Hébert explores the political negotiations around a set of scientific predictions regarding the future of these resources and the risks associated with their extraction. She focuses, in particular, on a scientific report commissioned by the US Environmental Protection Agency. She examines the boundaries this report drew

around what environmental futures were of concern, whose knowledge counted, and which timeframes were relevant. She argues that the tensions, or 'overflows' (Callon, Lascoumes & Barthe 2011), around the report reflect its overarching, if often frustrated, effort to separate scientific and technical truths from political contestations. While public participation in scientific assessments of risky futures can reinscribe exclusionary forms of knowledge, Hébert shows how it nevertheless opens new spaces for the exercise of politics.

Gisa Weszkalnys's paper focuses on São Tomé and Príncipe, a country where the existence of possible offshore oil has been identified, but the resource has yet to be commercially extracted. She introduces the idea of 'resource affect' to refer to the diverse affective resonances, including euphoria, excitement, scepticism, and trepidation, that emerge in contexts of resource prospecting, exploration, and extraction. She explores the nuanced affective horizons generated by the potential of an oil-based future in São Tomé. She looks, also, at the problematization of resource affect and the widespread efforts by international agencies to manage oil-related expectations and channel hope in São Tomé. Weszkalnys sees these efforts to curtail supposedly excessive expectations as an attempt to cultivate 'appropriate' affect.

In Mandana Limbert's paper, on Oman, she contrasts oil and another resource, water. Drawing on historical sources and oral histories, Limbert shows how the discovery of oil barely features in historical accounts of Oman, whereas water appears as a harbinger of promising futures. The future of oil and its depletion, on the other hand, is a constant refrain within political and economic discussions. Limbert's paper shows how some historical moments, activities, or transformations associated with natural resources become events, while others do not, and how some of these events are anticipated, but others are not. Here, again, we see how the time and place in which particular futures emerge can have long-term impacts, with some futures persistently recalled over an extended period of time, and other futures remaining relatively obscured.

The last empirical paper, by Austin Zeiderman, shifts the focus to look at conflicts over the failure of state science to know and govern the future not in the present, but in the past. Zeiderman draws a comparison between the flooding that affected Bogotá, Colombia, in 2011 and 2012, and the earthquake that hit the Italian city of L'Aquila in 2009. In both cases, people critiqued the state for failing to anticipate and prevent environmental disasters that took place. He argues that these cases reflect the constitutive relationship between political authority and foresight. While prognosis is central to political authority and legitimacy, Zeiderman shows how it may also be the ground upon which people make political claims on and critiques of the state.

The final commentary, by Elizabeth Ferry, draws out themes of temporality and uncertainty, anticipatory knowledge, and material signs from across the papers. Ferry reflects on the value of anthropological methods and approaches to cross-disciplinary discussions around the politics of environmental futures. The papers of this volume, she suggests, exemplify this anthropological strength, with their ethnographic depth and holistic perspectives.

Conclusion

The political impact of practices of imagining, modelling, and acting upon environmental futures is everywhere a feature of contemporary life, as competition for resources becomes more acute, and human domination of biogeochemical cycles intensifies (a process that some would argue marks a new era, the anthropocene

[Crutzen 2002]). Environmental futures are being envisaged in an increasing number of places, including through the scenario-planning practices of governments, scientists, and investors. These new ways of predicting or imagining the future build upon and complement existing regimes of calculation and prediction. We argue that contests over these prognoses are giving rise to new forms of nature, framings of time and space, and modes of politics.

Future-making often requires modellers to work with particular material objects and landscapes, from ice sheets to rock samples. These material entities are not easily subdued by prognostic practices. Rather, such practices always encounter limitations, making each future form potentially unstable, open to remaking, unmaking, or reinterpretation, perhaps by the politicians who commission them, or perhaps by the publics who are asked to believe them. It is in this messy process of negotiation that new forms of nature emerge. The sea off the coast of São Tomé becomes not just an expanse of water but a rock formation beneath the seabed that potentially contains a reservoir of petroleum. A river in Bogotá becomes not just a source of water but a transmitter and spiller of floodwaters. A stand of trees becomes not just a supply of wood and habitat for animals but a sink of carbon (Mathews 2015).

The process of looking to the future and making and remaking nature reworks our temporal and spatial categories. When modelling climate change impacts, the future becomes seen in blocks of decades or centuries rather than in terms of next month or next year. When a rock becomes seen as a resource – as in the silver of central Mexico that Elizabeth Ferry (2008) writes about – it produces a temporality that is linear, continuous, measurable, and finite. These shifting temporalities are closely tied to shifting spatialities. Imagining future climate change allows us to reimagine the global and the local, as well as the natural and cultural (Hulme 2010). When an ice sheet in one particular place – West Antarctica – starts to melt, it becomes tied to a global process of sea-level rise. To comprehend the future of Egypt's water supply, our gaze must shift to the mountains, thousands of kilometres away, where the rain falls that feeds the Nile.

Futures are not easily made, nor are people easily persuaded to believe in them. As both material and imaginative objects, always in motion, futures are open to challenge. The emergence of new ways of predicting the future has therefore produced new groups of actors who as collectives and individuals resist, modify, or make use of new kinds of environmental futures. These are emergent forms of politics, which do not look political in the classical anthropological sense (Dove 2000). The ethnographic settings that the authors in this volume write about press us to think about how new forms of politics come into being. This does not mean that we should discard our traditional disciplinary concerns with concepts such as citizenship and the relationship between states and subjects; rather, it shows us how a close study of practices of making the future can also make visible the emergence of new political collectivities. It would be easy, thinking with the categories of technoscience, to assume that there is only one world of future-making here, but the constitutive power of the imagination in practices of knowing the present and modelling the future means that multiple ontologies are potentially present, partially sensed, and bought into being by modelling practices. There is not one future, or even one kind of future that may be variously claimed (see Ferry, this volume), but multiple kinds of futures and of future-orientated politics.

Beyond looking at what our anthropological engagements with environmental futures can tell us about environmental politics and future-making, we are interested, also, in what these engagements might tell us about anthropology. Anthropologists have

come to understand that we cannot seal ourselves off from our informants and their ideas, and that we have to be open to the possibility that their categories and cosmologies might trouble our own ways of thinking. As Marilyn Strathern's classical study demonstrated, the kinship relations of our informants can lead us to rethink our own understandings of gender relations (Strathern 1988) or the networks of technoscience (Strathern 1996). It seems fitting then that in writing about environmental futures, we take seriously the power of those who craft these futures to trouble the empirical practices and theoretical assumptions of anthropologists, as people who engage in future-orientated practices of our own. The scientists, officials, and ordinary people described by our contributors make the future tangible, in some degree addressable, through mundane practices of running computer models or classifying landscapes, just as anthropologists interpolate the future of anthropology through our mundane practices of citation and theory-building.

Looking to these parallels can give us pause for thought. The practice of writing literature reviews like this one, for example, and the tendency in doing so to evacuate matter and context from theoretical arguments, can too easily resemble the simple summaries given by climate modellers who omit the histories and contexts that give their models purchase upon the world (Lahsen 2005). In this introduction, therefore, our goal is to situate the papers of the volume, seeing each one as doing material, political, and theoretical work in the world, through practices of linking particular landscapes, people, and histories. For each author, the environmental futures at stake emerge from his or her ethnographic fieldsites. Rather than advancing theoretical points in the abstract, in these papers theory emerges in relation to particular research contexts, which it only imperfectly clarifies. The authors who focus on the more technical end of future-making (Barnes, O'Reilly, and Kneas) have paid more attention to the material and infrastructural aspects of modelling. Those who focus on nation-states and politics (Limbert, Weszkalnys, and Chowdhury), on the other hand, have drawn more upon the production and reception of national narratives of resource production. Finally, those who focus on science and risk (Zeiderman and Hébert) have tapped into work on the interface between experts and different publics. The places in which these authors situate their work make all the difference to their choice of theories, and to the way in which their theoretical frameworks and empirical material emerge in relation to each other.

Further questions are raised for anthropologists by ethnographically engaging with those who model, in a broad sense of the word, the future. Most importantly, studying different practices of crafting futures teaches us that empirical evidence and the linguistic predictions of models emerge in relation to each other, as successive models often call for a reclassifications of data, of what matter is measured and how. Like modellers, we sometimes allow ourselves to forget that the material and the linguistic pull at each other through a process of ever denser co-mergence (Ingold 2012). Like modellers, we often allow ourselves to forget the histories of fieldwork which give rise to our data and sustain our theories. And like modellers, we can easily allow ourselves to make theoretical claims that are relatively divorced from our fieldwork and the limits of our evidence when we become entangled in professional or policy worlds. Studying modellers thus encourages us to change our understandings of the relationship between the material, the ideational, and the linguistic. Modellers describe tuning and parametrization as a skilled practice, which requires them to attend to the internal qualities of the model and to respond to pressures from their professional colleagues who are witnesses to their

modelling practices. In addition, however, modellers feel constrained by their sense of the material world, often gained either in earlier experience of fieldwork, or through their daily life. We too, as anthropologists, need to cultivate our respect for the ways in which the material world presses itself upon our imaginations, even as our linguistic terms and categories (like parameters) fail to capture fully the unruliness of our human and nonhuman interlocutors. Matter becomes insistently political in environmental and natural resource futures, and we cannot, in advance, tell what kinds of politics will ensue.

NOTES

[1] There is also a rich body of scholarship on futures within a number of other disciplines, including science and technology studies (e.g. Brown, Rappert & Webber 2000; Fortun 2001) and sociology (e.g. Adam & Groves 2007).

[2] The literature on risk has become too large to summarize in a single essay or book, but see, for example, Power (2004).

[3] Visions of the environmental future in non-state societies, on the other hand, have a rather different quality, including no necessary assumptions of environmental improvement or degradation (e.g. Evans-Pritchard 1940).

[4] See Nugent (2010) and Sharma & Gupta (2006) for helpful syntheses.

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