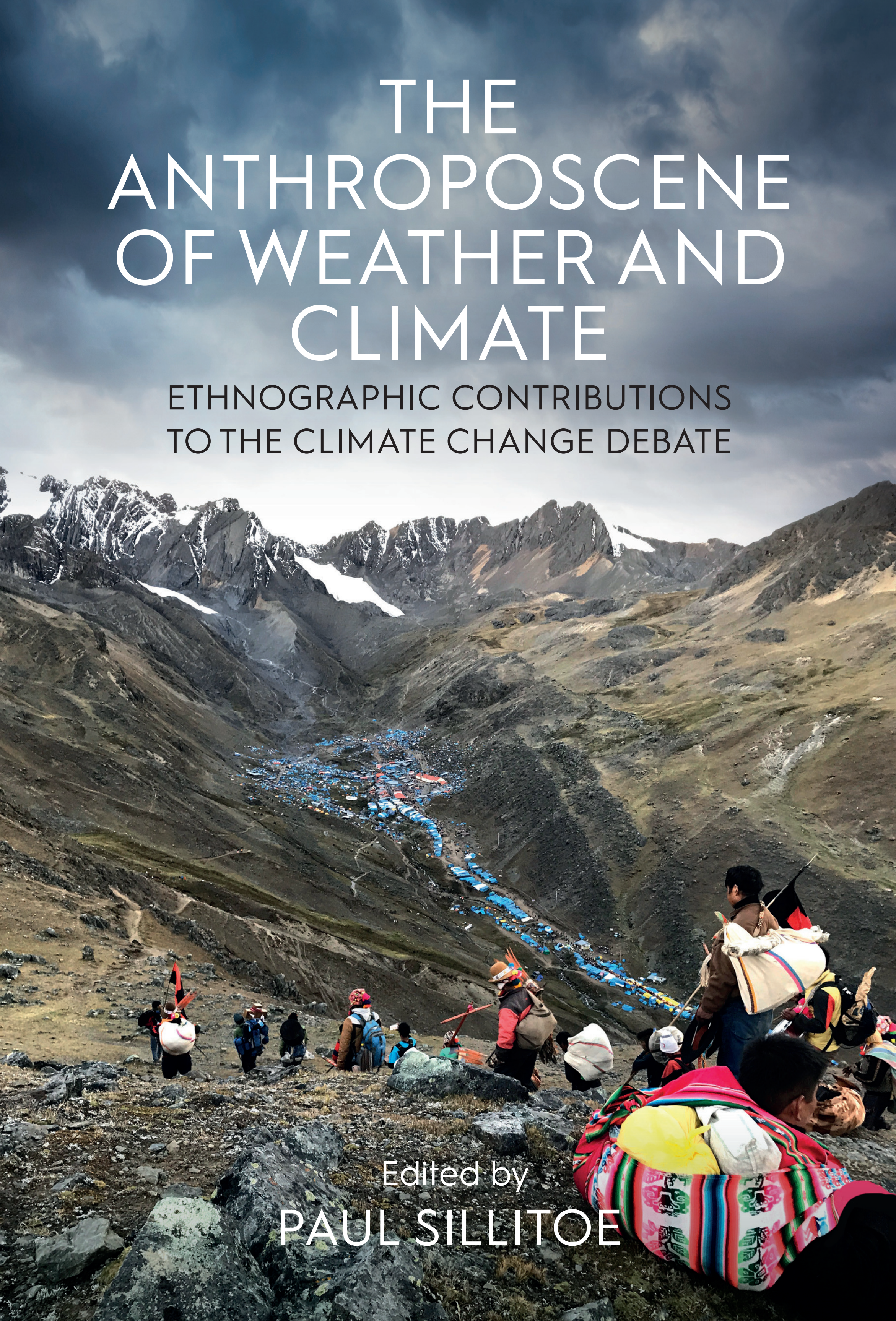

THE ANTHROPOSCENE OF WEATHER AND CLIMATE

ETHNOGRAPHIC CONTRIBUTIONS TO THE CLIMATE CHANGE DEBATE

Edited by

PAUL SILLITOE

The Anthroposcene of Weather and Climate

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We dedicate this volume to Steve Rayner and Mahbub 'Pial' Alam, valued colleagues who sadly passed away during the editing of this volume

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The volume comprises a selection of contributions to a discussion hosted by the Royal Anthropological Institute and the British Museum, London. We thank the Wenner Gren Foundation for a grant to support the dialogue. Particular thanks go to the Institute's Director David Shankland and all of the Institute's staff who were central to the discussion's organization and success. Entitled 'Weather and Climate Change', the meeting sought in particular to explore the discipline's contribution to the global warming debate. The response of colleagues showed the great interest in climate change, and concern that anthropology should contribute to it, seeking to foster interdisciplinary dialogue in promoting the anthropological perspective.

Introduction

Introducing the Anthropocene of Weather and Climate

Paul Sillitoe

The world is hotting up. Globally, average atmospheric temperature increased by about 0.6°C in the twentieth century (IPCC 2001: 2). This may not seem much, but the predicted climatic and environmental changes are alarming, and include global sea-level rises,[1] ocean warming and acidification, shrinking polar ice sheets and retreating glaciers, as well as the increased occurrence of extreme weather events such as hurricanes and intense rainfall with floods. This ranks among the greatest challenges of our age. The scientific consensus is that we face accelerating climate change that will have serious environmental effects. The causes and extent of forecast changes and the anticipated environmental consequences comprise a large part of the climate-change debate (IPCC 2015). According to the scientific evidence, human activity is largely responsible, notably through the burning of fossil fuels for energy. While human activities have impacted on the environment and arguably influenced the weather for millennia, as climate-change sceptics point out, they are doing so on an unprecedented scale today, as recently acknowledged by the introduction of the term 'Anthropocene' to denote the current period geologically,[2] marking the time when human activity became a dominant influence on climate and the environment. Since the mid-twentieth century, the date proposed for this new era's start, atmospheric CO_2 levels have increased by 26.14 per cent.[3] According to scientists, this is the main driver of changes in global climate, together with other so-called greenhouse gases,[4] which cause the planet's atmosphere increasingly to trap solar radiation, leading to an increase in global temperatures.

Other terms that feature in the volume's title, albeit without the anthroposcenic punning intent, and that it is as well to be clear about from the start, are 'weather' and 'climate' (Hulme 2017: 2–6). Weather refers to the atmospheric conditions at a certain place at a particular time and concerns variations in daily temperature, rainfall, cloudiness and winds. The climate, on the other hand, is the average of such weather conditions over an extended period of time, and regions are described as having a certain climate, such as tropical or temperate, according to the generally prevailing pattern of weather conditions. And, finally, the process of climate change is a global phenomenon extending over centuries, although only recently recognized as such, which, although attributed to worldwide atmospheric warming, affects various regions differently.

If human activities are responsible for these potentially catastrophic changes, anthropology surely has a significant part to play in our understanding of them, the discipline being, as the dictionary puts it, 'the study of humankind'. Yet it has been somewhat slow off the mark. After all, the United Nations (UN) Intergovernmental Panel on Climate Change has now produced five Assessment Reports, the first a quarter of a century ago. Until recently, anthropology had relatively little interest in peoples' experience and understanding of their regions' climates. When I was enquiring into the weather lore of a community in the mountains of Papua New Guinea, I could find few ethnographic contributions on the subject, and some thought the article that I subsequently published (Sillitoe 1994) decidedly wacky at the time, with one reviewer describing it as an 'offbeat topic'. In part, this lack of interest in meteorological issues was due to the rejection some time ago of arguments about climate determining cultural arrangements (Peterson and Broad 2009: 72–74; Rayner 2002).

Climatic determinism has a long history stretching back to classical Greek times, when Aristotle (1944: VII, 1327b) argued, for instance, that those living in cold European countries were 'full of spirit' and incapable of government, while those in hot Asian nations 'lack spirit' and were subject to slavery, and the Greeks, occupying a warm region, lived in well-governed liberty. A millennia or so later, among the medieval Arab philosophers, the renowned Tunisian historiographer Ibn Khaldun, in his global history of humanity, arguably 'saw everything in climate' (Gates 1967: 419), in attributing sociocultural dissimilarities to environmental differences. During the European Enlightenment three centuries later, de Montesquieu (1748: Books XIV–XVII) put forward a similar argument about the political influence of climate, in which liberty flourishes in frosty cold places and slavery in warm ones. And in the twentieth century, Ellen Semple, the pioneer human geographer, argued for the climatic determination of cultural arrangements: 'Climatic influences are persistent, often obdurate in their control … The debilitating effects of heat and humidity' are responsible for the 'inefficiency characteristic of the native races' living in such regions (Semple 1911: 7 and 10). Subsequent ethnographic enquiries have shown the error of such views; people who live under the same climate patently do not have similar cultures. This is not to deny that the weather sets certain environmental limits on what communities can do, as the challenges of climate change starkly underline.

Regardless of this limited start, anthropology indubitably has something to contribute, as this volume endeavours to show, one of several publications seeking to put the discipline at the forefront of the climate debate (Baer and Singer 2014; Barnes et al. 2013; Barnes and Dove 2015; Crate 2011; Dove 2014; Fiske et al. 2014) by exploring and clarifying the discipline's position regarding the weather and the climate-change argument. A key aspect of this perspective is that it proceeds through ethnographic enquiries with local communities, as the following chapters will illustrate. Drawing on research from communities around the world, they demonstrate the advantages of situating discussion of climate change ethnographically with respect to cultural context in order to better comprehend and accommodate different peoples' experiences, understandings and responses to ensuing environmental issues. While it is widely acknowledged that climate change is among the greatest global challenges of our times, it has local implications too. This volume brings these forward, amplifying anthropology's voice in this important debate, in which natural scientists and policy-makers have dominated so far.

Local Weather Lore: Precursors of Environmental Change

A common expectation of anthropology is probably that it will document other peoples' ideas pertaining to climatic phenomena in the ethnoscientific tradition. The way in which many people understand the weather may differ significantly from meteorological forecasts, as I discussed in my 'offbeat' article. Chapter 2 by Francesca Marin illustrates this further for Patagonian coastal fishermen,[5] for whom the weather is daily a primary consideration. Their perception of the weather determines to a significant extent when and how they fish, notably in consideration of the wind direction and force, rainfall patterns and temperatures, which influence not only fishing activities but also the movements of fish shoals. These fishers predict the weather in a processual way, in contrast to the satellite-informed scientific modelling of meteorological forecasts, although they refer to these today to supplement their understanding, a sign of globalization. Their predictions depend on a skilled perception of changes in their region's environment, drawing on experiential, multisensorial knowledge, deriving from observations of phenomena such as changes in the colours of seawater and a detailed familiarity of the coastline. Accessing and recording such embodied understanding presents particular challenges that are currently exercising anthropology (Garay-Barayazarra and Puri 2011; Tschakert, Tutu and Alcaro 2013; Yeh 2015).

Indeed, the idea of 'weather' itself is not universal, as Dan Rosengren discusses in Chapter 1 regarding the Matsigenka people of the Peruvian Amazon,[6] who have no such category that encompasses all atmospheric phenomena. The implication, of course, is not that these people are unfamiliar with meteorological events such as rain, wind and sun, but that they simply do not conceive of them as collected together in a climate-equivalent category and they relate to them in a radically different way from us. Similarly, my Wola friends in the New Guinea mountains have no category equivalent to climate, focusing instead on the daily weather (Sillitoe 1994: 246). According to Matsigenka lore, these meteorological events are under the control of subjective animistic forces, not physical ones. They distinguish three types of precipitation, for example, which differ regarding both their pantheistic origin and effect. The natural world is a part of humans and they a part of it; they shape it as it shapes them. It is a challenge to represent such knowledge of the world without distorting the holders' perceptions or leading climate-minded outsiders to think them unusual aberrations, just as it is a challenge to represent experiential understandings, such as those of the Patagonian fishermen, which depend on embodied skills. According to Matsigenka cosmological views, which are consistent and logical, knowledge is also primarily experiential, resulting from culturally mediated personal engagements with the local environment and not, as for us, propositional.

The environmental observations and knowledge of local populations can act as a bellwether of changes that are occurring regionally and give valuable granularity to the global focus of climate-change discourse (Reyes-García et al. 2016). In some regions of the world, such as the Peruvian Andes and Alaskan Taiga, changes in the climate are seriously affecting peoples' lives. They are the metaphorical 'mine canaries' that indicate the graveness of the changes that are occurring, to which the international community should be paying close attention. Some people today already find themselves at a loss to understand what is happening, as their traditional knowledge and practices are seriously undermined. In Chapter 3, Nastassja Martin and Geremia Cometti report on the Q'eros of Peru and Gwich'in of Alaska, two such communities where environmental changes are so extensive that they are starting to question their time-honoured ways of being-in-the-world and how they make a living on the land. Their reactions illustrate the different ways that people may construe, and consequently respond to, climatically driven environmental change that disrupts their relations with nature, shaking their values and beliefs. They illustrate internal versus external views of causality. The Q'eros blame themselves for devaluing relations with their divinities by prostituting their rituals in tourist performances, with the consequence that rain is too heavy in one season and absent in another (this is reminiscent of the 'moral meteorology' stance (Burman 2017; Elvin 1998)), whereas the Gwich'in blame others for invading their territory, holding the outside industrial world responsible for pollution that causes the changes in snowfall, ice conditions and animal migrations, along with increased river flooding and forest fires.

Local people may be largely unaware of the global warming debate itself, as shown in Mahbub Alam's and my discussion in Chapter 4 of a survey, conducted in the Hakaluki *haor* 'large lakes' region of Bangladesh, to assess knowledge of climate change. Nonetheless, local residents have observed considerable changes in their region's weather patterns, with flash floods, for instance, and also changes in the natural environment, such as shifts in lake flora and fauna, which they are at a loss to explain. There is an intriguing epistemological challenge for anthropology here, as Martin and Cometti point out. If people are struggling to comprehend what is happening in their region and why – their local lore destabilized by unpredictable changes, even apparently no longer relevant – how are anthropologists to make sense of indigenous ways of knowing and relating to the environment? There are other implications, as seen among the Matsigenka, who are understandably unaware of global debates over climate change, having no general idea of the 'weather' given their animistic understanding of meteorological phenomena; it puts them at a disadvantage today in discussions about environmental issues with the intruding Peruvian authorities. Those migrating into their region from the Andes, for instance, where they have problems attributed to climate change, are using their familiarity with global climate discourse to dominate the Matsigenka in dealings with the outside world.

Adaptation to Change and Extension Assistance

The wider environmental interactions and their implications lead on to discussions about adaptation to foreseeable climate-change impacts

(Adger et al. 2012; Fresque-Baxter and Armitage 2012; Lebel 2013). Mitigation, the other widely discussed response internationally, hardly features at the local level in underdeveloped rural communities, many of which currently face the environmental brunt of disruptions to the global climate largely caused by the developed industrial world, which itself endlessly negotiates mitigating by offsetting, or better reducing, its damaging atmospheric emissions. Predictably, where people face unfamiliar environmental disturbances, they may struggle to adapt. In Bangladesh, where local communities will likely be largely liable for adaptation actions, Alam's and my data suggest limited capability to cope with predicted impacts. Responses were markedly limited (and possibly irrelevant) regarding potential community coping strategies that draw on local resources and ingenuity, referring to the wrath of nature and praying for help, maybe even staging a rain-making 'frog marriage' rite in a drought. Elsewhere, the situation may be less bleak. The 'seasons' along the Patagonian coast, for example, are complex, and unforeseen changes in the weather demand flexibility in selecting the right time and place to fish. This flexibility may further the resilience of the fishing communities, arguably helping them adapt to climate-change-driven variations in the marine environment, such as sea-level rises, 'disappearing seasons', and changing reproduction cycles and distribution of fish along the coast. But other changes in the region, such as market demands, urbanization and tourism, may increasingly limit their options, undermining this flexible adaptation.

Adaptation is a global issue, as Herta Nöbauer reminds us in Chapter 5. Climate change, after all, affects the developed affluent 'West', which is largely responsible for associated global warming, as much as the so-called underdeveloped poor 'South', which is largely blameless but equally impacted. Her chapter takes us to the Alps and focuses on the retreating glaciers and snow cover that are among the significant signs of global climate change. Their retreat is increasingly impacting on people's lives and understandings of the environment, as she discusses in the context of an Austrian ski resort.[7] It is an unusual ethnographic location, anthropology having shown scant interest in alpine ski areas, although this chapter reflects growing interest in human–environment relations in the region, which is an obvious location for those interested in climate-change issues. She is particularly interested in how the retreating snow and glaciers are 'agents' impacting on resort workers' and managers' experiences and knowledge of the Alpine environment, which involve the interface between local-vernacular and global-scientific understandings of climate. The 'snow business' shapes the social and economic life of those who depend on it in these high-altitude regions. There are implications for employment in the glacier area, which in turn has a cultural impact and is changing values and work ethics via concerns over job (in)security. Those involved are using various strategies to cope with the uncertainties and challenges posed by climate-related changes, and to ensure that the ski area remains a major tourist destination that contributes significantly to the regional economy.

There are arguably grounds for outside intervention where local communities are ill-informed about climate change, or its implications for them, though they may be observing changes in their environments. There is scope here for anthropologists, building on the development practice of extension (that seeks to educate the 'beneficiaries' of projects about issues), to pass on information about climate change, as Yunita T. Winarto outlines in her account of experiences of 'Science Field Shops' among farmers in Indonesia in Chapter 8, where changes in rainfall and temperature are already affecting rice yields. She is of the opinion that farmers alone, limited to their traditional ways, cannot meet the challenges of increasing climate variability. The Field Shops programme, which involves interdisciplinary collaboration between anthropologists and meteorologists, seeks to inform farmers' decision-making with meteorological knowledge so as to improve their resilience in the face of climate change by helping them to comprehend the global drivers behind their changing environment. The anthropologists' role is not only as an ethnographer understanding local perspectives of weather, but also as 'cultural mediator and translator' between the local and scientific domains, facilitating learning in both directions and beyond to policy-makers. It is a challenging and demanding role, as shown by the Field Shops experiences in Indonesia, where the authorities are suspicious of putting the needs of local farmers first and there is scant interdisciplinary interaction within institutions.

In order to meaningfully inform people about climate trends, it is necessary to pay attention to the so-called 'user interface', where relationships are built between local stakeholders and outside organizations. In Chapter 7, Maria Ines Carabajal and Cecilia Hidalgo explore the challenges that face such interface building, focusing on connections from global institutions, such as the World Meteorological Organization,[8] to local communities, such as those of goat farmers in Argentina,[9] where they work on these extension issues. They point out that despite meteorological advances in monitoring and forecasting the weather, local awareness and use of associated knowledge lags far behind. In their investigation of related collaborative processes, they identify three categories of users: local farmers, farmer associations and various institutions (such as governmental and research bodies). A key issue in the establishment of user interfaces between these three categories of stakeholders is the unambiguous identification and recognition of the users who are to interact in the process, and how they understand and use climate information. The different and contested ways they make sense of climate-science data leads to their underuse. The chapter points to the importance of presenting scientific and actionable information comprehensibly and relevantly, in tune with the culture and experience of users, as a central feature of user-interface building, which should feature genuine dialogue and collaboration between all parties. Attempts to contribute to such mediation are not only challenging, as these chapters show, but are also subject to 'decolonial' critiques that censure outsiders, such as anthropologists, for assuming to speak on behalf of others and reducing 'their knowledge' to fit some foreign paradigm, although where fellow citizens do so, as with Winarto, Carabajal and Hidalgo, it takes some of the sting out of the criticism.

Indigenous Knowledge and Science

The aim of the extension approach is primarily to inform local communities about issues, in this case those pertaining to climate change. But as both the Indonesian and Argentinean experiences indicate, it is necessary to know about the cultural contexts of local communities to inform them in ways that correspond with their values and lifeways, and their understandings of the world, which are rooted in local circumstances and critically shaped by social and historical contexts. This highlights the significance of the above ethnographic accounts of peoples' weather lore and awareness of climate change. But cultural context involves considerably more than knowledge of some narrow domain, as the anthropological tenet of holism underscores. This is the argument of the 'indigenous knowledge' (IK) approach, notably in development contexts, which builds on the (to anthropologists) self-evident premise that local communities and peoples' knowledge should feature prominently in any interventions that affect them (Sillitoe 1998, 2015). It includes all knowledge held more or less collectively by a population that informs their understanding of things. It also points to the importance of interdisciplinary collaboration to address issues in the round.

Adapted to local conditions and focusing on provincial interests and concerns, IK is often communicated in foreign idioms and features aforementioned tacit experiential knowledge, which we anthropologists appreciate and understand to varying extents. But no matter how strange IK may seem, it would be unwise to dismiss it as irrelevant. In another weather-related paper, for instance, I discussed how my Papua New Guinean friends coped with the climatic perturbations that impacted on their livelihoods, sometimes resulting in serious famines and starvation (Sillitoe 1993). This publication was more acceptable to an anthropological audience, as it dealt with myth and ritual activities employed to appease the supernatural forces believed to be responsible for the adverse conditions, which were attributed to a pale-skinned female spirit being. But to a technoscientific audience, it is seemingly irrelevant, with meteorologists pointing to the recent correlation of such conditions with the El Niño Southern Oscillation, which is an irregularly occurring and complex series of climatic changes involving the warming of the Pacific Ocean that triggers large fluctuations in the region's weather, with serious consequences for the people living there (Ellis 2002). But when people believe in such supernatural causations (an issue taken up by anthropology's current 'ontological turn'), it is counterproductive to denigrate or ignore them because they seem so far away from scientific understandings, as they will inform their behaviour nevertheless, and therefore need to be accommodated in some way.

The implication is not that the IK approach rejects the contribution of science. If it did, we should presumably ignore the issue of global warming altogether as a fiction of scientists, like the climate-change deniers. The gulf that separates IK and science is not unbridgeable; they may often overlap. My 'offbeat' weather paper (Sillitoe 1994) overtly draws parallels, presenting meteorological observations and measurements made over several years alongside a discussion of local understandings of the same atmospheric phenomena. The implication of an environmental anthropological perspective that seeks to pay attention to scientific evidence is not, I might add, to translate local views into scientific terms, as some critics suggest, devaluing them in all probability in the process. However, their contrast furthers understanding of both local culture and climate, which undeniably set certain limits on, although they do not determine, human activities. The association of avowedly nonlocal understandings of environmental conditions with what I thought I understood about local views was also a critical response to postmodernism, which has argued that we cannot ever really understand other ways of being-in-the-world, by signalling that some of us never imagined it was possible.

Furthermore, using scientific data allows us to address questions that occur to us, but that local views may not focus on. This applies to climate-change framed enquiries too, as indicated by Marin's, Rosengren's, and Alam's and my chapters, which concern communities that have limited or no acquaintance with the climate-change debate, but whose locally focused concerns and understandings may nevertheless include observations of environmental changes that we may attribute to global warming. This interdisciplinary approach acknowledges the central part that the natural sciences play currently in our understanding of climate change. An in-depth understanding of IK and science furthers interfacing between them. In addition, local communities often absorb aspects of scientific knowledge, adapting new information coming from without alongside that generated within (Burnham, Ma and Zhang 2015). This shows the inadequacy of portraying IK in opposition to scientific knowledge rather than seeing it interacting to yield hybrid and multifaceted knowledge with a range of sources and subject to continual revision in the light of information received from elsewhere. IK is a dynamic mix of past practice and present invention with a view to the future, yet it maintains its distinctive cultural character.

The practices and knowledge of scientists and technologists are culturally situated too (Dove and Kammen 2015: 94–117). They are not neutral players or purveyors of purely objective understanding, and this has significant political implications. While international political forums and associated transnational scientific networks consider climate change to be a global phenomenon, insufficient attention has been paid to how natural scientists develop their assumed universally valid understandings that go on to inform political debates. Both the 'global' and 'universal' aspects of science are the result of complex, extensive, ongoing processes – as investigated, for instance, by science and technology studies – which are themselves informed by local concerns. Consequently, countries in the so-called Global South, such as Brazil, seek to influence the direction of climate-change science, in the light of the geopolitics of their regions and associated national discourses, as André S. Bailão shows in Chapter 11 discussing the contribution of Brazilian scientists to the production of regional and global climate models, focusing particularly on aspects that revolve around 'local' climate-change discourse. He confirms and critiques the idea of location in social studies of science, and the role of alliances and disputes between local scientists, and with policy-makers, in the formulation of national climate-change views and policies.

Politics of Climate Change

The political dimensions of cultural identity, often expressed in terms of national interests, complicate the climate-change debate further. The culturally mediated understanding that people have of the world, notably their environment, is a significant aspect of their identity. This can become particularly evident when their cultural ways are under threat.

There are few people more menaced than the Palestinian Arabs, as Mauro van Aken recounts in Chapter 10 when discussing their knowledge of seasons. One of these is *murba'nia*, the 'winter rainy season', characterized by three months of unpredictable and fluctuating rainfall and chilly intervals, during which the farmers in this semi-arid environment skilfully manage to conserve surface water and soil moisture through cisterns and land use that 'harvests weather' in order to see them through the dry, hot summer. Regardless of its apparent 'irrelevance' in the context of intensive irrigated agribusiness and modernization debates, this management continues as an aspect of family farming that emphasizes people doing work with their 'own hands', passing on skills and knowledge not merely to conserve past 'traditional' ways, but to prepare for the future by focusing on their practices for cultivating their own food, which are central to their fragile sense of autonomy under Israeli domination. Their weather lore is one aspect of their *fellah* 'peasant' identity, which expresses their cultural independence in confronting the displacement and marginalization deriving from Israeli appropriation of land and water. Furthermore, although Palestinians and Israelis face the same climate-change challenges, the contentious nationalistic politics surrounding natural resource access, along with the absence of shared knowledge about its use, make it unlikely that they will jointly deal with them successfully.

In short, the challenges of climate change are equally political as environmental, as the Bangladeshi work reported on by Alam and myself indicates, with a substantial number of respondents referring to political problems impacting on coping strategies, not natural changes, which poses some awkward questions for those in authority. If climate-change impacts are of the order some forecast, Bangladesh is at particular risk, notably to sea-level rises and catastrophic flooding – on one of the world's largest deltas – together with cyclones and drought. These threats have prompted a national policy debate about strategies to meet the challenges, but limited political action. Local adaptation options should figure in any reckoning, no matter how inadequate they may seem, because effective interventions need to chime with residents' experiences and ways, as pointed out and as the negative outcomes of the 'Flood Action Plan' illustrate. The policies and actions of national governments, often responding to those of international bodies, also inevitably influence local-level responses to any perceived climate-change threats.

Climatic change is a 'real-world' human problem and, as such, is increasingly subject to the politicization of associated knowledge (Barnes et al. 2013). In Chapter 12, which also focuses on Bangladesh, Camelia Dewan analyses certain climate-change discourses in development contexts as sites of associated power struggles between competing interests, conflicting agendas and divergent conceptions of climate impacts. Similar to development catchphrases before it, climate change presents events in a way that creates expectations of causality that legitimize particular development interventions (Mosse 2005). Adaptation has become a development buzzword and one that attracts donor funding. Embankments on the Bangladesh floodplain are currently framed as ‘climate-change adaptation’ infrastructure, defences in need of strengthening to protect communities from devastating floods following rising sea levels. Yet, Dewan’s chapter uses archival sources and oral histories to show that this ‘flood-protection’ infrastructure has, from the 1850s onwards, inhibited beneficial monsoon floods (*borsha*), increased siltation of waterways, and resulted in frequent and damaging *jalabaddho* floods (waterlogging). The World Bank’s current framing of embankments as climate-change adaptation is based on mismatched causal explanations that will only serve to make Bangladesh even more vulnerable to rising sea levels, increased and heavier monsoons, and more frequent tidal surges and cyclones. This climate narrative will further detract funding and attention away from other things that require immediate attention in the face of global warming: excavation of silted canals and rivers, and repairs of sea-facing embankment sections. The chapter emphasizes the importance of history and context in improving interventions aimed at addressing climatic change, and this is where anthropologists can play an important role.

In Chapter 9, Pasang Yangjee Sherpa investigates the associated interconnections between various institutions in neighbouring Nepal, a country also predicted to be significantly affected by climate change. She focuses on core climate-change policies and government agencies authorized to address associated issues, notably of ‘adaptation’ and ‘resilience’, and shows how these conceive of programmes to reduce climate-caused risks as involving technocratic solutions, and are subject to a controlling and constraining political environment, similar to that of top-down development generally. The interactions within and between these agencies, and beyond to other national and international bodies and local collaborators, feature constant manoeuvring for influence and control over the climate-change agenda. The local communities, together with nongovernmental organizations (NGOs) and civil society groups, are not powerless, but with varying effect interact tactically with these agencies, as Sherpa illustrates by drawing on the experiences of her own Himalayan community.[10] The ongoing unstable political situation in Nepal results in some uncertainty regarding the government’s response, although its dependence on international funding to address perceived climate-change threats brings with it some predictability, albeit subjecting it to external influence that may further mute the voice of local communities experiencing the impacts of climate change; moreover, donors too may be unreliable and may instead exacerbate the instability.

Climate-Change Sceptics

Anthropologists have been investigating international- and national-level climate-change discussions together with local experiences of environmental changes attributable to global warming, not only to contribute to the formulation of meaningful policies with respect to possible actions, but also to make scientific observations pertinent and predict consequences relevant to various communities (Rayner and Malone 1998: 75–85, 127–29). The risk otherwise is scepticism, which may prove a significant barrier to action. Calibrating official discourse against local understandings of climate-cum-environmental change will help to avoid promoting scepticism with proclamations and policies that seem out of touch with lived reality. Local experiences can tell us what is actually happening currently on the ground, as several of the chapters in this volume show, serving as a reality check against climate-change models (Reyes-García et al. 2016). If the climate-change predictions do not match up in some measure to local events, they will promote disbelief inimical to policy proposals to tackle problems. After all, it is with respect to their experiences and perceptions of current weather patterns that people assess such forecasts the world over and respond to initiatives.

Again, this applies not only to rural regions elsewhere, which are often of interest to anthropologists, as this volume shows, but also to metropolitan locales, where readers likely reside, and notably to opinion-shaping climate-change sceptics living there. Those who deny such change may point to notoriously inaccurate daily weather forecasts as evidence, which are subject to endless complaints, certainly my experience in Western Europe and seen elsewhere in the world. The inaccuracy increases considerably with week-long forecasts, which seem to be no more than computer-generated guesstimates about the movement of high- and low-pressure zones.[11] What are we to make of forecasts for longer timespans, such as those that comprise climate-change predictions, when according to chaos theory we only need a proverbial butterfly to flap its wings vigorously in Amazonia to generate a cyclone elsewhere a month later? An additional challenge is that the scientific community itself disputes the possible environmental consequences of global warming, with some media and political activists citing the most dramatic predictions, notably those of the highest

IPCC's Representative Concentration Pathways[12] (IPCC 2015: 57), which many climate scientists argue are the least likely (Riahi et al. 2011, 2017; Ritchie and Dowlatabadi 2017; van Vuuren et al. 2011), thus confusing the public debate. Those scientific predictions that are 'too far out there', notably those that incline towards the most extreme possible future global warming scenarios that are open to considerable dispute (Pielke 2018), encourage climate-change sceptics, particularly when they match nothing in current experience. Climate scepticism not only concerns knowledge levels, from aware to unaware, of associated science, but also cultural identity issues (Kahan 2015), notably when these feature political competition,[13] as noted above. It is a major challenge facing those who advocate the need for urgent action over climate change, with people not sensing the need given their own current experiences or their political allegiances and for whom the climate-change warnings seem like so much additional hot air.

The tendency to simplify changes in the environment by ascribing them to a single cause exacerbates scepticism, given the complexity of any ecosystem. Today, with the advent of climate-change awareness, the favoured cause is often climatic. This detracts from other important issues, such as poverty leading to communities degrading the environment, just as wealth results elsewhere in unconscionable pollution. It is a new version of aforementioned climatic determinism, promulgated by scientists who are narrowly specialized, and underlines the need for a broader interdisciplinary perspective, such as anthropology can bring to the discussions. In her historical and ethnographical review of Bangladesh's coastal embankments, Camelia Dewan underlines the shortcomings of such 'climate reductionism' (Hulme 2011). A long-term view of these environmental interventions shows that they are more than responses to changing climatic conditions, complicating current discussions of flood risks. The colonial authorities worked on the embankments long before global warming was an issue. The East India Company constructed them to protect the land from saline intrusion with deforestation of the Sundarbans mangroves, and the British colonial authorities erected more of them as railway and road infrastructure. It was not until the mid-nineteenth century that they were considered 'flood protection' and they have served this function since, as seen in the Flood Action Plan of the late twentieth century. It is a function that, with the advent of climate change, has increased in significance with concerns about rising sea levels. As pointed out above, it is thought that future development interventions should engineer higher and wider embankments, though these will arguably exacerbate the precarity of communities by conflicting with the delta's natural hydrology.

It can be argued that anthropology may also help us better understand the position of sceptical climate-change deniers, as one class of local knowledge holders (Dunlap 2013; Hamilton 2015; Hansson 2017; Kemp, Milne and Reay 2010; O'Neill and Boykoff 2010). The discipline is equipped to further understanding of human behaviour, which, as we know, is a challenging task. It is not only the natural environment of any region that is complex, but also the behaviour of human beings living there, which can be contradictory to boot. For instance, how many of us regularly walk or cycle to our destinations rather than travel by car, bus or train, and on these occasions how often do we make serious CO_2 offset arrangements to cover fully our contribution to climate changing atmospheric gases? And what about our diet, which is a culturally inflected behaviour for us all? The majority of us are regular meat-eaters, while knowing that livestock farming contributes significantly to global warming. Few of us are climate-change sceptics and most readers of this book probably accept, and are concerned by, the meteorological evidence for climate change. And yet we are behaving in ways that make it worse. We may argue that institutions are responsible for enabling such behaviour, but these are ultimately subject to collective human endorsement. Are we all hypocrites? It seems that we are struggling to understand our own behaviour, which suggests a need for some urgent social science research (Larsen 2015; Rudiak-Gould 2013a, 2013b).

Some climate-change deniers – both those who deny the science and those who accept it and argue that current policy approaches are misconceived – may be doubly hypocritical, particularly those representing some institutions, such as large corporations that lobby for scepticism and Western governments, whose policies support them for economic reasons. They want to avoid both the costs of changing their operations and the charge of responsibility for global warming, with the attendant claims for damages. Here we see that climate change raises not only difficult scientific issues but also moral ones, and that an overly technocratic focus that sidelines and disempowers local communities may have serious ethical implications. There are also some NGOs, as Alam and I point out in Chapter 4, which are climate-change disaster promoters rather than deniers, whose actions are also ethically dubious in seeking to attract philanthropic funding for their own ends by emphasizing the worst-case forecasts, often with dramatic images of flood victims. A question for many is how those largely responsible for climate change are going to compensate others for its effects on them. These communities are largely from 'less developed', and so less industrialized, nations, such as Nepal, which Sherpa tells us is responsible for only 0.025 per cent of global greenhouse-gas emissions (with 0.4 per cent of the world's population).

In Chapter 6, Noah Walker-Crawford explores the issues from an intriguing local perspective, through the experiences of a Peruvian farmer who filed a pioneering lawsuit against a German energy company,[14] demanding that it help his Andean hometown reduce flood risk from the melting of glaciers, which was attributed to global warming that the firm was responsible for, contributing to it with its coal-fired power stations. The legal system framed the lawsuit as a scientific-technical issue, equating global greenhouse-gas emissions with specific climate impacts such as flood risk and judging responsibility in terms of monetary compensation. This effectively sidelined the Peruvian farmer's knowledge and experience of climate change as a force that threatens his community. The legal focus on its quantifiable impacts as a worldwide phenomenon, albeit observed through local impacts, overlooked his understanding based on a first-hand encounter with the severe impacts of global warming. It judged his views as 'local' or 'anecdotal', and to have little to contribute, being incommensurate with such a global framing of climate change. Only those elites with the necessary technical expertise can participate in discussions in this global scientific context, which excludes individuals who know climate change only through their practical experiences, and hampers their moral claims for fair dealing. Nonetheless, the lawsuit afforded the farmer an opportunity to air some personal nonquantifiable aspects of climate change and to argue forcefully for 'climate justice', which he also did at the 2015 UN Climate Summit in Paris, where his identity representing marginalized people facing climate-caused environmental disaster gave him some moral legitimacy. It permitted him to make claims that unsettled climate politics as usual, in struggling to expand the climate-change debate from a scientific-technical to a moral-ethical discussion that concerns transnational relations – although it could arguably encourage representatives of the capitalist order, seeking to defend its assets and power, to promote further the sceptical 'climate-change denial' agenda.

Anthropology's Stance

Whatever the doubts surrounding meteorological data and associated computer modelling, they still point to accelerating climate change with epic environmental effects. Some authorities warn that global warming is speeding up and predict ever-worsening environmental outcomes, which is doubly disturbing as earlier accounts predicted the end of the world as we know it. A World Bank (2012) report, for instance, warns of a possible 4°C temperature increase above pre-industrial levels by the century's end, reaching a tipping point with sea-level rises bringing catastrophic floods to large parts of the world. While the uncertainty of long-term climate predictions recalls short-term weather forecasts, the stakes are clearly much higher than being caught in a rainstorm without an umbrella. In concluding my early Was valley climate essay, I pointed out that people around the world are, of course, aware that their 'region's climate' sets 'limits on their activities' and that how a 'population perceives of these limits and explains the weather regime responsible for them will have some bearing on its behaviour' (Sillitoe 1994: 268). Anthropology is the discipline pre-eminently qualified to further appreciation of such understandings and behaviour, which will indubitably inform responses to predicted alarming climate changes.

The chapters in this volume demonstrate that climate change is not a challenge solely for scientifically informed international resolution and global media debate, but that local experiences of environmental changes attributable to global warming and community responses to them also need to be taken into account. They are of a piece with anthropology's concern to contribute to debates over environmental issues, and the need for more sustainable ways, generally. While definition of the discipline is a topic of endless debate, with its unclear boundaries melting into cognate subjects (arguably promoting the necessary interdisciplinarity), something that continues to characterize it is working ethnographically at the local level. It has a great deal to contribute from this perspective. This volume shows what an ethnographic focus can offer in furthering our understandings, with contributions from around the world discussing local knowledge of, and responses to, the weather, climate and atmospheric perturbations, which need to feature in scientifically framed policies regarding adaptation and any mitigation measures. The volume is unique in advancing anthropology's growing response to the climate change challenge not only with its marked ethnographic focus – with some half the contributors being nationals of the countries featured – but also for opening up different perspectives on what the discipline has to offer in documenting diverse and sometimes conflicting perceptions, in focusing on experiences and critiques (including legal challenges) from the 'margins', in furthering collaborations to assist farmers and fishers among others, and so on.

In summary, while the following chapters deal with the usual anthropological repertoire – such as IK of weather, local perceptions of environmental change and climate-change impacts – they have a critical edge, considering, for instance, the different ways of framing global warming problems, whether from the perspective of, and attributed to, the international order or local activities. They touch on various contemporary debates within the discipline, such as the ontological turn, in discussing the incommensurability of different cultural ways of understanding atmospheric phenomena that we call collectively 'weather' and 'climate'. In this regard, they contrast the dominant scientific understanding, and how it is sociopolitically situated, with that of various local communities. Here the ethnography of institutions features, complementing the focus on the ethnography of communities. The current climate change challenge is complex, as intimated here, and this volume makes no claims to comprehensively cover this complex and contentious topic, nor the various strategies that have emerged to mitigate its affects, for instance, carbon offsetting, new 'climate change commodities', migration to elsewhere (sometimes in response to conflict exacerbated by environmental degradation) or emissions-reduction programmes such as the UN's 'Reducing Emissions from Deforestation and Forest Degradation' (REDD+) initiative. Besides mitigation issues, O'Reilly et al. (2020) discuss a range of further opportunities for anthropology to contribute to understanding the implications of climate change, including a critical appraisal of climate science's claims to authority, sustainable transformations, envisioning futures, and paying particular attention to vulnerability, risks and resilience.

Although local perceptions of climate-cum-environmental changes will inform people's responses to national strategies, they currently hardly feature in them, with the scientific causes and extent of forecast changes and anticipated environmental consequences dominating the climate-change debate (Ford et al. 2016). International policy discussions need to accommodate global cultural variation of knowledge and experiences, and not impose global science-informed views on communities. Among the contributions that anthropology has to make is advocacy for IK, arguing that the climate-change debate is not only an issue for scientists, policy-makers and politicians. There are further self-interested reasons for the discipline to engage with these challenges. Involvement has something to offer the discipline as it emerges, or is forced, from its postmodern tailspin by the 'impact agenda'. Contributions to understanding the impact of climate change on the world's environment, and possible adaptation and mitigation, are surely going to meet demands to demonstrate the relevance of the discipline's work (Simpson 2015). Furthermore, while we may be unable to answer the question about what anthropology is exactly, such work will put us in a better position to answer another question increasingly put combatively by student-consumers: 'What is the use of studying anthropology?'

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Notes

1. Sea levels rose about 17 cm in the twentieth century; the rate in the first decade of the twenty-first century is almost double this rate (Church et al. 2013: 1146–50).
2. Since the coining of the term 'Anthropocene' at the turn of the century, there has been a flurry of anthropological commentary (see, for instance, Haraway et al. 2016; Latour 2017; Mathews 2020; Moore 2016), doubtless prompted in part by the 'Anthropo' morpheme in this proposed new geological epoch label. It is beyond the scope of this volume to delve into this debate and other suggested labels such as 'capitalocene' (Haraway 2015), which connect tangentially with climate-change issues.
3. Atmospheric CO_2 levels in 1958 (the year full instrument measurement started on Mauna Loa) were 315.28 ppm and by early 2018 had increased to 408.35 ppm. Retrieved 2 March 2021 from https://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html-https://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html.
4. Notably methane (CH_4), water vapour (H_2O), nitrous oxide (N_2O) and ozone (O_3).
5. On the Valdés Peninsula of Argentina.
6. The Matsigenka occupy the Upper Urubamba region in the southeastern Peruvian Amazon.

7. The Pitztal glacier ski resort is located in the Ötztaler Alps of the Tyrol province, bordering Austria and Italy.
8. Through the Global Framework for Climate Services-GFCS, a UN-led initiative overseen by the World Meteorological Organization, which seeks to further the 'application of science-based climate information and services' (see www.wmo.int/gfcs).
9. In the north Santiago del Estero Province.
10. The Sherpa community in the Everest region, and those living in the Kailash Sacred Landscape Conservation and Development Initiative region.
11. While the United Kingdom's Meteorological Office, for instance, may dispute this, pointing out that modern Numerical Weather Predictions are accurate – running large amounts of forecast data using general circulation models – the everyday experience of many of us is that medium-term forecasts are unreliable.
12. These comprise a set of greenhouse-gas concentration trajectories.
13. As Steve Rayner put it to me: 'In the US, "I don't believe in climate change" is simply code for "I am a conservative Republican".'
14. Rheinisch-Westfälisches Elektrizitätswerk.

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Part I

Local Weather Knowledge

Chapter 1

There's Something in the Air – But What?

On Amazon People's Perception of Atmospheric Phenomena

Dan Rosengren

As a major exception to the public disinterest in scientific advances in general, the issue of climate change has for a number of years been prominent and has engaged many people from all walks of life. However, to Matsigenka people living in the Amazon tropical rainforest, the notion of 'climate change' is only so much gibberish.[1] Yet, when they find the notion of 'climate change' nonsensical, this assessment is not based on the same premises as those of the so-called climate sceptics. It is more elementary than the disbelief in the outcome of meteorological and climatological research. While in the modernist[2] West, most people arguably take 'weather', unreflectively, to be a class of physical phenomena occurring in the atmosphere (a perspective likely also shared by the climate sceptics and produced according to autonomous and universal physical laws), this notion is foreign to Matsigenka people, principally because in their cosmos, these phenomena are produced by other-than-human persons. There are consequently no such things as physical laws that explain the occurrence of atmospheric events without the intervention of subjective agents. In this the Matsigenka are apparently far from unique. As opportunities have presented themselves, I have made a small and unsystematic enquiry as to whether the notion of 'weather' is also absent in other Amerindian languages and in languages spoken in Asia and Africa, with the result that this notion appears to be less common than could be expected from a Western point of view. This absence probably means that the native speakers of these languages do not share the concepts that are fundamental to the comprehension of modernist meteorological assumptions.

The Matsigenka are a group of approximately 16,000 people living along the Urubamba and Upper Madre de Dios River systems in the Amazon region of southeastern Peru. They speak an Arawakan language closely related to the neighbouring Asháninka and other Campa languages, and together with the more distantly related Yine and Yanesha, they are described as pre-Andean Arawak. Until twenty-five to thirty years ago, the vast majority subsisted on an economy based on hunting, fishing, gathering and swidden agriculture, in a fluidly organized society that has been described as a 'family level society' (Johnson 2003). With the introduction of land reserves, so-called *Comunidades Nativas*, settlements have become permanent and more densely settled. An increasing number of people are today integrated into the market economy, which, for instance, may mean that they send their children to school, that they have access to and use modern goods such as clothes and tools, and, in the Upper Urubamba, that people regularly visit local urban centres. Even though they have heard of climate change, few recognize it as something to be taken seriously. When I asked people about their experiences, they frequently responded that they have not noted any significant changes in the weather, though no two years are alike (Rosengren 2018).[3]

On Knowing the World

While Matsigenka people rarely speak about weather, there are people, such as the English, who are renowned for employing weather as a prominent conversation topic as it is considered suited for safe but superficial socialization, since they tend to share a common comprehension of it (Golinski 2003). However, weather is not only understood as a class of physical phenomena in nature, it is also intensely experienced corporeally, sensuously and emotionally: in the rain we all get wet, we hear the thunder and see the lightning; when it is snowing we feel cold; and when the sun is baking we get warm; as the different kinds of weather develop, we also get happy, sad or disappointed, etc. The influence that these phenomena have on everyday life has made people try to explain and predict them. As a consequence, there is an immense corpus of folk knowledge that represents different traditions that go far beyond the concrete experiences of atmospheric events (e.g. Berland 1993; Huber and Pedersen 1997; Strauss 2003).

When these phenomena are described scientifically, they become abstractions, the understanding of which typically depends on models and categorizations produced with the help of instruments that quantify and measure what takes place in nature. This process leads to explanations becoming universalized; rather than primarily being founded on individual assessments, they are based on abstract models. In being turned into numbers and formulae, these phenomena become 'epistemic hybrids' (Helmreich 2014: 271), that is, they become corporeal experiences cloaked in abstract scientific explanations and thus acquire an aura of detached and objective scientificity.

Physical conditions have been assigned the qualities of independence and universality within modern Western science and society, and these features are commonly seen as epistemologically paradigmatic by modernist people. Even among anthropologists, the aim of understanding other peoples' meteorological perspectives on their own premises generally seems to have been overlooked. Though there may be exceptions, usually when anthropologists have paid attention to weather, it has been as a symbolic or metaphoric expression of existential conditions (see, for instance, Evans-Pritchard 1938; Lévi-Strauss 1969; Osborn 2009), or as a general background condition, based on modernist meteorological assumptions, employed in exploring social and cultural effects caused by the process of global warming (see, for instance, Crate 2008; Hastrup 2009; Rudiak-Gould 2013). In contrast, my aim here is to explore Matsigenka people's meteorology – understood in the ancient Greek sense as 'the science of that which is in the air' – as an alternative to modernist perspectives on processes in the atmosphere, and to examine their reactions and attitudes towards the local climate-change discourse.

The absence of a concept of 'weather' in the Matsigenka language does not mean that Matsigenka people are unfamiliar with or lack notions of rain, thunder, sunshine and so forth. On the contrary, the occurrence of these phenomena is recognized as an ordinary element in the everyday, and they influence life in significant ways in terms of subsistence practices and their organization, the design of clothes and houses, notions of comfort and wellbeing, and so on. In saying this, it would be wrong to suggest that there is a concordance between English and Matsigenka concepts regarding events in the atmosphere and their nature. In contrast to the modernist notion of, for instance, rain as the uniform outcome of a process in which drops of water are formed through the build-up of humidity in the air through condensation within clouds that fall to the ground because of their weight, Matsigenka people perceive various forms of precipitation that differ in crucial respects in terms of both origin and effect (for more on this, see below). The issue here is accordingly not primarily one of language and translation, but of distinct systems of knowledge and ontology (see Bird-David 1999; Ingold 2000; Viveiros de Castro 2004).

This focus on knowledge systems indicates a need to enquire about Matsigenka understandings of the environment and its nature. This is a classical philosophical question that has also attracted interest within anthropology, hence the increasing challenges to the nature-culture dualism that was central to modernist conceptions of the world during the 1990s (see Bird-David 1999; Descola and Pálsson 1996; Ingold 2000). Ideas formulated at this time subsequently contributed to the development of what has become known as the ontological turn (see for instance Bertelsen and Bendixen 2016; Blaser 2010; Descola 2013). As part of the challenge to the nature-culture dichotomy, Nurit Bird-David (1999) developed the notion of 'relational epistemologies' to describe systems of knowledge in which the knower and the known are seen as interrelated, something that, she argues, is characteristic of animistic understandings of the world, where human-nature relatedness is perceived as relations between subjects. Epistemologies held by animists have been described as 'a kind of sensory participation, a coupling of the movement of one's attention to the movement of aspects of the world' (Ingold 1999: S82). In contrast to modernist naturalism, animist epistemologies are embedded in the particularities of local life, and knowledge within them depends on the experiences and social contexts of the knowing subjects rather than being the result of detached studies of an autonomous reality. To confuse concepts from one language with those pertaining to another constitutes what Peter Winch (1970: 93) referred to as 'category-mistakes' and what Eduardo Viveiros de Castro more recently (2004) referred to as equivocations, that is, interpretations made according to standards of rationality other than those upon which the significance of the word or phrase was based. It is necessary not only to attend to linguistic problems of translation, but also to any ideological implications that may be involved (Rubel and Rosman 2003: 6). In his seminal essay on partial truths, James Clifford (1986) made clear a number of traps to be overcome in the writing of ethnography in order to avoid such mistakes. Clifford assumes that we all live in the same world and therefore presents differences in understandings of the world as epistemological. After the 'reflexive turn', within which Clifford wrote, came the 'ontological turn' and the notion of the 'universe' was substituted by that of the 'pluriverse' or 'multiverse': it was recognized that people not only interpret and understand the world differently, but also that the worlds they perceive and live in are actually distinct, and the differences in the perceptions of the world are accordingly ontological (see, for instance, Bertelsen and Bendixen 2016; Clammer, Poirer and Schwimmer 2004; Descola 2013). Arguably, there is only one physical world, so when I talk about different worlds, I am referring to 'lived-in-worlds' and the way they are perceived by variously situated subjects. Since people's perception of the world in which they live is produced in the subjects' engagement with the environment in which they find themselves, subject and object are mutually constituted. Accordingly, it is practically impossible to imagine a conscious subject with a corporeal body that is unrelated to the environment of which it is part (Meløe 1988; Merleau-Ponty 1989).

The act of knowing, and the social setting within which the known is practised and communicated, is consequently of central importance. Considering the significance of lived experience for the perception of the world, I am in agreement with Michael Jackson (1989: 3) when he cautions us that conceptual orders should not be taken as 'an inherent orderliness'. We are part of the world in which we dwell, and a vocabulary is therefore not a reflection of an independent physical reality, but an expression of the world as perceived. The meanings of words and other signs are consequently subject-related and derive both from practical engagement with the environment and the social processes in which meaning is negotiated (see, for instance, Bakhtin 1981; Mannheim and Tedlock 1995; Taylor 1985).

Problems of Translation

Given this perspective on knowledge, I have struggled with how best to represent concepts denoting atmospheric phenomena in a way that is both faithful to the way Matsigenka people perceive them and comprehensible to a modernist audience. As already noted, the modernist conception of 'weather' is problematic from a Matsigenka perspective. In the modern West, the various atmospheric phenomena subsumed under this category are supposed to have common physical laws that generate them according to scientific meteorological understandings. Conversely, for Matsigenka people, atmospheric phenomena are the results of agentive forces, other-than-human persons generating these occurrences through the conscious projection of objectives related to elements in the specific context. The consequence is that what modernist meteorology sees as phenomena that share common characteristics that allow us to place them all within the category of weather is understood by Matsigenka people to be a collection of sundry and unrelated phenomena.

Since Matsigenka people do not share the physical notion of 'weather' of modernist meteorology, the challenge consists in finding ways to speak about these atmospheric phenomena without adding or subtracting comprehensions that are central to one perspective but not to the other. In my initial attempts to find a common denominator from which to depart, I took it as self-evident that both Matsigenka and modernist meteorological perspectives ought to have in common that the phenomena they talk about take place in what we may describe as 'the atmosphere' or 'in the air'. To modern Western people, 'the air' is arguably rarely a problematic category: it is the medium in which we are immersed and that we breathe. When I enquired about how to refer to this seemingly obvious medium in Matsigenka, most of the people I asked thought hard before they responded and I got a few suggestions, such as 'wind' (*tampía*), 'vapour' (é*nkatsi*) and 'upwards' or 'high up' (*enoku*). However, my interlocutors all quickly withdrew their various suggestions, as they realized that the concepts they were proposing did not really correspond to what I was asking for.

After making several further attempts to discover their concept of 'the air', I eventually reached the conclusion that no corresponding term exists in the Matsigenka language. Based on the confusion of my interlocutors, I assumed that 'the air' was seen as a void of 'nothingness' and that its lack of tangibility coupled with its ever-presence and nonvisibility made it something that could not be talked of. Subsequently, however, I came to realize that I was looking in the wrong direction, as I had presumed there had to be a 'proper' word for 'air', as it was such an important element in my eyes. But instead of the concept I was looking for, I found the infix *-gite-*, which I have never heard of or seen other than as a complement that forms part of various word constructions. To illustrate the use of *-gite-*, there is, for instance, the word *morekagíteri*, which consists of the combination of the verb stem *moreka-*, meaning 'to burn', in combination with the infix *-gite-* and the suffix *-ri*, which is a nominalizer making the verb into a noun. Thus, *morekagíteri* literally denotes 'something that burns in the air' and in its actual deployment, it corresponds more or less to 'lightning', which is the common translation (Pío Aza 1923: 237; Snell et al. 2011: 286). However, the meaning of the infix *-gite-* is more inclusive than the English word 'air'; what we consider to be the atmosphere is only part of what *-gite-* refers to, as the infix is probably most faithfully translated into something like 'the setting'.[4] From the example of lightning, the association of *-gite-* with 'air' is logical, but when I enquired in the field about this concept, an elderly man compared the air that surrounds us with the perception of sub-aquatic beings, e.g. fish, of the water in which they live. Similarly, even though humans perceive of the air as a gaseous part of the environment, to other beings this medium is perceived as physically different and as constituting a more earth-like landscape. When Matsigenka people travel to visit their spirit friends living 'high up', they rely on the help of psychoactive substances that enable them to tune into reality on a different 'frequency' than the everyday one (Rosengren 2006). In the beginning of séances, as the drug is taking effect, the shaman climbs a 'ladder' that reaches the top of the roof of the house in which he and his fellow travellers have gathered, and from where they sally forth on foot through a landscape that earlier they saw as 'air', but that now forms a continuation of the earthly setting, to the abode of their spirit friends.

Worlds Apart

To comprehend the setting in which we live in the way that Matsigenka people do would mean conceiving of the various weather phenomena in very different ways from the way in which they are seen according to modernist comprehensions. Although many Matsigenka today speak Spanish and thus employ modernist notions of weather phenomena, these concepts are frequently incorporated into pre-existing ontological frameworks. Thus, the parts of the year when it rains a lot, and when it rains much less and sometimes not for two or three weeks in a row, are today talked about in Spanish as the 'rainy' and the 'dry' seasons (*tiempo de lluvia* and *de seco*). However, the use of these foreign terms has not necessarily affected people's understandings of the seasonal variations as based on hydrological characteristics rather than on the frequency of rain. Accordingly, in Matsigenka, the 'year' is divided into a season when there is much water in the rivers and brooks (*kimoárini*) and another when there is little or no water in them (*shiriagárini*).

From a modernist Western perspective, the Matsigenka terminological focus on the shifts of the water level in the rivers can be seen as analogous to the variation in precipitation between the rainy and the dry seasons: when it rains, the rivers swell and when it does not, they dwindle. In this case, the difference derives from alternative interpretations – that is, it is a matter of epistemological variation. Accordingly, to Matsigenka people, the regular recurrence of periods when there is much water in the rivers alternating with periods when there is much less is explained by changes in the cosmic river. In its upper, celestial parts, this river is visible from Earth as the Milky Way, Meshiáreni, which after leaving Earth continues downwards in the cosmic tier of worlds. On Earth, the river is known as Eni, 'The River', which on present-day maps is given as the Urubamba River, along which the majority of Matsigenka people live. When this river continues down into the underworlds, carrying the souls of the deceased, it becomes Kamavenía, the River of the Dead. On a cosmic scale, the different sections of the river are connected in such a way that when there is much water in Meshiáreni, there is little water in the lower parts, that is, in Eni (the Urubamba) and Kamavenía, and vice versa. Consequently, it is not rainfall that causes the water level in the rivers to rise, but the movement of water between the two opposite ends of the cosmic river. The frequency of rain is consequently not seen to affect the water level. The connection between the intensification of rainfall and high water levels in the rivers lies in the conception that it is easier for demons living in the subterranean worlds to enter Earth through the gates located in the riverbeds when the rivers are swollen than when the water level is low. Since many demons are associated with raining, their increased presence during the season of high flows explains the temporal overlap of heavy rain and high water levels. One interlocutor stressed that even during the so-called 'dry season', it would rain now and then and, thus, he asked, how could it be a dry season? Similarly, he continued, during the rainy season it did not rain every day, but still the rivers were swollen! To him, the logical distinction had to do with the water level, and the presence of demons was the explanation for the rain during the period of the year when there was much water in the rivers. This made much more sense to him than the notion of regular variations produced without the intervention of subjective agents.

This brings us again to Matsigenka people's comprehensions of the nature of that which modern meteorology terms 'rain'. In contrast to uniformly constituted raindrops, precipitation is produced by a variety of different agents and consists of different substances. The liquid that most closely corresponds to meteorologists' 'rain' is ínkani. It is produced by a group of spirits who are commonly known as the *inkanipiriegi* and who live in the world above Earth, from where we see it as the clouds in the sky. However, what is rain to modern meteorology can also be produced by the *impókiro* spirits, who live in the world above the cloud world and who are visible from Earth as the stars because of their brilliantly shining dresses. When these spirits urinate, they go out into the forest to relieve themselves, just like humans, and their urine falls to Earth as a light drizzle known as *itsini impókiro*, 'the urine of the stars'. As noted above, demons are also associated with rainfall – when they move on Earth, their presence can be noted by showers together with strong winds that follow them and that are known as *mararoenka*. All these kinds of precipitation are either benign or harmless. By contrast, the precipitation sent by the demon Ináenka, the mother of disease, causes severe rashes that are particularly dangerous to small children, who are hurriedly ushered indoors when it falls. Ináenka's 'rain' originates underground and is seen first as mist rising towards the sky that subsequently falls back on Earth in the form of light drizzle, characteristically at the same time as the sun is shining. The precipitation that Ináenka sends is distinguished as *parienkatagantsi*, literally meaning 'falling vapour' (the name of the demon, Ináenka, literally means 'mother of vapour'). *Parienkatagantsi* can be translated into English both as 'to drizzle' and 'to cause an epidemic', and to Matsigenka people, the two meanings stand more or less for the same thing.

The danger that is perceived when it rains at the same time as the sun shines neatly fits Douglas' (1991) notion of pollution being produced by 'matter out of place'. Yet 'matter out of place' is not how Matsigenka people conceive of this coincidence of rain and sunshine; rather, simultaneous precipitation and sunshine (not all that rare in the tropical lowlands) is a sign of the distinctiveness of *parienkatagantsi* from noninfective rain and, consequently, proof of the intention behind its appearance.

Even though the ways in which Matsigenka people perceive forms of precipitation differ from modernist Western notions of rain, it is still watery liquid falling from the sky. Explanations of other atmospheric phenomena overlap less with modernist scientific explanations of reality, in some cases being outright incommensurable with them. Consider the following expression: '*otonkaveigarira kareti*', found in the collection of Matsigenka stories told by H. and J. Vargas Pereira (2013: 348).

The sentence in which the expression appears is translated into English by the compilers Michael, Beier and O'Hagan (2013: 348) as: 'They told stories of what they were going to hunt, when they saw jaguars, when the thunder fired (as with a gun), when they heard the demons.' To a native English speaker, the translation of *otonkaveigarira kareti* as 'when the thunder fired (as with a gun)' probably seems odd, as thunder does not fire guns. However, when I checked the translation with interlocutors, they also rendered the expression in the same way. The word *kareti* is a noun that denotes 'thunder that is just above or close by', that is, when the sound of thunder is heard loud and clear. In the construction *otonkaveigarira*, *-tonk-* is associated with the verb *tonkagantsi*, which Snell et al. (2011: 511) give several meanings for, two of which are 'to thunder' and 'to sound "boom" (from e.g. the explosion of dynamite, thunder or the firing of a shotgun)'. Considering these various possible translations, one might ask why the translators chose to use the gun-firing alternative when, from a modernist perspective, 'to sound boom' might be considered the more obvious choice. One possible answer is that the use of metaphor was aesthetically pleasing to the translators. Another answer, which arguably is the more likely, is that talking of the firing of a weapon in this context is no metaphor to native speakers of

Matsigenka. 'Shotgun' is *tonkaméntontsi* in Matsigenka, a word that can be deconstructed as *tonk-a-mento-ntsi*: *tonk* is the verb stem signifying 'sounding loudly' (as, for instance, an explosion, thunder or the firing of a shotgun); *-a-* is an epenthetic segment introduced here to facilitate pronunciation; *-mento-* is an instrumental nominalizer that turns a verb into a noun; and *-ntsi* marks an unnamed possessor.[5] However, the expression *tonkaméntontsi* also refers to a kind of weapon used by the *saankaríite* spirits and that people describe as being like a mirror. When fired, this weapon produces a loud bang and a strong flash that is similar to when a mirror reflects light. As a consequence, what at first may seem to be a figure of speech may in the end turn out to be a description of an object in a world that is radically different from the one known by modernist Westerners.

My focus on knowledge has hitherto led me to treat the differing notions of atmospheric phenomena principally as a conceptual issue. Since I understand 'knowledge' to mean 'the certainty that phenomena are real and that they possess specific characteristics' (Berger and Luckmann 1971: 13), it is constituted by the subject as that which makes sense and is in accordance with how the world is perceived and experienced. With this also comes the development of practices and insights learned from parents and mates that have resulted from their previous experiences of practically engaging with the environment, understood in its widest sense as including physical, social and sensory dimensions. Thus, I take knowledge to be engendered through the physical, social and sensory engagement with the overall environment, and consequently it is not just a mental product, but also a sensual and practical one.

Knowledge is, as a result, not evenly distributed; there are people whose reputation for being experienced and knowledgeable make others listen to them, heed their advice and follow their example (see, for example, Barth 2002; Sillitoe 1998). However, although there are persons who are considered to be knowledgeable in various fields, that knowledge never becomes generalized and depersonalized. Even allegedly esoteric knowledge, referring to, for instance, cosmic conditions is considered to be relayed by people who have acquired the information from persons who have made the observations, or have been in contact with someone who knows it from proper experience. Those who are reputed to be knowledgeable are commonly older people, irrespective of gender and social position, as they are considered to be more experienced and wise than their younger peers. Being basically an egalitarian society (Baer 1984; Johnson 2003; Rosengren 1987, 2004), there are no formal hierarchies that are significant in terms of how knowledge of the world is constructed and deployed.

Myth and Meteorology

To Matsigenka people, the acquisition of knowledge follows not only from personal experiences, but also from relations with subjective forces in the cosmos, who teach people essential skills. In common with many peoples around the world, the Matsigenka have 'culture heroes' who in primordial times lifted them up from ignorance and introduced them to civilized life. These heroes usually appear in cosmogonic myths in which atmospheric phenomena frequently play a crucial role. Moreover, stories of this kind often explain why atmospheric events occur and, at the same time, reveal the associative patterns that lie behind the meaning and appreciation of particular phenomena.

One such cosmogonic myth tells about the near-extinction of humankind, an event that took place during primordial times when they walked around naked and lacked most of the knowledge and skills they have today. At the time, people were constantly threatened by attacks from demons and other malign beings, who came close to exterminating them. While telling the story, the narrator[6] stressed that, as the sun did not shine, the days were always gloomy and it was frequently raining – conditions that Matsigenka people commonly associate with dangers produced by demons. In the tier of worlds that forms the Matsigenka universe, the cloud world immediately above Earth is populated by a variety of beings: bright clouds are inhabited by benign spirits (such as the *inkanipiriegi*), while dark clouds are occupied by demons. The reference to the low-hanging dark clouds is consequently a hint of the closeness of demons to Earth.

One day, the myth says, a man and a woman appeared at the house of a shaman, who invited the couple to stay. Eventually, the visitors turned out to be *saankaríite* spirits who had taken pity on the suffering humans and therefore had come to help them defend and take care of themselves, and, at the same time, to introduce them to civilization.[7] The couple taught people to hunt, to fish and to cultivate a number of plants, and, most importantly, they taught the shaman how to defend people from the threat of demons. When humans mastered these skills, and the spirit couple prepared to return from whence they came, the clouds over Earth rose and cracked open, the sun appeared, the days became bright, and variable weather conditions were experienced for the first time in this new and better world.

The 'lesson' that can be drawn from such myths[8] is corroborated by experience. The association of sunshine and bright days with positive forces, and rainy and gloomy days with negative forces is, accordingly, no simple coincidence, but has to do with lived experience. In the Upper

Urubamba and the rest of the tropical lowlands of eastern Peru, overcast skies and rain are not infrequent events. More importantly, precipitation often produces a number of problems with regard to, for instance, communication and movement. Trails in the forest become muddy and slippery, while rivers swell and become rapid-flowing and dangerous. This means that most subsistence activities are negatively affected, and feelings of discomfort heighten with the increased humidity, bringing the fear that health may be affected. In contrast, dry and sunny weather is comfortable and produces no obstacles for everyday life; it is a safe time. It is also a prosperous time, as fishing is easier and more productive when the water level in the rivers is low. Also, many game animals are at their fattest at the beginning of the dry season.

The Perception of Meteorological Conditions, Notions of Climate Change and Environmental Relations

That the modernist meteorological notion of 'climate change' does not make much sense to Matsigenka people does not mean that they see the world as static. On the contrary, like other Amazonian people, they entertain notions of a highly unstable and transformative world (see, for example, Gow 2001; Londoño Sulkin 2012; Vilaça 2005; Viveiros de Castro 1998). Given the experiential basis of Matsigenka people's view on knowledge, to them the urgent problem is not the abstract notion of 'climate change', but the obvious and rampant process of deforestation, as this influences living conditions in an immediate and concrete way, negatively affecting access to game and the fertility of the lands, as well as their relations to animals, plants, spirits and demons.

As noted above, Matsigenka people's understandings of the nature of atmospheric events emphasize the concrete, local and experiential, and thus they do not produce meteorological abstractions of the sort generated by modernist science.[9] The significance of experience and the understanding of local settings come out clearly when Matsigenka perceptions of meteorological conditions are compared to the way in which migrants from the neighbouring highlands perceive the same circumstances. In the last fifty to sixty years, a great number of small-scale Andean farmers have come to the Upper Urubamba in search of land and economic gain. Many of the localities from which these migrants originate have suffered the consequences of global warming, as melting glaciers create problems as the availability of water declines in the dry season, affecting local agriculture negatively. In conversations I have had with migrants, many stated that global warming is one of the most urgent problems of our time. This opinion is probably associated with the highlanders' experience of deglaciation in their communities of origin, a condition that has meant that they have been introduced both to the notion of global warming and modernist meteorology. Even though they are most likely unfamiliar with the theoretical models and calculations that meteorological experts use when forecasting the weather, they acknowledge as a rule the climate-change discourse. This acceptance of scientific expertise is arguably associated with their integration into the market economy, which, among other things, has produced an ambition to advance socially. In their relation to the indigenous Matsigenka, this aspiration is commonly expressed in terms of being modern, as, for instance, manifested in the attention paid to the climate-change discourse. This is used to distinguish them from the Matsigenka, who do not recognize the process of global warming and who therefore are described as backward and uncivilized (Rosengren 2018). A few years ago, the time of the transition from the dry to the rainy season was spoken of by many of the local Andean migrants as an exceptionally warm period, and they frequently exclaimed that 'never ever has it been so hot'. Most likely this was an expression of exasperation caused by the heat of the day, as the mercury in the thermometers often reached 40ºC and above. In some instances, though, explicit reference was made to global warming. By contrast, Matsigenka people seemed rather unperturbed by the heat. They generally noted that it was not equally hot everywhere, pointing to the highland migrants' preference to live and work in places where most of the vegetation had been cleared, which are warmer than in the forest, where the overwhelming majority of Matsigenka people dwell. Many Matsigenka also observed that while their houses commonly have thatched roofs and walls made of palm slats, allowing air to circulate, Andean migrants prefer houses constructed by adobe bricks with roofs of corrugated iron. The different ways in which highland and Matsigenka people relate to and experience weather are thus influenced by social practices and dwelling habits. The distinct practices of the two groups are at the same time also associated with values emerging from their differing ontological perspectives: one animist and the other modernist. While the animist Matsigenka embrace what Bird-David (1999) describes as a 'relational epistemology', stressing the subject-subject character of their relationships with the environment, migrant farmers tend to objectify and commoditize the environment in accordance with modernist naturalism. To Matsigenka people, the forest is not only a prominent part of their dwelling, but is also a subject that needs to be respected and treated with care. In contrast, to the modernist migrants, the forest is a mere material element that can be cleared away in order to make their production more efficient and facilitate their social advancement. Paradoxically, those who are most aware of the climate-change discourse are in this area the agents that promote climate-change processes, while those who have no understanding of it contribute the least to these developments.

A Plea for the Future

In order to properly integrate Matsigenka people into national Peruvian society, local authorities and various nongovernmental organizations (NGOs) launch development projects to teach them new and modernist ways to organize and procure their living. These entail, among other things, turning nature into a resource and ignoring or turning certain agentive subjects into objects. Thus, in contrast to the educational project of the *saankaríite* spirits in the myth referred to above, these modernizing agents destroy Matsigenka people's ways of life, motivated by their belief that they know better and their ambition to do good. However, given that modernist society is the main cause of global warming, instead of teaching nonmodernist people such as the Matsigenka new ways of life, modernist people should probably try to learn from the kind of relational epistemologies that have allowed and enabled nonmodernist people to engage in sustainable practices.

Since indigenous voices provide an alternative discourse to modernist assumptions about the world's constitution, they defy modernist understandings not only of meteorology but also of environmental relations in general. Disregarding these alternative voices become increasingly difficult as concepts embedded in the dominant global discourse, such as modernity, development and Western ways of knowing, are further problematized. Accordingly, the homogenizing denomination of the current geological era as the Anthropocene – emphasizing humanity's impact on the climate – is increasingly challenged, as it obscures the primary cause of climate change, namely the modernist ideology of growth and consumerism. Not all of humanity can be blamed for the climate-change crisis (see, for instance, Blaser 2016; Haraway 2015; Malm and Hornborg 2014).

This plea is not that modernist people should convert and become animists; rather, it is to realize that modernist naturalism is not the answer to all problems. A more humble position in relation to other perspectives is consequently sought, as it hopefully will mean that encounters between different ontologies can function as openings, allowing perspectives and insights to emerge from subaltern positions to inform and influence modernist ways of life and thinking.

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Notes

1. I started carrying out ethnographic fieldwork among Matsigenka people in 1979 and I have since then visited them, intermittently, for both long and short periods. Currently, I have spent between five and six years in the field. My interest in Matsigenka people's perception of atmospheric phenomena goes back to 2010.
2. I make a distinction between 'modern' and 'modernist'. All people who live now are modern, while only those who espouse an ideology of development with its roots in the Enlightenment and industrialization of eighteenth-century Europe are modernist.
3. For more general ethnographic information on Matsigenka people and society, see Baer (1984); Johnson (2003); and Rosengren (1987 and 2004).
4. The infix *-gite-* is also used when referring to qualities of the setting and is then found in words such as *kutagiteri* ('day' and 'morning', from *kutari*, 'white' or 'bright') and *mamerigítema* ('an empty space', from *mameri*, 'not here' or 'inexistent').
5. This denomination I owe to Betty Snell and Mary Ruth Wise (personal communication, 14 October 2016).
6. Mrs Mirian Piñareal of Koribeni told me this myth.
7. This is an alternative version to the most well-known (or at least best-documented) account of how humankind acquired knowledge and material culture, in which it is Moon who is the bringer of civilization (see Baer 1984: 423–25; Chineri Pinedo 2016: 10–21; García 1942: 230–33; Johnson 2003: 208–9; Vargas Pereira and Vargas Pereira 2013: 96–98).
8. When I say that 'lessons' can be drawn from myths, I refer to the insights that non-Matsigenka people can acquire into aspects well known to, and taken for granted by, Matsigenka people.
9. Even in the modern West, attempts at generalizations emerged only with the development of the means for rapid communication over large distances during the nineteenth

century (Miller 2004). Through the development of the telegraph, data could be gathered from many places, and upon these models of weather development were elaborated. The modern notions of 'climate' and 'climate change' thus require a globalized view of weather systems together with detailed information on weather conditions for at least the last thirty years which is the period of time commonly used for defining 'normal weather'.

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Chapter 2

Climate Change, Weather and Perception

Fishing in Eastern Patagonia

Francesca Marin

Today, coastal net fishing is practised in both gulfs of the Valdés Peninsula: Nuevo and San José Gulf (Figure 2.1). The great majority of net fishers lives in Puerto Madryn,[1] on the southwestern coast of Nuevo Gulf. To go fishing, they drive between a dozen and almost two hundred kilometres, depending on which fishing beach they intend to reach. They usually go fishing for one day (or night) at a time, and very occasionally spend a few days in temporary camps on the coast. For the sake of clarity, I focus on coastal net fishing, though the central themes of the chapter also apply to the other two local artisanal techniques: inshore harvesting and commercial diving. The origins of local modern coastal net fishing date back to the beginning of the twentieth century, when Italian and Spanish immigrants settled in Chubut Province. The immigrants designed the three-metre rowing boat – which is still in use, though the materials used at present to build the boats are much lighter (fibreglass or a mixture of fibreglass and wood) than those used in the past (only wood) – and began to fish, in the same way as they had already introduced on the northern coast of Argentina (Mateo 2015).

The quantity of fish caught, and the time needed to do so, vary considerably and depend on experience, season and weather conditions. In particular, choosing the specific place to cast the net can take several hours of rowing and walking in the shallow coastal water. Through experience of fishing, the fishers' perceptions and actions have been fine-tuned in relation to their environment. This relationship with the environment is underpinned by a knowledge that is, as analysed by anthropologists in different contexts (for example, Ingold 2005; Vannini et al. 2012), place-specific, relational, multisensorial, activity-related and narrative.

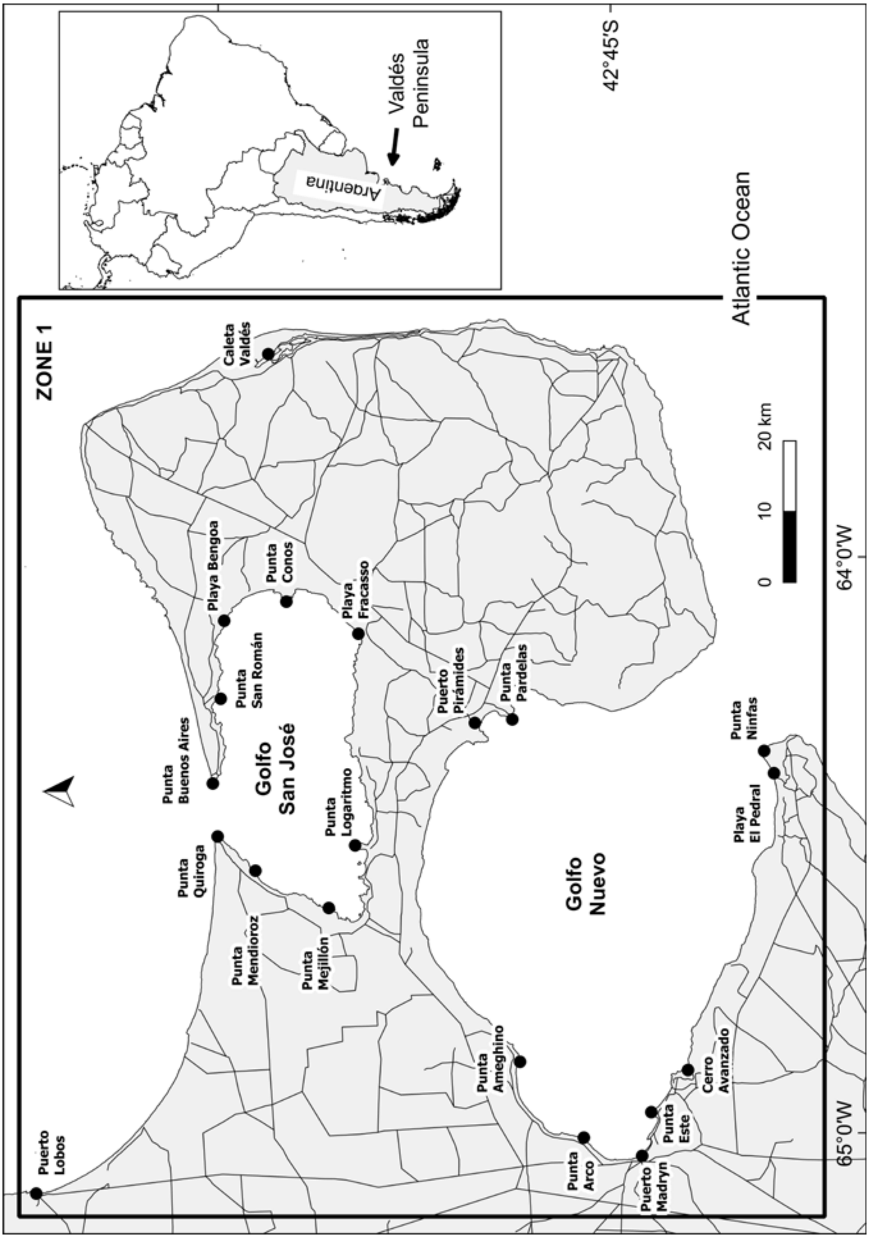

Figure 2.1. Valdés Peninsula map (thanks to O.P. Dell'Arciprete at CESIMAR-CONICET for producing it)

I begin this chapter by introducing the complexity of what are called 'seasons' in coastal net fishers' lives. In order to understand this fully, it is necessary to explain, as I do in the central part of the chapter, how fishers' skilled perceptions intermingle with algorithm-based weather forecasts. The combination of these two different ways of being attentive to weather events demands a certain amount of flexibility from fishers. In the concluding section, I explain how such flexibility can help fishers develop the ability of 'anticipating' (Nuttall 2010) the changes of the environment related to both weather and climate, and modifying the ways they fish.

The Seasons

> While we watch the sea and wait for the weather to improve, Tomaso[2] comments, 'Here we have cast some good nets. But it's been two or three years since we have had a good catch, as good as before. I don't know why. Before the wind used to keep from north, or from south, for seven and even up to fifteen days. Now there are three different winds per day. That's why we don't camp here anymore. It's senseless. Even before we did not stay here for a whole month; we used to go to [Puerto] Madryn at weekends. But it made sense to camp here because we had the same wind for many days.' He explains that it used to be different. During winter, it was cold and they fished silverside and Patagonian blenny. During summer, in the heat, they fished juvenile silversides. 'There used to be seasons [*temporadas*].' (Fieldnotes: 9 June 2015, Playa Villarino, San José Gulf southern coast)
>
> Tomaso: 'There are no seasons [*temporadas*] anymore. We need to learn again.' (Fieldnotes, 31 January 2016, Puerto Madryn)

When Tomaso talks, he seems to jump from one meaning of the word 'season' to another without specifying whether he is using it in the sense of the fishing, biological, commercial or even climatic 'season'. In Spanish there are two terms for 'season': 'estación', when referring to the climatic seasons,[3] and 'temporada' for the other three meanings mentioned above. Nevertheless, the features of the different meanings intermingle to the point of the two Spanish terms merging. At first, listening to Tomaso may appear slightly disconcerting, but the point is that he does not consider the different meanings to be separate. Once the activities, knowledge and skills needed in coastal net fishing are understood, the complexity of the term 'season' – as a combination of 'estación' and 'temporada' – becomes understandable. This became apparent during the fishing days in which I took part. Artisanal coastal net fishing is practised by a team of two to four fishers, with a seine net of between 70 and 100 metres in length, and, as mentioned, a three-metre rowing boat, which can also be occasionally used with a little portable outboard motor. Fishing mainly targets silversides (*Odontesthes spp*.) and Patagonian blennies (*Eleginops maclovinus*) (Ré and Berón 1999) during the day or, more rarely, at night. Made up of sand or pebbles (Figure 2.2), protected by promontories or exposed to the strong Patagonian winds, fishing beaches differ in size, ranging from a few hundred to thousands of metres long. At the back of some beaches are cliffs, while others merge into the Patagonian steppe.

Watching and Listening

On every fishing trip, the choice between dozens of available beaches is itself the result of knowledge acquired over many years. Fishers are particularly attentive and responsive to a variety of factors. Some of these concern the recent weather:

> Alfredo justifies his decision of reaching the beaches several hours before the right time for fishing by saying he wants to see whether there is seaweed on the shore. If there is much seaweed, the net would become very heavy. He thinks there might be seaweed because there have been many windy days and seaweed might have washed ashore. The first beach we go and watch, we get off the pick-up truck to get closer to the water. We walk for a while on a hard surface covered by *mejillín* (a tiny mussel), an intertidal reef, I suppose.

Figure 2.2. A pebbled beach partially protected by a cliff, on the coast to the north of Puerto Madryn (photograph taken by Francesca Marin)

> We can see neither young nor adult silversides. Alfredo suggests getting back to the vehicle and going to check other places. At the second beach, we do not even reach it by vehicle, since from the main beaten earth track (which is elevated here compared to some of the other beaches) we see the shore is 'dirty'. Alfredo makes me notice the different colours of wet and dried seaweed. The third beach is more protected from the wind and 'cleaner'. At the fourth beach, the sea is rough again. We have to wait: fish are not approaching the shore yet. (Fieldnotes, 15 December 2014, Puerto Madryn and beaches northward)

Additional factors are related to the presence of fish and other animals. For example, 'terns[4] that are diving' is interpreted as a sign that fish are swimming closer to the coastline. However, terns are not always present, nor are they the only factor to consider. A beach is often chosen due to it being sheltered from the wind, not having too much seaweed, being where there are no other fishers, especially if the beach is not too large, or presenting easy access. Most importantly, though, the presence of fish should be verified before starting fishing. When a beach satisfies all these requirements, the fishing team get out of their vehicle and subject the beach to a deeper inspection from elevated land formations, if these offer a view of the beach, or by standing close to the seashore. The fishing team observe the sea in silence for some minutes. They try to find out if and where there is a shoal they can reach. Concretely, they look for a slight change in colours: a spot, a darker area in the seawater. The darker the spot, the higher the density of the shoal underneath it. Sight is fundamental in this task and is carefully trained by fishers any time they pass close to the sea, even when they are not planning to go fishing. Fishers train their sight in relation to different types of light, particularly at night, when, in order to see, fishers use a handheld torch. As I was taught, when it was my turn to use the torch, the beam of light has to hit the water at the appropriate distance: neither too close, as the fish rarely stay very close to where the waves break, nor too far away, where light disperses in the darkness. The movement should be neither too fast, when it would be impossible to see any fish, nor too slow or of long duration, when fish would be disturbed and possibly flee. Similarly, so as not to disturb the fish, as soon as the hand movement is completed, the light must immediately be switched off:

> I try to simulate the semicircle I saw Alfredo doing, from left to right and back, but the result clearly does not satisfy him. Even after the catch, when I am asked to point the beam onto the net, I am criticized for lighting up the water: 'You mustn't do that! Only when we are looking for a shoal.' He explains that the light is not simply meant to make us see whether there is a shoal of jumping

> fish. The light makes the fish jump; it modifies their behaviour. (Fieldnotes, 15 December 2014, the coast to the north of Puerto Madryn)

Light is used sparingly, and fishers develop skills that combine hearing and sight. Hearing helps compensate for the limits of vision. Fishers stop moving, remain silent and listen to the fish jump. The stronger the sound, the higher the shoal's density. Once this has been heard, the light can be switched on to confirm the direction the shoal is moving. By checking the dimensions of water movements caused by the jumps, fishers deduce the dimensions of the fish themselves. Nevertheless, this technique works well only when the wind is light and allows the sound of the shoal to emerge. In northeastern Patagonia, fishing activities have often to contend with winds of at least nine knots. Such a wind, together with the waves, covers the sounds of the fish. Moreover, there are often medium to strong winds (15–25 knots). On these days, hearing is of no help and eyesight is significantly disenabled. Fishers only go net fishing in these conditions if they are in urgent need of money.

Forecasting and Perceiving

To avoid the problems presented by strong winds, fishers put in place a number of strategies. They listen to local radio and television, and consult internet forecasts on their smartphones (or call relatives and friends who have access to these devices). Forecasts from these media are useful tools, but three aspects have to be kept in mind: they can be wrong; they are of a different scale compared to the fishers' forecasts; and they can never replace fishers' perceptions.

I use the term 'scale' in the sense of spatial scale and do not intend to draw a parallel with the concept of time scale often invoked by climate scientists. Most of them point out that climate is out of reach for ordinary people whose climate experience is based on the senses and does not go beyond the short time scale of weather. Such researchers emphasize that they instead operate on a long time scale, the climate scale. This distinction between weather and climate allows the researchers to underline the limit of people's knowledge, including indigenous peoples, who lack instruments, methods and technology to step outside everyday present experience (Simonetti 2019). By contrast, the difference in spatial scale between media forecasting and fishers' anticipation suggests that fishers' knowledge is not lacking in terms of broad vision, but rather is enriched by their ability to understand not only atmospheric phenomena but also their relations with the environment (beaches, bays, headlands) and with the fishers themselves. This should appear clearly in the conversation excerpts I analyse below:

> Alfredo: Hi Francesca, how are you doing?
>
> Francesca: Hi Alfredo, good. And you?
>
> Alfredo: Could you check the forecast for me?
>
> Francesca: Sure, for where?
>
> Alfredo: Have a look at the area round here, Cerro Avanzado.*[5] For today in the afternoon.
>
> Francesca: It's bad, 20 knots at three, 25 at six and 24 at nine.
>
> Alfredo: And where's the wind from?
>
> Francesca: South at three and six. Then at nine, it's southwesterly.
>
> Alfredo: Oh, that's not bad. It's hitting the beach OK.
>
> (Fieldnotes, 8 January 2015, Puerto Madryn, phone call)

Such forecasts are indeed far from being the only way to foresee what the weather will be like before going to fish. Asu Schroer explains that for the falconers with whom she worked, the local media forecasts can only vaguely predict 'the weather that will actually prevail in the hawking location' (Asu Schroer 2014: 183). Fishers, when they can, also try to verify whether the internet forecast is correct. When they check the forecast for the southwestern coast of Nuevo Gulf, where Puerto Madryn lies, they go out and have a look at tree branches, flags and anything else waving in the wind. Nevertheless, it can be worthwhile approaching the coast and observing the colour of the seawater. When there are plenty of white horses, the sea is evidently rough. In such circumstances, fishing might prove rather difficult, as the only way to find fish is by walking back and forth along the shore, while stopping from time to time to fix your gaze on the water's surface. The rougher the sea is, the longer this search takes.

Despite the different strategies put in place, sometimes fishers are there, in front of the sea and potentially close to their catch, and yet obliged to admit their momentary inability to see and hear because the sea is too rough. This may happen when wind direction changes unexpectedly or because fishers have to rely on media forecasts only, as is the case when they decide to go fishing on a beach far away. When they are in front of the sea but 'unable to see', they decide to wait until the wind calms. They stop and have a *mate*[6] or chat about the weather, the latest extraordinary catch, the problems having their catch accepted in processing plants and other work-related topics. The more impatient ones go back to their vehicles and move towards more sheltered beaches. The point is that, by their very nature, these forecasts give no more than an indication of what the weather might be like in a certain area. Indeed, there is a significant difference of scale between internet forecasts and fishers' forecasts:

> Francesca: I think I understand the wind. If it comes from the coast…
>
> Tomaso: Always from behind, to not have waves.
>
> Juan: It has to hit you from the back. Here, at the Indio,* for example, you need wind from the west.
>
> Tomaso: This wind now would be good for Colombo,* let's say.
>
> Juan: Colombo,* Pardela*.
>
> Francesca: And why didn't you go?
>
> Tomaso: Because it is a 30 km wind. That is the only beach where you need a wind less than 18 km.
>
> Francesca: Why? Because there isn't any cliff?
>
> Tomaso: It is a long way back and the tide goes out a lot. I don't know why wind speeds up so much there. But when it is over 20 km, it knocks the shit out of you. Instead, here you can go fishing with 25, 27 km.
>
> (Recorded conversation, 12 March 2015, Puerto Madryn)

Fishers and other people accustomed to the coastal environment know that a wind blowing strongly from, for example, the south does not prevent fishing activity, which still remains feasible in most of the north-facing beaches. In particular, fishers develop the skill of perceiving wind and tides as 'made up of forces, changing, opposing each other' (Howard 2012: 135). Indeed, they explained that any kind of obstacle (including sand dunes, small bushes and buildings) is good for easing the encounter, along the shore, between water and earth. Thus, moderate to strong winds might not be a problem if one can go fishing in coastal areas protected from those particular winds. Moreover, beaches of the protected coast may still be exposed to winds, while beaches of the coast facing a particular wind can escape from it due to the morphology of the coastline. Like the kayakers Senior got to know for her research, fishers 'need to pay attention to how the shape of the land might interact with the wind to produce micro-conditions along the coastline and how different wind strengths and directions may combine to produce different results' (Senior 2015: 119). Thus, the knowledge about what winds each beach is individually exposed to, and protected from, is only available to those familiar with the shallow waters and seashore, a knowledge and familiarity that characterize the artisanal fishers' life and work. Furthermore, changes to coastal and urban morphology are sufficient to suddenly expose a previously protected area (for instance, when some coastal sand dunes disappear) or, on the contrary, to give it shelter (for example, when wind-breaking edifices are built behind a beach). Therefore, regularly visiting different sites is essential. 'Knowledge of wind acquired in other contexts is certainly germane, but is not sufficient. It needs to be qualified and adapted in relation to this place, to this activity' (Senior 2015: 112). More generally, the fishers' experience confirms that 'the scale of any element is proportional to its effects on other elements. These properties are not given prior to specific relational engagements' (Leach 2006: 159).

Finally, beyond the potential inaccuracies of forecasts and the matter of scale, there is a key difference between the information given by a weather forecast based on a mathematical model and knowledge resulting from a combination of such a forecast and the weather experience as lived. Generalized weather forecasts can give wind strength and direction, but cannot take into account how winds and sea waves interact with the different boats, nets and fishing manoeuvres. Media provide information that people can communicate, as I did myself when I gave information about the forecast on the phone. However, according to Ingold (2000: 21), information does not necessarily form a basis for knowledge; rather, 'knowledgeability' consists of being able to situate such information and understand its meaning. For example, fishing boats are all slightly different in terms of shape, weight and levels of maintenance: faced with a rough sea, they behave differently. So do fishers. Each fisher knows his boat's reaction to waves, its weight when it gets stranded, how far he and his fellow fishers are willing to let the boat sink, or how ready they are to throw away the catch to avoid this. Such knowledge informs concepts such as 'strong wind' or 'bad weather' and helps draw a line between 'choppy' and 'rough' seas. There is no pre-established threshold beyond which net fishing is not practicable, and acceptable risks differ from team to team. In effect, weather can be considered in isolation from activities, such as fishing, only theoretically. In real life, we are continually subject to the fluxes of weather (Ingold 2010), in which we are immersed, and that transform all our activities and perceptions (Senior 2015: 100–34).[7]

Preparing, Casting, Hauling and Boxing up

The most common boat amongst the fishers is a 2–3-metre fibreglass one. It is equipped with two wooden oars and a fishing net, accurately placed over the stern so that it can easily be dropped into the water, without getting tangled, when the moment comes. During the casting of the net, one fisher stands in the water up to his knees or hips near the shoreline, holding one end of the net. The second fisher stays on board and rows so as to make the net fall from the stern in a curve (Figure 2.3), the ends of which are the first fisher and another point along the seashore up to 50 metres away. Although fishers tend to fish in familiar environments, what they do is similar to wayfinding:

> 'Finding one's way' is not a computational operation carried out prior to departure from a place, but is tantamount to one's own movement through the world … we know as we go, not before we go. Thus the operation is not complete until one has reached one's final destination: only then can the traveller truly claim to have found his way. The notion of 'finding' has here to be understood in its original sense of exploratory movement, at once improvisatory and assured, guided by past experience and by a continual monitoring of fluctuations not only in the pattern of reflected light but also in the sounds and 'feel' of the environment. (Ingold 2000: 239)

The manoeuvre ends when the boat reaches the shore again. If there is a third or fourth fisher, they help by grabbing the second end of the net while the person on board gets off the boat and anchors it. They will then all haul the net out of the water, through slow and regular movements of their arms, counterbalancing it with their whole body through a skilful but taxing movement. One or two fishers haul the net from one end, and one or two haul it from the other end. Simultaneously, they walk towards one another in order to close the loop (Figure 2.4). While hauling the net,

Figure 2.3. Fisher rowing to cast the net (photograph taken by Francesca Marin)

fishers observe the fish, to check that they have gone into the bag of the net, where they will not be able to escape.

Usually, the net is cast in waters up to 6 metres deep (corresponding to the maximum height of the net). One edge of the net has weights on it and lies on the sea bottom, while the other has floats and remains on the surface. The fish have practically no way out. Nevertheless, if the water is moving a lot and lifts the lower edge, fish might be able to escape. In these circumstances, fishers lift the floating edge and beat it a few times on the water. The noise is meant to scare the fish, make them gather in the middle of the net and enter the bag. Only a detailed knowledge of the place allows the fishers to cast and haul the net efficiently, as underlined in Juan's tale:

> Juan: 'How strange', I said one day [to Ortiz], 'how strange that you don't catch what you should catch given that you have been fishing for so many years.' Once, we [two fishing teams] were fishing. We were doing alternate casts. There were fish in an area, we had seen them but didn't cast the net because we knew that in that area the beach has small waves underneath the surface, a whirlpool that turns over the bag [of the net] and prevents you from fishing. Ortiz cast the net and caught nothing. I told him: 'Man, a knowledgeable fisher cannot make such mistake! Like that you are making your men work for nothing.' (Fieldnotes, 9 June 2015, Puerto Madryn)

After hauling in, fishers stand in shallow water 30–100 cm deep, emptying the net while making sure that the neither it nor the boat gets stranded

Figure 2.4. Fishers hauling the net (photograph taken by Francesca Marin)

(Figure 2.5). This is partly achieved by estimating the available time before the tide goes out, based on the tide timetable and the knowledge of the formation of the beach and seabed as the water recedes. An estimate is a useful tool of anticipation, but not much more than that. Far more important is the relationship between fishers, a boat's movement and the movement of the water, the 'fine-tuning of perception and action' (Ingold 2000: 37). While the fishers empty the boat, it is floating in water that is as shallow as possible, normally a few dozen centimetres (Figure 2.6). Deeper water would mean more movement of the boat, complicating the boxing-up. During a falling tide, it is not sufficient to make this evaluation once, because wind strength and direction can influence the tide, increasing or decreasing its levels; rather, fishers must pay continuous attention to the movements of the boat. This attention is multisensorial. Through sight, fishers can establish how much the water is diminishing under the boat. Actually, thanks to the tightening and freezing (during cold months) or cooling (in summer) sensations of water, fishers can feel whether they are submerged up to their waist, knees or ankles without the need to look at the seawater. Finally, leaning against the boat with their bodies, or pushing and pulling it to stabilize or move it, they feel how responsive the boat is to their solicitations. If the boat reacts slowly, this means that

Figure 2.5. Fishers carrying a boat at low tide (photograph taken by Francesca Marin)

it is getting stranded and has to be pushed towards the open sea before it is too late.[8]

While determining the logistics of emptying the net, fishers also have to take into consideration the weather, the temperature of the air, the brightness of sun and the behaviour of fish and seagulls. When the sun shines high in the sky, fishing manoeuvres have to be realized more speedily, for the heat can easily spoil the catch. When it is hot, the catch must remain in the boat. If the catch is put in stacks of boxes (Figure 2.7) while the team keep casting the net, these are left close together, all along the beach. This is because in order to keep the catch fresh, they should have seawater poured over them by someone going back and forth. A piece of thick cloth covering the stacks of boxes is good additional protection from the sun. The cloth is also useful against seagull attacks. It only takes a few minutes to have a flock appear, apparently from nowhere, once fish are left unattended. While bird attacks can be seen and heard from far away, the effect of the sun on the catch is less easily visible from afar. The physically demanding activity makes fishers sensitive to solar heat, but they are also partially submerged in water that cools them down. As any mistake in assessing the temperature could mean the catch spoiling, fishers pay particular attention to it through touch. By passing a hand through

Figure 2.6. Fishers emptying the net (photograph taken by Francesca Marin)

the juvenile silversides or by grabbing a bigger fish, an expert can easily gauge whether they are getting hard from the heat of the sun.

The fishers' multisensorial perceptions of the environment, weather and animals' behaviour, and their interaction, have to be augmented by a cautious anticipation of the forthcoming weather influences. Fishers interpret weather changes as rapid as a gust of wind, and respond promptly to them, by changing the ongoing activity or concluding it, if necessary.

Practising Forecasting Flexibility

Fishers become skilled at making last-minute forecasts, their combination of the public forecast heard on the radio or checked online, personal forecasts realized by observing the colours of the sky during the previous day or hours, and their perception of weather on the spot. While working on the seashore, fishers pay attention to the colour of seawater, to animal attitudes and to how the sky looks. When seawater turns dark – dark green according to some fishers, black according to others – strong wind is approaching:

> Valeria: Later it will all be north [wind], you'll see, because the breeze has come. When people say 'the breeze is coming', it means that you see the sea becoming darker, greener far away and whiter closer to the coast. There was a woman in

Figure 2.7. Fisher resting in the shade of stacks of boxes (photograph taken by Francesca Marin)

> [Puerto] Madryn who used to say: 'the breeze is coming'. All people went out to see, but did not know what she meant. (Fieldnotes, 12 May 2015, El Riacho)

Animals are also good indicators of upcoming weather. The uncommon presence of dragonflies signals approaching rain. 'When seagulls [and other birds] go out [inland] it is a sign of an upcoming sea storm' (Antonio, 24 February 2016). Fish leave the coastline long before the storm comes. Unlike birds, which fly inland, fish move towards the open sea:

> Tomaso: Fish know everything. They know when the tide is about to fall and when the weather is bad. You may be fishing very well when all of a sudden the fish disappear. What happened? You did not notice it, and if you don't pay attention, the wind comes along. Instead the little guys have gone, before the bad weather starts hitting them, before the waves start breaking.
>
> Francesca: And what does the bad weather do to fish?
>
> Juan: It hits it a lot. Therefore, the little guys go 'inside' [out to sea].
>
> Tomaso: Instead of staying near the shore and eat, they look for depth and salvation.
>
> Juan: It's just like us. You say: 'How far can I go inside the sea? At what point does it start being dangerous for humans?' Well, for our guys it's the same. When is it dangerous for them to remain near the shore?
>
> Tomaso: It's like us. We know when rain is coming and it's the same for them.
>
> (Recorded conversation, 12 March 2015, Puerto Madryn)

Listed here, out of context, these signs may seem to leave no space for alternative interpretations. In reality, the tricky aspect of the continuous attention paid to the weather, before and during the fishing, is that there are contradictions. More precisely, there are difficulties when the weather perception does not match what the fishers themselves have seen earlier in the sky or the previous forecast coming from communication media. Eastern Patagonia, flat and swept by strong winds, is known for sudden weather changes. And yet, the signs of forthcoming wind or bad weather may or may not make it possible to understand in advance the intensity of a weather event and when it is going to occur. Dragonflies forewarn of rain, but not the intensity of the rain. The sea turns dark far away, when the 'breeze' is coming, but will it be so strong as to impede fishing? Birds and fish protect themselves, but how long before the situation becomes dangerous for fishers? These are delicate questions to answer, as to stop the fishing activity due to a false alarm would lose an opportunity for a good catch. So, the tendency of some fishers is to hope that an internet forecast of good weather is correct, despite appearances – like Rodrigo, who, facing a sea full of white horses, told me: 'Do you see this? It was supposed to be nice weather, and now a south wind is blowing. But nice weather will come later!' Nevertheless, the consequences of ignoring a sign or bad interpretation may be much worse than missing a potential catch. They could include abandoning one's boat and returning on foot, as Tomaso and his father told me:

> Juan: The forecast said it would be calm. You trust it and then, you see?
>
> Tomaso: We went there confident, it was flat. Suddenly, we saw a cloud. But you see, it may make some drops fall and then go away. You know how it is, the peninsula attracts all storms passing close to its edge. We thought it would pass and go away. No way. The cloud left and the wind remained. A strong one!
>
> Juan: We had to come back on foot [leaving the boat on the beach].
>
> Tomaso: We walked almost two hours. It's incredible how far the tide goes out. (Recorded conversation, 12 March 2015, Puerto Madryn)

In the worst cases, vehicles might get stuck on the beach when the high tide reaches them. Then, fishers might have to go back on foot, walking distances of dozens of kilometres just to find a place where mobile phones work. In a few hours, the damage caused by seawater to their vehicle could be very serious. Rather than preferring the personal and direct fisher's capability of forecasting over the internet or radio forecasting, or the other way around, fishers think they need to mix both and be ready to change their own forecast rapidly. Bearing in mind what they learn from the internet, they arrive at the beaches ready for sensations – on their skin, ears and eyes – that will confirm their expectations. They are not merely discovering the weather, hour by hour – they are, above all, checking with their bodies estimations they have already made before leaving home: that it will be a nice and calm day with light winds. If they perceive something contradictory, fishers will need to decide whether to rely on their perception and ignore the previous forecast, or whether to call their own perception into question.

Changes in weather are not the only reasons why the fishers modify how they are working in a particular moment. After throwing the net once or twice, all decisions have to be put to the test. When the net is emptied, the fishers understand whether their expectations will be satisfied or not. They check what is in the bag of the net before emptying it in the boat. For instance, is it a shoal of juvenile silverside of the correct size (normally 5–10 cm), as they thought, or are the fish too big? If it is a shoal of Patagonian blennies or adult silverside, then the fishers hope they will all be the same size. If the catch does not correspond to what they were looking for, the fishers begin their evaluations. If the weather forecast for the following day is good enough to go fishing, a choice has to be made between a not-so-good but guaranteed catch today and a potentially better catch tomorrow. The problem is that the market for fish is mostly determined a long way from the coastal fishing beaches. Fish-processing plants are highly selective when it comes to buying products from coastal net fishing. This is because the plants earn their main income from processing and selling prawns, a product of industrial and larger-scale artisanal fishing activities. Consequently, what they are willing to receive from small-scale fishers is strictly related to the room available and processing staff they have after processing the prawns. So, the choice between releasing the catch and going to look for a better one becomes harder. They could go looking for shoals of younger fish in those beaches where 'fish come in later' ('coming in' is used as a synonym for 'approaching the coastline'). The shoals approaching the coastline to these beaches, compared to those approaching other beaches, are normally made up of younger (and smaller) fish. But it seems that more and more young fish get mixed up with older fish in single shoals, and the reproductive cycles are no longer what biologists found locally in the 1980s and 1990s (Elías, Ré and Gosztonyi 1991; Ré and Berón 1999). Tomaso explains how this apparent reproductive change intertwines with the way in which the processing system functions, resulting in a situation that is difficult to manage:

> What happens is that young silverside is good till this size [indicating a size of 10 cm with thumb and index finger]. If you don't catch it, it grows and does not suit [anymore]. Silverside born in September or October does not suit you now [in March]. And young ones get mixed up with adults. A real mess. You are not sure it will be all the same size. And when it is mixed, you have to kill a lot uselessly. Whilst if you knew there is a plant buying young silverside in October, you would know you can start fishing for it, although it is never a full boat at that time of the year. And you do not need to hurry to fish later on. Imagine you go for adult silverside and find ten boxes of young silverside. There would be no need for wasting it. I have frozen fish at the new small plant, from last year. Big plants should do that as well, give room to keep our frozen products. But they don't give a damn about us. (Recorded conversation, 12 March 2015, Puerto Madryn)

From Practical to Conceptual Flexibility

So, what is Tomaso referring to when he says 'there are no seasons anymore'?

He is referring to the juvenile silversides, which no longer only approach the beaches from January to March. Now, they 'come in' later and, what is more, can come over the whole year. As a result, there are small amounts of juvenile silverside approaching the beaches throughout the year, and the distinct and massive presence that once started in January – until recently considered normal according to biological studies (Elías, Ré and Gosztonyi 1991; Elías et al. 2011; Ré and Berón 1999)[9] and to the experience of fishers – no longer occurs. Again, from a biological point of view, this means that there is no longer only one reproductive cycle in the year, but several, and the primary cycle begins later than it used to. Hence the expression 'we have to learn again' (Tomaso, 31 January 2016): the fishers need to change the attention they pay to beach features. They have to behave as an apprentice, testing new techniques, looking for new places or going to the same beaches as before, but in different periods of the year. They have to accept that they are learning and they will, probably more often than before, go fishing in vain. Tomaso speaks about the way in which juvenile and adult silverside are mixing together in the same shoal. These catches are particularly difficult to manage, as fish of different ages have different purchasers and preparation processes. Tomaso suggests that due to the increased amount of prawns in the local processing plants, the summer months are not as lively as they used to be for the juvenile silverside market. On the other hand, buyers tend to appear towards the end of the summer, when the prawn fishery is temporarily closed to allow biological reproduction. Tomaso also mentions that the winds are changing more frequently, making fishing more difficult. Moreover, like his father, he thinks that climate change (a term he and other fishers sometimes use),[10] water contamination and human-made changes to the coast are modifying fish life cycles, contributing to this change of meaning of the word 'season':

> Juan: We knew in that beach a lot of fish would come in. And now, it is not coming. You ask yourself: 'What's happening?' Every time you need to go farther, going back. It drives you crazy because you think, 'If I used to fish in this beach, in this season, in this period of the year, why isn't it so anymore?'
>
> Tomaso: But you see how things are. Climate is changing a lot. Here, in [Puerto] Madryn beach, with all the dunes that have been broken,[11] the beach is completely different.
>
> Francesca: What have been broken?
>
> Tomaso: Here, there were dunes everywhere.
>
> Juan: [Puerto] Madryn beach is becoming all rock, because sand doesn't come in anymore.
>
> Tomaso: There isn't the restoration that used to be.
>
> Juan: There is no sand restoration anymore.

> Tomaso: Sea has always eaten the beach and the dunes have always had the job of…
>
> Juan: Wind had the job of taking sand backwards to the sea.
>
> Francesca: When it gets uncovered during low tide?
>
> Tomaso: It has always been the work of nature. Taking away and bringing back sand. But now, without the dunes…
>
> …
>
> Francesca: And when there is sand, why is it good?
>
> Juan: Because it keeps the beach clean. The fish can manage its food.
>
> (Recorded conversation, 12 March 2015, Puerto Madryn)

Conclusion

All the above aspects are inevitably turning fishing practices upside down. Yet, I maintain that having to deal with fast-fluctuating weather conditions, the changes in nonhuman animals' behaviour and tiny daily environmental transformations – cyclical, like the tides, or not – is actually helpful experience for fishers. Indeed, the experience increases the fishers' ability to anticipate the big changes that are typical of many commercial fishing activities. The ability to anticipate is fundamental for fishers. Indeed, the notion of adaptation that authors (for example, Acheson 1981; Endter-Wada and Keenan 2005; Smith 1988) have often used to analyse the way fishers cope with such changes can be enriched with the notion of 'anticipation' particularly as developed in the relationship with, and perception of, weather variations and climate change. 'Anticipation' is described by Nuttall as fundamentally different from adaptation:

> While adaptation is largely about responses to climate change, anticipation is about intentionality, action, agency, imagination, possibility and choice; but it is also about being doubtful, unsure, uncertain, fearful and apprehensive. Anticipation … emphasises that people make the future, at least the immediate one. (Nuttall 2010: 23)

To put this in the terms of my research, we can refer to the first question in this chapter. What does Tomaso mean when he says 'we need to learn again'? What kind of knowledge is weather-related knowledge, so fundamental in fishing practice in general and artisanal fishing in particular? It can be 'sensitivity to critical signs in the environment and an intuitive understanding of what they mean for the conduct of practical tasks' (Ingold and Kurttila 2000: 192). It can be knowledge that undergoes continual generation and regeneration as people interact (observing, learning and anticipating) with the environment; that is, a knowledge based on a continuing relationship with the environment, not a one-off learning experience. In the words of Jane Lave, it is the 'knowledge-in-practice [that], constituted in the settings of practice, is the locus of the most powerful knowledgeability of people in the lived-in world' (Lave 1988: 14). Indeed, fishers acknowledge that changes occur from one year or month to the next, sometimes even day by day, because conditions are always changing. Due to rain, for example, access to beaches can be worn away little by little, and fishers who do not go there often enough to perceive the ongoing change may not realize that these entrances are about to become impassable. Therefore, they may find themselves in the situation of having a boat full of fish that they are unable to approach with their vehicle so as to load it quickly. Something similar is happening due to the action of the seawater constantly eroding the coast at each very high tide, and thus modifying the ground fishers practise their manoeuvres over.

Lending such importance to observation, continuous learning and anticipation suggests that 'the expert fisher' is not merely somebody who has been working at sea for many years, but is also a person who will continue to do so. Only through an assiduous presence 'on the coast' can they perceive the tiny changes of the environment, such as a beach becoming soft, solid or muddy, and seawater reaching further inland. Over time, they get to know even those beaches that change more often than others, like those that host wetlands.[12] By regularly going to these beaches, they learn about the continuous changes and so can predict a range of alternative conditions they will have to face at each fishing trip in those places. Furthermore, it is important to understand that fishers' expertise is local, but not in the sense that it is in the heads of local people or that all local fishers share the same knowledge. It is instead local due to the strong link between each person and each place, beach, cliff or track. It is knowledge that goes deep into the details of those places where the activity is practised. The experienced fisher, like the experienced craftsman described by Ingold and Kurttila, 'can respond creatively to the variations [of the raw material or the environment], and is ever alert to the possibilities these afford – and the hazards they present – for pursuing different kinds of tasks' (Ingold and Kurttila 2000: 186). Knowing a beach means being able to foresee its features during all the different stages of the tide's cycle. During high tide, an expert fisher can say where rocks are situated underwater. They also know whether those rocks are likely to be visited by Patagonian blennies and whether it is a place worth trying to fish when it is time to cast the net. They know where the sea bottom may have hook-shaped protuberances that have to be avoided in order not to tear the net. And, of course, they can say what kind of ground will be uncovered with the falling tide: sand, pebbles, intertidal reef or mud. This does not mean that fishers' moves are the execution of preformulated decisions, but rather that theirs is 'a skilled performance in which the traveller [or the fisher], whose powers of perception and action have been fine-tuned through previous experience, "feels his way" towards his goal, continually adjusting his movements in response to an ongoing perceptual monitoring of his surroundings' (Ingold and Kurttila 2000: 220). When fishers find themselves on a beach that they have not been to for a while, or perhaps have never been to, they need to learn (again) how to perceive the 'affordances' – to use Gibson's term (1979) – of the new environment. It is not surprising to hear fishers remarking that: 'We do not like that beach, because we don't get along well. Alfredo does, but we never find fish.'[13] The fact that fishers accept that a beach is good for someone and bad for others does not diminish the value of this kind of knowledge. This knowledge works within the framework of a relationship with the environment that is personal. This should not be taken as a dangerous synonym for non-objective knowledge, because it is indeed the best kind of knowledge: one that is suitable to what fishers are looking for; a pleasant and durable relationship with the places that provide them with fish. This knowledge is as detailed and adaptable, as is required to cope with changes in weather (e.g. winds), in the fishing environment (e.g. headlands, beaches and bays) and out of it (e.g. processing plants and the market for fish). No general, universal knowledge would serve the fishers equally well. Therein lies the profound difference between the *prediction* of algorithm-based forecasts – 'which is about calculating, on the basis of present information, a state of affairs that will obtain at some determinate point in the future' – and the *anticipation* made by fishers – 'which is about sensing the way things are going, and attuning the course of one own's ongoing activities to that sensed movement' (Ingold).[14] Fishers draw on the media forecast, as the *predictive foresight* allows them to yield a plan, but they rely on their own *anticipatory foresight* to carry on with their activities (Ingold 2013: 69–72, 110). The fishers maintain the same anticipatory attitude towards the fish market and wholesalers' requests as well. In this way, market needs, the environment, weather conditions and fishers' personal working preferences are intermingled in a perpetually renewing equilibrium that results in the ability to face changes as they appear.

However, this equilibrium might be jeopardized by factors external to the fishing world that undermine precisely the freedom and flexibility fishers have always experienced when choosing the right moment and place to fish. Although change and adaptation (Endter-Wada and Keenan 2005: 225) or anticipation (Nuttall 2010) are hallmarks of commercial fishing (Endter-Wada and Keenan 2005: 225), there are particular circumstances that may cause fishers to worry about the resilience of their activities. As in many other places, a major source of change, and therefore of concern for the Valdés Peninsula fishers, is the urbanization of the coast, and its reorientation towards recreation and tourism (Gale 1991). The relationship between the fishers and the environmental-management institutions, such as the Chubut Province Secretariat of Tourism and Protected Areas, is often difficult. Fishers tend to be excluded from the management of the protected areas, including the important fishing beaches located on the Valdés Peninsula coast. It is in this sense that the equilibrium that fishers have been able to maintain between environmental changes and commercial fluctuations is jeopardized by increasing government interest (evidenced both in planned policies and unscheduled actions) in 'nature' and tourism.

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Notes

1. Puerto Madryn has 120,000 inhabitants. There are three tiny settlements on the coast of the San José Gulf (each of them with 10–20 inhabitants) and one small town (500 inhabitants) on the northeastern coast of Nuevo Gulf.
2. Pseudonyms are used for all people in the text.
3. As pointed out by Orlove (2003), it would be wrong to assume there are four seasons everywhere. In South America, for example, this is not always the case. However, in the specific ethnographic context of this chapter, fishers and other people living there divide the year into four climatic seasons: autumn, winter, spring and summer.
4. In the area, there are three different species of tern: the South American Tern (*Sterna hirundinacea*), the Cayenne Tern, (*Sterna eurygnatha*) and the Royal Tern (*Sterna maxima*).
5. * indicates the name of a beach.
6. A traditional caffeine-rich infusion of dried leaves of yerba mate (*Ilex paraguariensis*).
7. For a relevant discussion on the different perceptions of 'air', see Dan Rosengren, Chapter 1 in this volume.
8. During a rising tide, stranding is obviously not a risk. Nevertheless, in beaches that are fully covered by water at high tide, the danger is of finding oneself caught between the sea and a cliff (when there is one at the back of a beach).
9. Local studies described the net-fishing resources as markedly seasonal. This is the case in particular with silversides, because they are migratory. According to the studies, adult silversides were caught mostly during autumn and spring, and juveniles during spring and summer (Elías et al. 2011, drawing on Elías, Ré and Gosztonyi 1991; Ré and Berón 1999).
10. Fishers speak of 'climate change' in different ways. For example, when Eduardo explains that the 'ecological transition we are living in has an influence on fishing' (13 April 2015), he refers mainly to changes related to climate.
11. Sand dunes were progressively removed to build hotels and houses along the seafront.
12. The above-mentioned Colombo beach and some other beaches host wetlands protected by the Ramsar Convention on Wetlands (Ramsar site 'Valdés Peninsula', declared on 20 July 2012). Fishers are very interested in these beaches, where they can find a species of silverside (Escardón o Pejerrey de tosca, *Odonthestes argentinensis*), on which the market places a greater value compared to the more common silverside (Pejerrey cola amarilla o manila, *Odonthestes smitti*).
13. Fieldnotes: 'Juan', 20 January 2015, Puerto Madryn.
14. Personal communication with the author, 2020.

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Part II

Adaptation Challenges

Chapter 3

Indigenous Responses to Climate Change in Extreme Environments

The Cases of the Q'eros (Peruvian Andes) and the Gwich'in (Alaska)

Nastassja Martin and Geremia Cometti

Anthropology is currently facing a major problem, one affecting not only its object (the nonmodern and modern societies it is concerned with), but also its methodology: the solid ground on which we all stand is dissolving into the realm of instability and uncertainty. Climate change is not 'metaphorically' affecting people; it is shaking them to such an extent that they are starting to question their own ways of relating to the world. Confronted with animals, plants, rivers, clouds and stars that will not respond to them in the way that they used to, human societies, especially those living on and from the land, are forced to reposition themselves. Here lies our methodological problem: if people themselves can no longer make sense of their own environment or claim that they know what is happening and why, and if they too feel lost in this globalized world that connects beings in strange and unpredictable ways, how are we anthropologists to make sense of indigenous 'ways of relating to the world'? How are we to describe a stabilized cosmology if its principles are already transformed, or destabilized enough, that what is truly 'significant' is not so obvious anymore?

While conducting our fieldwork (Cometti with the Q'eros from Peruvian Andes and Martin with the Gwich'in from northeast Alaska), we have both been confronted with the same situation: the collapse of the world we wanted to comprehend and analyse, and the breakdown of our own theoretical constructions. This initial traumatic situation led us to imagine a new set of questions concerning the loss of control that indigenous people, and ourselves, were experiencing. What happens in Gwich'in country when hunters' strategies begin to fail, when they pursue animals that inexplicably adopt new behaviours and trajectories, when they cannot predict or even find out where the animals are or will be, because their vision is blurred by a riot of new potentials and beings?[1] What happens in Q'eros' territories when the rain falls excessively during the rainy season and does not fall sufficiently during the dry season, when the quality and productivity of the potatoes maintaining livelihoods decreases and the frost does not come when it is expected, putting the whole subsistence economy at risk? In a similar vein, what happens to us anthropologists and to our own methods when we find out that we can no longer build a system to assemble the fragments of data we have gathered? In fact, the structures we came up with in order to construct the world we wanted to share in the field of anthropology is in a similar situation to the houses standing on the Yukon river banks: collapsing under the pressure of a tumultuous river that no longer responds to our needs and wants.

That being said, do we anthropologists need to let our desire for alterity melt with the glaciers and ice sheets around us, and therefore abandon our meticulous ethnographies, as many indigenous people are facing the exact same environmental catastrophe as us? Or, on the contrary, can we consider that when confronted with major environmental shifts on a day-to-day basis, indigenous people, particularly those living in environments massively affected by ecological transformations, are already laying down a form of response to the changing world as it is happening to them? Moreover, could we also consider that the responses of these collectives, while mostly living at the margins of the state government that rules them, are in all likelihood rather politically subversive, precisely because they are not what is expected by governmental institutions?

With these sets of questions in mind, this chapter will try to confront two ways of responding to climate change in extreme environments, and describe the very specific manner in which Gwich'in and Q'eros people reflect on their world and on their ways of relating to it. In giving them a voice, we are far from tacitly saying that they hold a better solution than our societies to the ecological crisis. Rather, we assume that, concerned as they are with maintaining animated relationships with the rest of the living world and having to deal with these now out-of-control beings, they might have interesting thoughts on our major and shared problem: how to cope with the world's rapid metamorphosis and how to metamorphose ourselves as humans in order to do so.

The Q'eros

The Q'eros are a Quechua-speaking community from the Peruvian Andes situated on the eastern slope of the Cordillera Vilcanota, roughly 100 kilometres outside of Cuzco.[2] They are around 2,200 people split into five transhumant communities: Hatun Q'ero, Q'ero Totorani, Marcachea, Quico and Japu. They span three ecological levels. The highest, the *puna*, extends between 3,800 and 4,600 metres. It is at this altitude that the alpacas and llamas are bred. On the *qheswa*, the intermediary level between 3,200 and 3,800 metres, the Q'eros cultivate different types of tubers. The *yunga*, the lowest level, between 1,400 and 2,400 metres, is a wooded zone where maize is cultivated.[3]

Since 2011, Cometti has carried out several pieces of fieldwork among the Q'eros, focusing on their relationship with the changing climate. Climatic and meteorological changes, especially through modifications in the rainfall patterns, are significantly impacting their agricultural production and are endangering the health and existence of their livestock. The unanimous view of the Q'eros farmers is that it rains a lot more during the rainy season and that the level of precipitation during the dry season has also decreased over the last ten years. The second most important phenomena mentioned by the Q'eros concerns frost, which is normally expected to appear during the nights of the dry season, when there are usually few clouds in the night sky. The Q'eros' general impression is that frost is becoming more persistent and the ground more frozen. Other phenomena, such as hail, fog and changing temperatures, are also mentioned.

Because of these phenomena, especially changes in rainfall patterns, the Q'eros maintain that the production and productivity of different types of potatoes and maize have drastically diminished. Moreover, the quality of the tubers themselves has also declined. According to them, the change in rainfall patterns is responsible for the propagation of *rancha*,[4] a disease that has been spreading through Q'ero, destroying a good part of the potato production. Atmospheric precipitation variation has also had a significant impact on livestock. During the rainy season, which coincides with the birthing season for alpacas and llamas, the young are particularly vulnerable, and strong and constant rainfall can be fatal. In contrast, pastureland dries out quickly during the dry seasons, reducing the food supply for grazing animals. Around August and September, alpacas and llamas are often underweight and malnourished.

The winter solstice plays a central role in the perception of atmospheric phenomena. The observation of the Pleiades (*Qutu*) is the occasion for the Q'eros to anticipate seasonal variations. The Q'eros, like other Andean populations, study the luminosity, temporality and size of the Pleiades in order to decide when to seed their different kinds of tubers. In the community of Hatun Q'ero, observing 'the signs of the night' is an annual and rotating function carried out each year by a member of the Hatun Q'ero community and appointed by that same community (other communities having abandoned this practice). The task of this official meteorologist is to observe the signs of future atmospheric variations, such as rain, in order to decide when they have to seed their tubers by empirically observing the Pleiades. The *arariwa* is not just a meteorologist; he also must be able to provoke rain or bring the frost when necessary, by means of certain specific offerings made to the *apu* (the mountain spirit) and the Pachamama (Mother Earth). The *arariwa* thus serves as a connector between the community of Hatun Q'ero and these divinities (and, by extension, the atmospheric phenomena), and is required to satisfy the agricultural and pastoral needs of his community. Poor harvests are interpreted as the consequence of his failure to assume this role of intercessor. In times of climate change, this role is becoming increasingly difficult to fulfil.

The *arariwa*'s problems in dealing with atmospheric phenomena have helped Cometti understand why the Q'eros thought they were losing control over other beings. In the last two decades, they have recognized that they were losing their power to communicate and influence nonhuman entities such as meteorological and climate phenomena. If the Q'eros' interpretations of atmospheric and climatic changes are complex and heterogeneous, there is nonetheless a common denominator. In a somewhat reductive manner, one could sum this up as 'degradations of the relationship between the Q'eros and the nonhuman entities, in particular the divinities, *apu* and the Pachamama' (Cometti 2015: 215). There is a reciprocal relationship between the Q'eros and other entities that inhabit their social world. For the Q'eros, what unites humans to other beings (humans or nonhumans) is a vital flow. According to Cometti 's interlocutors, there is not a common term to define this vital flow. They speak of the prevalence of *samay*.[5] In the Q'eros social universe, different entities live according to a hierarchy that depends upon their importance: *apu* and Pachamama dominate this hierarchy, then humans, and then alpacas and llamas. The ancestors, or *machula*, also occupy an important place in this hierarchy.

Through their ceremonies, the Q'eros are able to transfer this vital flow to different entities, which are constitutive of their social universe. In others words, by abandoning some of these practices or by undertaking them with less rigour and participation, the Q'eros have degraded their reciprocal link with *apu* and Pachamama. Thus, the rainfalls are more profuse than ever during the rainy season and do not provide enough moisture during the dry season. As a consequence, the practice of cultivating crops and breeding animals is becoming more and more difficult in Q'eros:

> Santos, one of Cometti 's most important informants, shared his concern:
>
> Our grand-parents were wiser. In those days, all the *paqu*[6] would congregate and organize huge ceremonies for the entire community in order to have something to eat and allow everybody to live well. Today a lot of us only think about earning money. It's our own fault if we've lost our beliefs. All the Q'eros you see in Cuzco 'selling themselves' as if they were real *paqu* are liars. They have no power. (Charkapata, Hatun Q'ero community, February 2012)

Santos' words illustrate one of the most widespread ideas among the Q'eros: the near-abandonment of ceremonial practices typical of their ancestors. According to them, in previous decades there existed a range of different ceremonies for the rain, animals, maize, potato and so forth.[7] Today, according to the elders, the new generation only thinks about money, and most Q'eros are no longer capable of carrying out effective ceremonies. There are, on the one hand, some Q'eros who are uninterested in ceremonies and move to Cuzco in search of employment, especially in the construction sector. On the other hand, one can find Q'eros who practise shamanism as their professional activity. In fact, for the last ten years, an important part of the Q'eros population started migrating to the Cuzco region to practise shamanic ceremonies for the inhabitants of the city and for tourists, using their romantic reputation the 'last Inca community alive' (Le Borgne 2003: 146), and in fact that they are still viewed as the most powerful shamans in Peruvian Andes.

Moreover, the presence of evangelical churches, in particular the Maranata church, was mentioned on several occasions, as Marcelino, an old farmer from Q'ero, shows: 'The "prayers" divided us into two trends when the Maranata arrived. Even more than a thousand prayers made by the Maranata would never have the same effect than one offer made to the *apu*. From now on, everything has changed, we stopped living just like our ancestors, we don't have confidence in anything anymore.'

Therefore, atmospheric and climatic changes are mainly explained by the abandonment of rituals, due to the fact that part of the population converted to religions that condemn practices such as the chewing of coca leaves or the conducting of ceremonies for divinities. In other words, climate change is imputed to a degradation of the reciprocal relationships maintained between the Q'eros and nonhuman entities, in particular their divinities. This interpretation tends to make the Q'eros feel guilty, especially for having changed religion or for thinking only of commercializing their ceremonies for the inhabitants and the tourists of Cuzco.

The Gwich'in

The Gwich'in people Martin has encountered, on the other hand, don't seem to feel as personally responsible for the fast-changing climate within their region. They instead feel flooded, affected by a pollution coming from 'outside', invaded by newcomers, humans and nonhumans, who did not belong there before.

We are in Fort Yukon, Alaska. Gwichyaa Zhee (the Gwich'in name of the settlement, which translates as 'house of the flats') is the homeland of roughly 600 Gwichyaa Gwich'in ('people of the flats'). The village stands 13 kilometres north of the Arctic Circle, in the midst of the Yukon Flats in the northeast corner of Alaska, where the 2,000 kilometre-long Yukon River meets the Porcupine River coming from Canada, and is surrounded by subarctic taiga. The very first impression that struck Martin when arriving in Gwich'in country was not the vivid presence of a different ontology, but rather a general sense of despair. She was straight away confronted with a situation of massive ecological change, over which nobody had any control or any solution, and the wreckage left by modernity. Humans, animals, plants and rivers all seemed to be taken into this great transformation movement, in which the known land and solid ground tended to disappear, along with all the certainties about 'what is what', 'who is who' and 'what is going to happen'.

Speaking about environmental metamorphosis is not a rhetorical manner of referring to subtle changes that only experienced hunters are starting to notice; it refers to very obvious ecological modifications that tend to intensify every year: sudden break-ups followed by huge river floods, massive forest fires, collapsing river banks due to the melting permafrost, animals changing their migratory route in unexpected and unpredictable ways, new animals coming into the country, polar bears moving south and cougars moving north in Alaska, people falling through the river ice during the winter in places where 'it always held' and so forth.

What modernity has left behind is not only alcohol, drugs, rusting heavy equipment and old snow machines; it is also a dualistic, reversible and external way of thinking about the environment, especially in the case of Alaska, where nature was transformed into an exploitable reservoir of natural resources on the one hand and into a wilderness sanctuary on the other hand, casting away all other forms of relations to the land that did not fit this pattern. Last but not least, the phenomenon of pollution in arctic and subarctic regions is now of great concern for people. What is a hunter supposed to think when he opens up the caribou he just killed and finds its intestines infected by the lichens it had eaten, which themselves are contaminated by acid rain? Not much, apart from saying: 'See, we get everybody's pollution. The Chinese pollute over there and the caribou die right here.'

In terms of climate, longer summers and shorter winters have been noticed, along with early and more sudden ice break-ups, bringing massive floods into the villages. In Gwichyaa Zhee in 2009, this phenomenon washed away many houses built nearby the Yukon River, when the sandbanks collapsed. Later that same summer, very large fires started in the Yukon Flats, preventing contact with the outside world. Indeed, the melting of the permafrost is drying the soils, which combined with the effects of a proliferation of pine beetles, leave a lot of dead standing trees susceptible to fire with the slightest spark. That summer, fires did not stop until the end of August. A very thick smoke obscured the air and sometimes we could not even see the other side of the Yukon River. A raw burning smell filled the village, the inside of houses, and the inside of people's minds and bodies. At the time, for everyone there, this precarious situation was strongly tainted with a feeling of 'imminent disaster'.

The animals, for their part, seem to be modifying their migration patterns so much that it becomes very hard to follow their trajectories or to predict from where they are coming and when they are going back. Geese have a tendency to adjust their routes in the spring: from people's accounts, they have a difficult time recognizing their safe landing zones due to the drying of the peat bogs. Caribous are staying longer in the Arctic coastal plain and migrate later to the subarctic forests. Very skinny polar bears are leaving the great north and crossing the Brooks Range in order to find food. Cougars, never seen in subarctic regions in the past, are appearing more and more, following rabbits, who have been following the grass that is now regrowing much faster on the Yukon Flats' burnt soil.

What is first quite obvious is that these northern environments can no longer be considered as 'renewable', as no hunter knows for sure if the animals are going to come back the following season and, alas for Marshal Sahlins (1972), there is now a very vivid conception of scarcity in these hunting-gathering societies. Indeed, the way the 'cycle of return' is conceived by the indigenous people is no longer so cyclic (Brightman 1993). Similarly, the animals that are supposed to 'give themselves' to the hunter (Brower 2004; Fiennup 2003; Nelson 1983), following the general pattern of northern animism, have lately been showing strong signs of resistance instead. Willerslev's (2007) idea – according to which the manipulating power that is present in hunters' imitation of prey rests in their dual capacity to incorporate its 'Otherness' while profoundly remaining the same – does not quite fit the current physical realm of concrete interspecies interactions. Of course, mimesis, seduction and all the other aspects of hunting in the subarctic that have been thoroughly described in ethnographies are still practised. However, hunters' ability to keep up a 'double perspective' in order to achieve a successful hunt often fails, for the very reason that the animals are themselves, as 'people' (*dinjii*, as they are called in Gwich'in), making their own decisions and choosing their own nontraditional paths according to the environmental metamorphosis they are experiencing.

Even salmon, animals that have always found their way back to their birthplace, are behaving in strange and unpredictable ways. As Simon Francis, Fort Yukon's oldest hunter, told Martin one day while pulling the net out of the water:

> We don't know. Every year it's different. Last year they went up the Chandalar. They've never done this before. They change every year. They smell the water and decide where to go. They have their own ways. But if the water smells different like it does now, they too can get lost (Simon Francis, Fort Yukon, Alaska, May 2010)

Wildlife biologists explain the salmons' behavioural modifications by the presence of minerals coming from the massive melting of the ice sheet up north, which disturb the salmons' orientation capacities. Simon, for his part, expresses his concern in a very poetic way: 'They are in the fog, like us in the smoke. They've lost their way.'

The supposed 'common sense' of northern hunters is no longer so common, and what used to work in the past, and what people used to know about the animals they prey on, is being disrupted by the increasingly uncertain state of animals. Instability might have been occasional in the past; today it is becoming the norm. Interestingly enough, the actual situation in subarctic Alaska resonates with origin myths found there: Gwich'in people often said they felt like they were 'floating around' in a world where the boundaries between beings had been blurred. Pushed back onto the raft that held a small animal and a lonely man at the origin of times, drifting away on an endless sea with no land to be seen, it feels like we have gone from speciation and differentiation back to the mythical origin of time, where places and beings were not clearly defined yet, where every living form was yet to be identified. However, there is a very significant difference: the unique, common and shared language between all living things is now nowhere to be found (Martin 2016).

Metamorphoses in an Instable World

A first assessment of these case studies shows two rather opposed ways of relating to climate change. As we have seen, the Q'eros explain meteorological and climatic changes through a degradation of relationships between themselves and nonhuman entities, in particular their divinities. This interpretation tends to make them feel guilty, particularly with regard to the commercializing of their ceremonies for Cuzco's inhabitants and tourists. On the other hand, in Alaska, Gwich'in people do not consider that the abandonment of their ritual practices has provoked the changes, but rather that the land is being invaded by external entities, both human and nonhuman, blurring the boundaries between territories, beings and species. There, ecological transformations are directly linked to the existence of 'another humanity', modern and industrial, provoking, from a distance, the phenomena currently observed in these regions, such as pollution, erosion, melting of the ice sheet, animals changing their migratory routes, floods and forest fires.

In other words, while the Q'eros blame themselves for the transformations they are experiencing in the Peruvian Andes, in the Alaskan taiga Gwich'in people are pointing at the 'outside' world to explain the massive changes confronting them. This difference in the attribution of causes can partly be explained by the different historical relations that Q'eros and Gwich'in maintain with the Western world, and these would probably require a specific study in order to clarify them. But beyond questioning who or what is responsible for these climatic and meteorological changes, we now discuss the analogies that can be made between these two ways of responding to climate change in extreme environments.

The disappearance of 'dreamers' and powerful shamans[8] is something that we both have noticed in our fieldwork, as have other anthropologists (Pedersen 2011). In Alaska nobody seems to be able to tell what the animals are going to do, as the subtle environmental clues that hunters used are now undergoing great transformations, and because the land is getting crowded, as they say there, by the invasive practices of other humans. Both Q'eros and Gwich'in are facing instability and uncertainty, embodied in climate change, and they both seem to have lost their power to communicate with nonhuman beings. This idea is widespread among the Q'eros. For example, on a foggy day, when Cometti was helping some people to pasture their alpacas, a young *paqu* told him the following story:

> One day, one of the most powerful Q'ero *paqu*, an *altumisayuq*,[9] decided to sit down outside his house and look at his sacred mountains, but an intense fog prevented him from seeing them. He started to chew some coca leaves and

> exhaled in the direction of *apu*. The *altumisayuq* politely asked the fog to move so that he could again see his sacred mountains. The fog did not move. He tried again. But the fog still did not move. It was the first time the fog did not follow his request. That day the fog stopped listening to us and the *altumisayuq* realised that something had changed in Q'ero. (Charkapata, Hatun Q'ero community, May 2011)

Sitting on the Yukon River bank with Clarence, former tribal chief of Fort Yukon, watching the icebergs go by during river break-up time one afternoon, he made the following comment: 'People are dying, from diseases, cancer. Animals are dying too, for the same reasons. There's got to be something in the land, the water, the air, something that's killing us.' It was by focusing on the liminal zone, where the 'something that is killing us' dwelled, that everything shifted in Martin's approach to Gwich'in cosmology in the actual situation. She suddenly stopped viewing these discourses as depressing statements acknowledging the overwhelming presence of an invasive Western world stressed by unstoppable ecological modifications. She realized they conveyed a profound recognition from the Gwich'in that they had lost control.

Such recognitions from the people we study led us to a deep transformation of our initial problematic, and a new set of questions emerged. Is there something unseen in the Gwich'in and Q'eros practices that allows them to be more informed than was previously the case? How is it that in Q'ero, despite the fact that people are abandoning some rituals, the majority of them continue to acknowledge and honour their divinities through different kind of ceremonies? How is it that in this state of ecological and political crisis, some Gwich'in in Alaska continue to leave their villages, houses and jobs, and go back to the forest to engage in relationships with these out-of-control beings?

The Q'eros certainly used to live with instability and uncertainty in the past, as Nicolas, a farmer from Q'ero, described:

> One January, when I was a child, the rain did not want to fall. After various ceremonies without success, the elders of the village ordered the younger ones to go down into the *yunga* to pick up some frogs and toads from the rivers. We got down and collected a large number of amphibians. The day after the rain begun to fall. Frogs and toads live a large part of their lives in the water and therefore they have a very close reciprocal relationship with the rain. They know how to call the water. (Espadilla, Marcachea community, August 2011)

This account shows that even in the past, they did not always have control over nonhuman beings. Climate change is certainly increasing the uncertainty, but nevertheless the majority of Q'eros still maintain reciprocal relationships with *apu* and Pachamama.

In Alaska, Martin started to look for situations where people were experiencing this 'loss of control' and places where hybridity and movement were overriding identity and stability. What if, she asked herself, the very unstable and uncertain state of things was exactly what was reproducing their desire to connect with (through hunting practices) their nonhuman neighbours? And if this was the case, how would we anthropologists have to reframe our way of talking about the situation of indigenous collectives in environments greatly affected by climate change? She began searching for details within their oral stories that would express failure rather than success, doubt rather than certainty. The idea was to figure out how they dealt with the fact that the general structure of their stories no longer quite fit their incarnated interactions with other living beings. She wanted to know if there was something within their own cosmology, rarely spoken of, that prepared them for the rather unstable state of things and that enabled them to keep relating to it ingeniously. She started to look for winks, smiles on the side, ironic comments and jokes about the stories they were telling. She hunted down any detail that showed that even though they talked about their relationship to the land in a rather homogeneous way, there was something else, something more to it, that had to happen 'on the side' and on an ambiguous level, for these blurry zones were the only ones that could welcome these uncertainties and inject them back into the general pattern. For example, the important part in a traditional story like 'Dinjik Dinjii Dilkwaii' ('how a moose killed a man') is not only about the fact that the hunter failed to kill his prey and instead got killed by the moose he was pursuing. Nor is it entirely about the reflexivity and distance brought by this story, which warns people to reconsider their actions and reposition themselves with a better understanding of the situation. What is important, in a much simpler way, is the fact that there always is a risk, an uncertainty, a peril in any hunt, that it has always been like this and that this is the very thing every hunter should keep in mind.

Back in Q'eros, the increasing uncertainty might be explained by the abandonment of several rituals; nevertheless, it is also because of this uncertainty, because of the elements not answering to the Q'eros in the way they did before, that numerous people are performing rituals and making offerings to their divinities. People are now fully acknowledging that a concrete reciprocal relationship rather than a phantasmagorical human control over nonhumans can make the difference (the nonhumans are showing them their power and resistance). The previous approach has been proved wrong by the rest of the living beings, who have chosen their own paths while they are responding to climate change. In other words, the Q'eros are aware that they might not have the same power as their ancestors, but they nonetheless still understand that opening a line of communication with nonhuman entities through rituals is the only way to survive climate change. For instance, during the carnival celebration, the Q'eros' families are still trying to re-establish or perpetuate a reciprocal relationship with *apu* and Pachamama. A good example is the *phallchay* (which takes its name from the gentian flower, *phallcha*), a propitiatory ritual for the reproduction of Andean camelids. During this ritual, the Q'eros ask the sacred forces for protection, multiplication and fertility of their alpacas.

In northern Alaska, Gwich'in have, as we have presented, an efficient and creative way of answering the global eco-human crisis, drawing their power from the ongoing state of instability at play in subarctic environments nowadays. It turns out that Gwich'in are subversive towards the outside world primarily because they are also subversive about themselves and they understand that there is always more to what they state. This 'more', in which lies the doubt, makes a creative future possible. In this light, the resistance to the Western world and its collateral damages does not come from an instituted ontology that is by essence different and opposable to it, but in humans' ability to dwell in these uncertainties and re-create new forms of relationships with new beings on a daily basis. The northern animistic world, if we want to call it that, restores itself in the very alteration it undergoes.

Conclusion

Approaching indigenous collectives from the perspective of their fragmentation rather than their established structure and of their uncertainties rather than their instituted and stabilized statements does constitute a significant turn, especially in the context of a drastically transforming environment. Cornelius Osgood, one of the first Gwich'in ethnographers, was very concerned in the 1930s as he was wrapping up his fieldwork. He confessed in his monograph that he failed to embrace the whole Gwich'in culture and that he only could access 'remains' of the ancient culture he sought, as it had already been washed away or destroyed by their encounters with Westerners (Osgood 1970). He deplored the fact that all he could talk about were parts of myths and stories, chunks of hunting times, fragments of a different way of relating to the world than his own. The whole story, the unaltered cosmology, had already vanished. But could there be another version to this story – one in which those 'fragments of ancient thought', as he called them, are what has always been there, lying underneath the surface of the lakes and stories, with details of relationships with other living beings generally forgotten and only occasionally exhumed when a collective imperatively needs to rethink its relations to a transforming world? Climate change, in this light, is reminding us of the modern failure to organize and categorize the human and nonhuman in cosmologies and as species. The incredible point about this pressing contemporary actuality is that these uncertainties have already been thought and formalized in the distant mythical times of the indigenous societies we work with. In those times, before speciation or while it was happening, nobody was truly themselves yet, but everybody was, for this very reason, intensely, assiduously becoming themselves. Then, while the process of individuation was happening for every being all the time and in all directions, identity was almost a 'non-sense'. Then, hybrids (such as the naa'in for the Gwich'in) were proliferating and challenging humans on how a common world could be built to live in.

This brings us to the specific responses that indigenous people in changing environments can provide to the transforming ecologies and politics in which they are immersed. If the Q'eros and the Gwich'in have different ways to articulate the reasons and responsibilities attached to the ongoing changes, they share an equal awareness regarding this new form of instability challenging their power to communicate with the beings they use to dwell with. Their renewed thoughts and patterns of actions are ways of responding to a world that has become out of control.

The Q'eros interpret environmental changes through a degradation of relationships between themselves and nonhuman entities, blaming themselves for the transformations they are experiencing in the Peruvian Andes. In Q'ero, climate change is a constant threat that manifests itself in a variety of forms and whose origin can appear intangible. Despite the introduction of new techniques in order to face environmental changes, the majority of them still carry on making offerings to the divinities and maintaining a reciprocal relationship with the territory in which they dwell, even through challenging uncertainties.

In the Alaskan taiga, Gwich'in hunters recognize on an everyday basis that the forces required to change a situation or to access a new level of understanding are to be gathered in the realm of other beings. This is at the core of almost every northern story: in times of crisis, one needs to seek the help of the other who lives in a mysterious territory usually not accessible to humans. If one survives this process, one comes back as a transformed being, enhanced by what was received. For instance, the loon brings the blind man under the surface of the lake and helps him recover his vision. He is now able to face his human life as a renewed man. The muskrat helps the man by diving deep down to the bottom of the sea and gathering dirt in his claws; with this, they create a land to walk on. This process, which can be described as a way to encompass some of the qualities of another in oneself, whomever this 'other' has become, is not only mythical; indeed, it is what Gwich'in hunters do when they walk in the liminal zone of the encounter with the animal they pursue. Whether the hunt is successful or not is not important; whether the animal is truly himself or is already transformed by what has been happening around him – a dramatically fast-changing climate, for example – does not stop the process either; it enhances it, as the animal becomes even more unpredictable. This unknown about the other, the unknown about the outcome of the encounter is part of what makes it so desirable. It is what takes the necessity of hunting to a whole new level; it is what a hunter has do deal with, facing somebody that might face him in return.

This voyage is in itself one of the most powerful responses to the Western world as well as to ecological alterations. Under the water, in the darkness of the forest, on the foggy mountain tops or in the gloomy northern sky, this travel process is more than ever becoming a necessity, not only because it helps in terms of meeting the forces needed to face the upcoming challenges, but also because the whole idea is to connect different beings in order to create something that does not yet exist, something that still pertains to the realm of the unknown.

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y Arqueología 38 (2020): 3–23; and 'Non-humain, trop non-humain ?', in Geremia Cometti, Pierre Le Roux, Tiziana Manicone and Nastassja Martin (eds), *Au seuil de la forêt. Hommage à Philippe Descola, l'anthropologue de la nature* (Tautem, 2019), pp. 211–28.

Notes

1. Following Philippe Descola's terminology (2013), we use the word 'being' as a general term that includes every possible entity, from human beings to natural beings (plants, animals, stones) or even supernatural beings (spirits, ancestors, divinities).
2. For more information about the Q'eros, see Cometti (2015); Flores Ochoa and Nuñez del Prado (2005).
3. However, due to the poor harvests of recent years and the fact that the heavy rain ruined the path to reach the places in which maize is cultivated, most have now abandoned this type of crop.
4. 'Rancha' is a potato disease caused by the parasite *Phytophthora infestans.* This disease is colloquially known as 'potato blight'.
5. Regarding the use in the Andes of the term *samay* and other terms related to this vital flow as *sami animu* and *kallpa,* see also Allen (2008); La Riva González (2005).
6. *Paqu* is the general term used for a shaman in Q'ero.
7. According to him, they abandoned several ceremonies, like the *llaqta hampiy* (taking care of the village), *papa hampiy* (taking care of the potato) and *sara hampiy* (taking care of the maize).
8. We talked about the disappearance of 'powerful shamans' and not simply 'shamans', as actually in Q'eros, for instance, the number of self-proclaimed 'shamans' has increased within the city, though they are not recognized in the mountain settlements. A similar phenomenon is happening in Alaska, where numerous 'medicine men' can be found in the cities of Fairbanks and Anchorage, though in the villages they would be called 'down-river Indians', a stereotype massively affected by Hollywood and its ideas and trends, or 'apple Indians', red on the outside and white on the inside, and so forth.
9. *Altumisayuq* refers to the highest position in the shaman hierarchy of the Andes.

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Chapter 4

Fornicating Frogs

Local Knowledge of Climate Change in Bangladesh?

Paul Sillitoe and Mahbub Alam

The scientific consensus is that we face accelerating climate change with epic environmental effects. The consequences of this will vary between regions. Among those predicted to be at risk of large detrimental impacts are parts of South Asia, particularly if sea-level rises are of the order that some forecast.[1] Bangladesh, one of the world's most densely populated countries, is frequently mentioned as being at peril of devastating flooding due to its situation on the large delta of the Ganges/Padma, Brahmaputra/Jamuna and Meghna Rivers (Brammer 2009, 2014; Hanlon, Roy and Hulme 2016). In addition to the increase in flooding induced by sea-level rises, the delta is also sinking, due to excessive groundwater extraction, floodplain engineering and the trapping of sediments in dams. While flooding of the Ganges-Brahmaputra-Meghna delta occurs annually and is an accepted part of life incorporated into the region's farming-fishing cycle, with up to two-thirds of the land area inundated in some years, the projected increases are unprecedented and catastrophic, and would put large areas permanently under water. According to the United Nations' Intergovernmental Panel on Climate Change (IPCC), 'Bangladesh is ranked as one of the most climate-vulnerable countries in the world. It is at extreme risk of floods, tropical cyclones, sea level rise and drought' (Carabine et al. 2014: 18). The panel reported that temperatures have increased throughout the twentieth century, as have the frequency of heatwaves, and projections suggest average annual temperatures increasing by 2°C or more. Rainfall trends vary markedly, with more extreme rainfall events predicted to increase, particularly during the monsoon and dry-season droughts. Sea-level rises, according to climate-change models, will continue through the twenty-first century, increasing between 26 and 98 cm (Carabine et al. 2014: 3, 10).

Some authorities warn that global warming is accelerating and predict ever-worsening environmental outcomes. According to a World Bank report, for instance, a 2.5°C rise in temperature by the second half of the twenty-first century will result in sea levels increasing in the Bay of Bengal by a predicted 65 cm and the flooded area in Bangladesh by an estimated 29 per cent, resulting in the loss of 40 per cent of productive land across the country's southern region (Adams et al. 2013: 123). The report also warns of a possible 4°C temperature increase above pre-industrial levels by the century's end, with even larger sea-level rises bringing more catastrophic floods and, paradoxically, extreme droughts too. A 1.5 m rise will inundate current coastal and inland areas, affecting 22,000 km^2 and some 18 million people (GRID-Arendal 2009). Those predictions that incline towards the most extreme possible future climate-change scenarios are open to considerable dispute, which encourages some scepticism (Dunlap and McCright 2010; Rudiak-Gould 2013), particularly when they match nothing in current experience.

We need to consider not only international- and national-level climate-change discussions, but also local experiences of associated environmental changes, as has been argued for other Asian communities (see, for example, Byg and Salick 2009; Lebel 2013; Suthirat and Takashi 2013; Vedwan and Rhoades 2001). While people have reflected on the climate for millennia and have long-standing weather lore (the ancient Vedas, for instance, mention meteorological issues – see Dove (2015)), it has become a matter of urgent concern with the advent of global warming. Local experiences can tell us what is actually currently happening on the ground and serve as a reality check against climate-change models. It is necessary to calibrate official discourse against local knowledge of climate-cum-environmental change, so as to avoid promoting scepticism with predictions that seem out of touch with lived reality. It is with respect to their experiences and perceptions of the current situation that people the world over assess climate forecasts and initiatives. If the climate-change predictions do not match people's experiences, to some degree, they will promote disbelief and resistance to policy proposals for tackling the problem. This is a major challenge facing those who advocate the need for urgent action over climate change, as many people do not sense the need, given their own current experiences. For them, the climate-change warnings seem like so much additional hot air, as this volume's Introduction notes, pointing to today's Western climate-change deniers.

The Hakaluki Region

The Hakaluki region is a complex wetland ecosystem of approximately 180 km^2, comprising over 200 interconnecting *beel* (small permanent bodies of water)[2] that merge in the monsoon floods to form a single *haor* (a large seasonal body of water) (Figure 4.1).[3] The Kushiyara and Sonai-Bardal Rivers bound the *haor* basin, in the eastern part of Sylhet adjacent to the Indian (Assam) border, which straddles the Moulavibazar and Sylhet districts.[4] It is Bangladesh's largest *haor* and is one of the large wetlands of South Asia that has diverse fen habitats that are home to a range of animal and plant communities (Sumon and Islam 2013: 188), including some rare endangered species. This has prompted the government of Bangladesh to designate it an 'Ecologically Critical Area'. In considering the inland Hakaluki region, this chapter also addresses another shortcoming in the current climate-change debate, as addressed locally, which focuses largely on coastal regions predicted to suffer total inundation and devastating cyclones, and pays less attention to increasingly flood- and drought-prone inland areas. While agencies recognize wetlands such as the *haor* as threatened ecological zones that demand conservation, they overlook the impacts of climate change as a major issue (IUCN 2006; Riadh, Chowdhury and Ishtiaque 2012). The only major weather-related issue that is considered is flash flooding, which many in North Bengal rank alongside droughts as the region's most pressing problem and that is dealt with in isolation from other critical issues, such as environmental degradation due to human actions. Otherwise, environmental work in the Hakaluki *haor* basin focuses on ecological conservation, natural-resource management and people's socioeconomic status (Khan and Islam 2005; Khanum 2013; Sarma 2010).

Some 190,000 people live in the Hakaluki region. In the monsoon, villages become islands, and people put vegetation around the banks to protect their homesteads from *afal* (large waves). Livelihoods depend largely on fishing and farming, which often compete over control of water levels that dictate what areas are available for fish or crops. There is heavy dependence on remittances from migratory labour. In the past thirty years, the area under grass (used for dry-season cattle grazing) and reed swamps has fallen considerably, with the use of *low-lift-pump irrigation* to cultivate paddy (largely high-yielding varieties) in the *boro* season.[5] Many Muslim families practise both fishing and farming, engaging in fishing for one part of the year (from mid-*Baishakh* until *Kartic*)[6] and farming for the remainder. With irrigation, the dry *boro* season now provides the main crop, and subsidiary cropping comes from rain-fed *aman*- and *aus*-season[7] cultivation of transplanted rice together with some vegetables (e.g. pulses, potatoes and mustard) on higher ridged bank soils, and from deep-water *aman* rice around basin margins. The Hindu families depend more on the fisheries and resort to a range of livelihood strategies during the *boro* season, such as rickshaw pulling, day labouring, road repairing, carpentry and so on. They manage *khanja* (pits) in low-lying areas where water remains all year, with plentiful

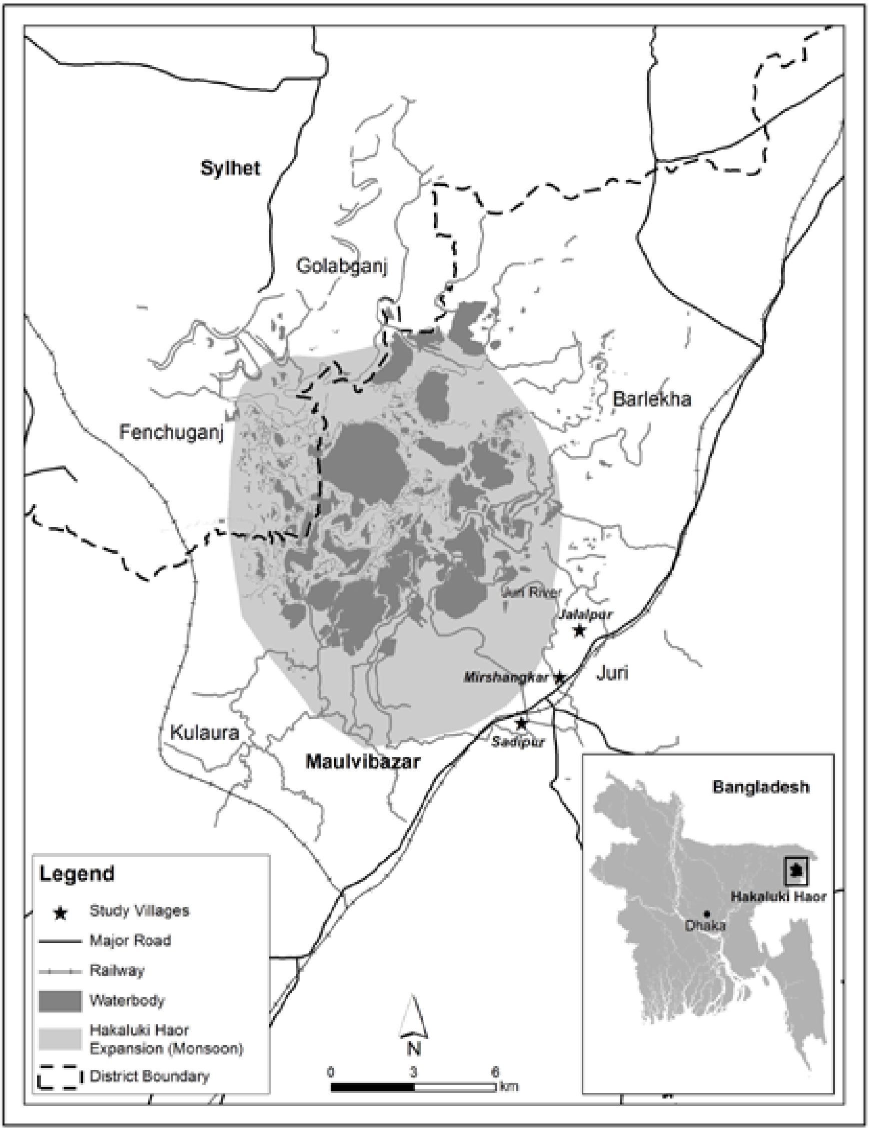

Figure 4.1. The Hakaluki region (© Paul Sillitoe and Mahbub Alam)

aquatic plants to supply shelter for fish to spawn and conserve stocks. The principal fish species of the *haor* are *kalibaus* (*Lebeo kalbasu*), *rui* (*Labio rohita*), *boal* (*Walago astlu*), *pabda* (*Ompok pabda*), *ghagot* (*Gagata cenia*) and *chapila* (*Gonialosa manmina*), with migratory species swimming up the Kushiyara River to arrive in the *haor* basin. Some engage in the fish trade as *paikar* (middlemen), buying directly from boats to sell on in local markets.

The Hakaluki Survey: Local Knowledge of Climate Change

A survey offers a way to assess the range of, and variability in, knowledge of environmental and climate changes held locally by a population. We administered a semi-structured questionnaire, largely comprising open-ended questions (see Appendix), to a random sample of 101 persons in the Hakaluki Haor region, representing 1.9 per cent of all the residents of the three villages of Mirshankar (80 per cent of respondents), Sadipur (12 per cent) and Jalalpur (8 per cent). The first two villages are larger and are made up of Muslim households that practise farming and fishing, and the third smaller village comprises Hindu households that depend on fishing eked out with menial seasonal labour. Table 4.1 gives the gender, age and religion of the respondents.

While one of us (Mahbub Alam) had conducted some in-depth ethnographic enquiries in the region, and we had arranged focus group discussions and individual interviews, the Bangla dialect spoken in the Hakaluki region is difficult for outsiders to understand, so two colleagues from the neighbouring district of Moulvibazar helped administer the survey and subsequently cross-check data.[8] Even with their assistance, some people thought that we worked for the government or a nongovernmental organization (NGO) focused on natural resources, and wanted to take the opportunity not to discuss environmental issues, but to complain about political matters, notably abuses by some powerful persons that made it difficult to access nominally common property resources, as they were seen to have usurped the land – themes that featured in the survey returns.

Table 4.1. Composition of survey sample (percentage of respondents) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

Gender		**Age (years)**					**Religion**	
Male	Female	20–29	30–39	40–49	50–59	>60	Muslim	Hindu
63	37	17	35	21	11	16	88	12

We structured the questionnaire so as not to predispose people to think of climate-related issues. It asked them initially about any environmental changes they had noticed in their region, and the reasons for them, before introducing the idea of *jalobayu paribartan* (climate change). There was near-unanimity that changes had occurred in the environment, with only two respondents thinking that there have been none (one man and one woman in their thirties). There was less agreement over the changes (Figure 4.2). Nearly half the responses referred to declining fish populations, with deforestation following close behind. Nearly a quarter specified declining water levels and the silting up of the *haor*, and similar numbers referred to the related issues of decreasing rainfall and flood levels. About a fifth of respondents thought that animal numbers were down and considerably fewer mentioned other changes. (There is no significant variation according to gender, age, religion or village, other than men mentioning water-level issues more often.) While several responses referred to weather-related issues, it is notable that none referred directly to climate change. Nonetheless, it is evident that local people observe that something is happening in their

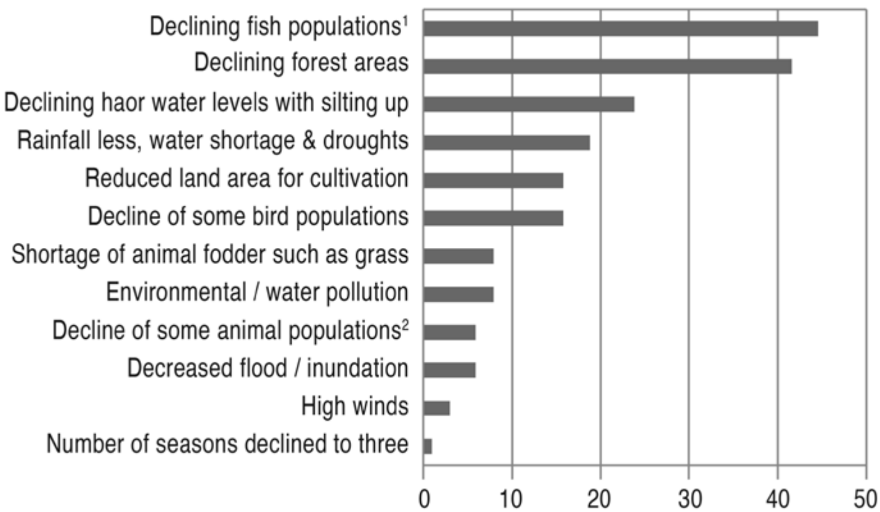

Figure 4.2. Changes observed in the natural environment (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

1 Fish mentioned: RangaChanda (*Chandaranga*), NamaChanda (*Chanda name*), Boisa (*Labeopangusia*), Balichura (*Awaousguamensis*), Ritha, (*Rita rita*), Chital (*Chitalachitala*), Rani (*Dario dario*) and Baghair (*Bagariusbagarius*).

2 Forest areas declining because trees taken for timber, medicine etc.

3 Animal populations in decline include snakes, domestic and wild animals.

environment – given changes in rainfall patterns, sedimentation rates, animal populations, land under forest and cultivation – albeit that they make no direct link to climate change.

The decreasing depth of the *haor* is a particular feature of environmental change locally, and people attribute declining fish populations partly to it. Thirty or so years ago, the water was 15–25 hands[9] deep in the monsoon months of *Ashar* and *Srabon* (June–August),[10] whereas today it reaches no more than about 10 hands, which villagers say is unprecedented. They speak of ocean-like *afal* (waves) previously, and the skill needed to manage boats when fishing far out on the *haor* during the monsoon. They attribute the fall in water depth to increased sedimentation, pointing to the increased frequency of flash floods from the north, resulting from excess rain in the hills and the large volumes of stone and sand that the rivers such as the Juri transport and deposit.[11] They attribute the damaging flash floods in part to the changing pattern of rainfall. Previously, it would rain steadily for three to four months, from *Chaitraya*[12] until the middle of *Baishakh*; however, nowadays, *boro tufan* (big storms), where it rains heavily for several days continuously before stopping abruptly, are more common. Associated thunder and lightning have also increased in frequency, with lightning strikes killing more people, as often graphically reported in the press. But the overall volume of rain has declined, contributing to a decline in water levels.

When asked the reasons for these changes, the responses showed even less agreement than, and overlapped considerably with, the previous ones about observed changes (Figure 4.3). Over a quarter cited falling *hoar* water levels as responsible for environmental changes and a similar number said that logging is a cause for declines in forests. A fifth mentioned infrastructure developments, notably roads, house-building and population growth as reducing cultivable land areas. The declines in fish and animal populations were likewise attributed to human activities such as inappropriate fishing methods, distorted access to water bodies and polluting farming practices. Again, it is notable that while many of the cited changes in the environment were attributed to human activities, none of the responses directly implicated climate change, other than, perhaps, the mention of logging and, by one person, wood-fired brick kilns. Barely 4 per cent of respondents referred directly to the climate-related issues of less rainfall and increased temperatures. Women were more often concerned about forest and land loss, and men with water issues and pollution, with older persons mentioning the latter more than younger (otherwise, there was no noticeable variation according to gender, age, religion or village). While respondents made no direct reference to climate change, they did refer to some issues and

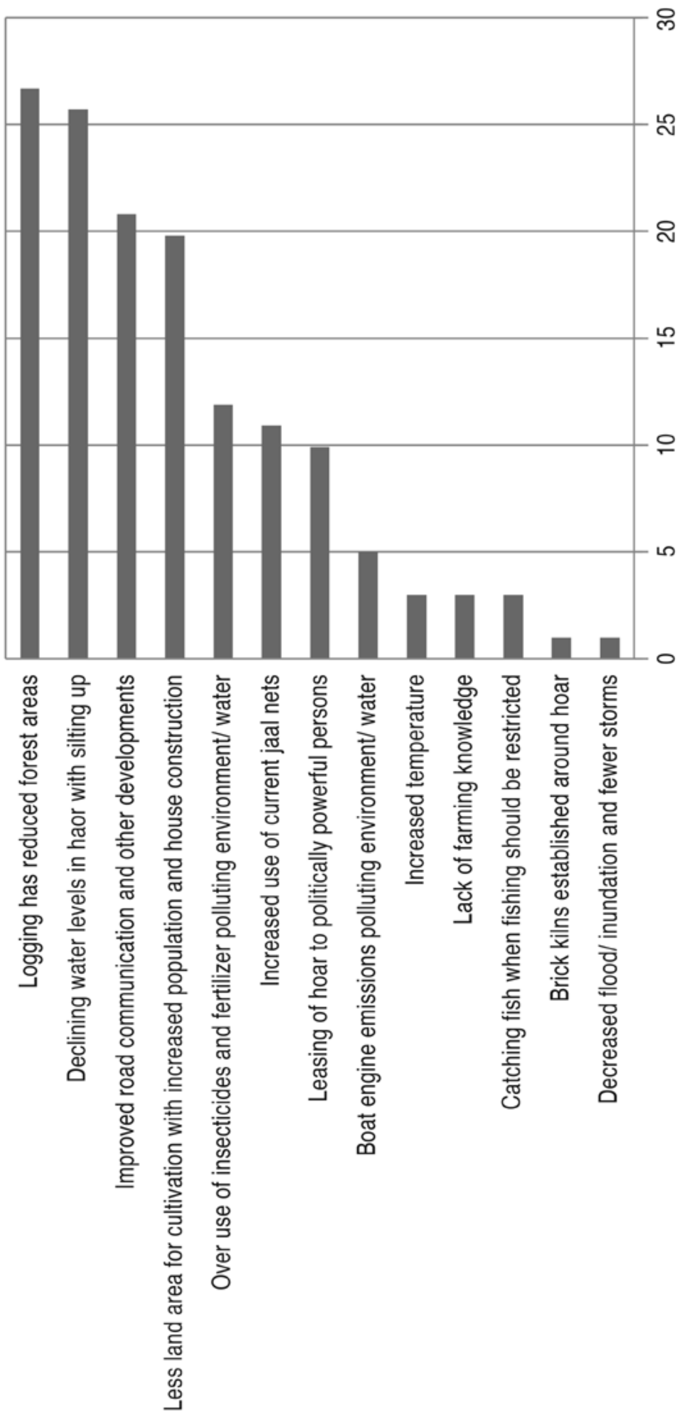

Figure 4.3. Reasons for environmental changes (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

experiences that point to its possible impacts, which they assessed in their own way.

With regard to human activities that impact on *haor* ecology, deforestation figured prominently in people's minds, particularly the clearing of forests for tea gardens in the surrounding hilly regions. The reduction in vegetation cover increases rates of soil erosion and so contributes to the silting up of water bodies. It also contributes to the frequency and ferocity of flash floods. The clearance of natural vegetation around the *haor* also featured, along with the planting of exotic species by the Forest Department that people said had a negative impact on the soil, such as acacia and eucalyptus.[13] The cultivation of hybrid-rice varieties, encouraged by multinational companies offering agrotechnological support and by associated changes in market conditions, has made matters worse, due to over-extraction of groundwater using deep-tube wells and environmental pollution with unregulated use of pesticides and insecticides further damaging *haor* ecology. Other human interventions that have consequences for the *haor* environment include road-building and the construction of embankments.[14]

While few respondents referred directly to weather-related issues when asked about observed changes in the environment, 92 per cent of them said that they had heard about climate change, with Hindus somewhat less informed in this respect than Muslims. When asked what they understood by climate change, people gave a range of sometimes contradictory replies (Figure 4.4). Nearly one-third thought that it referred to increased heavy rainstorms and flooding, while a few thought the reverse – that it referred to declining water levels and drought. Over two-fifths of respondents mentioned changes in the seasons, about a half thought summers are warmer and winters colder and wetter, while the other half thought the reverse, with warmer winters coming earlier. About one-fifth mentioned changes in temperature and strong winds, while others gave replies that suggest they were less sure about climate changes. Women were more likely to refer to increased rainfall and flooding, men referred more often to changes in the seasons (otherwise, there was no significant variation according to gender, age, religion or village).[15] While the government and NGOs draw on the scientific debate over climate change and may introduce local people to it, this process is not particularly evident in the Hakaluki region. This may reflect the fact that development workers and community activists are largely focused on the impacts of predicted sea-level rise on the coastal zone.

When asked about climate-related changes in their region, respondents gave similar answers to those they gave for the previous question, which suggests that they were not well informed about climate-change

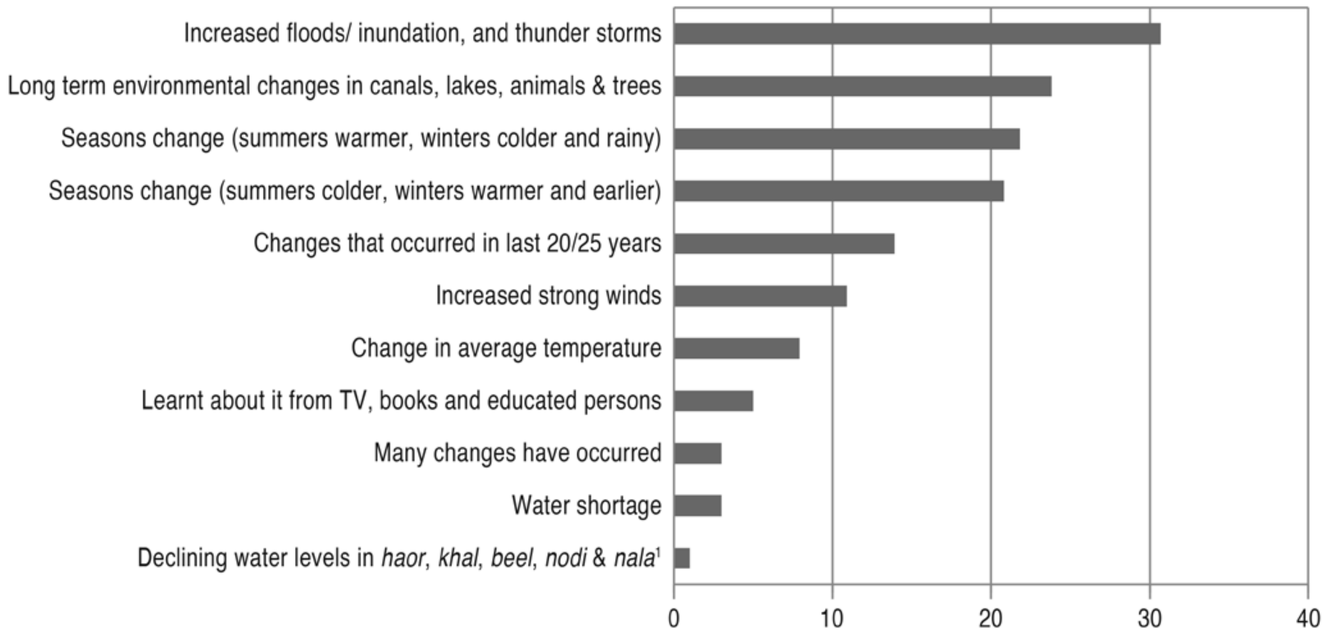

Figure 4.4. What is climate change? (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

1 *Haor* (large lake), *khal* (canal), *beel* (lake), *nodi* (river) and *nala* (marsh).

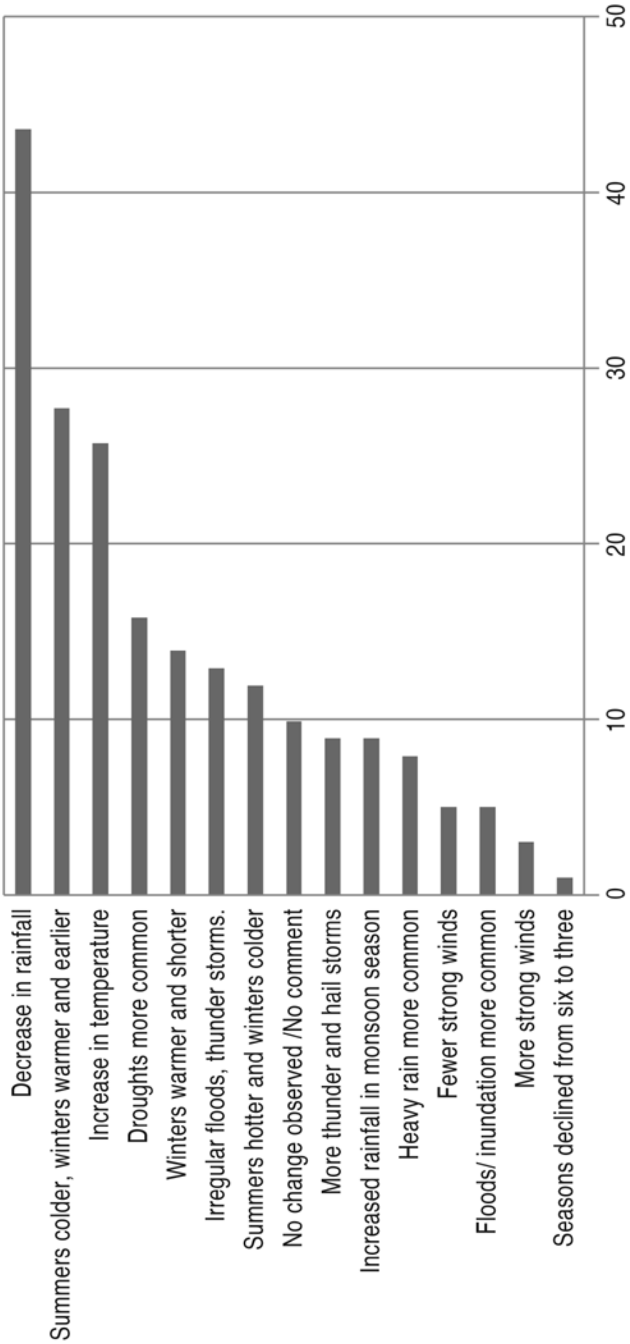

Figure 4.5. Climate change in the Hakaluki region (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

discussions per se and that they interpreted the term *jalobayu paribartan* according to their own local experiences (Figure 4.5). There was general agreement that some changes to the seasons have occurred: that they have become less predictable, with unseasonable cold or hot spells in summer and winter. The signs of seasonal change do not necessarily occur at the expected time of year, with the seasons merging more than previously. The weather is now often misty, which was not the case before. Otherwise, the responses again showed considerable contradictions, with two-fifths of those surveyed, for instance, referring to increased rainfall and flooding, while another two-fifths mentioned decreased rainfall, with some adding that the summer drought period may be longer, with late and less rainfall. Similarly, one-eighth said summers are hotter and winters colder, while two-fifths thought the reverse. A few respondents said strong winds are more common, but others that they were less frequent. It is difficult to account for the contradictory variations in the responses. We might anticipate some age-related aspect to these, reflecting differing life experiences over different periods of time, but a review of the responses according to age does not reveal any noticeable pattern (similarly, there was no noticeable variation according to gender, religion or village).

A comparison of local people's views of changes in their region's climate with rainfall and temperature records from nearby meteorological stations at Sylhet and Srimongal[16] suggests why there was such variation in respondents' views (Figure 4.2). While Srimongal is consistently warmer and Sylhet wetter, the temperature and rainfall trends over fifty years show scant further regularity. They fluctuate up and down, with no clear trend for temperature or rainfall increasing or decreasing over time. Given this, when pressed to state what climate changes they have observed in their region, respondents' answers may have varied depending on which years they have in mind as benchmarks. So the variability in responses actually confirms our expectations that people's observations of weather phenomena should match up with meteorological data (what is seen and experienced 'out there' being the same for us all), though local knowledge and explanations of these observations may differ from the scientific ones. The meteorological data suggest that, like most of the world to date, the region has not experienced any locally noticeable warming trend – although analysis of further data by Islam and Neelim (2010) shows otherwise[17] – impeding attempts to examine local perceptions of climate change. Nonetheless, the local population's experiences of differences in weather patterns indicate (like such differences from the norm elsewhere) that atmospheric changes due to global warming are affecting them.

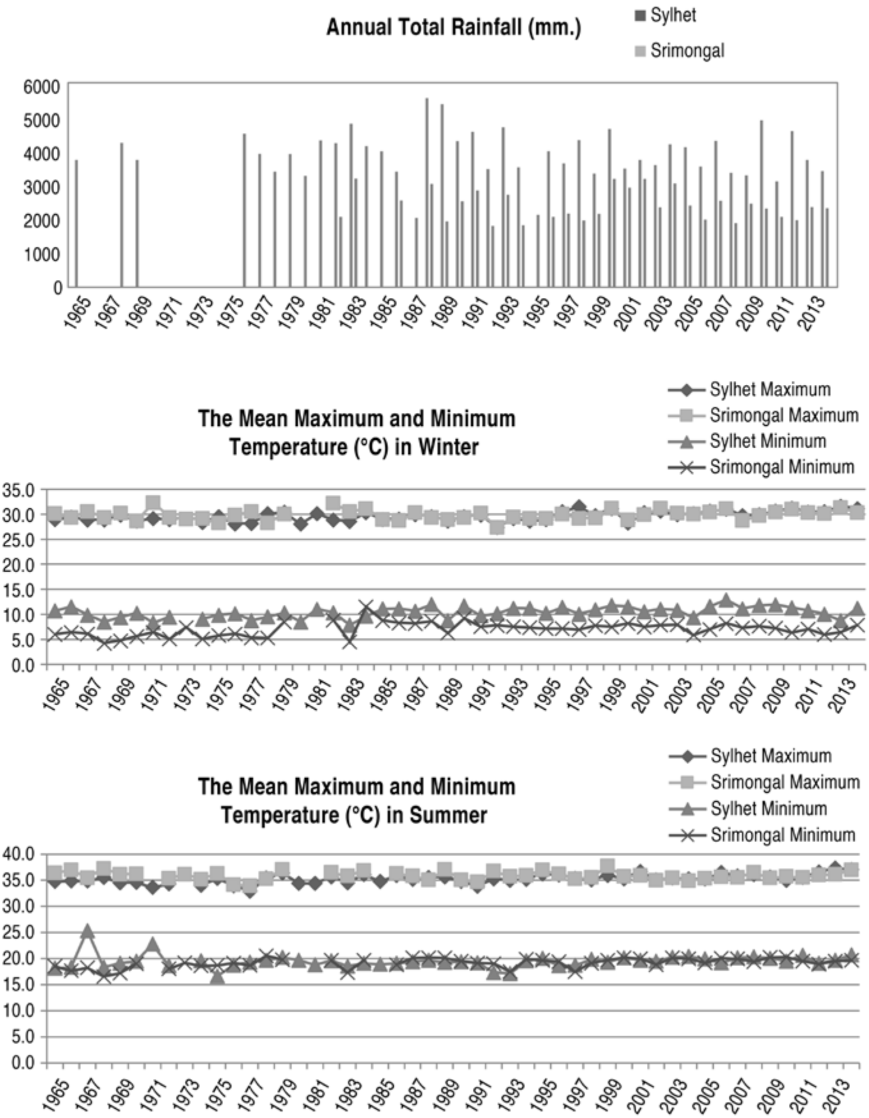

Figure 4.6. Meteorological data (Sylhet and Srimongal stations) (official data analysed by the authors)

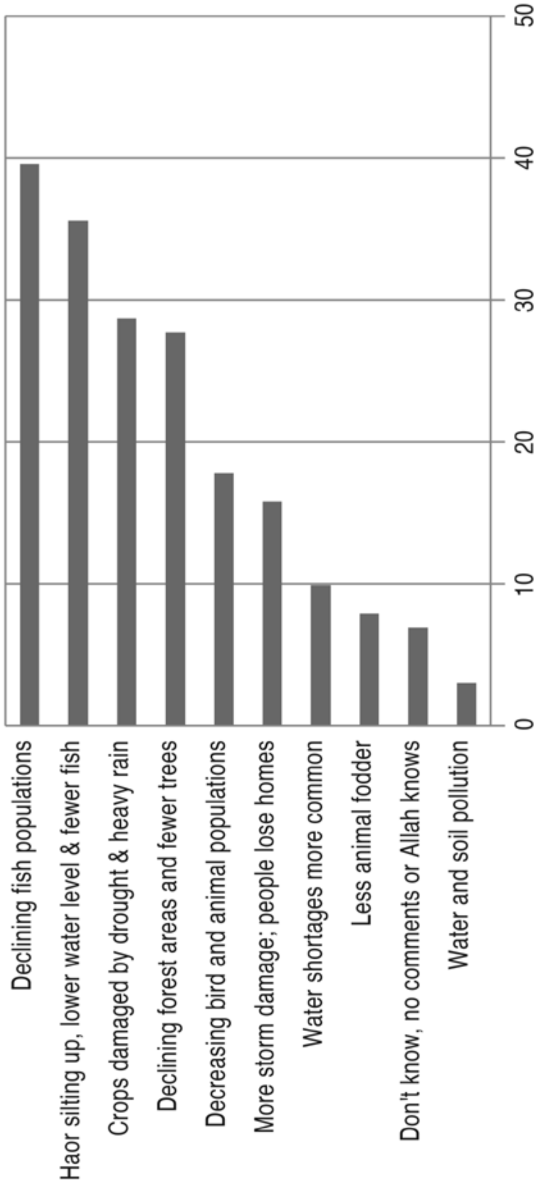

Figure 4.7. Effects of climate changes on the local environment (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

When asked what their experience of the effects of these climate changes have been (Figure 4.7), people's responses reflected those they gave in answer to the previous question about the changes they have observed in their region's natural environment (Figure 4.2), which indicated that they made scant distinction between environmental change generally and that attributable to the climate. Declining fish populations were again a major concern, according to two-fifths of respondents, followed closely by the silting-up of the *haor* water bodies that was also associated with fewer fish. Over one-quarter again mentioned decreasing forest areas. A similar number mentioned crop damage due to droughts or heavy rain, which was not specified previously, and this proportion increased to over one-third when we include falls in fodder supplies. Nearly a fifth of respondents again thought that animal numbers were down. Men again showed more concern for water and fish issues, and women for crops and fodder, which somewhat reflects their different livelihood responsibilities. (Otherwise, there was once again no significant variation according to gender, age, religion or village.)

Adaptation in Bangladesh

The survey responses suggested that climate change per se is not currently an issue locally, as opposed to certain environmental aberrations. It appears that government organizations and NGOs are depending on, and reacting to, international warnings, notably with respect to predicted impacts. According to the IPCC: 'There are clear signs that the impacts of climate change are already being felt' (Carabine et al. 2014: 5). The consequences of predicted climate trends are grim. The World Bank (Adams et al. 2013) reports that climate change will particularly affect Bangladesh, as it is a potential 'impact hotspot' threatened by extreme and variable weather events that will negatively impact infrastructure and livelihoods, and increase poverty with a 'high risk of inundation in areas with the largest shares of poor populations' (Adams et al. 2013: 110). It talks of some places being under water and of others not having enough water for drinking and irrigation. The Asia Foundation points to 'disasters including drought, extreme temperature, floods, and storms. These events have killed hundreds of thousands of people, destroyed homes and livelihoods, and cost approximately $16 billion in damages' (Asia Foundation 2012: 14). The projected impacts include destruction of infrastructure and settlements (e.g. homesteads swept away), degradation of the natural environment and ecosystems (e.g. droughts leading to wetlands drying up), increased incidence of disease and malnutrition (e.g. waterborne intestinal infections), crop failures and food shortages (e.g. flash floods across paddies), lower livelihood security and lower incomes, displacement of communities and mass migration (e.g. to urban areas), and economic development reversals, all of which will impact disproportionately on, and increase the vulnerability of, the poorest households (Practical Action n.d.: 2). There is also likely to be an increasing incidence of water shortages, exacerbated by inefficient water use concomitant with rapid urbanization and industrialization, and penetration of saltwater from the Bay of Bengal 100 km or more inland along tributary channels during the dry season.

The predicted impacts of climate change take up a considerable part of international and national level policy deliberations, and relate to the second principal dimension of the debate: responses to climate-change forecasts. These comprise, in climate-change-speak, adaptation and mitigation measures, or risk preparation and emission reduction. It is adaptation that features centrally in Bangladeshi policy discussions, which is unsurprising, given the alarming nature of the foregoing predictions and fading hopes that global temperatures will remain within safe limits. The second, mitigation strand scarcely concerns poor rural communities across the delta, as they contribute trivially to CO_2 emissions that are responsible for climate change. The World Bank urges action to enhance resilience to the impacts of climate change through multidonor-funded adaptation interventions and disaster-preparedness improvements (Adams et al. 2013). The government of Bangladesh has an action plan that comprises six pillars (Ministry of Environment and Forests 2009: 27–29). The adaptation measures that are recommended include reducing risks to agriculture through the adoption of crops adapted to watery conditions, implementing water supply and sanitation programmes, building health systems to handle new diseases, strengthening early-warning systems, managing the country's changing hydrology, constructing infrastructure to protect vulnerable areas, monitoring impacts on ecosystems, devising a climate-proof development plan and building government capacity to manage adaptation. Some NGOs flesh out these skeletal policy generalizations with practical suggestions, such as diversifying livelihood options, breeding local crop varieties resilient to climatic extremes, establishing seed banks to supply varieties after disasters, raising water pump levels to avoid drinking water contamination, building up house plinths above floods, dredging rivers and planting vegetation to protect banks from erosion (Practical Action n.d.: 10). For *haor* regions in particular, adaptations should include breeding quicker-maturing rice varieties for shorter seasons, establishing fish sanctuaries and instituting more efficient common-pool resource arrangements (Sumon and Islam 2013).

While, on the one hand, such dire forecasts represent disconcerting dark black clouds on the horizon for most Bangladeshis, on the other hand, they present a certain silver lining for some. They lead to burgeoning international funding to assist poorer nations, such as theirs, in preparing for predicted climate changes and challenges. A virtual industry has emerged locally, as the government and parts of the nongovernmental sector have latched onto forecasts of climate change, encouraged by the large sums of development assistance pledged to help them. What are these bodies doing to prepare for the predicted changes, whatever they turn out to be? While institutions such as the World Bank recommend urgent action and economic development to encourage adaptation and build resilience to the risks facing farming communities, urban infrastructure and water resources (Adams et al. 2013), there is more talk than action. A cursory review indicates a plethora of policy recommendations and a lack of practical actions (e.g. Ministry of Environment and Forests 2009; Asia Foundation 2012: 23–32; Practical Action n.d.). The dilatory responses are arguably understandable, given the uncertainty about what is happening and the implications of observed climate and environmental variations, or, worse, they may suggest to some the attitudes of sceptics or deniers. The dubiety of the long-term climate-change predictions notwithstanding – no one is sure what the future holds – the flow of resources prompts bodies to plan endlessly, and generates copious policy-related documents and advice.

Local Approaches to Adaptation

One way to break out of endless policy discussions about probability-modelled scenarios and internationally driven predictions is to assess what is actually going on across the country. Local people may offer information that broadly matches the debate as framed by climate change. First, they can report on any changes they observe in the environment that may be due to climate change, as discussed above, even though they may be unaware of the debate itself. Second, they can say what they are doing (or could do) to cope; that is, they can articulate local preparedness and scope for adaptation to the consequences of the forecast climate change. A rolling review of possible local coping strategies is necessary, as much of the burden for adapting to any changes will likely fall directly on local communities. They may have to depend heavily on local resources and ingenuity. These may seem inadequate, given the scale of the challenges, particularly from the international metropolitan perspective that informs policy debates. The limited resources available to local innovators, in contrast to foreign experts, in part constrain the potential for grassroots action.

The increasing cultivation of 'floating gardens' (Irfanullah et al. 2011; Sen, Paul and Lamin 2011: 46–56) illustrates the potential for drawing on local practices that make effective and imaginative use of limited resources. These comprise beds of water hyacinth (*Eichhornia crassipes*) and paddy straw, several metres long, held together with bamboo poles, which support a layer of soil and compost in which farmers plant crops that include a range of vegetables and spices, such as okra, gourds, aubergines, beans and ginger. The *kachuripana* (water-hyacinth beds) can float on any depth of water, going up and down with flooding, and may be tended from boats and even moved by punting. These have been common in low-lying southern areas of the country for generations and their use is gradually spreading to other regions, with help from some NGO projects. According to one source, 'floating gardens have been successfully employed to allow vegetables to be produced in waterlogged areas, protecting the poor from malnutrition and providing a source of income during the post monsoon and peak rainy seasons' (Practical Action n.d.: 9–10). While such coping strategies may seem paltry to outsiders, as the only mitigations to climate-induced environmental changes that many local communities have, they merit serious consideration by policy-makers.

At first sight, other responses may seem of even less relevance or help. When rivers and ponds dry up, people talk of the wrath of nature and may supplement prayers for rain with rites presumed to have roots in the deep past. During prolonged drought periods, some communities arrange a 'frog marriage' rite (Pial 2015). They catch a male and female *sona bang* (frog – *Hoplobatrachus tigerinus*)[18] and tie them together on a *kula* (rice-winnowing fan). While boys and girls carry the frogs' fan-bed on their heads around the village, women pour water over it from pitchers. They also present the children with some rice at each homestead they visit. As they process around the village, the participants sing to attract the attention of Megh Raja, the 'Cloud King', who is associated with rainfall.

The song heard by one of us as a child in Brahmanbaria was the following:

> Cloud King! You are my own brother.
>
> Our doorsteps are drying up due to no rain.
>
> Although it is raining it is not enough.

> Our Prophet is true; Please Allah, give us rain.
>
> The marriage of frog's daughter is arranged with a medal made of gold.
>
> So, the female frog gives some rain.
>
> The mustard seeds were eaten by insects when rice grains were eaten by people.
>
> Male and female frogs, both of them are sitting on the bank of the river.[19]

People comment that by tying female and male frogs together, they encourage them to fornicate, mimicking their activity during the *Ashar* (start of the rainy season), when frogs commence their spawning, croaking loudly in the monsoon rains. This represents their wish that nature's Cloud Raja sets the frogs croaking with rainfall. In some parts of the country, communities conduct the rite beyond the customary months of *Joyshtra* (May–June) into *Srabon* (July–August), when heavy monsoon rains normally fall, a sign of increasing weather variation. It is an indication of how local people perceive the weather and how they may respond, in part, to climate change. These songs are constantly evolving and incorporating new aspects.

These practices likely strike many as being of scant relevance to climate-change concerns, yet they scarcely differ in their ineffectiveness from meteorological science, which cannot control the weather either, though it may forecast it more accurately.[20] In fact, the science is arguably doubly impotent, having exerted negligible leverage, to date, with regard to the climate-change crisis that it predicts, in the face of a political deadlock, internationally, on appropriate action. Although environmental scientists may dismiss such practices, they tell us something about local perceptions of change. And to dismiss them may be to misconstrue such rites, which are more to do with subliminal communication and the shared expression of anxieties, than with belief in actually determining the weather, which is regarded as being in the hands of Allah and fate.

Even though local adaptation strategies may seem limited, they warrant consideration, not only because they are often the only option realistically available, but also because any interventions to cope with the predicted impacts of climate change need to be in tune with residents' experiences in order to be effective. Local people will respond to adaptation and mitigation recommendations according to what they can accommodate and make sense of. Policy formulated in a national- or international-level vacuum may prove unhelpful locally, as was illustrated by the World Bank-funded 'Flood Action Plan', which made life more difficult for many, particularly poor people (Sillitoe and Alam 2012). The plan was to control the annual monsoon flood and protect the floodplain through the construction of costly flood defences comprising embankments and sluices (Brammer 2004). The consequences of these engineering interventions illustrate the dangers of imposing solutions on people without a full understanding of their situation and knowledge (Rasid and Haider 2003). In interrupting the monsoon flood, the interventions devastated fisheries and made farming more vulnerable to shocks. This prompted desperate farmers, to the chagrin of development experts, to dig holes in the newly constructed embankments that were stopping floodwaters from draining away and that were preventing them from cultivating their inundated plots in a timely way. This illustrates how the failure to accommodate local perceptions and practices in formulating policies may lead people to resist them if they do not match their understanding of their problems and needs. There is a lesson here concerning possible proposals for even more engineering interventions to meet the challenges of climate-induced environmental change, for further polder-like mistakes that impede natural water flow could undermine communities' adaptation options.[21]

The experience of the Flood Action Plan shows the hubris of high-tech approaches that assume they can contain and manage natural forces. It points to the need to learn from local people how to live with the delta rather than attempting to dominate it (Rasid and Haider 2003), in accordance with arguments made for some decades now about considering local knowledge in development (Hornidge 2012; Sillitoe 1998, 2000; Sillitoe, Bicker and Pottier 2002; Sillitoe, Dixon and Barr 2005). The challenges posed by accommodating local perceptions and practices in formulating climate-change mitigation and adaptation strategies are considerable. There is a sociocultural and epistemological gulf between the contrasting philosophies of living with, or dominating, nature. It is necessary to beware of interpreting and testing local experience and knowledge according to our scientific approach, distorting their understanding. Instead, we need to devise ways to exchange knowledge between the different worldviews. There is a place for outside technical and other kinds of assistance. Rapid and extensive environmental change may render local knowledge less effective or even inadequate, as the extensive flood-prevention engineering schemes illustrated by disrupting local understandings of aquatic resources. But outsiders need to be sensitive to the local context, as some NGOs recognize in their advocacy of community-based adaptation projects: 'Identifying communities' own priorities and needs, and valuing their knowledge alongside science-based knowledge is key to developing sound adaptation strategies' (Practical Action n.d.: 8).

The Hakaluki Survey: Local Adaptation to Climate Change

The responses to the question about the effects of environmental-cum-climate changes on people's occupations and livelihoods indicate that these are already substantial and that they are at some risk. There are two principal effects evident: declining fish catches and fewer employment opportunities, both of which result in falling incomes and more hardship, particularly for the poorer households (Figure 4.8). Four-fifths of responses related to the decline in the number of fish caught and over two-thirds of them referred to the worsening employment situation. Population growth together with environmental change is probably contributing to employment problems. There is a tendency for fishing problems to concern Hindus and men more, and for occupational issues to affect Muslims and the under fifties more (otherwise, there was no significant variation according to gender, age, religion or village). The fish catch has fallen dramatically with the decline in the depth of the *haor* and with the monsoon flood waters draining away faster than previously. The decline in fish diversity and numbers are connected to changes in *haor* ecology. Furthermore, some irresponsible fishers use fishing gear that does not allow small fish fry, such as those of *puti* (*Puntius chola*), *taki* (*Anebas testudineus*), *khalisha* (*Colisha fasciatus*) and *chang* (*Channa orientalis*), to escape and ensure the conservation of future stocks. These unsustainable fishing methods are locally thought to exacerbate any climate-change-induced problems (Figures 4.3 and 4.12). The numbers of those fishing have also increased across the *haor* region.

The change in rainfall patterns (not totals), from gentle rain over long time periods to sudden heavy storms of short duration that damage crops, impacts negatively on farming practices. Moreover, the occurrence of flash floods, particularly during the *Baishakh* month harvest period, can wash entire crops away. It affects both local rain-fed deep-water rice varieties that grow with the gradually rising monsoon flood waters and the introduced deep tube-well irrigated ones, which are susceptible to irregular and unexpected heavy rain and flood damage. These weather events also disrupt the supply of fodder for animals, and households may resort to collecting less nutritious but ubiquitous *kachuripana* water-hyacinth foliage to cope. Other aquatic plants that supply edible foliage and roots that poor families collect during the lean fishing period, and sometimes sell in the market, such as *shapla* (*Nymphaea nouchali*), *shaluk* (Nymphaeaceae) and *singra* (*Trapa bispinosa*), have decreased with the changing *haor* ecology, depriving people of much-needed food and income.

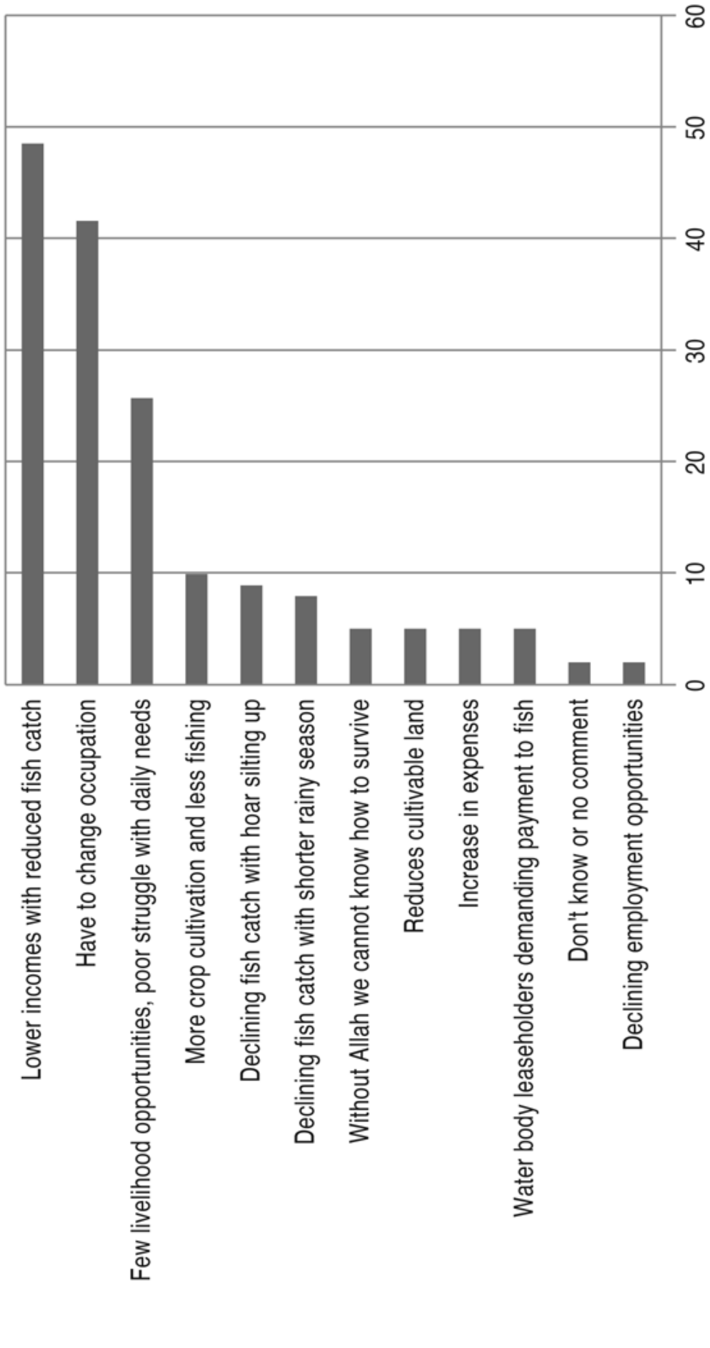

Figure 4.8. Effects of climate change on occupations/livelihoods (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

Figure 4.9. Steps taken to cope with environmental/climate change (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

[1] Such as farm labourer, local shopkeeper, brick kiln worker, rickshaw puller etc.

The responses to the question about the steps people take to cope with environmental-cum-climate change were discouraging with respect to the capacity to deal with these issues locally. Some are endeavouring to meet the challenges as best they can. Some farmers in the *haor* region, for instance, have established a network that allows them to hire large numbers of day labourers quickly, to help save crops during destructive heavy storms and flash floods. But nearly two-thirds of replies indicated that they had no plans, or means, for coping with the changes, with a further one-tenth saying that they were looking to those in authority to do something to help them (Figure 4.9). The more positive among them (over one-third of respondents) said that they would find another occupation if environmental changes cause their current livelihoods to become untenable. (There was no noticeable variation in responses according to gender, age, religion or village.)

The implication of finding other work is that they may go elsewhere to seek employment, probably in Bangladesh, but some may go overseas, notably to the Middle East, if they can arrange it. Several poor families migrate temporarily to the neighbouring districts of Sunamganj and Mymensing in search of work during the lean fishing period (a movement facilitated by the improved communications network). There they pull rickshaw vans, for instance, or work as day labourers in the brickfields. Migration is a common response to difficult situations locally and has become increasingly associated with climate-change pressures, as Mallick and Etzold note in their edited volume on the topic: 'climatic risks and environmental change have certainly … been a significant factor contributing to people's migration' (2015: 8). People's dependency on natural resources in the *haor* region has been reduced by environmental changes, and they deploy a diverse range of strategies to survive, though some of these are barely adequate. As fish stocks have declined in the *haor*, many fishermen have given up their traditional occupation and are trying to adopt new livelihood strategies: some successfully, as can be seen from the construction of small brick houses that are a mark of relative prosperity, which have been built largely with overseas migrant labourers' cash remittances to their families.

Predictably, when asked about the effectiveness of steps they can take to cope with environmental-cum-climate change, respondents' comments were similarly discouraging, with nine-tenths of them making a disparaging or helpless comment (Figure 4.10). No one suggested that there might be steps they could take locally. Those with a more optimistic outlook pinned their hopes on the government or local politicians doing something effective. Women were somewhat more pessimistic than men (see also Cannon 2010; Shaw 2014), and Hindus and Jalalpur village

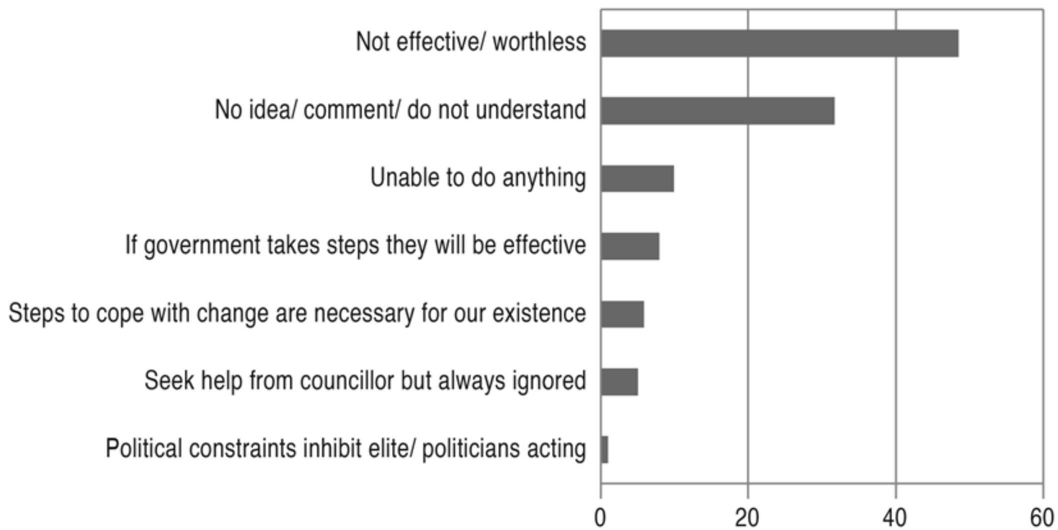

Figure 4.10. Effectiveness of steps taken to cope with change (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

residents were more likely to feel helpless or not understand the question (otherwise, there were no significant variations according to gender, age, religion or village).

Opinions on the effects of environmental-cum-climate change on the respondent's socioeconomic status were uniformly pessimistic, particularly from poorer households (Figure 4.11). While we should approach responses to a question about people's economic standing with caution, as they may exaggerate their problems in the hope of some assistance or minimise their difficulties out of shame or pride, the consistency of the negative comments suggests that there is a genuine increase in hardship and poverty. It is noteworthy that none of these responses referred to environmental or climatic conditions, although the question assumes them. Instead, the respondents referred to economic conditions per se, and these had a marked political dimension to them, mirroring the responses to the previous question.

While a few people mentioned environmental measures, when asked what information and support could help them cope with changes (Figure 4.12), somewhat over half of the respondents expressed a wish for education about what they might do, which correlates with the majority having pessimistic views about their capacity to manage locally. Other comments (about one-third) again had a political dimension, with the issue of access to fishing waters featuring relatively prominently. Women more often expressed a wish for some education, while men voiced politically related concerns and mention environmental issues. Individuals aged over sixty were less concerned about education, as were Muslims, while no Hindus or Jalalpur residents referred to environmental issues (otherwise, there was no significant variation according to gender, age, religion or village).

Policy and Politics

While many survey responses mentioned the need to tackle environmental problems, a substantial number referred to politics as a particular concern. Political issues are often interconnected with environmental ones, as, for example, in the problems with the gerrymandered leasing of water bodies. So, rather than ecological and climatic responses to questions framed around environmental topics, many answers focused on political concerns – as was the case, for instance, with 32 per cent of the replies to question 9: 'What information and support might help you cope?' Political issues are commonly prominent with regard to environmental problems in rural areas (Brouwer et al. 2007; Sillitoe and Alam 2012: 167–72).

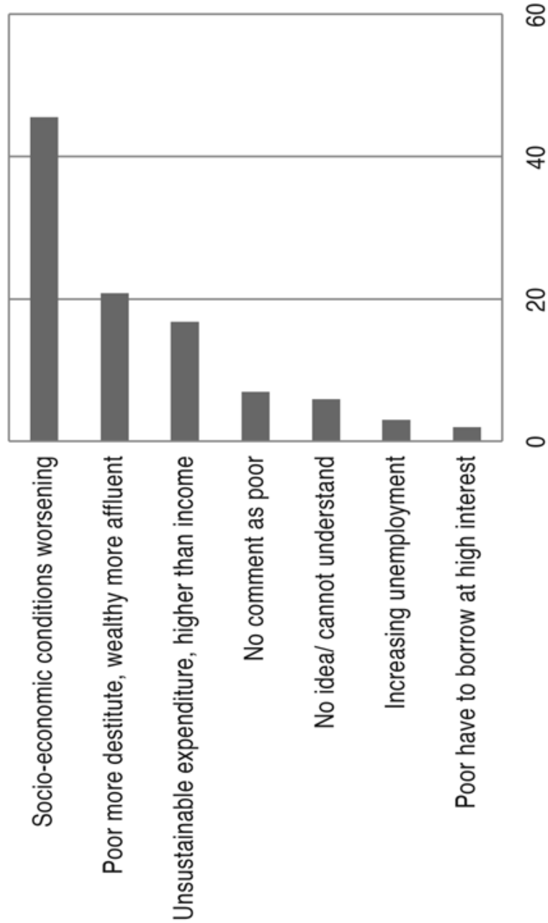

Figure 4.11. Effects of changes on socioeconomic position (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

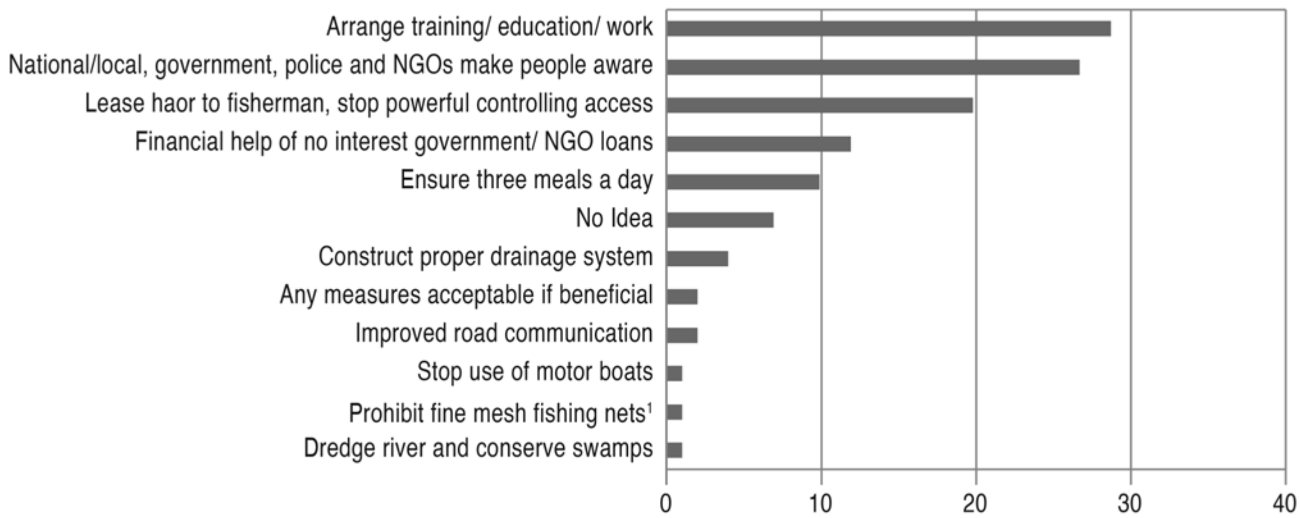

Figure 4.12. Information and support to help respondents cope (percentage of responses) (data collected and analysed by the authors with Mir Yousuf Ali and Iffat Ara Nipa)

[1] Such as *kapri* and current nets.

The political concerns relate to the hierarchical structure of rural communities, where many people, notably the poor, expect to depend on others. This results in a mindset where clients think that they are unable to sort things out for themselves and depend on the patronage of those above them, notably wealthy politicians, businessmen and bureaucrats, who often employ thugs to intimidate and enforce their views. This is evident in the survey returns where, when asked what they can do in the face of climate-associated environmental changes, large numbers replied that they did not know or that they could do nothing. For instance, 89 per cent responded to question 8, 'Are you able to cope with these changes?', that they could not cope or could not do so without outside assistance.

A fatalistic outlook reinforces the hierarchical order, prompting people to think that they are inadequate to do anything without patron leadership. A frequently heard answer to questions about what the future holds and how people might respond is the Arabic phrase, commonly used throughout Islam, that it is *Insha'Allah*, 'God's will'. This underlines that activities such as the fornicating frog rite, which no one mentioned in the survey, are not thought of as coping strategies. Similarly, none of the Hindu respondents mentioned the *gonga puja* (worship of the Ganges) ritual, easily interpreted as a coping mechanism protecting fishermen from misfortune, with its focus on the sacred Ganges and its flooding that is central to fishermen's livelihoods. It is arguable that a fatalistic mentality is a realistic approach to the weather (and, by extension, climate change), as it acknowledges that humans are unable to control it and even have problems predicting it, as noted earlier,[22] unlike those seeking to control it by such means as engineered flood-control measures. In contrast, this attitude could be seen as characteristic of people living with nature. Consequently, the more dire the climate-change predictions, the more likely the local response is to be forlorn, not because of scepticism, but because such forecasts make it seem increasingly improbable that they can do anything in the face of such a fate.

The survey responses raise the question of what to do in such a hierarchical sociopolitical situation, where people are conditioned to depend on and follow their superiors, a view reinforced by a fatalistic philosophy of life. The prevalent attitude in communities, that they are unable to cope with any environmental changes without the assistance of patrons, thwarts participation and stymies the argument that people should be encouraged to draw on their local knowledge in responding and adapting to change. What can we do? One answer is that we need to promote education, to inform people of predicted climate-change induced environmental changes and to encourage them to think about how they might respond, drawing on local resources and knowledge. Education is recognized locally, with 55 per cent of respondents referring to the need for it, and governmental organizations and NGOs promote a range of educational programmes:

> Mass awareness raising on the impacts of climate change and how to cope with the challenges can be carried out through a variety of means, such as the distribution of posters or leaflets, running discussion sessions with different groups such as NGOs, Upazila level officials (agriculture, disaster management unit), or setting up school and college environmental clubs that can arrange discussions on local issues. (Practical Action n.d.: 10)

Anthropology might contribute to such efforts by promoting culturally relevant alternative approaches to such education, informed by local ways of passing on knowledge. This includes identifying and possibly modifying educational schemes, and deploying media that effectively reach people – play acting, shadow puppets, folk singing and so on. There is considerable research on this to draw on.

There are contradictions here, as with any political concerns. Culturally framed education, which is sensitive to local political arrangements, will probably comply with these arrangements, when it is arguably necessary to free people from hierarchical domination to liberate local inventiveness and ingenuity. Another option is education that is aware of cultural context, but that nonetheless seeks to empower people to understand climate-change issues and come up with their own adaptation strategies. However, such education is arguably tantamount to political interference in local affairs because it challenges current patronage power structures by reducing people's ignorance and impotent attitudes, as the self-evident 'knowledge is power' argument underscores. It might also arguably challenge people's religious beliefs by seeking to overturn the fatalistic attitude that Allah preordains what happens in the future. Perhaps it is for local people themselves to make political changes rather than interfering outsiders, as the 'decolonial' argument advocates.

However, this outcome would seem unlikely, given that the local powerful elite, including government and NGO employees, have vested interests in the status quo. This fact would suggest that any education programme also needs to target the rural and urban elite, particularly governmental and nongovernmental officials with the power to inform any interventions. This becomes particularly pressing in the climate-change context, which demands urgent action. But it is also a question of national-level political issues and policy debates. Those engaging in policy formation are from the wealthy elite, few of whom intend to reduce their own political power, as will be necessary if local people are to engage with climate-change issues meaningfully. In short, the elite need to beware of climate politics seeming a cynical charade, appearing to debate climate change and turning out policies endlessly so as to access resources available internationally.[23] The policy analysis and recommendations, without the action, also perhaps suggests some scepticism about scientific predictions of climate change, to which the *Insha'Allah* 'god-willing' fatalism of Islam may also arguably incline people. After all, what can Bangladesh do about the global atmospheric CO_2 crisis, which is largely the fault of industrial nations and not underdeveloped ones (Hanlon, Roy and Hulme 2016)? Any local mitigation measures will have a minimal impact, as noted, and so concerns instead focus largely on adaptation, which so far as it involves poverty-stricken communities is not perhaps a political priority, providing no subsequent unrest threatens the position of the elite, which may be a concern with empowerment schemes that seek to encourage communities to manage matters for themselves in the face of predicted climate changes. The dilemma is that in protecting their privileged status, by failing to empower local communities now to advance their own adaptation measures, the powerful may find resulting unrest and chaos threatens them more gravely later.

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Appendix

জলবায়ু পরবির্তন বষিয়ক প্রশ্নমালা

Climate Change Questionnaire

Department of Anthropology, Durham University
Department of Social Sciences and Humanities, Independent University Bangladesh

উত্তরদাতার ববিরণ: (Respondent details:)

নাম: (Name:)

লঙি্গ: (Sex:)

বয়স: (Age:)

গ্রামঃ: (Village:)　　　পাড়াঃ (Para location:)

ইউনয়িনঃ: (Union council:)_

আপনার পশো কি?: (What is your occupation?:)

১। আপনার অঞ্চলে পরবিশেরে কোন পরবির্তন কি নজরে পড়ছে ? (Have there been changes in the environment?)

হ্যা (Yes)　　　না (No)

২. হয়ে থাকলে পরবিশেরে কি কি পরবির্তন হয়ছে? (If yes, what changes have there been in the natural environment?)

৩। এ সব পরবির্তনরে কারণ কি? (What are the reasons for these changes?)

৪। আপনি কি জলবায়ু পরবিরতনরে কথা শুনছে? (Have you heard of climate change?)

হ্যা (Yes) না (No)

৫।শুনে থাকলে জলবায়ু পরবিরতন বলতে কি বুঝেন? (If yes, what do you understand about climate change?)

৬।আপনার এলাকায় জলবায়ুর কি কি পরবিরর্তন দেখা গেছে? (What changes in climate have occurred in your region?)

৭। জলবায়ুর পরবিরর্তন পরবিশেরে উপর কি কি প্রভাব ফেলেছে? (What are the effects of climate changes on the environment?)

৮। জলবায়ুর এই পরবিরতন সমুহ আপনার জবিীকার উপর কি প্রভাব ফেলেছে? (How does climate change affect your occupation/livelihood?)

৯.। পরবিশে ও জলবায়ু পরবিরতনরে সাথে খাপ খাওয়ানর জন্য আপনারা কি কি প্রয়াস নহিয়িছেনে? (What steps can you take to cope with environmental/climate changes?)

১০। জলবায়ু / পরবিশে পরবির্তনরে সাথে খাপ খাওয়ানর এই প্রয়াস ককতটুকু কাযকরি? (How effective are these steps to cope with environmental/climate changes?)

১১।এই পরবিরতনরে সাথে আপনার গৃহস্থালীর আর্থ–সামাজকি অবস্থা কভিাবে প্রভাবতি হয়ছে? (How does environmental/climate change affect your socioeconomic position?)

১২। আপনি কি মনে করনে এই পরবির্তনরে সাথে মানয়িে নতিে পারনে? (Are you able to cope with these changes?)

১৩। মানয়িে নয়োর জন্য কি ধরণরে তথ্য ও সহায়তা দরকার? (What information and support might help you cope?)

Notes

1. The *IPCC* currently predicts sea level rises of 0.4 to 0.67 m by 2100 (Church et al. 2013: 1201).
2. All of the terms in this chapter are standard Bengali words.
3. The *beel* cover an area of 4,635 ha and the important ones are Baghalkuri, Balijhuri, Barajalla, Chatla, Chinaura, Dulla, Haorkhal, Lamba, Pinlarkona, Pioula, Sakua, Tekonia and Tural (CWBMP 2006).
4. It comprises five *thana* 'administrative areas': three in Moulavi Bazar (Kulaura, Juri and Baralekha) and two in Sylhet (Golapganj and Fenchuganj).
5. The *boro* season extends from January to May, which is the dry season when farmers cultivate an irrigated rice crop.
6. *Baishakh* is the first and *Kartic* is the seventh month of the Bengali Calendar (mid-April to mid-November).

7. The *aman* rice crop (transplanted and broadcast) is usually cultivated in December–January, and the *aus* crop in July–August.
8. We acknowledge our debt to Mir Yousuf Ali and Iffat Ara Nipa, and thank them for their help. We also thank Independent University, Bangladesh for a grant to cover their work.
9. One hand is approximately 45 cm.
10. *Ashar* (mid-June to mid-July) is the third Bengali month, when the rainy season begins, and *Srabon* (mid-July to mid-August) is the fourth rainy season month.
11. The same process has happened in neighbouring Tural Haor and Nagur Haor, where the waters are now so shallow that it is reportedly hardly worth fishing anymore.
12. *Chaitraya* is the last month of Bengali year (mid-March to mid-April) and is dry and hot.
13. *Acacia auriculiformis*, locally called *akashmoni*, and several species of Eucalyptus trees.
14. See Camelia Dewan's chapter in this volume on embankments in the Sundarbans and their socioecological impacts.
15. For a discussion of gender issues in relation to flooding, see Cannon (2010) and Shaw (2014).
16. The meteorological stations of Sylhet (30 km northwest) and Srimongal (40 km southwest) are the two nearest to the Hakaluki region.
17. The analysis of meteorological data by Islam and Neelim (2010: 26, 28, 35, 57, 58 and 64) for Sylhet (over a longer timeframe) indicates that the mean maximum temperature for winter and minimum temperatures for winter and summer have increased, but rainfall shows no change.
18. They distinguish *benga* ('male frogs') and *bengi* ('female frogs') by their different croaks.
19. *'Megh Rajare tui amar suddor bhai*
    Ek guri Megher laiga duar bhijjya jai
    Duar bhijjya jaite jaite monai dilo fal
    ek ushtha da falai demu kochu kheter file
    Benger zhiyer biya shonar medel diya
    alo bengi megh diya ja
    Megh dila jemon temon duar bhijlona
    nabi shotto Allah keno megh dilaina
    Houra khailo poke dhan khailo loke
    mega megi boiya roise ganger kule.'
20. Regarding indigenous weather forecasting, our enquiries suggest that there are no consistently held indicators, but a varying range, often informed by individuals' experiences and observations. They include the following predictions. Cold winters follow warm winters and also hot summers. If there is much continuous rainfall in the months of *Chaitraya* (March–April) through to *Bhadro* (August–September), it will be a hot summer and cold winter. If it is foggy in the mornings and evenings during *Chaitraya*, this signals delayed rains and a hot summer; whereas if the rains start at the end of that month, it will be cool. And if the rain comes and goes, the winter will be warm. If the wind carries the warm smell of cloud during the *Chaitraya* (drought period), this is a sign of coming rains. In some years it rains in the month of *Magh* (January–February) and not *Kartic* (October–November), and this signals cool weather. Frequent dark clouds in the middle of the month of *Falgun* (February–March) signal no rain and hot weather, whereas rain at this time indicates that it will be cool.
21. See Dewan's chapter in this volume for discussion of the 'Flood Action Plan' that featured the construction of embankments, dykes and polders to control seasonal floods.
22. A fatalistic outlook with regard to climate-change predications has been noted elsewhere in Asia – for instance, in rural Thai communities, where it is associated with Buddhist beliefs (Kittipongvises and Mino 2013; Suthirat and Takashi 2013).

23. For an indication of the sums of money involved, see, for example, Global Climate Change Alliance+ (2012) for the funds made available from the European Union from 2011 to 2017 for projects in Bangladesh.

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Chapter 5

Weather, Agency and Values at Work in a Glacier Ski Resort in Austria

Herta Nöbauer

> Our existence is literally melting away.
>
> —Fieldnote, 8 August 2015

Reinhold, the chief technical manager of the Pitztal glacier ski resort in the Tyrol, western Austria, once more raised his concerns about the retreating glaciers and snow cover. It was the summer of 2015. We were standing in the open air at around 2,900 m elevation, when this local man, in his mid-fifties, explained the profound changes that had been occurring in the landscape around us. He pointed around the surrounding area, describing how far the glaciers reached when he had begun working in the resort in the 1980s. Since that time, all the local *Ferner*[1] (the regional term for glaciers) had been steadily shrinking, as indeed had all of the glaciers in the huge Ötztaler Alps area along the Austrian and Italian border.

During my fieldwork in Pitztal, I frequently heard similar concerns to those of Reinhold voiced by other men working in this alpine cryosphere environment. In many of these narratives, as in those of the wider local population, glaciers and snow often appeared as powerful and dangerous forces of nature. According to many, people 'go along with nature'[2] and its power. It provides their livelihood and it can bring happiness just as much as it can present them with danger, challenges and worries. Exposed to such meteorological and natural forces, workers in the glacier ski area strive simultaneously to control, manage and even dominate the 'otherness of the weather' (Hulme 2015) as much as possible. In doing so, they specifically aim to provide 'snow reliability' to the many thousands of tourists visiting the resort.

I propose that snow, like a glacier, is a unique and forceful materialization of the atmosphere and the weather. I conceive of it as a vital materiality. Similar to crevasses, icefalls, glacier-outburst floods and glacier fractures (Beniston et al. 2018; Carey 2007; Sökefeld 2012), avalanches, snowstorms, rapid snow-melt or extensive snowfall may endanger living beings, the built environment and infrastructure (Arbeitsgemeinschaft österreichischer Lawinenwarndienste 2017; Mergen 1997; Stoddart 2012). Political theorist Jane Bennett elaborates a conception of the 'vitality of materiality', or what she calls 'thing-power', in which 'vitality' indicates 'the capacity of things – edibles, commodities, storms, metals – not only to impede or block the will and designs of humans, but also to act as quasi agents or forces with trajectories, propensities, or tendencies of their own' (Bennett 2010: viii). Following Bennett's ideas, through its vital capacity, snow can not only impede or block the intentions of humans – it can also act as a power or force of its own.

Humans have been fascinated by snow throughout history and across cultures (Kirk 2013; Mergen 1997). The white appearance of snow and winter landscapes, and the former's capacity to transform quickly from soft to hard, fluid to frozen and back again, as well as its awesome, troublesome and dangerous powers, have led humans to attribute to snow a rich variety of cultural meanings, social significances and the status of a living being (Diemberger 2013; Glowacka, Washburn and Richland 2009; Gorman-Murray 2010; Kotnik 2007; McGibbon 2000; Pechtl 2015; Stoddart 2012). Western sciences for a long time viewed snow and glaciers as 'dead matter', sterile and inhospitable, though they are now acknowledging their physical vitality (Sattler, Sipiera and Psenner 2006). The vital and flexible character of snow makes it an essential atmospheric, geological and ecological actor in climate shaping, landscape and glacier formation and soil humidification. Its social and cultural capacities are no less significant, as it can act as a conduit for such vital things as lumber, sledges and snow mobiles, or people such as hikers, hunters and skiers. Conversely, it can impede the movement of humans and of modes of locomotion such as cars, trains, tractors and aircraft. In the destructive force of blizzards and avalanches, snow can destroy humans, animals, forests and the built environment. Lastly, declining natural snowfall and retreating snow cover, which are regarded as prominent casualties of global warming, have the potential to destabilize the skiing industry, which is very important for the national and regional economies of Austria.

At the same time as being a highly active and powerful materiality, snow is rendered as an abundant cultural material, a multivalent resource and a social issue by humans, who cultivate it in multiple ways, as will be discussed later. Local experiences with snow, together with vernacular forms of knowledge about it and the increased scientific knowledge gained since the early twentieth century, have enabled the cultivation and management of snow in substantial ways – or, to put it in Tsing Lowenhaupt's words: 'The agency of nature in affecting human affairs develops in tandem with human abilities to know it and manage it in particular ways' (2001: 6).

The multifaceted relationship between snow and humans, two vital bodies (Bennett 2010) acting upon and affecting each other in multiple ways, will be the topic of this chapter. In order to give the human–snow interconnectivity a theoretical frame, I will, as already mentioned, draw on Bennett's theorization of a political ecology of things beyond the human–nonhuman and life–matter binaries (Bennett 2010: 10), as well as proposing a theory of the distributive agency of the human–nonhuman congregation. In contrast to the dominant strand of political ecology, which often does not explicitly deal with theories of materiality or material culture, Bennett makes a plea for a change in environmentalist rhetoric towards 'vital materiality' in order to challenge the human domination of nonhumans (Martínez-Reyes 2017). During my anthropological fieldwork, I witnessed, again and again, that ski areas are highly moralized and politicized from diverging standpoints. For instance, environmentalists have accused ski-resort companies of 'destroying nature' or 'polluting the environment' by expanding ski areas and snow-making infrastructure. In turn, representatives of the ski areas have rejected such claims, blaming environmentalists and environmental laws for jeopardizing the stability and future of economically and demographically threatened alpine regions. In her theory of distributed agency, Bennett (2010) criticizes such blame games, though without depoliticizing things. This makes her theory attractive when discussing the multiple and distinct standpoints.

In this chapter, I take the glacier ski area of the high alpine valley of Pitztal, where I have conducted research on the anthropology of snow and issues of vertical globalization,[3] as an ethnographic case study. I focus on the mutual dynamics that emerge between its workers and the environment of snow and ice. I undertook several periods of fieldwork between 2012 and 2016, ranging from two to six weeks in length, in a number of different places within the Pitztal valley. Although I visited the glacier resort in each of these stays and made a broad range of contacts, formal fieldwork on the glacier itself was carried out during the winter season of 2014 and in the summer and early autumn season of 2015. The warmer season is actually the most intensive time for the workers, so my seeming paradoxical choice of timing to research snow and ice issues was perfect for learning more about occupational engagement in the alpine cryosphere.

Human–environmental dynamics in alpine cryosphere environments have only received scholarly attention in the last decade or so (Dunbar et al. 2012; Elixhauser 2015; Huggel et al. 2015; Strauss 2009). This has been primarily prompted by the profound changes and risks occurring in the alpine cryosphere due to the changing climate. Retreating glaciers and snow cover have been described as some of the most significant signs of global climate change (IPCC 2013). However, there has been almost no anthropological enquiry focusing on glacier ski areas. This is perhaps surprising because, as I argue, they provide a good site and entry point for learning more about such dynamics. In particular, they are outstanding places to gain new insights into the multifaceted processes, discrepancies and paradoxes shaping the human–snow–cryosphere relations in the European Alps, which are deeply shaped by global tourism. Glacier ski areas provide numerous sites that are specifically defined for use by a variety of people, both 'enclavic tourist spaces' and 'heterogeneous tourist spaces' (Endensor 2000) for ski tourists, open common spaces for alpinists and other visitors (especially in the warmer season), and, last but not least, open areas of environmental commons, such as water resources. This chapter highlights their significance for local people as 'occupationscapes', 'defined as landscapes formed and performed through histories of occupational behaviour' (Hudson et al. 2011: 21). This concept articulates the structural and political dimensions of landscape formation through labour and shares certain similarities with the phenomenological approach to landscape proposed by Ingold in his conception of a 'taskscape', in which 'the habitual practices of humans form familiar patterns which can become landscapes or places' (Hudson et al. 2011: 29) – or, to put it in Ingold's words, 'tasks are the constitutive acts of dwelling' and 'the entire ensemble of tasks, in their mutual interlocking' (Ingold 1993: 158) designate the concept of 'taskscape'.

Taking the abundant potentialities of snow and various other nonhuman quasi-actors along with the local workers' engagement into account, I intend to illuminate the multifaceted interactions that take place in the alpine cryosphere environment and the distribution of agency among humans and nonhumans within it. In doing so, this chapter aims to contribute to the understanding of a political ecology of snow and ice that gives nonhumans a position more comparable to that of humans.

Having clarified my approach and focus in this introduction, I will now outline the importance of snow as an economic resource in the Pitztal. By highlighting the local commitment to tourism and the value thereby generated for the 'white gold', I will show how it has contributed to the socioeconomic transformation of the Pitztal region from extremely poor to wealthy. In the subsequent section, the main part of the chapter, I explore the multifaceted dynamics characterizing the relationship between the workers in the glacier ski area, the majority of whom are men (see Carey et al. (2016) on gendered dimensions of knowledge production about glaciers), and the snow and other vital materializations of daily weather and of climate change. In my discussion of the manifold practices of snow management in the glacier ski resort, I explore the economic and social significance of, and values arising in, the encounter between the forces of snow and weather, and the various social and political attempts at controlling the weather. In the conclusion, I will sum up the main analytical findings.

Commitment to the 'White Gold' in Pitztal

As in many regions in Austria and elsewhere, in the Pitztal valley, snow provides the dominant rationale for the regional economy and identity. Snow constitutes the most important occupationscape, both for the local permanent residents and the significant numbers of seasonal migrants, who currently come mainly from Eastern European countries. Of the more than 400 ski resorts in Austria, three are located in this valley and one of these is the glacier ski area. These resorts were established between the late 1960s and the early 1980s. Although there was already some alpine tourism in the Pitztal in the nineteenth century (Pechtl 2005), modern winter tourism was initiated by provincial politicians, together with local inhabitants, in the 1960s, a decade later than in neighbouring regions. The former mentioned shared the socioeconomic and political aim of reviving the Pitztal, which at the time was extremely poor, and hoped to give its economy a more secure footing. This ambitious goal was expressed in the following commitment by local shareholders of the mountain railways in 1966: 'We will put our existence, our future, and all of our energy into tourism' (Hochzeiger Bergbahnen 2009: 6).[4] The four political communes of the Pitztal, which together currently have around 7,500 permanent residents, have since that time undergone profound socioeconomic change. They have been transformed from an extremely poor high-alpine region that in the past had an economy primarily based on agriculture into one whose wealth now derives from a service-based tourist economy. Just as in many other alpine regions, the newly discovered economic value of snow (Denning 2015) has led Pitztal inhabitants to refer to it as 'the white gold'. Tourism is supplemented by some small-scale trade and farming, mainly as a sideline, and alpine-pasture farming, which is mostly integrated into tourism. In the past there had been a pattern of seasonal (though increasingly permanent) out-migration by local residents. Tourism has brought stability to residence levels and even an increase in the population in the past few decades. However, while there is some small in-migration, out-migration has recently increased again and poses a degree of threat to the Pitztal, as it does to other alpine regions in Austria and elsewhere. Therefore, the commitment to winter tourism continues to have great economic, social, cultural and emotional power in the Pitztal. This commitment has led to the transformation of snow into a commodity circulating within the circuits of the global economy and global cultural flows.

However, this far-reaching commitment to mass-tourism skiing has in the past few decades come to be contested, due to the concomitant profound human interventions in the landscape and the changing climate, as will be discussed below.

Working with and against the Forces of Snow and Ice

Glacier ski areas share many similarities with ski resorts in nonglaciated areas, such as lift and restaurant infrastructure, piste management, snowmaking and safety measures for skiing. At the same time, they differ from them in several respects: among other things, the unique atmospheric, climatic and ecological conditions that characterize their environment. As I experienced and witnessed throughout my fieldwork, elevations of 3,000 m and above pose myriad challenges to human physiology and health, to technical apparatus,[5] to snow-making technology (see below) and to many of the plans humans make in order to engineer the cryospheric landscape.

Although glaciers in general have been shrinking since the end of the Little Ice Age in the nineteenth century, since the mid-1980s, glaciers worldwide have undergone a more or less dramatic retreat (Bender et al. 2011: 407). Glacial loss and lack of snow cover not only affect ecological balances, but also impact directly on people living in the vicinity, affecting their local economies, regional and global tourism, modes of perception and senses of place (Cruikshank 2005; Dunbar et al. 2012; Orlove, Wiegandt and Luckman 2008; Wiegandt and Lugon 2008). The retreat of the glaciers in the Ötztaler Alps, which are (still) home to the largest end-to-end glaciated area of the Eastern Alps in Europe, is particularly drastic (Fischer 2017).[6] Nevertheless, glacier ski areas are marketed to tourists as providing 'true snow reliability' when compared with resorts at lower elevations. In a similar vein, due to their high-altitude locations, glacier ski resorts have been mostly considered in climate research and tourism as exclusive future skiing reservations. Climate-research models project that ski areas in Europe located below 1,200 m will disappear towards the end of the century (APCC 2014: 16, 25; Marty et al. 2017), though a recent study has revealed that there may also be a decrease in snow depth of about 50 per cent for elevations above 3,000 m by then (Marty et al. 2017). This echoes Reinhold, who finds it difficult to imagine the Pitztal glacier ski area as having reliable snow in the long-term future: 'We will have to make even greater efforts and fight even more on the glacier in ten or twenty years. We will need more equipment and more staff' (interview, 8 August 2015). Heinrich was convinced that there will still be skiing on 'their' glacier in the next few decades at least. The high altitude combined with snow depots (huge hills of harvested snow – for details, see below) and snow-making would continue to make it possible. However, unlike Reinhold, he considered the elevation to be one of the most important criteria in this respect. However, the reliability of snow also depends on the geographical orientation of specific slopes, as was also emphasized by Reinhold.

Glacier ski areas incorporate a whole range of legal provisions (including environmental assessment regimes) and standard operating procedures as a prerequisite for their establishment and maintenance. Many of these regulations relate to particular weather, ice and snow conditions. Familiarity with these regulations is very important when carrying out field research in order to fully comprehend the diverse tasks and narratives of the workers. Among other criteria, rapidly changing weather, snow and ice conditions must be monitored several times a day by the staff in order to make, and keep, the ski area safe for skiers. Beside the daily weather forecast, measurement of the wind is especially crucial, as members of the technical staff are individually responsible for immediately stopping the lifts once the wind speed becomes a risk factor. To put it more precisely, the unique and rapidly changing wind conditions at high elevations directly impact on the safety of mountain railways and hence on the security of humans and the stability of business economy. Thus, the relevant staff need to acquire and apply sound knowledge about the weather and wind, among other things, and must observe them in detail. More recently, staff have begun to use wind-sensing technology affixed to the cable-car pylons to measure wind force. Depending on the position of the lifts, their weight and the cable technology, they must be shut down once wind velocities reach 40–80 km per hour. Some workers report that many tourists do not understand that it is necessary to stop lifts under these circumstances and they complain aggressively that they have paid for their lift tickets. The movement of glaciers, crevasses and the breaking-up of ice are further potential dangers to skiers, and thus must also be monitored and appropriately managed (Amt der Tiroler Landesregierung n.d.: 21–22).

In particular, so-called 'atypical dangers' such as avalanches, a piste entirely freezing, crevasses that cannot be filled in or ablation (i.e. the melting of snow and ice cover over large areas) must be constantly safeguarded against and/or eliminated. If this is impossible, then pistes must be closed (Amt der Tiroler Landesregierung n.d.: 23). In the early years of the Pitztal glacier ski area, the workers frequently had to experiment with different methods to find the most suitable for dealing with such circumstances. Through trial and error, they discovered, for instance, how to fill crevasses with snow and ice rather than with other materials such as straw. When glaciers move, they have an impact similar to that of melting permafrost and destabilize the towers of the T-bar lift. As a consequence, each year workers must adjust and relocate the lift towers. Ablation poses another challenge, as I saw during my fieldwork. Bare rock, debris or permafrost soil appears in ablated areas, which must then be adapted into a 'piste-friendly' base by flattening the ground. Drilling and blasting technologies are used to break up the rocks and vast amounts of stones are removed in trucks. In this context, workers would warn me, again and again: 'Pay attention and keep away the next few minutes!'

While these tasks are mainly defined by provincial piste-security regulations, other practices, widely described as snow management, have emerged from the economic and competitive imperative for 'snow reliability' and are interrelated to the changing global climate. These are regulated by environmental assessment legislation. However, both categories of practice intersect with each other, insofar as they share the safety of tourists and piste security as their prime principles. 'Snow reliability' in ski resorts has received the greater attention in studies of tourism and climate change and its impact on the cryosphere since the turn of the millennium (Mayer, Steiger and Trawöger 2007). Among other effects, glacial retreat and permafrost degradation in alpine rocks, debris and soils are considered to be major hazards in alpine regions. They cause the break-up of rocky slopes and consequent rock falls that endanger the built environment and infrastructure, and cause casualties (Krautblatter and Leith 2015: 147). To Heinrich, who is in charge of piste security, melting permafrost poses the most serious problem:

> Really my biggest concern up here is the permafrost … This is very dangerous because you never know when it starts falling apart. But once it is melting, the rocks break apart and rockslides then become a big danger to our guests and all of us … I know when and how to trigger avalanches for security reasons.

> But we do not know how to deal with the melting of permafrost except by covering some areas with textiles. (Interview, 14 November 2014)

From a somewhat different perspective, which is shaped by his senior management position, Reinhold has identified three major problems facing the company:

> We do not have sufficient snow. We already need to make it snow up to 3,000 m. As you can see, we do have the snow depots and the snow cannons, but at the same time we do not have enough water for making snow. And another problem is our enormous energy needs and the extremely high costs of it for the company … However, with our photovoltaic solar power plant we will save money. (Interview, 5 December 2014)

Making Snow Reliable: Practices and Values

Against this backdrop of challenges, problems and dangers facing the company's workers, in this and the next section I describe the three most important practices of making 'snow reliable' and the pistes secure on the Pitztal glacier ski area (which is similar in this respect to many other glacier ski resorts). These are making snow depots and covering these with geotextiles,[7] covering sensitive and dangerous areas of the glacier and permafrost with textiles, and making snow by means of technology. As I will demonstrate, this mixture of practices can be understood in terms of Lévi-Strauss' notion of 'bricolage' (Lévi-Strauss 1966): different available materialities are combined with a variety of experimental and technological or scientific forms of knowledge to ensure snow reliability. While these practices are mainly linked to the economic value of snow, I show that they also have social significance and value for the workers.

The most crucial practice in providing 'snow reliability' takes place at the beginning of the season in September and consists of making pistes out of the snow stored in huge outdoor depots. These are made by workers either during the season, or at its end in May, when they use snow groomers to collect the snow, ready for redistribution again in August and early September. Once distributed, this snow has the appearance of thick (50 cm) white stripes running across the brown-grey rocky landscape. This method has been in use for more than a decade. This harvested snow comprises two-thirds natural and one-third technologically produced snow, which together amounted to approximately 3,000–4,000 m^3 in 2015. These depots present a materialized assemblage of natural snow, the bacteria within it, glacier water and the technical snow that is made from it, weather, human labour, snow-making technology, snow groomers, diesel, textile materials and, last but not least, environmental legislation. Moreover, they are of social significance to workers, as illustrated by Heinrich, who emphatically stated: 'These depots stand for my job future!' (fieldnote, 29 July 2015). What is important to note in his statement is the double meaning that for him, the snow depots are both powerful representations of snow reliability and of his secure occupational future.

Depending on the weather, producing the snow depots takes between four and six weeks. Once collection is complete, the workers cover the hills with large white geotextiles in order to prevent the snow from melting too soon. During my fieldwork stay in 2015, there were seven such huge hills of snow awaiting distribution and 7.5 hectares of textiles were protecting them. Usually the textiles can be reused for three seasons. However, as was explained to me by Heinrich, some covered snow depots might, depending on the natural snow cover on the glacier, stand there as long as three seasons without melting. However, snow conditions were different in 2015, when Heinrich lamented: 'There was nearly no snowfall this summer. It might be then that there will not be enough snow in the depots to open in September. However, if so, then we must go along with nature and not against it.' 'And what does this mean?', I asked him. He responded: 'It means that we have to open the season later' (fieldnote, 29 July 2015).

In addition to the snow depots, certain glacier and permafrost areas are also covered with textiles during the summer period. The aim of this is to prevent the ice and permafrost from rapid melting and to keep the pistes safe. The specific 'sensitive' and dangerous zones protected in this way are around the ski-lift towers, the rocky outcrops on the glaciers, and retreating and collapsing glacier terminuses (Mayer, Steiger and Trawöger 2007: 165; Olefs 2009: 35). The covering method has been exploited at various lower glaciers in Europe since the mid-1990s (Mayer, Steiger and Trawöger 2007: 165 fn. 12), but the fleece textiles were first used in Austria, including in the Pitztal glacier resort, in the early 2000s, as a consequence of the extremely hot summer in 2003 ('Ein Pflästerli für die Gletscher' 2006: 8). This was before glaciologists from the University of Innsbruck had experimented with project with different textiles to protect glaciers in ski areas in Austria, including the Pitztal, between 2004 and 2008. This research has shown that the covering method resulted in a 60 per cent decrease in ice and snow ablation (Fischer, Olefs and Abermann 2011: 95). These scientific findings were echoed in the narratives of several glacier workers when they attributed a social and ecological value to the snow-management practices. 'We are sometimes blamed by environmentalists for destroying the glacier', Heinrich emphasized with strong feeling. He continued: 'But the opposite is the case. We are protecting the glacier and caring for it!' (fieldnote, 29 July 2015). However, as he and others stated in various conversations, it is impossible to cover the whole glacier and so stop it melting. In contrast to the research cited above, the use of textiles has been criticized by ecologists and environmentalists. According to their critique, textiles mar the appearance of the landscape and impact negatively on the micro-organisms of the snow and ice (see Bundesministerium für Wissenschaft, Forschung und Wirtschaft (2017) on research project Cover Up). These distinct and competing scientific standpoints are reproduced in the differing national-regional environmental regimes on the use of textiles: in contrast to Switzerland, for instance, where covering with textiles must be approved by the respective canton's planning administration ('Die Gletscher sind wieder abgedeckt' 2013), in Austria it is defined by environmental regulations as part of the maintenance of a glacier ski area (Bundesministerium für Wissenschaft, Forschung und Wirtschaft 2017).

Snow-Making: Attempts to Imitate and Modify the Weather

Unlike the use of snow depots and textiles, snow-making by means of 'modern' technology goes back as far as the 1930s. The first experiments were initiated in a laboratory in Japan by the physicist Ukichiro Nakaya, whose research on the composition and capacities of snow is still relevant for today's meteorologists. The current broad range of experiments with snow-making and its widespread application globally are opening up global trajectories of weather modification (Nöbauer 2017, 2018).

Snow-making can be conceived of as a sociotechnological-ecological system shaped and driven by a political ecology. The political ecology consists of numerous actors and quasi-actors standing in particular relations to each other. The most significant human actors include lift-company shareholders, ski-resort managers and workers, as well as various experts, such as technicians and researchers, and managers within the construction and snow technology industries, environmentalists and political administrators. An essential precondition and effect of enabling the snow production described above are the consumers, the tourists and competitive sportspeople who ski on the snow. The most prominent nonhuman actors are the weather forces, weather-measurement technology, environmental-impact assessments and water legislation; also relevant are vast amounts of water and the infrastructure for storing and distributing it, energy and the infrastructure for producing and distributing it, machinery for making snow (primarily snow cannons) and, last but not least, the computer systems that control and activate the daily making of snow.

The physical principle of snow-making imitates natural snowfall. The formation of snow basically relies on a specific interplay of air and wind, to which water and energy are added by humans using technological means. To produce snow, the water droplets that are sprayed out from snow cannons under high pressure must freeze. Cold air temperature (usually between -4 and 0°C), low relative humidity and cold water temperature (around 0°C) are essential conditions. The drier the air, the more snow can be produced. Large amounts of water and energy are required for this process. The water is taken from communal water sources, collected in large, specifically constructed pools and then pumped through a wide network of pipes to the snow cannons. Snow-making may be activated by a fully automated computer system or manually by workers. The quantity and quality of water used is strictly regulated by provincial and national legislation in Austria (see below). Glacier water is used for snow-making in the Pitztal glacier resort. Two-thirds of the energy required is taken from the Tyrolean power grid (widely based on hydropower) and one-third is derived from the glacier company's own photovoltaic solar-power plant. Thus, to be precise, it is not the snow itself that is technical; rather, it is the application of technology and energy to make snow out of water that can be described as such. The glacier workers, like many people in Austria, use the term 'technical snow' instead of the more widely used 'artificial snow'. Like some of his colleagues, Heinrich emphasized this difference in several of our discussions: 'There is nothing in it; I mean there are no chemicals or the like in our technical snow. It is not artificial snow. We have very strict regulations' (fieldnote, 14 November 2014). Here he is referring to the specific legislation regarding snow-making in Austria, which prescribes both the quality and quantity of water to be used. While I will return (below) to the Tyrolean government's water legislation known as the Wasserbuch (literally, 'water book'), at this point I need to explain the so-called 'water purity rule' cited above by Heinrich. According to the Austrian Industrial and Commercial Standards ÖNORM (No. M 6257), ski areas are obliged to ensure the use of good-quality water so as to protect the soil and the health of skiers, and children in particular. As a consequence, chemical or bacterial additives are prohibited. Countries such as Italy and Germany share this commitment. By contrast, other countries, such as Switzerland, Canada and the United States, permit the use of chemical additives in snow-making.

Snow-making has given rise to a significantly broader and stronger critique of its ecological impact than has the use of textiles. This is primarily due to its high consumption of energy and water (de Jong 2013; Gross and Winiwarter 2015). A whole range of scientific and technological projects have been established in Austria and elsewhere to reduce the amount of energy and water used. Contrasting environmentalist standpoints are echoed by equally contrasting scientific discourses on snow-making. However, the different environmental legislative frameworks related to the use of water and the diverse energy sources (fossil fuels, hydropower and solar power) are often not taken into account in the controversy about the ecological impacts of snow-making.

Around 67 per cent of all ski pistes (which in total amount to around 23,700 hectares) are currently supplied with technically produced snow in Austria (WKO 2016). This high percentage puts Austria, together with Italy, among the leading countries in Europe in the use of human-made snow for alpine ski tourism. Ski-lift companies consider snow-making indispensable for securing winter tourism. Annually, they invest approximately €150 million into snow-making infrastructure (WKO 2017). Meanwhile, the snow-making technology industry has entered the global economy, with an annual turnover in the billions of euros. In the province of Tyrol, which has by far the most ski areas in Austria (totalling 7,300 hectares), nearly all slopes are supplied with technically made snow (Steiger and Abegg 2015: 323). All three ski resorts in the Pitztal valley use snow-making systems. However, each has a distinct technological system at work: one resort employs a fully automated system operated exclusively by computer systems, while two (including the glacier resort) have adopted a technological mixture composed of manually operated and part-automated snow cannons. Workers on the glacier need to check the temperature and air condition, and physically move the snow cannons within the landscape. In addition, a unique machine otherwise found only in Switzerland, called the 'all weather snow-maker', is installed on the glacier (see below). On the glacier, around 15 per cent of its 85 hectares of piste is supplied with technically produced snow. Compared with the Austrian average, and with other (glacier) ski areas,[8] this proportion of technically made snow is rather small. However, the snow-making is frequently seen as surprising for somewhere at such a high elevation. Many people would expect there to be sufficient natural snow cover on Austria's highest glacier ski resort – even more so as it is marketed as an area that still has natural snow reliability.

Nevertheless, snow-making on glaciers is not a recent innovation. It was already used on a few glacier termini in the 1980s. What is new, since the mid-1990s, is its employment for economic reasons at high elevations. These areas hold sufficient natural snow cover, but are supplemented with technically made snow so that the ski-lift companies can plan a definite opening to the season in September, when there is otherwise insufficient snow to cover the rocky base (Mayer, Steiger and Trawöger 2007: 161–63). This economically driven provision of 'snow reliability' in autumn thus correlates with 'technical snow reliability', as Steiger and Mayer (2008: 292) term it. The first snow-making system (based on snow cannons) was introduced on the Pitztal glacier in 1991, ahead of the trend elsewhere. However, a couple of workers already retrospectively associated this early installation with 'climate change' in their accounts to me during my fieldwork. The retreat of glaciers back then had already begun to disrupt the courses of the slopes. Facing these changes, and the decrease of skiers during the summer, the company decided to reduce the skiing season from twelve to eight months.

The subsequent turn to snow-making in the early 2000s was aimed at 'beschneien' (literally, 'snowing on' or 'making it snowing'), even on huge areas of glacier. Tourism researchers have identified this latest employment of snow-making as an effect exclusively caused by global warming (Mayer, Steiger and Trawöger 2007: 161–62). A recent scientific study even claims that the albedo ('whiteness' reflectivity) effect[9] caused by snow-making could to some extent be an effective method of inhibiting climate change (Schwaiger et al. 2017).

In addition to the snow-making system using snow cannons in the Pitztal glacier ski area since the early 1990s, another specialized piece of technology was adopted in the autumn of 2009. While it is largely based on the same network of snow cannons, it is organized around a huge and multi-ton machine called the 'all-weather snow-maker', which is fixed into a building specially constructed for it, at an elevation of around 2,900 m. As its name indicates, the machine, which made a long and challenging journey from Israel to the Pitztal glacier, works independently of the weather and is capable of producing snow even at ambient temperatures as high as 30°C. The desire for such weather-independent technological capability on a glacier attracted my interest from the very beginning of my research on snow and in fact prompted my decision to conduct fieldwork in the Pitztal in particular. The 'snow-maker', as it is called by the workers and the majority of local people, is, in contrast to the snow cannons, based on vacuum ice. The principle of transforming water into ice and snow by using a vacuum has been applied in various extreme environments and at varying heights and depths (such as in sea-water desalination and gold mining) in different regions of the world. After the resolution of countless problems due to its emplacement at high altitude, in 2009 it began operation for the first time in the alpine cryosphere environment (for details, see Nöbauer (2017, 2018)).

A few workers expressed their ambivalent attitude towards the snow-maker in their conversations with me. Even though they did not deny the importance of snow-making with snow cannons, they criticized the power consumption of the snow-maker as being 'much too high'. Heinrich explained that this machine goes 'against nature because it would be unnatural to have snow at warm temperatures' (interview, 14 November 2014). According to him, 'technology should always go along with nature and not against it' (interview, 14 November 2014).

In these final passages, I will illustrate how the vitality of the glacier water and the water legislation are appearing, as powerful actors and quasi-actors, so as to block both the all-weather snow-maker and the glacier managers' plans. As the snow-maker is enclosed within a building and was inaccessible to me during my previous stays, by the time of my fieldwork in 2015, I was curious to witness its snow-making procedure. Its operation was expected to start one month before the intended opening of the season. However, I was to be disappointed because I could see only occasional, small batches of snow slowly 'spat out' and transported on its conveyor belt to the outdoor space. I had heard from a few workers that 'there would not be enough glacier water' and that the snow-maker 'would not be compatible with the glacier water'. I asked them and myself: 'What does this mean?' It took me some time to find the explanation for this awkward relationship between glacier water and a machine meant to bring independence from weather. The difficulty was grounded in the vital materiality of glacier water and water legislation. These two entities have the power to impede and block both the seemingly autonomous will of humans to engineer the cryosphere landscape and a form of technology associated with autonomy from the weather. The first power arises from glacier water, which has a high potential to impede and block by its very nature because it carries debris and sand from the rocky environment. When glacier water passes through the pipes to the vacuum pump inside the snow-maker's building, the debris in the water is sedimented on the wings of the vacuum pump, transforming into a kind of cement. The dried, hard material regularly blocked the pump. A worker was responsible for removing this cement and cleaning the system, again and again. The second power emerges from the environmental impact assessment and water policy, as regulated by the Tyrolean government's Wasserbuch. Both can and must be considered as materialities that are able to impede or block either the entire construction of a water-storage system or the use of water for snow-making. During my fieldwork stay, the glacier company's managers were stressed and angry that they had to wait for a considerable period of time for the formal permission to expand the water sources that were to be taken from clean spring water. However, they have still not received this permit by the end of 2019 (Reinhold, personal communication, 7 December 2019). In order to cope with the ongoing problems that the glacier water was causing to the all-weather snow-maker, the company thus decided, after the end of my fieldwork, to modify its water storage pool. The proposed new pool material and technology would be able to significantly dispose of the sediment in the pool (Reinhold, personal communication, 14 September 2017) so that it would no longer block the pump. It is important to mention that the water policies would have no power were it not for the actions of the environmental activists and the political administrators of environmental regimes. However, to put it another way, these humans' activities would be less effective if they were not able to rely on legislation. Agency here is distributed among manifold humans and nonhumans.

Conclusion

This chapter has focused on the dynamics emerging between the vital forces of the weather and workers in the Pitztal glacier ski area in the Austrian Alps. Taking Bennett's theory of vital materiality as a starting point, I have considered snow as a vital materialization of the weather and of climate change. In doing so, I have given snow a theoretically and methodologically more comparable position to that of humans in my exploration of nonhuman and human powers to mould the alpine cryosphere. I have demonstrated that some materializations of the weather, especially the retreat of snow and glaciers, appear as powerful actors that deeply impact upon workers' affects, experiences, tasks and work on the glacier area. These workers counter the power of the weather with a strong social, political and individual will to control and manage it, as much as possible, with established practices of snow management, such as making snow depots, covering glacier and permafrost areas with textiles, and making snow using technology. Their efforts to manage those forces, which are never entirely controllable, not only stabilize and promote the economic value of snow as a commodity, but also provide the workers with a sense of existential and economic security, and of their masculine and rural identity. Moreover, the workers attribute the social and ecological value of 'protecting the glacier and caring for it' to these practices and the dominant economic value of making snow reliable. This valorization stands in stark contrast to the environmentalist narratives about their work. However, the value of glacier protection, as seen by the glacier workers, is, I propose, shaped and probably promoted by the powerful societal position of specific sciences, and especially of the glaciologists (Carey et al. 2016), who suggest the use of textiles for covering the glaciers and permafrost areas. As explained, the contrasting ethical and political positions towards 'good' and 'bad' actions in the cryosphere environment can be either supported or, sometimes at the same time, contested and rejected by scientific standpoints and evidence. Thus, the powerful position of sciences such as technology and glaciology in Austria and elsewhere should be considered if we are to critically analyse the metaphors used for describing human agency in the natural world (Hulme 2015: 236) and the 'protection of the glacier'. Like snow and other vital materialities, scientific materials are, according to their particular relations with other actors, highly significant actors in the political ecology of the alpine cryosphere.

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Notes

1. 'Ferner' literally means 'snow from previous years' and is the term used to refer to glaciers in this alpine region of western Austria.
2. The metaphor of 'going along with nature' is widely used in the Pitztal. While it may be applied in various contexts and even in (sometimes seemingly) antithetic senses, it basically expresses that local people consider their relationship to nature as one of adaptation.
3. I use 'vertical globalization' to describe the increasing flows of people, ideas, infrastructure, communication technology, trade and finance oriented towards environments of high elevations, including high mountain areas and the sky. While this orientation is geographically directed upwards, vertical globalization may also be directed downwards beneath the surface of the earth (e.g. towards the maritime areas or in the extraction of diverse resources).
4. German original:'Wir legen unsere Existenz, unsere Zukunft und all unsere Kraft in den Tourismus' (Hochzeiger Bergbahnen 2009: 6).
5. At high elevations of 3,000 m and above, there is a lower level of oxygen, which rapidly causes fatigue and exhaustion, and sometimes headaches and dizziness. Therefore, the staff must drink five litres of water a day in order to stabilize their blood circulation. The specific atmospheric conditions also affect technical apparatus, such as coffee machines and cooking equipment, which must be constantly re-adjusted. For instance, the temperature at which water boils is lower at high altitudes, while more coffee is needed per cup when brewing at higher elevations.
6. On average, the glaciers in the Pitztal region retreated more than 24 m in 2016; the year before, their shrinkage was even greater, with nearly 66 m the average (Fischer 2017: 23).
7. Some Austrian glaciologists (Fischer, Olefs and Abermann 2011; Olefs 2009) have experimented with various materials (including different colours and thicknesses) for coverings, such as membranes, biodegradable textiles and nonwoven fabric. Their results have shown that white-coloured geotextiles comprising nonwoven fabric that is breathable and permeable are the most effective. Even prior to the glaciologists' experiments, the Pitztal glacier resort had applied exactly these latter textiles. After three seasons of use on the glacier, these textiles are sent to be reused in the construction industry.
8. In the neighbouring Ötztal glacier ski areas, 77 per cent of the 111 km of pistes are covered with technically made snow (www.soelden.com/schneeanlagen).
9. The albedo effect (from the Latin word for 'whiteness') is a measure of the reflectivity of a surface such as the Earth. The brighter a surface (such as snow cover), the more of the sun's energy is reflected back into the atmosphere. The more solar radiation is reflected back, the more the Earth and global temperatures are cooled. Thus, the retreat of snow cover has a warming effect on the Earth's climate.

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Chapter 6

The Moral Climate of Melting Glaciers

Andean Claims for Justice at the Paris Climate Change Summit

Noah Walker-Crawford

Confronted with melting glaciers that threaten to destroy his livelihood, the Andean farmer and mountain guide Saúl Luciano Lliuya filed a lawsuit against the German energy company RWE[1] in November 2015. He demanded the firm take responsibility for its contribution to global warming and help alleviate climate-change impacts in Peru. In taking on one of the largest greenhouse-gas emitters in Europe, this is the first case of its kind and is ongoing as of 2021. This civil suit could make legal history – if Saúl wins, it could create a precedent that would make other polluting companies vulnerable to climate-change litigation. The lawsuit not only has the potential to disrupt climate 'politics as usual' (de la Cadena 2010) but raises fundamental questions about how we should conceptualize human relations and responsibility in a time of increasing planetary transformation.

Quechua-speaking farmers like Saúl have long faced discrimination by Spanish-speaking urban Peruvian elites (Poole 2004). National discourses of development take little account of rural Andean political and social concerns. Facing climate change in a context of historical marginalization, Saúl sought legal redress from a foreign polluter. Yet the international discourses of climate change in science and politics say little about those who live with the worst impacts. Growing up in the Cordillera Blanca region of the Peruvian Andes, Saúl has witnessed glaciers melting and weather patterns changing, but as a layperson, he can contribute little to technical discussions.

Those who do participate in these discussions often conceptualize climate change in terms of scale, differentiating between global processes and local impacts (Tsing 2005: 104). This 'scalar politics' sets the terms for what is considered to be reliable knowledge and who can contribute to broader discourses (MacKinnon 2011). Scientific approaches may conceptualize particular forms of knowledge as global and universal, while designating other knowledges as local (Turnbull 1997), thereby excluding laypeople from the production of global knowledge (Wynne 1998). When only scientific experts have a licence to make trustworthy public statements about the climate, laypeople are epistemically marginalized to the local sphere – even if they face the devastating impact of climate change in their everyday lives.

Building on a scalar approach, analysts and policy-makers have sought to quantify processes, impacts and possible responses related to climate change. For example, *The Stern Review* made a groundbreaking argument for political action by describing the potentially disastrous economic impacts of climate change (Stern 2007). Such approaches conceptualize climate change in terms of quantifiable impacts. Applying a 'logic of equivalence' (Li 2015), they propose technical solutions that ameliorate measurable effects. Saúl's lawsuit relies on this approach, connecting RWE's historic industrial emissions with measurable impacts in the Peruvian Andes. It alleges that RWE contributed to glacial melting that led to an increased risk of flooding for Saúl's house from the glacial lake Palcacocha. The lawsuit seeks 'to determine that the defendant is liable, proportionate to its contribution towards impairment (share of global greenhouse gas emissions), to cover the costs of appropriate safety precautions in favour of the claimant's property from a glacial flood from Lake Palcacocha'.[2] But the logics of scale and equivalence exclude what is not quantifiable, such as social and cultural displacement caused by water scarcity. Saúl fears he will lose his way of life because of global warming. Even if his lawsuit relies on a scalar model that leaves out non-experts, it has given him a platform to demand justice based on his personal experience of climate change.

Drawing on an ethnographic account of Saúl's struggle for climate justice in the Peruvian Andes, the German court system and the 2015 Paris Climate Change Summit, I will trace how scalar assumptions in scientific and political discussions have excluded non-experts from the production of knowledge on climate change. When Saúl came to the international stage of climate politics, he encountered a 'technopolitics'[3] that addressed the quantifiable impacts of climate change, but that had difficulty accounting for his experiences when they did not fit into scientific models. Through his lawsuit, he strategically deployed a technopolitical approach to make a broader claim that calls into question fundamental assumptions at the heart of many political and public discussions on climate change.[4] Drawing on his lived experience of a changing Andean environment in the Cordillera Blanca, his claim invites us to go beyond limited technical conceptualizations and consider climate change as a moral issue involving translocal relationships.

This contributes a new perspective on recent discussions of the 'Anthropocene', a controversial name for a new geological epoch in which humans are decisive in shaping the planet's environment. While the term can imply that a universal humanity is to 'blame' for climate change, critics point out that contemporary anthropogenic transformations of the planet are deeply intertwined with the rise of industrial capitalism (Tsing 2015). With his claim, Saúl argues that responsibility arises out of the relationships involved in the creation and impact of global warming. This echoes Donna Haraway's argument that responsibility arises out of two entities' ability to respond to one another (Haraway 2008). In public discussions, anthropologists can approach the Anthropocene as a 'planetary and temporal imaginary' that shapes how people conceptualize the world and its processes (Moore 2016: 41). While we might start by questioning the notion of universal culpability, anthropology can go further and contribute ethnographic perspectives that point to the specific relations among people, industry and the environment that more appropriately characterize the causes and impacts of climate change and other contemporary transformations.

The Politics of Scale: Climate Change as Global Knowledge

High up in the Peruvian Andes, above the city of Huaraz, lies the dangerous glacial Lake Palcacocha. In 1941, a large piece of ice dislodged from the glacier above the lake and fell into the water, causing a massive flood that broke the lake's natural moraine dam. This produced an avalanche of water, mud and boulders that left much of the area below in ruins and killed around 1,800 people in Huaraz (Carey 2010; Wegner 2014). Saúl's father, a baby at the time, avoided death because his family lived on higher ground outside the city. Glaciers in the Cordillera Blanca have undergone a long process of retreat since the nineteenth century (Schauwecker et al. 2014; Stansell et al. 2013). When the glacier above Palcacocha shrunk, it created space for the lake to grow. The lake reached a dangerous volume once again in 2009 (see Table 6.1). If the events of 1941 repeat themselves, a glacial lake outburst flood could threaten thousands of lives downstream (Somos-Valenzuela et al. 2016).

The two dams built in the 1970s are no longer sufficient to protect against disaster. Since the 1990s, Peru has undergone a neoliberalization

Figure 6.1. Lake Palcacocha in February 2017 (photograph taken by Noah Walker-Crawford)

and decentralization process that has greatly reduced the state authorities' capacity to build and maintain infrastructure. Budgets have been cut and, in some cases, the reforms led to ambiguities about which state agencies were responsible for particular issues (Pinker and Harvey 2015). In Huaraz, this contributed to reducing the authorities' capacity to handle glacial risks (Carey 2010), leaving thousands at risk of a flood from Palcacocha. Since 2009, the Peruvian authorities have planned to decrease the flood risk by pumping water out of Palcacocha and building a new dam. Plagued by limited budgets, infighting and corruption scandals, government agencies had yet to implement these measures as of 2021. Authorities installed temporary siphons in 2011 to reduce the water level, but experts have warned that only a new dam will sustainably mitigate the risk.

If Palcacocha floods the valley, Saúl will be among the first to face the deadly wave. His house lies in Nueva Florida on the outskirts of Huaraz, a district populated primarily by rural farmers who moved to the city to pursue economic opportunities. He divides his time between the city and the nearby village of Llupa, where his family tends to their fields. For Saúl, the government's inability to address the flood risk at Palcacocha is yet another manifestation of the authorities' unwillingness to support their most vulnerable populations: 'We receive no support, no development from the state.'[5] Other ethnographies have described a sense of state abandonment among rural Andean Peruvians. Authorities promise support and development, but often fail to provide meaningful social and economic opportunities (Harvey 2005; Rasmussen 2015). Saúl has argued that politicians hail grand investments in industrial development but give little priority to agriculture.

Such political promises fall within a broader narrative of progress and development. This promotes a politics of scale that celebrates national economic growth and marginalizes farmers who have little to contribute in monetary terms. Scale in this context figures as a measure of significance. Theorizing the politics of scale, MacKinnon argues that powerful social actors can legitimize social control by associating themselves with

Table 6.1. The evolution of Lake Palcacocha (sources: Somos-Valenzuela et al. (2016); Portocarrero Rodríguez (2014); Cochachin and Salazar (2016))

Year	1941 pre-flood	1974	2003	2009	2016
Volume (m^3)	10–12 million	0.5 million	3.8 million	17.3 million	17.4 million

'higher' scales, such as the national scale. At the same time, they may disempower subaltern groups by confining them to the 'local' (MacKinnon 2011: 24). This reflects the discursive separation between experts and laypeople as the latter are usually relegated to the disempowered local scale. Recent multinational mining operations in the Peruvian Andes have led to significant growth in macroeconomic terms but have provided limited benefits to rural populations whose concerns are rarely taken into consideration (Bebbington and Bury 2009; Li 2015). For many rural Peruvians, scalar politics promoted by the urban elite have become a measure of exclusion and abandonment.

In this context, Saúl faces a dramatic environmental shift that he came to associate with climate change. He first encountered the latter concept through the media, public discussions, and conversations with tourists through his work as a mountain guide. He has lamented that in addition to the visible recession of glaciers, annual rain cycles are increasingly imbalanced. His community used to expect heavy rains at the end of the dry season in August, which made it possible to plant crops, but now they often wait weeks or even months for the rains to come. Unlike those in previous decades, rains are now more often torrential, causing damage to crops. New agricultural pests such as fungi and moths have appeared. Extreme-weather events are more frequent, with early-morning frosts threatening entire harvests in the dry season.[6] Locals are concerned that glacial retreat might threaten tourism by climbers, an industry that provides significant income for rural farmers in the area. Glacial meltwater feeds the rivers that farmers rely on for drinking water and irrigation. Saúl has expressed fear that the area might dry up if glaciers disappear, making agriculture impossible.[7] As the Andean environment becomes increasingly unstable, these changes exacerbate the marginalization and vulnerability that Saúl and many of his compatriots already feel. According to scientific conceptions that Saúl and others in the area have begun to adopt, climate change is a global process that encompasses the planet and is mainly caused by industrial emissions and contamination across the world.

I first met Saúl in late 2014 when I was working with the German nongovernmental organization (NGO) Germanwatch. After attending the United Nations (UN) Climate Summit in Lima, we travelled to Huaraz, where a mutual friend introduced us to Saúl. For the people at Germanwatch, he was an exemplary person facing the challenges and injustices of climate change. As he wanted to make a public claim against the polluters he considered to be responsible for destroying his mountain environment, the NGO put Saúl in contact with the German environmental lawyer Dr Roda Verheyen, who was at the forefront of international discussions about climate litigation. She saw an opportunity under German law to make a company responsible for its greenhouse-gas emissions in relation to climate risk in Peru. Thanks to its operation of coal-fired power plants since it was founded in 1898, the energy company RWE is the largest German emitter. Germanwatch offered to collect donations and foot the bill for all costs related to mounting a legal case. With this support, Saúl decided to file the civil suit against RWE for its contribution to the risk of floods at Palcacocha, which threaten his property in Huaraz.

As the legal claim progressed, I facilitated contact between Saúl and his lawyers, and accompanied him on visits to Europe. In addition, I contributed to the lawsuit's scientific argumentation. Later, I left Germanwatch and began an ethnographic investigation of people's engagement with climate change around the city of Huaraz. As I conducted fieldwork in Saúl's village and neighbouring areas, I remained in close contact with him and continued to accompany him on his travels as an interpreter and advisor.

Drawing on a scientific study (Heede 2014), the lawsuit claims that RWE produced 0.47 per cent of historic industrial emissions. Accordingly, Saúl requested that the company contribute 0.47 per cent of the costs for the government project to reduce the volume of the water and to build a new dam at Palcacocha. This amounts to around US$20,000, which Saúl would receive if he wins. He has pledged to contribute the money to the regional government's lake safety project. This is small change for a large company, but the precedent could have immense repercussions. If he wins, millions of other plaintiffs affected by climate change could potentially seek compensation in the German courts. In addition, this could set the basis for similar lawsuits in other jurisdictions. Past emissions would become an immense economic liability.

Saúl's lawsuit draws on scientific publications to argue that a causal link exists between RWE's emissions in Germany and flood risk at Palcacocha in Peru. Describing the general processes of global warming, it relies on reports from the UN's Intergovernmental Panel on Climate Change (IPCC) that summarize and synthesize academic research on climate change.[8] Regarding the Cordillera Blanca, the lawsuit cites recent scientific studies to argue that 'increased rates of glacial melting are caused by global climate change and the risk of a glacial lake outburst flood is hence increased'. It draws on further studies and Peruvian government reports to argue that Saúl's property in Huaraz faces an imminent flood risk from Palcacocha. Though a potential flood would affect thousands in Huaraz and surrounding areas, the legal framework prescribes an individualizing perspective that focuses on Saúl rather than on the collective.

Making the Local Legible

Couched in scientific and legal terminology, the lawsuit presents evidence that differs greatly from Saúl's experience of climate change in his daily life. While the lawsuit describes how industrial greenhouse-gas emissions likely contributed to measurable glacial retreat in the Peruvian Andes, climate change for Saúl means that his life is steadily turning upside down: as the glaciers above his home rapidly retreat, he can no longer rely on regular rainfall for agriculture. This speaks to a broader issue. Marino and Schweitzer warn of an epistemological politics that haunts climate-change discussions and gives precedence to scientific insights over experiential knowledge (Marino and Schweitzer 2009: 216). According to the IPCC, research on climate impacts and vulnerability has insufficiently considered interlinked social, economic and cultural factors (IPCC 2014: 11). Nygren argues that traditional scientific approaches often posit a dichotomy between scientific and local knowledge. Within this framework, science is seen as the only valid form of universal knowledge (Nygren 1999). Such an approach inadvertently but systematically suppresses 'local' knowledges because laypeople typically cannot contribute to scientific insight (Wynne 1998). In the 1950s and 1960s, rural Andeans in the Cordillera Blanca faced exclusion from scientific discourses when government officials mapped the development of glacial lakes. Rather than relying on local Quechua names, they gave each lake a number. 'For engineers and government officials, the supposedly objective quantification of physical environments often demonstrated the efficacy of Western science and engineering over local folk knowledge' (Carey 2010: 85).

Saúl's lawsuit builds on a scientific conception of climate change as a global issue with varying local impacts.[9] This scalar approach draws attention to measurable scientific conceptions of environmental change while excluding perspectives – such as Saúl's experience of a shifting environment – that do not fit into the dominant framework. The act of scaling can impose a particular perspective in order to identify and study different features of our social world and environment (Hastrup 2013). Scaling simplifies complex social relations and transnational linkages by ordering discourses and phenomena into different categories of varying significance (Strathern 2005). According to Anna Tsing, general-circulation models that represent the global climate rely on a scalar framework whereby the 'global scale is privileged above all others' (Tsing 2005: 102). The German court system draws on such a framework to set the standards of epistemological legitimacy: it privileges scientific knowledge over contributions from Saúl based on his engagement with the Andean environment. Saúl could merely provide anecdotal knowledge that exemplifies scientific insights.

In recent decades, scientific researchers have sought to integrate local perspectives into studies of the environment. In the field of natural resource management, academics and practitioners have incorporated 'traditional ecological knowledge' into scientific frameworks (Cruikshank 2005). Seeking to participate in scientific discussions, anthropologists and other researchers have drawn on ethnographic insights to produce data that is legible for natural scientists and can therefore be included in their climate models and scientific studies of climate (Roncoli, Crane and Orlove 2009: 104).[10] Finan (2009: 176) argues that these contributions can provide a 'human face' to climate-change research. However, drawing on an ethnography of Sami farmers in Lapland, Ingold and Kurtilla suggest that such approaches may involve a conflation of concepts. Describing a research project that sought to determine how scientific data on climate change relates to local experience, they found that scientists talked about climate while locals were concerned with weather: 'Climate is an abstraction compounded from a number of variables … that are isolated for purposes of measurement. Weather, by contrast, is what it feels like to be warm or cold, drenched in rain, caught in a storm and so on' (Ingold and Kurtilla 2000: 187). Cruikshank argues that if researchers seek to integrate local approaches, they risk subordinating them to dominant scientific frameworks. Through synthesizing and systematizing knowledge, we may lose the human experience at its base. Local insights become an 'object for science rather than [being] intelligence that could inform science' (Cruikshank 2005: 257; see also Nadasdy 1999). According to this scalar framework, laypeople can merely provide local examples – such as weather data – relating to broader phenomena.

Recognizing that scientific models cannot capture the full meanings of people's engagement with weather and the environment, anthropologists have sought to contribute critical perspectives in climate-change discussions: 'our responsibility is to interrogate and challenge prevailing scientific views and perspectives, rather than to bring a perspective on social, cultural, and economic life that merely confirms them' (Crate and Nuttall 2009: 396). Emerging out of situated practices, scientific knowledge claims universality through its discursive framework (Wynne 1998). Recognizing this, we can study, ethnographically, how people draw on different knowledges to make sense of environmental change. In her ethnography of climate-change discourses among scientists, policy-makers and activists, Callison (2014) traces how different groups translate climate change into terms that are meaningful and relevant for them. These often relate to moral and ethical concerns about how humans should interact with each other and their environment. In this context, facts gain legitimacy and significance from varying epistemological frameworks.

Accordingly, she argues for a conception of climate change that accounts for its many possible meanings (Callison 2014)

As suggested above, Saúl's lawsuit draws on a scalar notion of climate change that privileges a global perspective over local insights. His conception of climate change is based both on scientific accounts and his engagement with the Andean environment – what Ingold and Kurtilla might call 'weather'. While Saúl's opinion had a subordinate standing in the courtroom, the lawsuit gave him a platform to make a broad argument for climate justice based on multiple forms of knowledge.

Addressing Climate Change: Technopolitics in the Courthouse

In November 2015, Saúl travelled with his father to Germany to submit the lawsuit. He was nervous about the prospect of leaving Peru for the first time. On a freezing morning in the city of Essen, where RWE has its headquarters, he approached the regional courthouse. The press had been alerted and a television film crew awaited him. He had come to face

Figure 6.2. Saúl at the courthouse in Essen (photograph by Alexander Luna, used with permission from the photographer and Saúl Luciano Lliuya)

a powerful company to defend the glaciers that gave him life and threatened death. Feeling a mixture of excitement, fear and determination – as he later told me – he submitted his lawsuit to the court. At a press conference later that day, he explained his motivations: 'I'm presenting my case here in Germany because this is an issue of justice. RWE should be held accountable for its pollution.'

After filing the lawsuit in Essen, I accompanied Saúl with a Germanwatch delegation to Paris, where we attended the UN Climate Summit. While these summits revolve around technical negotiations between national delegates, they also involve numerous side-events staged by NGOs and activists trying to make their voices heard. As thousands of delegates ran about the conference grounds and campaigners vied for attention, Saúl fed the media's and general public's appetite for human stories representing the complex processes of climate change. For many, his struggle gave a face to the countless people confronting the injustices of global warming. Exemplifying the UN summit's inherent scalar politics, Saúl came to epitomize the local 'victim' of climate change.

While he made a strong moral argument for climate action, Saúl had difficulty engaging with technical and political discussions around climate change at the conference. This became evident in a panel discussion on companies' accountability for climate change. The event took place at a school, where activists had organized an alternative People's Summit. He arrived at a classroom in which four panellists sat in front of a small audience. The speakers were notable scientists and environmental lawyers at the forefront of legal and scientific discussions on climate justice.[11] They were delighted to have Saúl in the room. As one of the first people to take legal action against a major corporation over climate change, Saúl was a rising star in the world of climate justice.

The panel discussion revolved around scientific and legal strategies to hold major greenhouse-gas emitters accountable for climate change. According to the panellists, climate change raises ethical questions of responsibility. One of the speakers was Richard Heede, a natural scientist who had spent more than a decade quantifying this ethical dimension in terms of major companies' proportionate emissions. Such studies provide lawyers with an evidential basis to develop legal claims against emitters. Saúl's lawsuit, which became a major issue of discussion on the panel, follows this approach.

Though his claim was at the forefront, Saúl felt he had little to contribute. He followed the discussion through an interpreter and possessed limited technical knowledge of the issues at stake. Soon, he began to doze off. As some of the world's top climate scientists and environmental lawyers discussed his lawsuit's strategy and its political ramifications, he struggled to keep his eyes open. He later explained that while scientists did valuable research and handled statistics about climate change, they might not always grasp how communities experience these processes. Every place has its own beliefs, practices and histories that are interwoven with past and contemporary environmental change. For Saúl, the mountains gave his community life. 'In a scientific sense', he told me in an interview, 'the mountains conserve water which people, animals and plants depend on, but they're something more than that as well.' For him, the snow-capped mountains surrounding his village were beings that he respected.[12] He worried what would happen to these beings when the glaciers melt and the snow disappears. At the panel discussion in Paris, his experiential knowledge of climate change seemed out of place – it was merely a nonscientific 'local' example in a 'global' scientific discussion.[13]

In the following days, Saúl gave numerous interviews to the international press and spoke at several events. Delegates at the conference talked about climate change, but in a way that he could not easily engage with. The climate negotiations involved a 'technopolitics' that sought to keep the ongoing transformation of the planet's environment under control. Timothy Mitchell defines the term 'technopolitics' in reference to scientific projects in colonial and postcolonial Egypt to harness the powers of nature. In practice, these projects often failed when the environment did not fit the scientific conceptions, but offered unexpected resistance (Mitchell 2002). At the UN Climate Summit, thousands of delegates had gathered to discuss endless minute details pertaining to the draft agreement. When they spoke in meetings and press conferences, they discussed climate change in terms of how many hundreds or thousands of megatons of greenhouse gases a country emitted, how much money governments should contribute to international climate funds or to which overall degree global warming should be limited. Saúl found it difficult to relate to these technopolitical discussions, which spoke little to his own experience of watching glaciers disappear and feeling rain patterns change. The negotiations revolved around a technopolitics that hailed a grand project to limit the extent and impact of global warming, but that largely excluded local and subnational perspectives that did not meet scientific standards of evidence.

Technopolitical terminology serves policy-makers as a means to quantify and document climate processes in their search for effective solutions. Quantifying problems can create an impetus to offset a measurable loss by offering benefits of an equal value. For example, economic losses in a particular area due to climate change can be balanced by creating new economic opportunities. This involves a 'logic of equivalence'. Fabiana Li defines the latter concept in her ethnographic research in the northern

Peruvian Andes, where conflicts between farmers and mining companies often involved claims of equivalence. When the expansion of mining led to the contamination of farmers' water sources, the company offered to provide treated water and compensation payments. Many farmers rejected this logic of equivalence, which emerged from a scientific understanding of the environment and disregarded alternative knowledges and forms of value attributed to the landscape (Li 2015).

Legal cases often involve claims of equivalence, which can turn political debates into technical discussions that ultimately turn on a monetary calculus. Antina von Schnitzler describes a lawsuit in South Africa by five Soweto citizens against their government over the constitutional right of access to water. The authorities had installed prepayment water meters to combat widespread nonpayment for public services. With the meters, households received 6,000 litres of free water every month, but had to pay if they wanted to use more. The claimants argued that this amount was insufficient for large families and thus violated their human dignity. The court had to determine what amount of water equated to the abstract value of human dignity (von Schnitzler 2014).

In a similar vein, Saúl's lawsuit demands that RWE contribute a share of the costs of reducing flood risk at Palcacocha proportionate to the company's historic contribution to anthropogenic climate change. It builds on a scalar approach that invokes climate change as a global process with both local causes and local impacts. Building on a scientific quantification of RWE's historical emissions, it draws a line of causation from the company's factories in Europe to climate-change impacts in Peru and then translates this relation into the sum of US$20,000. According to von Schnitzler, legal cases usually depend on expertise to set the parameters for an issue, showing the court what is relevant and where it can intervene. This often produces a 'legal technopolitics' that turns political questions into legal-technical issues (von Schnitzler 2014: 340). Saúl's lawsuit involves a technopolitics that turns the broad issue of who should assume responsibility for climate change impacts into a legal-technical question of how much RWE should pay Saúl in proportion to its emissions. At the UN, negotiators framed the political question of engaging climate change as a technopolitical issue of equivalence when they proposed technical solutions to problems that are made visible through scientific measurement.

As we spoke one day at the Paris summit, Saúl expressed his worry that policy-makers might come up with misguided solutions if they insufficiently addressed people's concerns with climate change impacts. He explained that political decisions in Peru were usually made by civil servants who are not familiar with the livelihoods they shape through their actions. Sometimes they made bad decisions because they did not know the reality of rural life. He feared the same could occur with decision-makers and scientists at the Paris summit. They had scientific facts and statistics, but these did not tell the full story of climate change. Every area had its own problems. Reading scientific reports was useful, he said, but to truly know a problem, you must live it. For him, the elites of the international climate circuit typically lacked this intimate and crucial knowledge of climate change.

Climate-adaptation projects may offer misguided solutions if they do not consider climate-change impacts in relation to people's situated conceptions of value and significance in their engagement with the environment. Saúl's lawsuit reduced his broad concerns to a claim of equivalence. If RWE pays him because of a court decision, it absolves itself of its legal responsibility in relation to him for this particular case. For Saúl, climate change concerns much more than US$20,000 or any other quantifiable sum – it involves not only the risk of flooding, but also his fear that glaciers will disappear and agriculture may no longer be viable. The figure distorts his aspiration that RWE should take responsibility for obstructing his lifeworld. However, he was not concerned about winning US$20,000 – even if he does, he would not benefit personally, as the money would go to regional authorities in Peru to finance flood safety works at Palcacocha. However, he did consciously mobilize the claim to make a symbolic argument that trumped monetary considerations. He employed a logic of equivalence to create a platform for his broader moral claim. According to Marisol de la Cadena, mainstream Peruvian 'politics-as-usual' disregards rural conceptions of a sentient Andean environment – for example, politicians do not consider earth beings to be valid participants in mining disputes (de la Cadena 2010). At the UN, climate politics-as-usual excluded ideas about climate change that did not fit into the scalar framework of technopolitics. Countering climate politics-as-usual, Saúl intervened in the wider discussions at the Paris summit with his claim for climate justice by strategically deploying multiple meanings and knowledges of climate change.

Tracing 'Response-ability'

Saúl's claim produced a strong resonance among many climate activists at the Paris summit. One evening, he joined several hundred people at an event promoting climate justice in a Parisian church. Speakers from a wide variety of countries spoke at the gathering, arguing that governments should finally act to stop global warming and help those who are worst affected. Saúl was asked to address the crowd; so nervous his hands were shaking, he overcame his fear of speaking in front of other people and stood up. He told the gathering that he came from the Peruvian Andes, where he could see the effects of climate change. Melting glaciers had caused a lake to fill up with water and it was now threatening to flood his house. Because he was not responsible for this situation, he had decided to file a lawsuit against RWE. The people applauded. For many in the audience, most of them European activists, Saúl projected a strong emotional force. Numerous spectators approached him in the following days to offer congratulations and encouragement, boosting his confidence and motivation. Following his public appearances and media attention, he became a climate-justice celebrity at the Paris conference (Avila 2015; Endres 2015; Seidler 2015; WCEL 2015).

At the church, Saúl no longer faced the difficulty of engaging with technopolitical discussions as a layperson. For the activist crowd, his experience of climate change legitimized his moral commitment to make emitters responsible. He gave numerous interviews to the press, which reported on his perspective in international media outlets. This points to an epistemological ambiguity in public discussions on climate change: even if political decision-making relies on scientific expertise, non-experts can make compelling moral arguments in an attempt to shift the debate. In his public remarks at the Paris summit, Saúl combined scientific evidence with his experiential account of climate change. This allowed him to make a claim that has the potential to unsettle climate politics-as-usual by asserting a relationship of responsibility between himself and RWE. Transcending the local and global scales, he drew a link between those who contribute to climate change and the people who face its consequences in the first instance.

For Saúl, this link implied that RWE was responsible for helping him address the impacts of climate change. His assertion is reminiscent of Donna Haraway's argument that if two entities are able to respond to each other, they are involved in a relationship of responsibility. She presents this as an ethical framework for shaping relations between people and animals (Haraway 2008: 71). Kregg Hetherington builds on Haraway's notion of 'response-ability' in his article about Paraguayan farmers' struggles against soy-bean cultivators. He argues that agriculture is based on a mutual responsiveness between farmers and crops. If farmers are attentive to their plants' needs and respond with appropriate interventions, crops will have higher yields. In much the same way, he describes, farmers have responsive relations with each other, chemicals, crop pests and soy-bean cultivators. These relations of responsiveness are usually dynamic and unpredictable (Hetherington 2013).

Over the course of his life, Saúl has engaged in responsive relations with his Andean environment. As a farmer, he responds to the needs of his fields and crops. When he guides tourists on climbing tours, he heeds the mountain's warnings. But in recent years, the environment has begun to respond in new and unexpected ways. As crop yields have decreased and weather patterns have shifted, farmers struggle to respond to unprecedented ecological instability. Faced with this situation, Saúl felt a responsibility to protect 'his' mountains and compatriots.

Haraway uses 'response-ability' as an ethical framework: if we can respond to one another, our responsibility is to treat each other well. Her approach can also serve as an analytical framework for capturing Saúl's understanding of climate change and responsibility. Scientific approaches often posit a nonpersonal 'objective' notion of causality, which obscures the agency of the Earth and its inhabitants (Latour 2014). Drawing on the notion of responsiveness, we can account for active engagements between people and environment. Rather than stratifying the world in terms of global processes and local events, this highlights the complex, cross-scale and cross-level interrelationships that bring about social and environmental change.

Climate change entails a process of responses between humans and other beings, environments and materials. In response to an ever-increasing demand for commodities, mobility and energy, organizations and individuals have extracted and burned fossil fuels, releasing more and more greenhouse-gas emissions into the Earth's atmosphere. The atmosphere responded by increasingly insulating the sun's rays as the increased concentration of greenhouse-gas particles prevented more of the energy from escaping. Many regions of the Earth slowly became warmer in response to the increased energy kept within the atmosphere. Glaciers in the Cordillera Blanca responded by melting and receding at unprecedented rates. Witnessing such dramatic shifts across the planet, governments and activists initiated an international process under the auspices of the UN in 1992 to negotiate a political response. In 2015, facing governments' continued failure to find adequate solutions, Saúl Luciano Lliuya responded to the ever-increasing threat of climate disaster by suing RWE. From the company, he sought to elicit a response to help him and his community. He wanted to make RWE assume its share of responsibility.

Transcending the restrictions of a strict scalar interpretation of climate change, this approach provides an enticing perspective on recent discussions in the natural and social sciences about humans' impact on the planet. In August 2016, a group of scientific experts at the International Geological Congress took a controversial step when it argued that the

Earth should officially be considered to have entered the Anthropocene, a new geological epoch in which humans are shaping the planet's environment more than any other factor (Carrington 2016). The concept of the Anthropocene arose from scientific discussions over the past decades on humankind's impact on the planet's material layers. As social scientists picked up on the debate, the historian Dipesh Chakrabarty argued that humanity has now become a geological agent – determining the planet's present and future (Chakrabarty 2009). According to Bruno Latour, the Anthropocene exemplifies humans' intertwinement with an Earth that possesses a forceful transformative agency (Latour 2014).

The Anthropocene sets a discursive framework that shapes how we think about the world and the possibilities we see for it (Moore 2016). Taking the Anthropocene at face value, we might find that all of humanity (or at least all of it since the Industrial Revolution) is responsible for glacial retreat in the Peruvian Andes. This involves a scalar notion of global processes and local impacts. But for Saúl, humanity as a whole should not be held accountable: industrial greenhouse-gas emitters are more responsible than most individual people and institutions. Critics argue that the Anthropocene implies a universalist notion of humanity, implicating all people in contemporary planetary transformations (Macfarlane 2016). These transformations are not an inevitable development for humans as a species, but emerged out of particular contingent histories of modern capitalism, which entailed an increased exploitation of diverse landscapes and ecologies (Tsing 2015). Saúl's claim points to the fundamental inequalities at the heart of these processes. Driven by demand for industrial products, a small number of companies and countries have produced an inordinate share of greenhouse-gas emissions, while those – largely at the margins of the global economy – who suffer the worst impacts have contributed little to the Earth's pollution. Saúl's argument invites us to re-examine universalist notions of humanity and responsibility in discussions of the Anthropocene. Overcoming a restrictive scalar framework, we can trace the planet's contemporary transformations by following the responsive relationships between particular actors and environments.

Conclusion

The Paris Climate Change Summit ended in December 2015 with a celebrated agreement that seeks to limit global warming to 1.5–2°C, but that does not legally bind governments to implementing specific measures. Saúl travelled back home to his community in Peru, which continues to face the challenge of living in a deteriorating environment. While the lawsuit against RWE sought to help Saúl's region mitigate climate risk, it also set a standard of evidence that privileged a scalar framework of scientific knowledge. This granted little standing to those who lack academic credentials but can feel the environment changing around them. It also individualized the issue by focusing on Saúl, hiding the challenges his wider community faces. Reflecting a broader political discourse, the lawsuit proposed technical solutions couched in a logic of scale and equivalence. Such technopolitical approaches fail to account for the complex understandings of climate change that Saúl and others have gathered through engaging with their environment. Nevertheless, Saúl's lawsuit gave him a platform to contribute to public discussions in Germany and beyond, where epistemological legitimacy is often ambiguous and contested. He drew on different forms of knowledge to argue that responsibility for climate change should arise from the relationships that bring about environmental change. A focus on these links calls into question the politics of scale in climate discussions – it turns climate change from a global issue to a matter of translocal relationality.

After the conference, Saúl returned to his village in Peru as a celebrity. The news spread to his home via newspapers, social media and word of mouth. While some supported his efforts, others were more critical: where were the practical benefits? How would this help people in their daily lives? At the same time, malicious rumours of Saúl engaging in the cause for his own personal benefit began to spread. Some even claimed that he went to Germany to sell Lake Palcacocha. While many have come to see Saúl as a climate-justice hero on the international stage, his position in his own community was much more ambivalent.

As ethnographers, we are well equipped to study how people engage with contemporary environmental transformation. The example of Saúl's claim demonstrates that climate change has multiple and entangled meanings. Anthropologists not only contribute local data to scientific research; they also point to the fact that the issues at hand may be more complex than scalar frameworks and technopolitical approaches suggest. Drawing on ethnographic insights, we can highlight which aspects might be neglected in scientific and political discussions of climate change.

If the Anthropocene becomes an increasingly popular concept for describing our contemporary predicament, we will require critical discussions in national and transnational contexts about what responsibility should entail in an age marked by human transformation of the environment. Recognizing that the idea of the Anthropocene can shift people's understanding of global transformation, sociality and environment (Moore 2016), anthropology can provide a critical perspective on the diverse epistemological approaches and contested notions of responsibility that emerge through social engagements with climate change and the Anthropocene. Such analyses must account for the conceptual limits of the Anthropocene and should consider how it may deploy a scalar politics that excludes particular insights. This can contribute to broader scientific and public discussions that seek political responses to contemporary transformations.

In its legal reply to the claim, RWE deployed extensive legal and scientific arguments to deny the applicability of climate change as a causal link for responsibility. After the case was dismissed by the lower court in December 2016 on the basis of legal technicalities, the Higher Regional Court in Hamm allowed a hearing for the lawsuit in November 2017. In a landmark decision, the judges argued that RWE could be held responsible for climate-change impacts if the facts held up.[14] As of June 2021, the lawsuit had entered the evidentiary phase, with the court examining, on the basis of scientific expertise, whether RWE's contribution to climate risk in Huaraz could be traced and quantified. RWE's representatives surely realized that the lawsuit involved much more than US$20,000 – it could set a legal precedent that may redefine the meaning of responsibility in climate politics. 'The lawsuit is a good beginning to stop global warming and glacial retreat', said Saúl. 'The big companies need to be conscious of the damage they're causing. But what we really need to do is change the economy; to come up with an economy that's clean and ecological. That's something we all need to work for.'

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Noah Walker-Crawford completed his Ph.D. in Social Anthropology at the University of Manchester. His work focusses on the knowledges and notions of responsibility at stake in discussions about climate change. His research follows climate justice claims between the Peruvian Andes, German courts and UN Climate Summits, exploring how legal activism reframes climate politics.

Notes

1. The acronym derives from 'Rheinisch-Westfälisches Elektrizitätswerk' (Rhenish-Westphalian power station), the company's official name until 1990.
2. See p. 2 of the redacted version of the lawsuit (*Saúl Ananías Luciano Lliuya v RWE AG*, Reference Number 2 O 285/15 at Landgericht Essen [Regional Court Essen]) available at https://germanwatch.org/sites/default/files/announcement/20822.pdf. All citations are translations by the author from the original German. For further court documents, including unauthorized English translations, see germanwatch.org/en/huaraz.
3. 'Technopolitics' refers to a 'politics based on technical expertise' and excludes nonscientific perspectives (Mitchell 2002: 41).
4. Saúl's assertions relate more closely to ongoing discussions about climate change and justice in small-island developing nations (see Kelman 2010).
5. All quotations from Saúl are the author's translation from Spanish.
6. For discussions of the impacts of climate change on small-scale agriculture in the region, see Heikkinen (2017); Mark et al. (2017).
7. See Bury et al. (2013) for a discussion of climate change, glacier runoff and water use in the region.
8. It draws in particular on the reports of Working Group I ('The Physical Science Basis') and Working Group II ('Impacts, Adaptation, and Vulnerability') of the IPCC's Fifth Assessment Report (the reports are available at www.ipcc.ch/report/ar5).
9. The lawsuit draws on IPCC reports that only integrate peer-reviewed scientific research, making it difficult for non-experts such as Saúl to contribute.
10. For example, Green, Billy and Tapim 2010; Nyong, Adesina and Osman Elasha 2007; Riedlinger and Berkes 2001.
11. The panellists included the scientists Peter Frumhoff (the Union of Concerned Scientists) and Richard Heede (Climate Mitigation Services) as well as the lawyers Carroll Muffett (the Center for International Environmental Law) and Andrew Gage (West Coast Environmental Law).
12. For a discussion of people's relations with earth beings in the Peruvian Andes, see de la Cadena (2015).
13. Marisol de la Cadena presents a similar case in which protestors involved in a mining conflict in the southern Peruvian Andes were concerned that a proposed project would affect mountain beings, but they chose to emphasize scientific environmental concerns when approaching state authorities so as to lend their claim more legitimacy (de la Cadena 2015: 275).
14. An unauthorized English translation of the decision is available at: https://germanwatch.org/sites/default/files/announcement/20812.pdf.

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Part III

Flows of Knowledge

Chapter 7

Making Sense of Climate Science

From Climate Knowledge to Decision-Making

Maria Ines Carabajal and Cecilia Hidalgo

Producing climate information in order to enhance decision-making processes is a long-term challenge faced by academic and operational institutions (i.e. meteorological, hydrological and agricultural organizations). Despite the celebrated advancements of climate science in monitoring and forecasting, there are still gaps between the climate knowledge that is being produced and its social and widespread use (Baethgen, Carriquiry and Ropelewsk 2009; Funtowicz and Hidalgo 2008; McNie 2013; Meinke et al. 2006; WMO 2012). Climate information is under-utilized for various reasons: limitations inherent to the climate system (e.g. in the variables that can be monitored or predicted, temporal and spatial scales of prognostic information – Baethgen, Carriquiry and Ropelewsk (2009)); technical aspects of the information (e.g. the communication of probabilistic information or the timely release of information to meet decision-making needs – Cash, Borck and Patt (2006)); cognitive factors that influence the way users perceive the science-generated information (e.g. in terms of communication, trust, credibility, accessibility and experience – Bowyer, Brasseur and Jacob (2014); Cash and Buizer (2005); Peterson et al. (2010)); institutional arrangements or procedural factors that constrain the use of new knowledge (e.g. rigid operating protocols – Hidalgo (2018); Podesta, Hidalgo and Berbery (2013); Srinivasan, Rafisura and Subbiah (2011); Taddei (2008); Vaughan and Dessai (2014)); or structural factors that shape the capacity and willingness of different decision-makers to use information (e.g. lack of access to knowledge or of choices regarding alternative technologies or policy changes – Rayner, Lach and Ingram (2005)).

Since 2009, in order to overcome this under-utilization, the exploration of channels of communication and of innovative partnerships between scientists, operational institutions and stakeholders has become a priority in South America. In line with the Global Framework for Climate Services (GFCS) (2009) launched by the World Meteorological Organization (WMO), the aim of providing climate services in the region has made apparent the need to build a 'User Interface' to facilitate sustained interaction between producers of climate information and those who need to interpret and make sense of it, be they intermediate users (i.e. academic or operational professionals) who work on climate products (maps, reports, models, etc.) or end users (agricultural producers, farmers, peasants, governmental agents, etc.) who make decisions on the basis of climate information. The GFCS brought together many initiatives that were conceived as part of a 'new paradigm' of meteorologists, hydrologists and agronomists collaborating in academic and operational organizations. However, in this region there was found to be a lack of knowledge concerning who the users were and how they understood climate products. Social scientists were invited to participate in, and facilitate, the monitoring and implementation of the new paradigm. The authors of this chapter became 'embedded anthropologists' within a large research network committed to the provision of climate services in southeastern South America. This chapter is based on this ethnographic research and presents an account of the interinstitutional collaborative process in Argentina, which first targeted the agricultural sector. Our fieldwork, carried out from 2013 to 2017, has provided valuable insights into the challenges and potentialities involved in the creation of workshops, where experiences and knowledge were exchanged by climate-information providers and three different types of users: intermediate users – a wide range of academic, governmental, research and resource-management institutions; end users connected with large farming associations and grain-exchange institutions; and end users who were small goat producers and rural students from vulnerable areas of the country (rural zones in the north of the Santiago del Estero Province).

Disparate and often contested ways of making sense of climate science came into play in these 'user spaces'. In this chapter, we first focus on the global context that framed the actions taken at regional and national levels to promote a deeper involvement of the agricultural sector. We then describe the process of building a user-interface platform, which required diving into the complex world of farms and other organizations from the agricultural sector. This sector involved many potential and existing types of users that need information about the average seasonal conditions to make decisions. As a matter of fact, each type of user brought to light obstacles to be overcome by academia and the institutions responsible for monitoring and producing seasonal forecasts in Argentina. This forecast is also known as 'Seasonal Outlook', a quarterly forecast of precipitation and average temperature for the next three months, which is issued monthly.

The lack of a preliminary mapping and characterization of the audience to be invited to participate in these workshops was a main difficulty. A proper identification of who the 'users' were and how they used and made sense of climate information emerged as a gradual consequence of face-to-face interactions and interinstitutional engagement. An increasing 'sense of ownership' (Dilling and Lemos 2011) of the problem of the gap between the climate knowledge that was being produced and the social appropriation of such information grew among the participants in the workshops. A reflexive process regarding the link between information providers and end users was triggered. Institutional scientific reflexivity and self-examination became crucial to making knowledge relevant to society (Hidalgo 2006; Rayner and Malone 1998). While the workshops were designed and organized with the stakeholders, the active commitment of the anthropologists involved in the process nurtured reflexivity and awareness of the complex nature of building relationships and ensuring their sustainability over time. Furthermore, collaboration triggered a self-reflexive stance that transcended the issue of the provision of climate services to urge a collective consideration of how to improve the social appropriation of knowledge.

Methodology

The authors of this chapter are anthropologists who carried out fieldwork within the framework of a five-year project, funded by the Inter-American Institute for Global Change Research (IAI) and entitled 'Towards Usable Climate Science: Information for Decision-Making and the Provision of Climate Services for Agricultural and Water Sectors of Southeastern South America' (2013–18). One of the authors was the Principal Investigator (PI) of the project and the other recently obtained a Ph.D. as a doctoral fellow. Researchers of climate sciences, social sciences and agronomy, as well as a wide range of stakeholders (government agencies and nongovernmental organizations (NGOs)) of Argentina, Brazil, Paraguay and the United States constituted a Collaborative Research Network (CRN3035) to contribute to the provision of climate services in southeastern South America. A major design feature of the project was a close partnership and continuous interaction with the Regional Climate Centre for South

America (RCC-SSA) recently established by the World Meteorological Organization's Regional Association III (WMO-South America). The challenge to coordinate and participate in such a complex, multinational, multi-institutional and interdisciplinary team shaped the expectation that an approach in which social sciences were essential components would make a difference in some way.

Fieldwork involved participant observation during regular interinstitutional meetings, including a monthly meeting held at Argentina's National Weather Service, where institutions that produce and/or use climate information debate and jointly formulate a national quarterly publication, *Climate Outlook* (Barnes et al. 2013; Fiske et al. 2014). The authors also participated in institutional and academic events, conducted personal visits to organizations responsible for producing, managing and communicating hydroclimate information in the region, and carried out more than 50 interviews with institutional representatives, scientists from different backgrounds, technicians and experts.

The Global Framework for Climate Services

This project was proposed in 2013, when the concept of 'climate services' adopted by the WMO began articulating the agendas of meteorological and hydrological institutions at a global level. The US National Research Council's Board on Atmospheric Sciences and Climate defined climate services as 'the timely production and delivery of useful climate data, information, and knowledge to decision makers' (National Research Council 2001: 2). The interest in climate services was triggered by an increased awareness among policy-makers and the general public about the importance of weather and climate for climate-sensitive sectors and the sustainable development of society. Growing concerns about the direct and indirect socioeconomic impacts of climate variability, climate change and high-impact weather events oriented the attention of WMO members towards the satisfaction of fundamental global societal needs, such as food security. In response to the growing demand for actionable climate information, the WMO developed the GFCS, which promotes the use of relevant science-based climate information and prediction. The main objective of the GFCS is to enable societies, especially those that are deemed most vulnerable to climate-related hazards, to better manage the risks and opportunities arising from climate variability and change (Hewitt, Mason and Walland 2012).

The Framework consists of five components or pillars, which are illustrated in Figure 7.1.

The 'User Interface Platform' (UIP) pillar underlines the centrality assigned to the achievement of a sustained interaction between producers and users of climate information. However, building such a platform, rather than a merely informational device, presupposes at least a preliminary acquaintance with who the users are and how they make sense of climate products. When the GFCS guidelines and the creation of the RCC-SSA prominently figured on public and private agendas in Argentina, the lack of accurate knowledge about differentiated users and their understanding of climate products was recognized as a main limitation. A broad distinction classifies them as 'intermediate' and 'end' users. The former are those who use the climate information that national meteorological and hydrological services (NMHSs) produce to elaborate their own products or services customized for specific recipients – productive, governmental, scientific, technical and operational sectors. The latter are clusters of stakeholders and practitioners who use the climate information produced by NMHSs and other agencies in decision-making processes. Identifying, mapping and reaching these end users was the key to succeeding in the establishment of a proper UIP in Argentina.

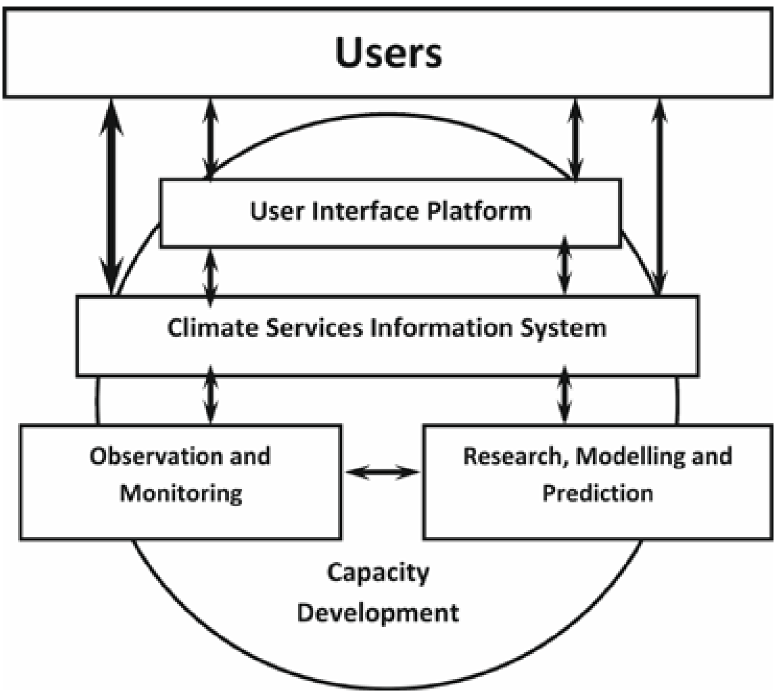

Figure 7.1. Climate knowledge for action: a global framework for climate services empowering the most vulnerable (Source: WMO (2012))

A 'New Paradigm': Networking and Dialogue with Users

The Argentinean National Weather Service (NWS) is a public institution created in 1872. After more than fifty years of military management by the Argentinean Air Force, the NWS was transferred to the civilian sphere at the end of 2006, as a decentralized agency of the Ministry of National Defence. During those years, it was oriented towards the aeronautical activity, with forecasting mainly being aimed at aviation. In the narrative of its agents, the priority was to meet the needs of the air force, as indicated by its former director: 'I worked at the Weather Service for 50 years, 40 of them under military management. The process under the air force shifted the focus of meteorology towards the field of aviation. This happens every time an agency is in the hands of a single user: it gets distorted.'[1] In other words, the service had lost sight of the diversity of users outside the institution. The transference to civilian administration was the landmark that enabled the institution to follow a new pathway. A variety of sectors sensitive to climate information rather than just aviation started to occupy a prominent position among the NWS authorities' concerns, as targets of climate products and services. As part of this new institutional orientation, in 2007 the NWS organized a monthly open meeting to discuss the production of the seasonal climate forecast, the so-called 'consensus meeting', to generate the quarterly climate forecast. This ongoing space involves several academic, technical, operational and governmental institutions, all of them intermediate users of climate information (Figure 7.3). They exchange perspectives in an interdisciplinary mode and contribute to the co-production of climate knowledge (Carabajal 2016). Over time, sustained interaction has allowed many of the institutions participating in these meetings to become involved in the CRN3035 project, with the common goal of establishing a regional climate centre for the provision of climate services in southeastern South America. Given that past collaborations had not included such a strong engagement of anthropologists, many participants found it a novelty to

Figure 7.2. The Global framework for climate services: main innovations (data collected by the authors)

work hand in hand with both the 'social' and the 'natural' dimensions of the project.

In Argentina, global initiatives such as those contained in the GFCS aroused collective enthusiasm, not only at the NWS but also among the other institutions. Indeed, these institutions embraced the aim of strengthening collaboration and improving the social relevance and usability of their products and services, but despite the excitement of participants, the interpretation and long-term harmonization of global principles, regional goals and national institutional practices would not be univocal and free of tensions.

In the following pages, we describe the open questions and disparate ways of making sense of the 'new paradigm' endorsed first by authorities and staff of the NWS, and quickly echoed by a wide range of operational and scientific institutions. The new paradigm was presented as an institutional vision that was quite distinct from that prevalent in the era of military management, as an ideological and conceptual transformation in line with global trends, but charged with a sense of ownership and responsibility experienced from an inside-out perspective. At the same time, the need for organizational re-engineering aimed at interinstitutional and interdisciplinary cooperation was stressed. The new paradigm functioned as an 'action guide' depicting the coming of a 'collaborative turn' (Balmer et al. 2015; Hidalgo 2018) that set two main goals. One of the goals was to strengthen collaborative networks between operational, governmental and scientific communities, and the other was to develop new workshops so as to reach out to different types of user. We will now concentrate on the efforts oriented towards the satisfaction of the second goal.

User-Interface Experiences in Argentina

Since 2013, major efforts have been made by the operational, technical, scientific and academic communities of Argentina to meet the diverse interests, expectations and needs of the many relevant climate-sensitive sectors. These efforts have boosted the implementation of participative spaces of the co-production of knowledge with different types of users. This turning point not only inaugurated an opening-up process, which took climate users into account, but also focused on interdisciplinary efforts to link natural and social scientists in planning and designing these new workshops. To a great extent, the institutions involved in the IAI project realized the complexity of this challenge to 'go beyond the classical dimension of meteorology, i.e. observation, monitoring and forecasting, to interact with users and create collaborative approaches'.[2] This process will create a pathway for meteorological science to have greater societal impact.

In the cases described below, the meetings began by addressing the agricultural sector of Argentina because of its high sensitivity to climate variation and its key role in the national economy. The main goal of the meetings was to gather information about the sector, its principal features, needs and expectations, and the sociocultural factors involved in the process of interpreting and making decisions using climate information. These 'face-to-face' spaces were expected to foster communication and reconcile users' needs with the information provided by national institutions and agencies. Receiving feedback from users would allow institutions to assess whether the information provided was perceived by them as salient, credible and legitimate (Cash et al. 2003), whether the products were understood and became critical input for decision-makers and/or whether new products should be designed.

The Complex World of Users

The design and implementation of workshops for end users required the exploration and identification of the needs and expectations that many sectors, such as agriculture, energy and health, might have regarding climate information. Proper mapping and characterization of users – actual and potential – were badly needed at both the local and sectoral scales. National and local institutions first had to chart their own set of users. In the case presented in this chapter, the actors to be reached and the priorities to be set were those of the agricultural sector of Argentina, whose users have varied profiles. Among the intermediate users are a large number of academic organizations, governmental organizations and NGOs that develop agroclimate products (models, reports, maps, forecasts, etc.). The end users may be actors directly associated with producers (such as extension agents and/or technicians) or the agricultural producers themselves, be they subsistence producers within the regional economies of the country or medium-sized and large capitalized actors leading the production of commodities for export, like soy, corn and wheat. Each of these end-user profiles has its own particularities, with different levels of access to and understanding of the information regarding, and diverse tools to adapt to, changes in climate.

So far, three main workshops have been held, among other relevant activities (e.g. dissertations, workshops and talks), each of which addressed different agricultural user groups.

The First Workshop: Who Are the Users?

The first workshop was held on 26 November 2014, at the NWS headquarters, and it addressed intermediate users,[3] who represent sectoral, governmental institutions and agencies with extensive knowledge and expertise in agriculture. The participants of this first meeting (Figure 7.3) had already shared common spaces such as the 'consensus meetings', described earlier, and collaborated in research projects in which they exchanged perspectives and supported government decision at the local level. The meeting was organized with the active commitment of anthropologists and involved institutions closely related to the NWS. The process of planning served as an incentive to improve the documentation of the different agroclimatic products available in order to avoid possible discrepancies and/or overlap (e.g. weather and climate forecasts, agroclimatic information, drought alerts, intraseasonal and seasonal predictions and the like). As a result, the anthropologists of the team created 'a map' of the climate products that each institution provides through its website and agreed not only to put communication on

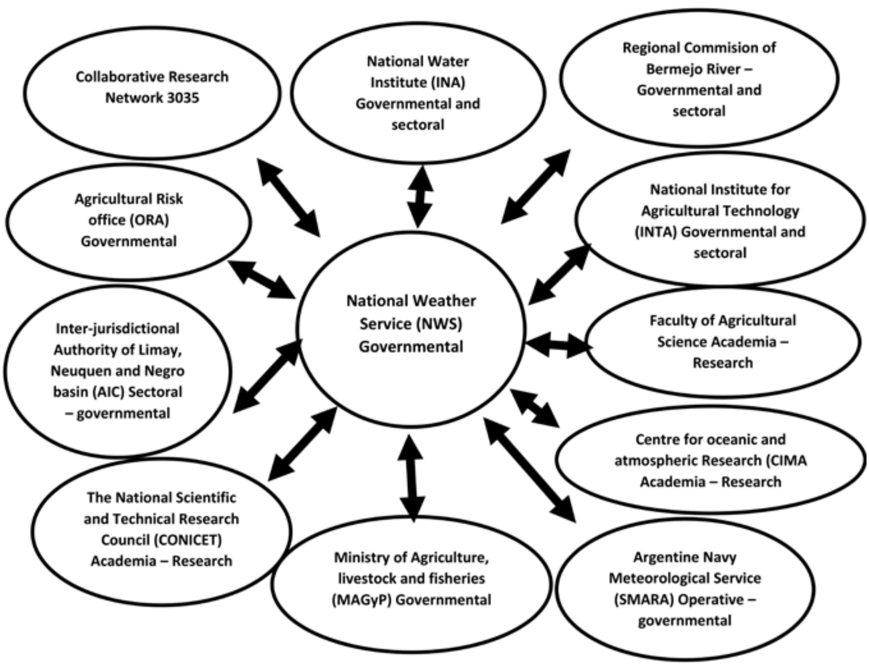

Figure 7.3. The first participatory meeting with 'intermediate users' involved in climate services processes, 26 November 2014 (data collected by the authors)

the agenda, but also to address it as a joint endeavour. Interinstitutional and interdisciplinary links already in existence were consolidated in the process, although the networking did not extend far beyond an already well-known group of participants: only a few rural extension workers from the Instituto Nacional de Tecnología Agropecuaria (National Institute of Agricultural Technology (INTA)) and one end user, a cooperative production representative, participated in the meeting.

After the host institution (NWS) was introduced, the three main activities to be held were presented. The first involved forming teams to answer a set of questions about climate information, its production, access and use, and this gave rise to a discussion during a general feedback session. Next was the presentation of the meteorological and climatic situation, as it impacted on the agricultural sector, the so-called 'declaration of emergency and/or agricultural disaster', as a starting point for making visible the crucial role of reliable data and information in supporting public policies. The third activity introduced the representatives of the Agricultural Risk Office (the Ministry of Agriculture) and INTA, who described their products and responsibilities. Finally, the PI of the CRN3035 project outlined plans for joint action and the continuity of linking activities with other user profiles, such as the producers of the Pampean region. The presentations and discussions became a platform for the participants to enunciate the commitment to the goal of providing climate services and at the same time to make visible their essential contribution to that goal.

The NWS took advantage of the meeting to show the monetary costs of collecting the data – in terms of equipment, communications, maintenance and taxes – to generate high-quality and timely products, thus raising awareness of the expenses behind the data. In this regard, they considered it necessary to make the commitment and responsibility that their work entailed visible to these important intermediate users, seeking recognition for the efforts that operational institutions make to generate data in real time and to build various products for the large sectors. One of the strategies to bring to the fore their commitment was to demonstrate the cost-benefit ratio, i.e. the value of the data, and the enormous amount of work involved, in processes ranging from the collection of data at the weather stations to producing finished products, such as the quarterly weather forecast. Incredibly, none of the participants correctly estimated the real monetary cost of collecting meteorological data, except for the members of the NWS. As one meteorologist put it: 'It is costly for the Service to provide data when someone requests it, but the recognition either within the Service or from the other institutions is important. We would like to receive that recognition.'[4] This narrative shows that the value is not only measured in economic terms, but also in terms of the recognition of the institutional effort to update and make the meteorological information available. The search for recognition implies transcending the task of making data available – the main function of the institution – by making it valuable, visible and relevant to users. Recognition is perceived as a relational term, implying intermediate users' appreciation of the information and the service they receive.

The participants from the universities and the National Scientific and Technical Research Council (CONICET) of Argentina did show their appreciation of the work performed by the NWS, not only in terms of the monetary costs involved, but also regarding its ability to keep and make public its vast historical observational data record. However, they valued these data only as a necessary condition for modelling, because models cannot be created and run without such data. Nor can the numerical models be used for short-term weather forecasting or for making longer-term scenario-based projections of climate change without NWS data. When blamed for setting agendas with no clear articulation with operational applications or without any orientation towards supporting decision-making (governmental or nongovernmental), academics explained that without robust research that complemented observational activities, the implementation of the new paradigm would not be possible. In the meantime, participants from agricultural governmental institutions and agencies appealed to their relative closeness to agricultural users, stressing that the relationship that they had with users was central for a proper assessment of the availability, reliability, understandability, consistency and essential contribution to decision-making of the range of products and services delivered to the different user communities. The anthropologists did exactly the same, showing their key role in understanding the social and political contexts in which information could be used. As the social dimensions of the goal of providing climate services became so prominent on this agenda, the voice of the anthropologists grew stronger. As a result, many issues became evident. The weak articulation of disparate efforts, timid networking and the lack of communication between governmental institutions often resulted in similar products, maps and forecasts, with different interpretations and messages relating to the same agroclimatic conditions, causing confusion among the recipients.

The discussions about interinstitutional collaboration, networking and the need for recognition nurtured a reflexive atmosphere among the participants, and gave rise to a final and most relevant question:

what about the 'end users'? While everyone celebrated the opportunity to inaugurate these meetings and the demonstration of the will to work together, it was clear that further work would need to be done to reach the end users: the decision-makers, representatives of producer associations, individual producers – i.e. those who use the information in their daily activities. The absence of end users in this first meeting caused an uncomfortable awareness of a task yet to be faced, namely, the proper identification of end-user profiles. The institutions attending the meeting were users, but 'just' intermediate ones (see Figure 7.3). For example, by operationalizing the knowledge produced at universities, the NWS was, in fact, a user of the academic sector. However, participants would have to find a way to interact face to face with the 'end users'. When a NWS meteorologist was asked to define their users, he replied: 'We define the user as the producer, the typical farmer, who sows, harvests and works in the field; these are the users that we really work for. We differentiate them from the staff of intermediate institutions that also consult us.'[5] This comment shows that the end users were conceived of as the recipients of their daily efforts – those that give meaning to their work. At the end of the meeting, an agrometeorologist from academia claimed: 'I would have liked to meet the users of smaller agricultural sectors or networks of producers. The voice of the small user was missing.'[6]

A sense of ownership of the problem of the need to reach different types of climate-information users within the agricultural sector (Lemos and Morehouse 2005) had grown among the participants. The awareness that no end user was present at the first meeting led the organizers to recalibrate endeavours towards the second meeting, in which the institutions were able to meet representatives of large farmers' associations and NGO and corporate agents, in order to exchange perspectives and understand how they made sense of climate information. It was clear that workshops enhanced mutual understanding between researchers and end users about specific contexts in which forecast usability could be increased, but that it was through the processes of face-to-face interaction with users and self-reflexivity that institutions with operational responsibility could 'own the problems' of improving the social appropriation of knowledge and of connecting science with society. Furthermore, all the participants in the first meeting became aware that successful interactions would require social scientists' interventions in order to identify different types of users so as to develop suitable profiles and establish effective communications. Otherwise, 'user categorizations' would become homogeneous (Sivakumar 2006) or follow stereotyped patterns. The complexity of knowledge co-production became apparent to all.

The Second Workshop: Reaching out to the Big Players in the Agricultural Sector

The second meeting was held on 26 August 2015 at the National Institute of Agricultural Technology (INTA) and was co-sponsored by the NWS. INTA was selected as the host institution, because the main target of its policies is the agricultural sector; therefore, INTA's broad outreach to various producer groups allowed it to give greater support to the event. This meeting addressed the big players in the agricultural sector of the Pampa region and Mendoza Province (Figure 7.4), a total of forty-seven actors: seventeen representatives from farmers' associations, grain-exchange institutions and rural consultants; twenty-five from the organizing institutions; and five anthropologists from the CRN3035 project.[7] Highly qualified users attended the meeting: technicians, representatives and advisers of agricultural and livestock producers, agronomists and professionals of agricultural meteorology. Most of them often hired private consultants in agrometeorology who offered talks and actively participated in discussions on key planning dates for sowing and harvesting. They also received specialized reports and analyses, and in

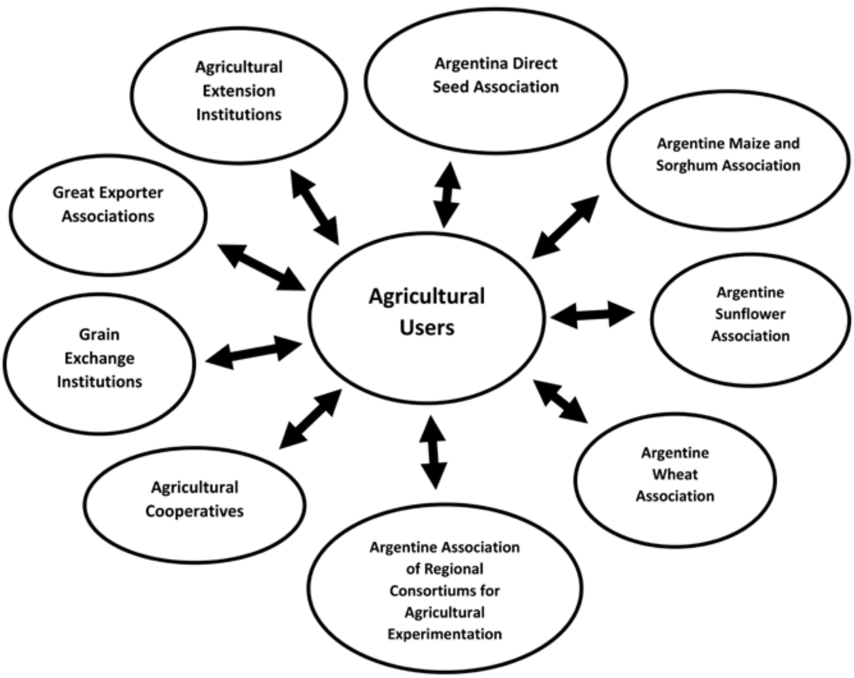

Figure 7.4. Interface in action: agricultural institutions and end users participating in interactive spaces, 26 August 2015 (data collected by the authors)

turn disseminated them to groups of associated producers. Therefore, the level of information they managed was high, and their outreach to agricultural producers made them excellent interlocutors to approach this sector for the first time.

The meeting was planned collectively, with all the institutions and agencies in charge of the first meeting joining efforts to organize the second meeting. Participants of the Ministry of Agriculture, the Centre of Oceanic and Atmospheric Research, the Faculty of Agricultural Science, and sectoral institutions such as the National Water Institute and the Regional Commission of Bermejo River together oversaw the strategic coordination of the meeting, such as who would participate, what activities would be conducted and how the end user issue would be addressed. From the beginning, the stated goal was clear: the meeting organizers had agreed not only to deliver presentations on the range of information they produced but also to 'listen' to users' needs and 'to be listened' to as a collective group that had to renew their credentials and gain recognition from a relatively unknown audience. The institutions expected to make their work visible and to be rewarded for their efforts. 'There must be give and take of information and services',[8] claimed one meteorologist.

During the organization of the second meeting, all the institutions decided to highlight the leading role of the NWS, acknowledging the opening-up process that it was going through, after its transfer from military to civilian management. This meeting was identified by the organizers as an excellent opportunity to improve users' views on the image of operational institutions, especially the NWS, and also to (re)gain authority and legitimacy among powerful and demanding stakeholders, such as the users invited to the second meeting. Therefore, they decided to highlight the features of the new paradigm: the collaborative turn that they were experiencing and the level of integration that for the first time the institutions had achieved after the first formal meeting eight months earlier. It was a question not only of building internal awareness of the changes that they were implementing together, but also of communicating the features of this transformation to the end users. The increased interaction and collaboration among institutions would be reflected in the image of the 'new' NWS. All the institutions, especially the NWS, aimed to make a good impression on the participants by emphasizing the goal of rebuilding the relationship with end users.

During the opening address, representatives of INTA and the director of the NWS – through a video created especially for the occasion – announced and celebrated the participation of end users and decision-makers from different agricultural associations of Argentina. The participants were then asked to engage in small group discussions, which lasted more than four hours. These smaller round tables created an atmosphere in which the participants shared their experiences, needs and opinions about the type, access and availability of the meteorological information they were receiving at the time, and they were able to clarify any queries about forecast services. This meeting rose to the institutions' expectations, as it finally made it possible to explore and map the kind of climate information that these target users needed, as well as the sources of meteorological information that the users considered credible and reliable.

The under-utilization of the climate information was notorious. In the meeting, the agricultural users emphasized that the relevance of the information depended on whether it fit users' needs and whether it was delivered in a timely way, and was comprehensive and appropriate to the context in which the data would be used. Indeed, one of the main user expectations was found to be that climate information should allow them to make decisions at local levels, using what they called 'local field information' so that 'they sow with the forecast'.[9] This expectation showed that participants were not acquainted with the limitations inherent in the available climate knowledge. In their search for information, they consulted with a wide range of private advisers, who felt free to offer nonvalidated opinions and predictions, given that they were not constrained by the mission of providing official figures and forecasts. At present, research and operational climate institutions are unable to provide products with a high level of accuracy at this scale, given limitations that have not yet been overcome concerning the variables that can be monitored or predicted, and the temporal and spatial scale and accuracy of prognostic information. The extent of the Argentine territory adds further difficulties for national institutions in obtaining localized information. This situation is of crucial importance for vulnerable or poor farmers, who do not have proper access to valid information. For large farmers' associations, it is less deleterious, because they have the financial resources to acquire advice from renowned private experts. These private agroclimatic consultants take advantage of the situation regarding national forecasting and build credibility for themselves by providing detailed and daily advice to these users, though with less accountability than is demanded of the public sector.

From this, it would seem that in order for national institutions to build credibility and legitimacy in agricultural sectors, they should recognize the huge differences in legitimacy and accountability between public and private sources, and aim to have a strong presence at key moments when the information is urgent. One meeting participant stated: 'There cannot be missing links in the information chain; someone must link the sources, and it is not the farmers' fault that they do not consult NWS information.'[10] Indeed, this level of 'place-based' interaction is very demanding and complex for governmental institutions, especially for the NWS after fifty years of military management. Finding ways to strengthen the relationship with end users is one of the main challenges in delivering climate services to local levels. This particular type of user highlighted that the value of information lies not only in the product, but also in the translation and advice that the institutions may offer. When a future climate event is forecast, it is not sufficient to do so in probabilistic terms, as the producers require guidance in their specific decision-making process. For example, the announcement 'El Niño is coming to southern South America' could be translated as 'It is a good opportunity to sow between October and December'.[11] Temporal and spatial scales of information also affected the discussions about the responsibilities of the NWS and the other organizing institutions – for example, a farmer's request: 'When it doesn't rain in November, it gets complicated. Critical periods: December–January. December is crucial. If you could predict November, that is ideal. That defines the most important thing: whether to make sorghum and not corn, hyper-early weaning, you can define the purchase of a forage pasture or not, sell the farm, but well in advance, before the drought, because then everyone would be selling, even the purchase of rolls or of balanced food that gets very expensive.'[12] How far should governmental institutions go to meet local users' requirements for a high level of specificity? They have national commitments, but the challenge is generating actionable climate information that can assist a whole spectrum of end users, not just the big players of the Pampa region.

Last, but not least, during the meeting, users demanded that governmental institutions provide certain types of seasonal and agroclimatic products. Operational institutions were surprised to discover that products fulfilling many of these requirements had already been developed or experimentally trialled, but users were unaware that they existed. Under-utilization was grounded not only in technical aspects of the information, but also in a very basic communication barrier: many existing products were almost unknown and therefore were not used. With regard to the known products, the participants acknowledged some constraints on their full utilization, given their poor accessibility and/or difficult interpretation. Forecasts and products contained useful information, but operational institutions could not decide whether they should 'keep it simple' or add more data to products or maps. The institutions made decisions on a daily basis, but a lack of feedback from users presented a gap they still needed to fill in order to deliver understandable and actionable information. Following the discussions, a plenary session was held, where end users and information providers expressed their commitment to interacting and building close collaboration that could overcome all the obstacles that prevented the full usability of the available agroclimate products and services.

Roving Seminars: Reaching out to Small-Scale Farmers

Roving seminars were carried out on 7–12 September 2016 and they were aimed at different types of end user: small-scale goat farmers and rural students in three vulnerable areas in the north of Santiago del Estero Province. These activities were funded by the WMO and their main goal was to improve the communication of climate information so as to help small-scale farmers handle climate risk and the use of resources. Moreover, the intention was to increase interaction between the NWS and end users, in this case goat farmers.

Unlike the previous meetings, in which intermediate users (those who use climate information to make their own set of sectoral products) and large farmers' associations were invited to the headquarters of the NWS and INTA, this programme allowed the NWS to travel to remote places and reach another type of end user – those who were more vulnerable to climate variations and less able to respond to these changes. Organizing these workshops required additional efforts, such as greater funding and commitment of time, to organize activities at a distance and move them from one locality to another. Local leaders (teachers and priests) and rural experts (agricultural technicians and extension agents) supported the meteorologists during the organization and implementation of the seminars. Without the participation of these key intermediaries,

Rovin Seminars			
PLACES	(1) Nueva Esperanza	(2) San Jose del Boquerón	(3) Sachayoj
TARGET USERS	secondary school students and teachers	primary and secondary school students and beekepers cooperative	subsistence farmers
GENERAL ACTIVITIES	Rain Gauges distribution		
	National Weather Services introduction, mission and vision, responsabilities. Forescasts on different time scales		
SPECIFIC ACTIVITIES	Sample of Measuring instruments of weather - Film projection		THI Temperature - Humidiy Index

Figure 7.5. The NWS in the territory through roving seminars of 7–12 September 2016 (data collected by the authors)

connecting with users would have been impossible. Therefore, cooperation between the NWS and these local stakeholders was key to the success of the activities. The NWS does not have data sources in these towns, as the closest weather station is located in a large city, far from them, and the forecast does not accurately depict local climate conditions. The aim of the seminar was to build capacity among rural communities and to distribute rain gauges for them to make local measurements. It was hoped that the distribution of these devices and the interactions with the beneficiary institutions – those expected to create products based on this local information – would strengthen communication between the NWS and local producers and build relationships for future collaborations.

Three seminars were held for two different types of audience. The first two were delivered to young students from agrotechnical schools, some of them children of local producers or rural teachers. The presentations gave an overall view of the NWS and showed the activities that the institution carried out, by means of slides, a film and meteorological instruments, in the hope of motivating the students. The meteorologists trained these youngsters so that they would be able to pass on the information to their families. The third seminar was aimed at small family enterprises, goat and pig breeders, so the talk was about meteorological and agrometeorological issues as well as preventive measures to mitigate the adverse climatic effects on animals. In general, the meteorologists pointed out the common ground formed in these seminars by the positive predisposition of the participants, and the opportunity of learning from and interacting with NWS technicians and local stakeholders. As stated by a meteorologist: 'They were happy. They told us that they had never done a workshop like this. I expected them to be interested but their enthusiasm went well beyond our expectations.'[13] The meteorologists recognized the impact that this first event, conducted by experts from Buenos Aires, had on the participants, and stressed that the small farmers and students greatly appreciated the seminar; instead of making demands, as had been the case in the previous meeting, they were thankful. Furthermore, the experts agreed that in these territories, communication was the main problem, as the farmers did not have access to the internet or other infrastructures required to access the forecasts. One of the meteorologists reported: 'At a distance and with these communication problems, the interaction must be done face to face.'[14] Because of this, it is difficult for the NWS to provide local information and therefore strong presence is an essential factor to ensure the institution is known. In the previous meeting, given the knowledge and resources available to the big players of the Pampa region, it is easier for these target users to gather climate information through social media channels. However, reaching out to small-scale farmers in vulnerable areas would require different strategies, such as face-to-face interactions and the identification of local intermediaries who could be the voice of the NWS among these producers and students.

Conclusions

As embedded anthropologists, we have documented several cases of interaction between scientific and operational institutions, which, led by the NWS, rose to the challenges of generating the participatory spaces required to meet the goal of providing climate services in southeastern South America and the country. The organization of meetings with intermediate and end users allowed us to monitor the ways in which participants made sense of the orientation towards usability of climate science, which was condensed into the motto of a 'new paradigm' for climate services. Disparate and often contested ways of making sense of climate science came into play in these spaces, where the enforcement of the orientation towards users turned out to be more complex than had been expected.

In the first place, the implementation of the new paradigm implied reorganizing the intrainstitutional and interinstitutional relationships, and rethinking the research and operational agendas, in order to create a local 'user platform' in line with state-of-the-art international standards. Achieving this goal depended, to a large extent, on an appropriate characterization of the different types of users that the service aimed to reach, of their particular dynamics and of the sociocultural and political contexts that influence the access and use of information. Hence, the generation of spaces for dialogue became the key to achieving a contextual understanding of the decision-making processes, and thus to producing relevant, timely and useful information. However, before the end users were to be reached, the first dialogue spaces sought to involve the participants from the most important operational and academic institutions linked to the agricultural sector, many of whom already had a history of collaboration, but who hitherto had not articulated their actions with such a clear common goal. It is not surprising, then, that when the first meeting was organized, it was mainly these participants who were convened and that each of them highlighted their own crucial contribution to the common goal. In turn, they recognized themselves as intermediary users for the others, that is, all the institutions needed the data and information that the other ones provided to improve their own sets of products for the agricultural sector. The NWS would claim its central scientific and economic value in the provision of meteorological data, INTA would claim primacy as a provider of agrometeorological data, scientists would highlight the value of their models, and ministerial agencies would boast of their proximity to decision-makers: each party asserted its essential role. Willing to face institutional re-engineering and having developed new interinstitutional relations, the participants soon noticed that the spectrum of interlocutors needed to be broadened so as to reach the end users of the agroclimatic information. The general recognition that the agricultural producers were under-represented made it evident that many challenges remained to be addressed, among them the lack of tools to identify a wide variety of end users, their needs and expectations in terms of information, and the barriers that prevented their full utilization.

These challenges were taken into account in the organization of the second and third meetings, in which the institutions were increasingly willing to interact and meet the demands of, for example, the large associations of Pampean producers and grain-exchange associations. To the extent that these end users, who were powerful in economic and social terms, already had their own advisers in agrometeorology, the need for recognition of the operational and academic institutions came back into play during the second meeting. All the institutions set out their claims for value, legitimacy and quality, disputing positions against private advisers and consultants from the agricultural sector. The workshops allowed the institutions to specify objectives well beyond the provision of information in order to make visible the value and quality of the service they provided and thus (re)position themselves as the authoritative source for the users, achieving recognition of their work and recovering institutional legitimacy. This challenge increased with the institutional decision of the NWS and its partners to become immersed in the distant reaches of the nation by identifying user profiles in the regional economies located in Santiago del Estero Province.

We have described a process in which institutional recognition of the complexity of the 'user' approach has triggered a reflexive framework that has been crucial in generating socially relevant knowledge and services. We are convinced that this systematic and deep reflexivity was enhanced by the active participation and collaboration of the anthropologists. We believe that success in the construction of a useful climate science will depend on the sustainability of interactions over time. The first and second meetings and the roving seminars allowed us to see that under-utilization of climate information could be overcome by close and frequent interaction, helping to build trust, credibility, legitimacy and the relevance of the climate information. Dialogue helped all types of users understand the main limitations concerning the variables that can be monitored or predicted, and the temporal and spatial scales of forecast information.

However, it is still a challenge for national information-providing institutions to solve the technical aspects involved, namely the timely release of uncertain information suited for decision-making needs. This challenge will be not overcome without the effective participation of users. Increasing the quality and quantity of the information is a necessary but not sufficient condition. Further research will be needed to demonstrate and describe how sustainable participatory spaces reconfigure the knowledge practices of scientific and operational institutions as well as the decision-making contexts of the different users. Reducing the gap between science and society will depend on making the most of the actors' enthusiasm for building collective knowledge, opening up institutions to society and generating frames of long-lasting interaction and commitment.

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Notes

1. Interview with NWS ex-director Hector Ciappesoni, 'One Hand to Meteorology', 29 October 2013. Access date November 2016.
2. Fieldwork notes: NWS institutional event, director's speech, 8 October 2014.
3. In this event, many of the participants visited, for the first time, a new building, updated with modern equipment and with extensive infrastructure facilities in tune with the 'new paradigm'. The attending intermediate institutions were as follows. Governmental sector: Ministry of Agriculture, Livestock and Fisheries (MAGyP); Agricultural Risk Office (ORA); National Institute for Agricultural Technology. Scientific institutions: Center for Oceanic and Atmospheric Research (CIMA)); Faculty of Agricultural Science (FAUBA). Operational institutions: National Weather Service (NWS); Inter-jurisdictional Authority of Limay, Neuquen and Negro Basin (AIC); National Water Institute (INA); Regional Commission of Bermejo River (COREBE); Argentine Navy Meteorological Service (SMARA).
4. Fieldwork notes, first workshop, 27 November 2014.
5. Fieldwork notes first workshop, 27 November 2014.
6. Fieldwork notes first workshop, 27 November 2014.
7. The second workshop attendees: the Argentine Direct Seed Association (Aapresid), the Argentine Maize and Sorghum Association (Maizar), the Argentine Sunflower Association (Asagir), the Argentine Wheat Association (Aaprotrigo), the Argentine Association of Regional Consortiums for Agricultural Experimentation (CREA), agricultural cooperatives (Cooperativa Agrícola Ramallo), grain-exchange institutions (Bolsa de Cereales de Buenos Aires, Córdoba and Rosario), and grain-exporter associations and agricultural-extension institutions.
8. Fieldwork notes, first workshop, 27 November 2014.
9. Fieldwork notes, second workshop, 26 August 2015.
10. Fieldwork notes, second workshop, 26 August 2015.
11. Example proposed by an expert in a plenary discussion of project CRN3035, 12 May 2017
12. Interview with a member of Argentine Association of Regional Consortiums for Agricultural Experimentation (CREA), SOBA Project, 31 October 2018
13. Interview with a meteorologist from the NWS, 4 November 2016.
14. Interview with a meteorologist from the NWS, 4 November 2016.

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Chapter 8

Practising Anthropology by Providing Climate Services for Farmers

The Case of Science Field Shops in Indonesia

Yunita T. Winarto

During the period in which I began my engagement facilitating farmers in a dry, rain-fed ecosystem in Yogyakarta Province in Java, Indonesia, in the early rainy season of 2008, rains fell continuously for seven days in a row. The farmers interpreted this as an indication that it was time to begin their rainy-season cultivation. However, after the initial deluge, not a single drop of rain fell for three full weeks. In the farmers' terms, this long dry spell was known as *benthatan.* Unexpectedly, two days of heavy rains followed the long dry spell, and the rice and maize, which had only recently been planted and had grown slowly during the dry period, were damaged due to the heavy rains and flooding. Farmers questioned these sudden heavy rains following the long dry spell (Winarto et al. 2011:188–89). Six years later, in 2014, at the time I began introducing methods of agrometeorological learning to the farmers of another dry, rain-fed village in Western Nusa Tenggara Province, an elderly farmer's interpretation of the fall of intensive rains based on local cosmology led farmers to expect plentiful rains at the beginning of the rainy season in around November. However, his prediction proved incorrect and the farmers experienced an extended drought. Every year, in February, the villagers of this area traditionally hold a ritual for 'catching up sea-worms' (the ritual of *Bau Nyal*é). This festival usually occurs at a time of heavy rains. However, in February 2015, the weather was surprisingly dry (Taqiuddin 2017) and the people could not explain why it was so.

These are but a few examples of the increasing occurrence of unexpected weather phenomena in local habitats that have aroused puzzlement among farmers in Indonesia. Their expectations about weather events, informed by generations of traditional knowledge, have been upended beyond their ability to understand and to foresee. They did not at first realize that the unusual conditions were the result of climate change.

The experience of these farmers is not unique. Farmers all over the world have reported changes in both rain patterns and the timing of rainy seasons (Jennings and Magrath 2009), and local traditional knowledge – though empirically rich and detailed – often constrain people from understanding and explaining the drivers of hazards and disasters that are beyond their ability to predict and understand. The consequences of climate change include global warming, increasing climate variability, and more frequent and severe weather events that affect people's livelihoods, particularly in vulnerable areas such as tropical Asia. Increases in temperatures, along with shifts in seasonal patterns, may have grave consequences for human health, as well as for agricultural and ecosystem productivity (Winarto et al. 2018b). These effects will worsen with time.

Over the past decade, a growing number of anthropologists have conducted detailed ethnographic fieldwork among widespread local communities so as to examine the various problems deriving from, and people's diverse knowledge of and strategies to cope up with, climate change (Barnes and Dove 2015; Colombi 2009; Crate 2009, 2011; Crate and Nuttall 2009; Ellis 2003; Finan 2003, 2009; Henshaw 2009; Marino and Schweitzer 2009; Nuttall 2009, 2010, 2012; Roncoli, Crane and Orlove 2009; Roncoli et al. 2003; Strauss 2003, 2009; Strauss and Orlove 2003). These anthropologists are trying to glean 'the effects of climate variability and change on human societies, cultural perceptions, the connections of global and local processes, and the contribution of human actions to Green House Gas concentrations' (Fiske et al. 2014: 15). As suggested by the Global Climate Change Task Force of the American Anthropological Association (Fiske et al. 2014), anthropologists need to play a more significant role in climate science and policy by engaging in collaboration with other disciplines in both the social and natural sciences. The increasingly significant contributions of anthropologists include research in much wider areas, so as to connect diverse scales, places and paths; addressing various issues related to adaptation, vulnerability and resilience; and developing research frontiers by also enhancing their engagement with local communities.

My own experiences in building up interdisciplinary and transdisciplinary collaboration in assisting farmers in Indonesia have led me to agree strongly with the proposal that anthropologists should play a more significant role in climate science and policy. In light of the degree of vulnerability that local communities have to overcome in dealing with the implications of the unusual risks arising from increasing climate variability, I argue for greater anthropological engagement with local communities in a manner that extends beyond simple ethnography or the implementation of a participatory approach (Roncoli 2006). Examples of such an engagement include the collaborative and interdisciplinary research undertaken by Button and Peterson (2009), and Crate and Fedorov (2013) in directly facilitating local communities to cope with the consequences of climate change through the exchange of local and scientific knowledge.

By considering the prognosis of continuous and ongoing climate changes and their probable consequences, which are likely to be increasingly variable, I question the extent to which such limited exchanges are sufficient to assist people in sustaining their adaptive responses over the long term. For example, Crate and Fedorov's (2013) interdisciplinary project involved eight knowledge-exchange sessions. Would an additional cycle of knowledge exchange be provided in the future if the people were to face entirely different kinds of hazard and calamity? Similarly, Button and Peterson (2009) returned to observe the results of their participatory work after a relatively short period of time. It is unclear if the problem-resolution strategies introduced to local communities could be sustained if the scientists were no longer available to provide assistance. Would the local people and other stakeholders be able to resolve further hazards and disasters in the future by referring to their experience of receiving the scientists' help in the past? Whilst anthropologists have often built up intimate relationships on an ongoing basis over lengthy periods with the people they have studied (see Crate (2009, 2011) and Crate and Fedorov (2013) with regard to the Viliui Sakha in northeastern Siberia, or Nuttall (2009, 2010, 2012) with regard to the Inuit), the need to build up long-term, sustainable community collaborations involving scientists from various disciplines presents a new challenge.

My experience of observing a short-duration training project implemented by the Indonesian state and several nonprofit organizations has convinced me that a lack of commitment to the continuous education of local farmers has hindered the institutionalization of new knowledge due to the absence of nurture for their learning through continuous reflection and reiteration (see Winarto et al. 2018a). As an anthropologist, I have learned how farmers can interpret new knowledge, and modify, accommodate and combine it with other existing elements, so that it becomes the basis of action or, alternatively, and particularly in the absence of institutional support, how the knowledge may become forgotten without being recalled again (Winarto 2004). During this period of dynamic and ongoing climate change, it is important both to follow and build on traditional learning processes, and to enhance them by establishing new, sustainable ways of learning. The state's one season-long training without any follow-up activities as carried out in the Climate Field School (CFS) proved to be ineffective in institutionalizing the new learning in farmers' responses to increasing climate variability and its unexpected consequences (Crane and Siregar 2011). A mutual and enduring learning situation may provide a means for establishing the new understanding of climate variability over time that could have diverse impacts on farmers' ecosystems and farm productivity. Responsive farming practices need to be developed under the unprecedented changes of climate. The long-term educational commitment is thus urgent in order to address later questions concerning the ongoing puzzling problems that will arise. The role of anthropologists is critical in enabling new scientific methods and knowledge, such as agrometeorology, to be transmitted to local communities in such a manner that they also improve farmers' ways of learning and enrich their existing knowledge, becoming internalized as a part of their learning and doing.

This chapter examines the development of a novel process of practising anthropology, with innovative interdisciplinary and transdisciplinary collaboration in the provision of climate services to farmers in Indonesia via Science Fields Shops (SFS), an educational programme of agrometeorological learning (Winarto and Stigter 2013, 2016, 2017; Winarto, Stigter and Wicaksono 2017). The first section of this chapter presents the SFS approach, with a focus on its underlying purpose of providing seven climate services to farmers in two regencies: Indramayu Regency on the north coast of West Java Province, and East Lombok Regency on the east coast of Lombok Island in the Province of West Nusa Tenggara. The second section examines the novel contribution of anthropologists in their engagement with both the agrometeorologists and the farmers in establishing and institutionalizing the SFS over time. The final section presents a reflection on anthropologists' role as creative agents in the provision of climate services.

Science Field Shops in Indonesia: Providing Climate Services to Farmers

Indonesia is located along the equator in the tropical monsoon region and has two major growing seasons: the rainy season and the dry season. Smallholding farmers in Indonesia conventionally replicated their traditional planting strategies and the introduced Green Revolution intensification technologies in each growing season.[1] However, the consequences of climate change have confused farmers, as they must now face unusual risks and/or opportunities that are not in line with their conventional cropping strategies. Thus, providing climate services to farmers in order to improve their anticipation of, and capability to respond to, these consequences is an urgent need (Winarto et al. 2018b). A significant shift in farmers' mindsets and practices – which have been formed over the past five decades of the Green Revolution paradigm – is necessary in order to enable them to develop more flexible decision-making processes to address climate-related changes in future growing seasons. Accordingly, the main focus of the SFS is to improve the farmers' ways of learning.

Seven climate services have been established as the primary means of learning agrometeorology. The services involve the exchange of knowledge, both new and scientific and traditional and empirical, between scientists and farmers, farmers and farmers, and farmers and extension intermediaries (if available) (Stigter and Winarto 2015; Winarto et al. 2018b). These activities are aimed at improving farmers' knowledge and understanding of the recent past and present conditions of their fields, and they are positioned as active learners, researchers and analysts of their own discoveries.

Figure 8.1. A farmer measuring rainfall (photograph by Aria S. Handoko, the Science Field Shops-Universitas Indonesia, 2015)

Guidance on daily rainfall measurement and agroecosystem observation constitute the first and second SFS climate services. By carrying out daily rainfall measurements and agroecosystem observations on their own fields, farmers are expected to learn: (a) the methods and procedures of measuring rainfall and the practice of daily agroecological observation; (b) the rainfall data revealed by those measurements; (c) the variability of rainfall across different stations (places) and times; (d) the impact of particular rainfall patterns on their fields and plants; and (e) the detailed conditions of their agroecosystem.[2]

Monthly meetings are held between farmers, scientists and (where available) extension intermediaries to discuss the farmers' data, their fields' vulnerabilities, and ways to resolve problems. The role of farmers as researchers and the dialogic approach taken in the regular meetings are the most important elements that distinguish SFS practice from other learning methods such as extension meetings and single-season training of the CFS (Crane and Siregar 2011).

The third SFS climate service involves measuring seasonal yields and identifying explanations for differences in measurements, observations, inputs (amounts and timing) availability, affordability and use. At the end of each planting season, scientists help the farmers to make yield

Figure 8.2. Farmers discussing their rainfall and agroecosystem data at a monthly meeting (photograph by Yunita T. Winarto, the Science Field Shops-Universitas Indonesia, 2017)

comparisons between their different fields, and intrafield comparisons between the same seasons of different years and between different seasons in the same year. Farmers perceive this exercise as beneficial because they are able to evaluate and learn probable causal factors related to differences in agricultural yields, and it is expected that based on these evaluations, farmers will be empowered to improve their strategies under similar/different climate conditions in the future.

Smallholding farmers invited to join the SFS operate their farms either as owners or operators. Those who are willing to join and do not own land are asked to mount their rain gauges in other farmers' fields with their permission and involvement in the learning process. To empower them within this transdisciplinary learning programme, farmers are invited to organize the SFS activities on their own, and the fourth climate service entails assisting them in managing these SFS programmes. It is important to help farmers to prepare for the ongoing and dynamic phenomena of climate change, which have created uncertainties in terms of what to expect from the weather and climate in the near and distant future.

The scientific input of the agrometeorologist in providing updated seasonal climate predictions in the form of seasonal rainfall scenarios based on the satellite data of the El Niño Southern Oscillation for the forthcoming three-month period, adjusted to their seasonal monsoon climate, is the most significant element of the fifth SFS climate service. This allows the agrometeorologist's own scientific development of considering the predictions of gradual rainfall reduction and more serious heatwaves to be harnessed for the farmers' use. For farmers, these scenarios have been very helpful in helping them to predict future climate conditions and to incorporate these scenarios into their anticipation and decision-making strategies. For example, a group of rainfall observers in a village in Indramayu provided their suggestions to their fellows to avoid planting watermelon in the second dry season of 2017 due to their understanding of the probable disastrous impacts of La Niňa as predicted in the seasonal scenarios they received. Their decisions to halt planting watermelon saved them from any bankruptcy, unlike their fellows who did not follow their advice.

The sixth service provided by the SFS is the delivery of new knowledge and answering farmers' queries regarding the agricultural/climatological problems they face throughout the year. Providing answers to such questions is an ongoing policy of the SFS and will continue even when the scientists withdraw and the out-scaling of the SFS has been settled.

Farmers are always curious and creative in the trial-and-error-practices they develop to solve immediate problems and to increase their agricultural yields, and the seventh SFS service aims to introduce new ideas and experiments that will supply answers to urgent local questions. Such experiments include new testing strategies that should help reduce methane emissions by improving water and biomass management, select suitable rice varieties under particular climate conditions, determine proper fertilizer and pesticide application methods, ascertain appropriate planting distances between rice hills, and identify the degree of soil homogeneity in farmers' fields (Stigter 2016; Walker 2017).

In summarizing his experience with the SFS, one farmer-facilitator declared that 'the advantages were enormous'. Specific success stories include the avoidance of harvest failure, the gain of additional yields, the sustaining of yields in the midst of ongoing hazards, and learning from mistakes that have led to yield reduction and harvest failure (Taqiuddin 2017; Winarto, Stigter and Ariefiansyah 2017; Winarto et al. 2018b). In addition to the benefits to farmers, the anthropologists have advanced their own knowledge of climate-related issues in farming and agrometeorological analyses, as well as their facilitation skills, by teaming up with the agrometoerologists in bringing the applied dimensions of agrometeorology to Indonesian farmers.

Anthropological Engagement in Establishing Agrometeorological Learning

During his visit to Indramayu in 2013, the first agrometeorologist involved in the SFS, Kees Stigter, who used to work in some African countries and China argued that in delivering the agrometeorological science to farmers, extension intermediaries are necessary. As an agrometeorologist, he did not have the training to deliver the products of applied agrometeorology directly to farmers. Thus, in his visit to Indramayu in 2013, he confessed that he would not have been able to deliver the applied science to the Indonesian farmers without the anthropologists' assistance: 'In my visits to African countries, I used to work with extension workers and not with farmers. This is the first time in my life that I can assist the farmers directly with your guidance and help' (Stigter, personal communication, May 2013). Stigter's remark highlights the critical role of anthropologists in bridging the gap between scientists and local communities.

Even without any training and experience in agrometeorology, simply by 'being there' (Roncoli, Crane and Orlove 2009), and being humble enough to learn, as well as by having an understanding of farmers' learning and knowledge (Winarto 2004, 2011), we had the confidence to accept the agrometeorologist's initiatives and assist Stigter's efforts. The origins of this transdisciplinary collaboration date to the end of 2007, when Stigter was visiting Gunungkidul, following the termination of a CFS held in a hamlet.[3] Stigter learned of farmers' puzzlement regarding the new problems they were experiencing in the face of climate change and offered his help if the farmers would be willing to commit to adhering to his innovative approaches, and the farmers agreed. However, based on the challenge of presenting concepts grounded in Western science to local village farmers, it was determined that Stigter would require aid in sustaining his educational initiatives. Thus, the anthropologists' journey began with the role of 'facilitator' to the farmers. While immersing themselves into farmers' daily life, the anthropologists helped the farmers better understand the agrometeorological observation method and the ways of documenting their data. In doing so, the anthropologists had to translate the scientific terms into the farmers' own vocabularies so as to enable them grasping the new meaning easily. Assisting farmers in practising the new methods of observation, documentation and evaluation became part of their roles. By understanding farmers' problems and constraints in mastering the new scientific ideas, the anthropologists were able to communicate those constraints to the agrometeorologist so as to inform him of any problems found in the field. By doing this work, the anthropologists gradually assumed the role not only of facilitator and translator, but also of collaborator and mediator to both of them. Mediating the two domains of knowledge – the scientific and the local – had been part of the anthropologists' significant work.

In Winarto and Stigter (2013: 425–26), we summed up the three main roles of the anthropologists as: (1) the main organizers of the SFS;[4] (2) facilitators working closely with farmers in managing and assisting them; and (3) ethnographers observing, documenting and interpreting the entire sequence of events. The latter was possible due to the presence of students conducting their ethnographic fieldwork by accompanying farmers to the fields and observing their activities while assisting them if necessary. Throughout the students' and the anthropologists' immersion in farmers' daily lives, an ongoing reflection of the progresses as well as the obstacles the farmers' experience were able to be documented. Such a close relationship provides an opportunity for a continuous learning by both sides through ongoing reflection and intersubjectivity. However, participation as engaged anthropologists in climate science and applied agrometeorology was an evolving process and, as such, it involved a number of challenges to be resolved over time. Despite the initial successes of the SFS, we determined that we needed to become even further engaged with these communities on a long-term and collaborative basis.

Being Creative Cultural Translators, Mediators and Facilitators

Being translators, mediators and facilitators, as advocated by Fiske et al. (2014), was not as simple and easy as we had expected, as the scientist and the farmers had each developed their own ways of knowing, based on different premises, concepts and methods. Even though I had a general understanding of how both domains of knowledge worked, agrometeorological science was relatively new to me, and in the early years of accompanying farmers, it was a demanding job to identify the appropriate simple Indonesian terms for abstract agrometeorological concepts such as 'air convection', 'evaporation', 'transpiration', 'atmosphere', 'El-Niño/La-Niña', 'solar radiation', 'orographic rain', etc. Literal translations were often inadequate in conveying the underlying concepts upon which the terms were based, and I had to learn how to transform the abstract concepts into concrete descriptions and visualizations informed by what farmers knew and did not know. I ultimately succeeded in this task by learning from the references related to climate change and by being creative in finding effective strategies for communication, such as drawing on a piece of paper, using concrete examples and repeating the same word several times when explaining a term in simple Indonesian, so that the farmers gradually grasped the new meaning.

A similar problem, with a higher degree of difficulty, was the translation into Indonesian of the meteorological terms in the monthly seasonal climate scenarios, which were sent in English by the agrometeorologist. As the anthropologist, I had to circulate the translated version via mobile phone to farmers to help them determine their immediate actions, if necessary. Selecting the Indonesian words for technical terms such as 'near normal', 'above normal' and 'below normal' was a significant challenge. As in the above case, I learned to understand the farmers' interpretation of a 'normal' rainfall pattern as it related to their daily lives and farming activities. Gradually, through repetition during each monthly meeting and numerous informal visits and discussions, farmers developed an understanding of the range of 'normal', as well as the 'above normal' and 'below normal' in each month based on rainfall data collected in each field. The farmers' own common sense of those ranges of rainfall based on daily experience was gradually replaced by precise quantitative data. The process was easier for the farmers who had collected more than five years of rainfall data. Led by Kees Stigter and later on by his substitute, Sue Walker, and by Ariefiansyah from our SFS team, they could identify the ranges of 'normal', 'above normal' and 'below normal' monthly rainfall by developing the probability rainfall graphs based on their own data. Therefore, the shorter the duration of learning, the more difficult it was for the farmers to grasp novel terms and concepts. Only by engaging in continuous interaction with the farmers and following their observations and discussions over time could I grasp their interpretations and misinterpretations of new terms and concepts learned in the SFS.

A similar approach was also useful in developing my role as a 'mediator' between the two domains of knowledge. From the beginning, I understood that the 'rules' of operationalizing the SFS was in the agrometeorologist's hands. Thus, adhering strictly to the methods and rules he had established for measuring rainfall and observing the agroecosystem was a must. However, because the agrometeorologist did not spend extensive time in the field, he could not convey the details of how to lead farmers in documenting the data. The incremental improvement of the monthly data sheets filled in by the farmers and of the contents of their log books are examples of how the anthropologists developed innovative ideas to help the farmers focus sharply and precisely on what needed to be documented. The anthropologists further processed the data sheets, transferring them into a digital spreadsheet so as to enable the agrometeorologist to read, interpret and analyse the farmers' data in order to follow what was going on in their fields and habitats, and to determine what needed to be done in order to improve the farmers' understanding (Prahara, Winarto and Kristiyanto 2011; Winarto and Stigter 2016). The determination of the new knowledge and methods for the agrometeorologist to deliver in the SFS was also influenced by listening to the anthropologists recount their observations. Though he complained of the farmers' sloppiness in data documentation in the early years, the agrometeorologist gradually came to understand our explanations of the difficulties the farmers had in inscribing and documenting the complex phenomena they encountered in their fields and habitats. The shift from complex spoken descriptions of related components of agroecosystem and rainfall data to simple written texts with numbers and fewer words represented an enormous change in the farmers' ways of expressing and analysing.

Though farmers were able to improve their data-collection skills, we had to accept the reality of their inability to document their observation as completely as the scientists preferred, meaning that 'garbage in and garbage out', as the agrometeorologists complained, was often inevitable (Winarto and Stigter 2016). The farmers' consciousness of the importance of having proper documentation increased as they understood the significance of being able to 'tie their knowledge into the book so as not to "fly" away', in the words of one elderly farmer. Another agreed that: 'I would like to make my own *pranata mangsa* [the Javanese agricultural calendar] for my children and grandchildren to refer to in the future.'

Some farmers requested that we convert the manual data and rainfall graphs created from our collaboration into a digital system, and we eventually developed a means of digitization. In addition to digital monthly and annual rainfall graphs, following the introduction of a probability graph of rainfall data in the 2016–17 'training of trainers' by Sue Walker (who replaced the late Kees Stigter),[5] the farmers and the anthropologists began collaborating to produce probability graphs to define the range of 'near normal', 'above normal' and 'below normal' for each farmer's dataset. This co-creation of rainfall graphs represents evidence of the incremental development and evolving changes experienced by both the scientists and the farmers.

Without positioning ourselves as the farmers' friends and companions, as well as programme facilitators, and without our creativity in identifying any and every possible means of improving our co-creation of knowledge, I would strongly argue that sustaining and developing the SFS would have been impossible.

Establishing and Institutionalizing a New Tradition of Learning

The early stages of the institutionalization of a new tradition of learning involved changes to the way in which the farmers recorded their empirical observations in writing, and marked a significant difference between the approaches of the SFS and the CFS. As a farmer who had joined a CFS prior to his participation in the SFS observed, the former did not involve the systematic production of a dataset by individual farmers over a long time period, whereas in the SFS, each participant gradually built up a sense of ownership over the data they had personally collected over months and years from the same rainfall station.

However, going to the field every morning to observe their fields and measure rainfall at the same hour was a new 'habit' that the farmers had to develop, and obtaining their cooperation and adherence to established procedures proved to be challenging. As Stigter advised, based on the increasing uncertainties the farmers would face in the future, 'measuring rainfall should be part of your habit, like drinking a cup of water or coffee every morning'. Not all farmers were happy to do such work and develop this new 'habit' in the absence of the financial rewards as offered by other state-sponsored projects, and withdrawal from participation in the SFS was common during its early stages. As observers and outsiders, we could not force the farmers to continue to participate. We also observed that number of members of the group/club fell in cases when the SFS had been formed by a local agricultural official who had made a decision about who should join.

Those who decided to continue as members of the rainfall observers group learned that rainfall data could not be acquired without their enthusiastic and persistent willingness, effort and motivation. With the agrometeorologist's guidance and the anthropologists' facilitation, correction and explanation of the nitty-gritty of mounting a rain gauge and measuring and documenting the data, the farmers gradually internalized the rules for practising the new skills they had learned.

To address the initial difficulties in identifying the rainfall station of each farmer when they reported the data, the anthropologist introduced the idea of assigning a code to each rainfall station, for example, BUKL01 (BU = *Barat Utara* or northwest zone; KL = Karang Layung, the name of the village; 01 = number in the list of all rainfall stations in one regency). Though the farmers only referred to these codes when making their written and oral reports for the monthly evaluations, over time they came to embody an 'identity' for each rainfall station and also indirectly identified their associated farmers/rainfall observers. Over the years, a kind of 'belonging' gradually linked the farmers with their rainfall stations and the associated datasets they were collecting.

Another challenge hindering data collection was the farmers' tendency to move the rain gauge to the yards of their houses during busy times of field activities (e.g. ploughing, harvesting) or in the fallow period. Upon learning of this practice from our field observation reports, the agrometeorologist prohibited it, declaring that the resulting rainfall measurements would be worthless. Though it was not easy to establish the rule, the farmers were ultimately able to understand our explanation of why it was not acceptable to remove the rain gauges, and together we developed a compromise whereby shifting the rain gauge around during busy times in the field was allowed, but bringing it home was not. An additional challenge arose when one farmer decided to move his rain gauge to another field permanently, without changing the code of the rainfall station. After discovering this and processing the resulting dataset, I realized that it would not be possible to have the same code for the different rainfall stations because of the diverse ecosystems distinguishing the two fields, but I needed to devise a means of expressing this in a manner that would convince the farmers. I explained that the farmers' own rainfall data showed variations even among different fields located near each other. If a farmer were to present the data collected from two different fields as a single bundle of data rather than as two different datasets, then it would not accurately represent the conditions of one rainfall station. After listening to this, the farmer who had moved the rain gauge to another field agreed to change the code for his new rainfall station so as to distinguish it from the earlier station code of BUKL01.

Following on the numbering of the existing rainfall stations, his new rainfall station was assigned the code of BUKL43. From this point on, he only reported the data from the new rainfall station. After this incident, I began to announce the rule and repeat its explanation when introducing the SFS to new groups of farmers in different locales.

The above are examples of rules developed over time based on our experiences in the field. Once they were internalized by the farmers, the same procedures were introduced to new members and new clubs/groups. By observing practices that were incongruent with the rules as set up by the agrometeorologist and by discovering the farmers' modifications and innovative decisions taken in response to the existing circumstances, the anthropologists had opportunities to learn and develop their responses. Through similar processes during various other activities, such as agroecosystem observation and documentation, yield evaluation and farmer-field experiments, the institutionalization of new forms of knowledge was gradually established.

Enriching Knowledge and Stimulating Changes to Crop Farming

Since the early 1990s, my examinations have shown me that farmers are diligent observers of their own fields and practices (Winarto 2004). *Ilmu titèn* (memorable detailed science) is the term used by farmers in Yogyakarta to refer to the thorough knowledge they have developed of their own fields and habitats. Taxonomies of soil texture-type-colour and types of rainfall are examples of such knowledge (Kristiyanto and Winarto 2011). However, farmers' interpretation of everyday phenomena they encountered is based on their accumulative experience and subjective understanding. Without any objective knowledge received from external agents such as scientists and extension intermediaries, farmers rely on their own interpretation of the efficacy of their own strategies as they were accustomed to do in the past. Example was their habit to apply recommended balanced chemical fertilizers as introduced in the Green Revolution package. Relying on their interpretation that applying the recommended fertilizers' components improved crop productivity, they did not understand the impacts of the excessive use of nitrogen on the growth of plants and the probable disease infestation. Rice blast infestation on rice has been increased in the past decade along with the increased rainfall intensity and humidity in the rainy season. Climate variability was beyond their imagination and they had no understanding of its drivers.

Gradually, for rainfall observers, the new elements introduced in the SFS became part of an 'interconnected pattern of interpretive elements

[that] can be activated by minimal inputs' (D'Andrade 1992: 29; see also Strauss and Quinn 1997). Once farmers understood the meanings, as well as the function and benefits, of the newly introduced elements, they could be integrated into the existing interconnected systems of crop farming and, incrementally, a new interconnected pattern of interpretive elements was developed. For example, numeric rainfall data provided them with an additional element to be interpreted in combination with other elements of their knowledge of field agroecosystem and plant growth. The data collected from diverse rainfall stations located throughout the regency allowed farmers to realize how varied the rainfalls actually were in the region, and this discovery supported the agrometeorologist's insistence that rainfall should be measured separately at each rainfall station, with its unique ecosystem. When the farmers noted that the same rainfall measurement in two different fields resulted in differing impacts on the soil and amounts of water trapped in the field, they recognized the causal factors underlying those differences while interpreting their connection with another element, namely, the varied soil texture. The longer they conducted the rainfall measurements and the more the dataset expanded, the more new elements to their own observations and the richer the understanding they gained of the relationships between rainfall patterns, humidity, variations in the maturation ages of particular plant varieties, and the impact of pests and diseases.

Based on his thoughtful examination of the relationship between rainfall patterns in different seasons and pest and disease problems, one farmer was able to draw his own annual graph modelling those components. By drawing two graphs – the rainfall and the growth of pest population or the intensity of disease – for rainy season and dry season planting separately, he was able to conclude that pest population would be higher in the dry season than in the rainy season. On the contrary, the occurrence of diseases would be higher in the rainy season than in the dry season. These graphs were simple and easy to understand. Feeling satisfied of his discovery, the farmer told his fellows in the regular monthly meeting and others in his neighbourhood to anticipate the probable pest outbreak in the dry season and the disease infestation in the rainy season.

The overuse of chemical pesticides was another element discussed quite frequently in relation to pests and diseases. The connections between rainfall, humidity, pests and diseases, and farmers' treatments were strengthened through repeated discussions during the monthly evaluation meetings, and some young farmers were motivated to try to reduce the quantity and frequency of pesticide application. They discovered that this produced the same (or even much higher) yields, while resulting in less damage, by comparison with fields that had been sprayed excessively. Their evidence strengthened the connection between those elements and led to persistent changes in their pest management practices. It was our regular discussions that were the driver of this change. As one farmer informed us: 'Because you always raised the question in the monthly meeting as to why we kept spraying *obat* ['medicines', a local term for pesticides], I was curious to discover whether or not reducing the spraying would cause damage to my crops.' Simply by being there, listening to farmers' reports and discussions, raising some questions and providing explanations if necessary, the anthropologists' presence and queries served as an effective means to induce a significant change in local practice, without any efforts at imposition or enforcement. We simply raised questions regarding the farmers' strategies every time we had the chance to observe and/or to discuss their agrometeorological analyses. A rainfall observer told me how he changed his behaviour regarding the spraying pesticides after receiving our repeated questions as to why he had to spray the plants. Farmers also modified their strategies of sowing seeds in the nursery, after learning from one another's effective strategies under the delay of the rainy season planting or at the beginning of a dry season.

The dissemination of monthly seasonal climate scenarios was another novel element introduced by the SFS. As argued by Roncoli et al.: 'Recollections of the past, observation of the present, and expectation for the future shape our experience of climate phenomena and our understanding of climate information' (2003: 181). Prior to joining the SFS, the custom was to implement a repetitive cultivation strategy each planting season, without any consideration of probable 'abnormal climate conditions'. By developing an outlook of future climate scenarios, in combination with patterns gleaned from recent and long-term experiences in detailed observations of rainfall and their fields' agroecosystem, the farmers were able to anticipate probable risks and/or opportunities. Farmers' ability to foresee future climate conditions grew on the basis of an understanding of the seasonal scenarios, and of the interconnections between their past and recent experiences. The strategies that were most effective could thus be defined, due to the farmers' improved anticipation capability (Nuttall 2010), and their standpoints were strengthened based on the evidence they gained from being successful in harvesting or, alternatively, experiencing harvest failures. Being responsive to the probable forthcoming climate scenarios became perceived as a correct and sensible path.

Improving their confidence as to the effective strategy in particular climate conditions also motivated the farmers' resistance towards certain government policies, once they understood their probable maladaptive consequences. For example, based on the forthcoming La Niña, during the dry-season period of 2017, the Ministry of Agriculture defined a policy for farmers on the north coast of West Java of continuously planting rice in fields usually left fallow, or those planted with other secondary crops following the dry-season planting. However, a group of rainfall observers in a village in the middle of Indramayu Regency had gained experience and knowledge from SFS participation, and they knew the great risks to their fields and yields posed by the increased and severe pest and disease problems associated with continuous planting. These farmers strongly voiced their reluctance to plant rice three times a year and, unlike those who dared not do otherwise, those who stuck to their decision not to follow the government's policy were saved from total harvest failure. Unfortunately, in the next growing season, severe, regionwide pests and diseases outbreaks resulted in harvest failure even for those who had limited their planting to two periods. As one rainfall observer lamented: 'I planted paddy five times, but I did not harvest anything.'

Though the farmers' reluctance to plant rice three times in a row did not yield any significant change in the central state's policy, a collective strategy made at the village level could have produced more resilient rice cultivation. However, this was successful only when, upon the village leader's invitation, a group of rainfall observers at a village in Indramayu Regency was able to provide their anticipative strategy at a village meeting. Based on a climate scenario foreseeing the forthcoming El Niño in 2014/15 as associated with a possible late start to the rainy season and a short duration of rainfall, the rainfall observers assisted the village leader in determining a planting schedule and the choice of rice variety of short maturing age that would reduce the risk of harvest failure from the early cessation of rains. This strategy was combined with the result of observing the peak flight of white-rice stem-borer moths in the beginning of the season. By referring to the pest's life cycle and the period of moonlight, the farmers and the village leader determined the planting schedule so as to avoid the time of high population of white-rice stem-borer moths during a full moon at the primordia stage of rice plants. Therefore, the strategy was also aimed at avoiding crop damage due to the outbreaks of white-rice stem-borer moth infestations. Whilst farmers in other areas on the north coast of Indramayu kept planting rice without any additional irrigation and experienced severe harvest failures, farmers in that village could harvest their yields (Winarto, Stigter and Ariefiansyah 2017). Thus, whereas the other rainfall observer, who kept planting rice, bitterly lamented his inability to engender a collective decision, in the absence of a warning system or planting alternatives provided by the authorities, later rainfall observers had pride and confidence in their own anticipative and responsive strategies.

Another significant change to the farmers' cultivation schema and practices occurred with the adoption of scientific premises in conducting agricultural field experiments. Farmers had previously performed trial-and-error experiments to test whatever strategies they intended to implement in a plot over a single period of time, and it was common to provide different treatments to address several variables at once. This practice was implemented by a number of rainfall observers conducting the new farmer-field-experiments we had introduced in 2013. The latter was called the 'win-win solution'. Rather than carrying out systematic experiments involving the modification of a single variable among different plots of land, a number of rainfall observers had implemented various types of treatments in their experimental plots simultaneously. Fortunately, after being corrected by the agrometeorologist and receiving further explanation and reiteration from the anthropologists, the farmers grew to understand the logic of, and the procedure for, carrying out experiments based on scientific premises, and they obeyed those rules in later experiments. Whereas previously one farmer might modify up to four variables (crop variety, planting distance, water management and soil tillage) in a single field, they ultimately learned to test only one variable at a time, which would be altered in different plots while the other variables remained constant. The farmers agreed that they obtained better results when conducting experiments using this method.

All of the above examples demonstrate the gradual and incremental changes in farmers' cultivation schema and practices produced through ongoing interaction between, and reflection by, the knowledge provider (the agrometeorologist), the facilitators (the anthropologists), and the recipients (the farmers). Through continuous dialogue and mutual respect and commitment, the scientists were able both to build upon and extend the farmers' ecological and scientific knowledge and practices, thus providing them with tools to adapt and respond to current and future challenges deriving from the increasing climate variability.

Towards Future Anthropological Practice in Climate Services: A Reflection

Anthropologists' engagement in the SFS is an example of their potentially significant role in climate science and policy on the basis of interdisciplinary collaboration with scientists from other disciplines, and of engagement with local communities or other stakeholders. This kind of collaborative work aligns well with the knowledge-exchange practices advocated by other researchers (e.g. Barnes and Dove 2015; Crate 2011; Fiske et al. 2014); however, such projects are demanding in terms of time, effort, financial support and the need to think creatively in the face of emerging and unexpected problems. Any anthropologist willing to engage in such exchanges must be prepared to dedicate his or her time and passion in persistently carrying out the work on a continual and ongoing basis.

In comparison with other state-sponsored programmes delivered over short-term periods, as well as such time-limited programmes of developing knowledge exchange as previously implemented by Button and Peterson (2009), and Crate and Fedorov (2013), the implementation of continual study by anthropologists through establishing learning institutions such as the SFS could be more beneficial in advancing local people's learning of scientific premises and rules (I emphasize the term 'learning' instead of 'knowledge' per se). Achieving this aim depends on the anthropologists' work in materializing the applicable dimension of agrometeorological knowledge on the ground, in their roles as cultural translators and mediators between other scientists and farmers, and as facilitators for farmers. This kind of work not only improves the farmers' scientific-learning process, but also enhances the ways in which agrometeorological knowledge is implemented within local domains of learning. Such a significant role should be sustained and improved upon by anthropologists in any future collaborative work related to climate issues. Yet, as Lassiter (2008) argued, this kind of work requires particular methods of training in order to advance and improve young anthropologists' knowledge, skills, and passion, to enable them to engage in a more collaborative form of ethnography. Continual training has to be established for the new generation of scholars to move them beyond being merely cultural translators and instead involve them in the work of community engagement.

My experiences have increased my confidence that such collaborations do not lead to ethical violations if they do not jeopardize farmers' livelihoods or cause other trouble for them, and do aid them in reducing their vulnerabilities and improving their resilience in the face of unusual risks. However, without the consent and agreement of a local community in building up the collaboration, anthropologists should not enforce their intended aims, and when facing farmers' queries, they should remain humble in consulting the appropriate experts. For future advancement, anthropologists looking to assist local communities in addressing climate change should build networks involving experts in diverse disciplines depending on the nature of the varying risks, hazards and/or vulnerabilities to which the farmers have to respond.

However, even such an ongoing form of engagement has its time limits, and an exit strategy should be defined that considers the financial support and time allocations available. Within the available timespan, anthropologists should work with the farmers to design a means of preparing them to be able to disseminate their new learning and to facilitate their fellows being rainfall observers once the scientists have departed. Among the seven climate services provided in the SFS, the scientists could only continue their participation in two over the long term: the dissemination of seasonal climate scenarios and the provision of new knowledge based on farmers' own needs and requests. The other services have to be continued by farmers individually and as groups. Thus, more structured training needs to be provided for farmer-facilitators and extension workers (if available) to improve their knowledge and skills relating to climate, weather and agrometeorological issues, as well as to strengthen their confidence as able facilitators for other farmers.

Carrying out advocacy among policy-makers is an even more demanding and challenging task. Based on my experience in introducing and promoting the SFS as an effective educational commitment, and in involving policy-makers to support the programme in their regions, additional strategies have to be considered in implementing such inclusion efforts. Despite the fact that the SFS could not be operationalized without the involvement of anthropologists, our expertise regarding climate and weather issues was questioned, relative to that of the scientists involved in meteorology-climatology-agrometeorology. Policy-makers accustomed to designing technologically driven, project-based, short-term programmes with a top-down approach will be reluctant to develop any longitudinal educational commitment such as the SFS, and changing this perspective will not be easy. A thorough understanding of the regional bureaucratic culture, administrative systems and programmatic approaches needs to be the basis for advocacy to policy-makers, and further study is necessary to address such challenges in the future.

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Notes

1. The Green Revolution was introduced in Indonesia in the early 1970s to increase agricultural production.
2. The agroecosystem observation and documentation is of the commodities, ecosystem, soil types, land management, sowing methods, total monthly rainfall, rainfall impact on fields, planting schedule, water management, growth conditions, fertilizers, pests and diseases and their control strategies, natural enemies and root depth. These were collected on large data sheets and in the farmers' own log books.
3. Climate Field School (CFS) is an Indonesian state's one-season-long training for farmers and was developed on the basis of the methods of the Integrated Pest Management Farmer Field School (IPM FFS) introduced in the early 1990s. Once in every ten-day period, the facilitators provided resources on various subjects related to climate, weather and their implication for farmers' fields and crops. The training on measuring rainfall and observing agroecosystems was carried out in the designated plot for observation, not on individual farmers' fields. Farmers were positioned as the CFS participants and not as researchers of their own fields. No further facilitation was carried out by the CFS in the period after training (Anantasari, Winarto and Stigter 2011; Boer 2009; Crane and Siregar 2011).
4. Throughout the course of our work, until the time we decided to 'exit' from Indramayu and East Lombok Regencies in early 2018, our team, which was under the responsibility of the Center for Anthropological Studies, Faculty of Social and Political Sciences, University of Indonesia, was not successful in obtaining financial support from the regencies' governments' annual budgets. We had to find donors from other institutions, from within the country and abroad, to enable us to pursue our collaborative work. However, in planning our 'exit' from the field, we assisted the farmer rainfall observers to organize their own group with the expectation that they would not only be able to arrange the SFS activities on their own, but would also be able to generate financial support from various sources. In early 2018, we finally managed to obtain agreements and commitments from the regencies' governments to incorporate the SFS into their five-year development plans and budgets.
5. Professor Kees (Cornelis Johan) Stigter was a visiting professor at the Faculty of Social and Political Sciences at the University of Indonesia (2011–16). He initiated the SFS from 2008, but passed away in May 2016 in Jakarta after visiting Indramayu to deliver the training of trainers for farmer facilitators and attending the monthly regular meeting. Professor Sue Walker, an agrometeorologist from the University of the Free State, South Africa and the African Agricultural Research Council, replaced the late Professor Stigter from November 2016.

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Chapter 9

Nepal's Climate-Change Cultural World

Pasang Yangjee Sherpa

This chapter explores national-level climate-change policies as they pertain to the everyday lives of Himalayan people at the local level. It focuses on the 2011 *Climate Change Policy*, the National Adaptation Program of Action (NAPA), the National Framework for Local Adaptation Plans of Action (LAPA) and the National Planning Commission's (NPC) 'Climate Resilient Planning' document that form the core climate policies on which other policy documents are based. It reviews and builds on recent literature to unravel the ways in which adaptation programmes currently operate and to underscore how the omission of nonclimatic factors and context-specific vulnerabilities from adaptation programmes has caused them to fail in meeting their stated goals. It also draws from ethnographic fieldwork in the Mount Everest region in northeastern Nepal between 2009 and 2012, among conservation and development practitioners in Kathmandu in 2014 and in Humla, northwestern Nepal, in 2016.

It employs the 'cultural world' (Bodley 2003) as a conceptual framework for exploring national actors involved in the design, preparation and implementation of climate-change policies. The national climate-change cultural world is understood as an extensive social environment, where entities routinely interact to secure their existence and where, in spite of their operational differences, they share understandings about the global climate-change phenomenon and the institutional roles, rights and obligations to respond to it.

The chapter reveals that biophysical, technomanagerial and apolitical approaches to climate change are extant in Nepali climate policies. It discusses biophysical understandings of climate change in the policies that focus on predetermined adverse effects for different regions. It shows that human systems are considered separate from natural systems and that people are treated as apolitical passive recipients who primarily live in rural regions. Policies depict climate change solely as a problem, limiting the understanding of its multidimensionality.

While climate-change policy-making initially emerged as a possible transformative opportunity to reach the most vulnerable, assessments have shown that, as conceived within the donor-recipient culture, they privilege Western scientific understandings of climate change over local knowledge and pursue technomanagerial approaches to dealing with climate-change effects that fail to consider the intersectionality of factors that produce context-specific vulnerabilities. Although discrete cases of indigenous knowledge are recognized during LAPA[1] preparation, there is no recognition of the multiple knowledge systems, institutions and worldviews in which they are embedded.

Everyday Reality

Humla, a northwestern district of Nepal, was dry when I visited in the spring of 2016. Drought is not unusual in this food-insecure mountain region. However, Ram Dai[2] believed this was the driest it had been in the last forty plus years of his life. He pointed to the fields with plants struggling to emerge from the dry soil and repeated his worrying observation as if he could not get it out of his mind. Dai and I were walking to his village, a few hours of downhill hiking from Simikot, the district headquarters, and across the raging Karnali River. After an hour, we came across some of his fellow villagers resting on the edge of a fresh road they had just dug. A few men sat next to a rock above us and continued to break it with their hand tools. Road-building offers supplemental income to the villagers. 'It is a hard job with little pay', Dai claimed. In the village, I met a lone grandmother sitting on the roof, looking helplessly at her field and wondering aloud if there would be enough to eat later in the year. Seasonal streams that originate on mountain tops are the traditional source of drinking water. Development projects had previously invested in bringing stream water to the village, but the lack of sustained assistance rendered these efforts fruitless in the long run. As we left the village, I asked Dai: 'Why not use water from the river? It is so close to you.' He explained that it would be costly and require special expertise, investment and machinery, all of which are difficult to acquire in this remote rural region. The lack of infrastructure to bring water makes irrigation impossible, and villagers continue to rely on rainwater. Several hours later, just before we reached Simikot, there was a heavy downpour. I saw signs of relief on Ram Dai's face, which quickly disappeared when we both realized we were not prepared for the rain. We ran from one house to the next, trying to stay dry.

Climate-change effects are an everyday reality for mountain people in the central Himalayas. The challenge of coping with food insecurity in Humla remains painful to the Humli villagers, regardless of whether it is perceived as a World Health Organization (WHO) issue, as it has been for the past several decades, or a NAPA issue, as it has been since 2012 (Nagoda 2015). Life continues. The scale at which food insecurity affects villagers every year, and the lack of local resources – social and economic – to allow villagers to overcome this challenge makes sustained external institutional support crucial. The need to facilitate successful adaptation and enhancing adaptive capacities within the context of sustainable development is clear, as the effects of climate change become increasingly apparent (Jones and Boyd 2011). The availability of institutional support on its own, however, does not necessarily solve the problems. It may instead cause further exclusion of the most marginalized, who are often illiterate, from access to institutional benefits (Nagoda and Nightingale 2017; Nightingale 2017; Regmi, Star and Filho 2016), even when the local participation of specific social categories, such as 'women' or 'dalits', is emphasized in the institutional design. Differential power dynamics in the governance structure prohibit meaningful participation of the most marginalized in the decisions regarding what policies are put in place, and where, when and how policies are implemented (Nagoda and Nightingale 2017; Nightingale 2017). Vulnerability to climate change is often due to nonclimatic factors such as socioeconomic situation or caste-based discrimination (Nagoda and Eriksen 2015; Pandey and Bardsley 2015). Sociocultural, economic and political stressors intersect with climate-change effects, and contribute to different context-specific vulnerabilities among heterogeneous members of local communities (Puschiasis 2015; Nagoda and Eriksen 2015; Sherpa 2014). Lack of consideration of such vulnerabilities in climate policies can lead to the failure of adaptation programmes that supposedly target those most in need of assistance. The diversity of the milieus, the high variability of climatic features and the multiplicity of factors of change in the Nepali Himalayas call for very detailed multiscale temporal and spatial analyses (Smadja et al. 2015). Discussions of climate change need to avoid generalizations (Smadja et al. 2015) so as to remove uncertainty in adaptation responses.

Recent publications examining climate-change policies (Khatri et al. 2015; Nagoda 2015; Nagoda and Nightingale 2017; Nightingale 2017;

Ojha et al. 2015; Vij et al. 2017, 2018), the process of policy-making (Helvetas and RRI 2011; Nightingale 2015) and their implementation at the local level (Bhattarai, Beilin and Ford 2015; Pandey and Bardsley 2015; Regmi, Star and Filho 2016; Sherpa 2015) show that climate-change adaptation activities in Nepal have been ineffective, failing to meet their stated objectives or contributing further to vulnerabilities at the local level. In particular, Nepal's climate-change policy analyses conducted by Helvetas and RRI (2011), Nagoda (2015), Nightingale (2015, 2017), Nagoda and Nightingale (2017), and Ojha et al. (2015) allow this chapter to further discuss national-level climate-change cultural world. I also draw upon my previous research on Sherpa perceptions of, and institutional responses to, climate-change effects in the Everest region between 2009 and 2012, and the interviews conducted in Kathmandu with conservation and development practitioners in 2014 and with local villagers and climate-change adaptation officers in Humla in 2016.

This chapter recognizes the significance of institutions at the local, national and international levels, as well as institutional links between them, in operating adaptation programmes, as has been demonstrated by several studies (Ojha et al. 2015; Nagoda and Nightingale 2017). It concurs that a proper appraisal of climate-change challenges and opportunities in Nepal requires investigation across all levels. Understanding the local or the national in relation to others in the 'chain of policy development' (Nagoda and Nightingale 2017) is imperative. Therefore, this chapter investigates climate-change policies and policy-making at the national level in relation to the local and the international. Government agencies as part of the national climate-change cultural world are one of the many actors that are significant partners to international donors and play the role of key planners of local climate-change responses.

The National Climate-Change Cultural World

In *The Power of Scale*, Bodley (2003) compares cultural worlds that illustrate characteristics of human organization and the unintended consequences that arise as scale increases. He describes cultural worlds as 'the most extensive social environments where people routinely interact to secure their existence, and where in spite of linguistic or ethnic differences, people share understandings about the nature of the world, and about the common human rights and obligations' (Bodley 2003: 7). The most striking aspects of the different cultural worlds are the scale and scope of human activities that each permit, the distinctive ways in which *imperia*[3] are constructed in each, and how social power is organized and distributed (Bodley 2003: 7). Bodley argues that contemporary human problems – environmental deterioration, poverty and human rights abuses – are unintended consequences of the operation of personal power networks that have become too big and too dangerous to be safely controlled (2003: 3).

Bodley's cultural-world perspective affords multiscale analysis of heterogeneous actors – their diverse worldviews, agency and relationships – and the consequences of their actions. It offers a lens through which a national-level complex, consisting of governmental climate-change agencies and their policies in relation to other relevant institutions, can be examined. In the national climate-change cultural world, entities routinely interact to secure their existence in this most extensive social environment. In spite of their operational differences, these entities share understandings about the global climate-change phenomenon, and institutional roles, rights and obligations to respond to it. This perspective offers a pathway to cultural analysis that asks a set of questions about meaning and relationships as seen from actors' perspectives (Campbell 2013: 355). It opens up conceptual space for us to consider governmental agencies as important national actors and to situate them in relation to other groups and institutions. The international is distinguished from the national as the site from which climate-change ideas and resources currently flow and the local is distinguished as the site where national climate-change policies are implemented. This cultural-world perspective does not require the exclusion of nonhuman actors or indigenous cosmologies or multiple epistemologies, just as it does not exclude policies and the policy-makers. This perspective is complementary to seeing cultures in the Himalayan environment as 'vantage points on the diverse ways and contexts in which people bring community into being, on the assembling of actors and localities, on the inclusions and exclusions, the bringing closer and the rendering distant, that vitalize the possibilities of social interaction and subsistence in a part of the world characterized by transition and intermediacy' (Campbell 2013: 355).

In Nepal's climate-change cultural world, government agencies are powerful bodies of national authority that interact with each other and with international nongovernmental organizations (INGOs), nongovernmental organizations (NGOs) and civil society groups with varying degrees of institutional capacity at different levels. However, cross-institutional engagements are not without contestation and conflicts of interests. Development agencies can heavily influence climate policy-making via financing and privileging Western and scientific worldviews on climate change (Ojha et al. 2015).

According to Dixit (2010: 5), Nepal's institutional landscape is constituted by governmental and semi-governmental organizations, multilateral and bilateral donor agencies, educational institutions, international and local NGOs, and federations of user groups. These organizations work on issues of development, environment, climate and poverty alleviation, with specific activities focusing on 'drinking water, irrigation, hydropower and energy system development, community empowerment, capacity-building in disaster preparedness and response, and national resource management' (Dixit 2010: 5). Dixit groups institutions into three solidarities – the state, market and civil society – each of which is described as 'a social carrier of a different type of knowledge, one that reflects the needs of its particular world view and filters out other points of view' (Dixit 2010: 5).

Similarly, Vij et al. (2018: 77) recognize climate policy paradigms (CPPs), the comprehensive set of prevailing and institutionalized ideas and strategies of policy actors. Building on the work of Hall (1993) and Howlett (2009), Vij et al. (2018) argue that policy paradigms influence the ways in which actors respond to particular issues, as they set the prevailing ideas about what is considered logical, acceptable, appropriate and desirable. They argue that underlying the design and implementation of climate policies and plans are CPPs. They identify four CPPs in Nepal: (1) disaster response and relief (since 1997) (2) disaster risk reduction (DRR) (since 2003); (3) climate change adaptation (CCA) (since 2009); and (4) localized actions towards CCA and DRR (since 2012). They argue that there has been a 'layering' of CPPs, a process of adding new frames, goals and instruments to existing institutions without replacing pre-existing ones. In comparison, they argue that Bangladesh has 'layering', 'drift' and 'conversion' of CPPs. Drift and conversion refer to changes in existing institutions or elements due to the external environment or the redeployment of existing institutional elements for new purposes (Hacker 2004; Hacker and Pierson 2010). While layering can be advantageous in providing support for new CPP to build upon the experience of the older ones, Vij et al. (2018) conclude that it can also cause fragmentation of policy efforts due to overlaps and the introduction of new actors and instruments that create confusion and competition within various paradigms.

Climate-Change Adaptation in Nepal

The government of Nepal signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and designated the Ministry of Environment (MoE)[4] as the focal point to implement relevant provisions. In 2005, Nepal ratified the Kyoto Protocol. In 2010, the NAPA was prepared with support from the United Nations Development Programme (UNDP) followed by the 2011 *Climate Change Policy* with support from the World Wildlife Fund (WWF). These major climate-change policy documents were prepared at the national level through different coalitions of policy-makers without political deliberations among the affected people (Ojha et al. 2015).

The government of Nepal recognizes that the country is affected disproportionately by climate change although it accounts for only 0.4 per cent of the total global population and is responsible for only 0.025 per cent of total greenhouse gas (GHG) emissions (MoE 2010). The government of Nepal identifies adverse impacts of climate change on a sectoral basis that includes agriculture, food security, water resources, forests, biodiversity, health, tourism and infrastructure (MoE 2010). It expects climate change to increase occurrences of natural disasters that undermine Nepal's development efforts and its overarching goals of reducing poverty and enhancing economic wellbeing (NPC 2011). Extreme events are highlighted, especially in the context of disaster planning and risk reduction. The melting of Himalayan glaciers and glacial-lake outburst floods (GLOFs) in particular have been stressed when depicting negative climate-change impacts internationally (Sherpa 2015). Instances of premature and overblown alarmist attention to GLOFs in the Everest region have been called out by glaciologists in favour of systematic studies of the cryosphere (Ives 2013; Watanabe, Lamsal and Ives 2009).

As a least developed country (LDC) vulnerable to climate change,[5] Nepal receives funding from international donors for climate-change adaptation activities. The National Climate Change Support Programme (NCCSP) is the first significant intervention on climate-change adaptation in Nepal financed by the UK government's Department for International Development (DFID), the European Union (EU) and the UNDP. The first phase ran from 2013 to 2017 with financial support from all three donors. The second phase (2017–22) is supported financially by the DFID with technical assistance from the UNDP. The NCCSP is guided by the NAPA, the *Climate Change Policy* and the National Framework on LAPA. The NCCSP corresponds to combined priority 1 of NAPA, which is to 'promote community-based adaptation through integrated management of agriculture, water, forest and biodiversity sectors'. It is also in line with the objectives of the Nepali government's Three-Year Plan (2010/11–2013/14) to promote green development, making development activities climate friendly and resilient, mitigating the negative impacts of climate change and promoting adaptation. The NCCSP in its first phase prepared and implemented 100 LAPAs in fourteen climate-vulnerable districts identified during the

NAPA preparation process (NCCSP 2018). It is continuing its efforts in the second phase.

Climate-Change Policies

Core climate-change policies in Nepal include the *Climate Change Policy*, the NAPA and the National Framework on LAPA (Dhungana et al. 2013; Nagoda 2015; Ojha et al. 2015). The Reducing Emissions from Deforestation and Forest Degradation (REDD) Preparedness Plan (RPP) and climate-related legislation that supports Nepal's climate-change policies (Helvetas and RRI 2011), the 'Climate Resilient Planning' document of the NPC, the Village Development Committee (VDC)[6] level LAPA documents, and other policy documents prepared at the ministerial, district and local levels, further constitute Nepal's climate-change policies. The Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) strategy framework produced by the Ministry of Forest, Soil and Conservation (MoFSC) is not included in this list because the REDD+ process, while related to climate change, operates separately (though not exclusively) from climate-change adaptation at the local level. National climate-change discussions, including the NPC documents, do not highlight REDD+ as a climate-change activity, although as Nightingale (2015: 220) points out, the 'readiness' efforts of the REDD+, aimed at sequestering carbon in forests, emphasize benefit sharing, the diversification of livelihood opportunities and other social programmes that can easily be classified as 'adaptation'.

The Ministry of Population and Environment (MoPE), the MoFSC and the Ministry of Science, Technology and Environment (MoSTE) serve as the primary governmental agencies working on climate-change issues. The MoPE, as the NCCSP implementing agency, has partnered with the Ministry of Federal Affairs and Local Development (MoFALD), the District Development Committees (DDCs) and the District Energy, Environment and Climate Change Sections (DEECCS) for the implementation of LAPA. In addition to institutional partnerships, governmental agencies have also created operational units for climate-change-related activities. The Climate Change Council within the MoPE, for example, was constituted on 23 July 2009 and had the Prime Minister as its chair, along with representatives from several ministries and the NPC to provide high-level coordination, guidance and direction for the formulation and implementation of climate-change-related policies. However, such operational units get 'layered' (Vij et al. 2018) as new units in various ministries are formed. Within the MoFSC, the REDD Implementation

Centre (IC) works on REDD+ programmes. The REDD IC coordinates the REDD+ readiness process, under the auspices of the World Bank's Forest Carbon Partnership Facility (FCPF), along with other REDD+-related projects (MoFSC 2017).

The National *Climate Change Policy*

The *Climate Change Policy* (Government of Nepal (GoN) 2011a: 5) envisions 'a country spared from the adverse impacts of climate change, by considering climate justice, through the pursuit of environmental conservation, human development, and sustainable development – all contributing toward a prosperous society'. It identifies local communities as the main stakeholders and earmarks 80 per cent of the Climate Fund, made available after the Kyoto Protocol, for the local communities (Helvetas and RRI 2011). The main goal of this policy is 'to improve livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emissions socio-economic development path and supporting and collaborating in the spirit of country's commitments to national and international agreements related to climate change'. Its stated objectives include (GoN 2011a):

1. establishing a climate change centre as an effective technical institution to address issues of climate change and also strengthening existing institutions;
2. implementing programmes related to climate adaptation and maximizing the benefits by enhancing positive (and mitigating adverse) impacts;
3. reducing GHG emissions by promoting the use of clean energy such as hydroelectricity, and other renewable and alternative energies, increasing energy efficiency and encouraging the use of green technology;
4. enhancing the climate adaptation and resilience capacity of local communities for optimum utilization of natural resources and their efficient management;
5. adopting a low-carbon development path through pursuit of climate-resilient socioeconomic development;
6. developing capacity for identifying and quantifying the present and future impacts of climate change, and adapting to climate risks and adverse impacts of climate change; and
7. improving standards of living through the maximum utilization of the opportunities created from conventions, protocols and agreements related to climate change.

The National Adaptation Programme of Action (NAPA)

The Nepal NAPA report was produced following the guidelines contained in the Decision 29/ CP.7 of the UNFCCC, which established a least developed countries expert group in 2001. The UNFCCC template for the preparation of the NAPA involves climate vulnerability assessments and identification of adaptation measures to systematically address climate change adaptation issues. The Nepal NAPA document stated:

> Nepal's NAPA is set within the country's development objectives. These objectives have been articulated in the national planning strategies and are aimed at addressing the specific economic and socio-political conditions prevailing in the country. Nepal's development goals, and therefore the NAPA framework, are set under the overriding goal of reducing poverty in the country … A series of National Five-Year Plans and Three-Year Interim Plans aimed to achieve poverty reduction by providing a policy framework that encourages investments in primary sectors that form the backbone of rural development and poverty reduction. (MoE 2010: 3)

The NAPA is 'a strategic tool to assess climatic vulnerability, and systematically respond to climate change adaptation issues by developing appropriate adaptation measures' (MoE 2010). The NAPA project identifies six thematic working groups with two cross-cutting themes. The remits of the thematic working groups include: (1) agriculture and food security;(2) climate-induced disaster; (3) urban settlement and infrastructure; (4) public health; (5) forests and biodiversity; and (6) water resources and energy. Livelihoods and governance, and gender and social inclusion are the two cross-cutting themes identified by the NAPA project, which identifies nine urgent integrated projects as immediate priorities for the national adaptation programme. The implementation of these adaptation measures is estimated to be about US$350 million. According to the document, these nine projects aim at:

1. promoting community-based adaptation through the integrated management of the agriculture, water, forestry and biodiversity sectors;
2. building and enhancing the adaptive capacity of vulnerable communities through improved systems and access to services related to agricultural development;
3. community-based disaster management for facilitating climate adaptation;
4. GLOF monitoring and disaster-risk reduction;
5. forest and ecosystem management in support of climate-led adaptation innovations;

6. adapting public health services to face climate challenges;
7. ecosystem management for climate adaptation;
8. empowering vulnerable communities through the sustainable management of water resources and the provision of clean energy supplies; and
9. promoting climate-smart urban settlement.

The Nepal Climate Change Knowledge Management Centre (NCCKMC) was created in 2008–10 under the NAPA preparation process (Nepal Academy of Science and Technology (NAST) 2017). NAST, an autonomous top-level body that promotes science and technology in the country, runs the NCCKMC as a knowledge-management centre for the production and dissemination of climate-change knowledge in order to strengthen the capacity of stakeholders. Five years after its inception, the full potential envisioned for the centre remains unrealized.

The National Framework for Local Adaptation Plans of Action (LAPA)

The National Framework for LAPA document (GoN 2011b) was designed to encourage consultation with local communities and to produce projects relevant at that level. It emphasizes a 'bottom-up, inclusive, responsive and flexible' approach to climate adaptation (Helvetas and RRI 2011: 14). The LAPA framework is a manual for adaptation planning and implementation that: (1) describes the key steps involved in integrating climate change into development planning; (2) provides a list of tools that could be used to facilitate the process; and (3) explains the key concepts that are relevant to the process of adaptation planning. The LAPA framework is designed to support the following:

1. The development of local adaptation plans, which reflect location- or region-specific climate-change hazards and impacts. The plans support adaptation options that are available locally and that are accessible to the most vulnerable communities and households, including women.
2. The integration of local adaptation priorities into village-, municipality-, district- and sectoral-level planning processes in accordance with the Local Self-Governance Act.
3. The implementation of local adaptation plans by supporting the timely and sustainable delivery of adaptation services to the most climate-vulnerable, including women.

4. Iterative adaptation planning, through constant monitoring, evaluation and feedback.

LAPA supports the 'operationalization of the policy objectives outlined in the NAPA, the *Climate Change Policy* and Climate Resilient Planning by facilitating the integration of climate change resilience into local-to-national development planning processes and outcomes' (GoN 2011b: 2).

Climate Resilient Planning

The NPC is the apex advisory body of the government of Nepal for formulating a national vision, periodic plans and policies for development. The NPC assesses resource needs, identifies sources of funding and allocates budgets for socioeconomic development. It serves as a central agency for monitoring and evaluating development plans, policies and programmes. It also serves as 'an intellectual hub for the exchange of new development ideas and proposals from scholars, the private sector, civil society and development partners' (NPC n.d.).

The 'Climate Resilient Planning' document of the NPC was prepared with the intention 'to facilitate ministries, departments and development organizations in analysing sector-specific climate issues with a greater understanding of climate variables at the local level and in adopting measures to reduce the emerging and anticipated climate threats which … development plans and programmes [face]' (NPC 2011: 4) The proposed tools in the document are expected to help integrate climate concerns into the implementation of development plans and programmes. The document emphasizes that in order to make development plans climate-resilient, the government needs to increase '[its] level of awareness about the inter-linkages among climate variability, climate-change hazards, vulnerability, and development', which is also a prerequisite to recognizing climate risks (NPC 2011: 11). The document promotes a conceptual framework and systemic approach that isolates natural and human-constructed systems for analysis as a way to simplify the complexity entailed in the evaluation of risk (NPC 2011: 11). If a development action is assessed to be at risk, the document suggests that the systemic approach would allow for the identification of the nature of the hazard(s), an assessment of the extent of the risk, a working out of response options and the identification of appropriate intervention(s). The climate framework presented by this document envisions achieving a society and economy that is resilient to a changing climate. In a resilient society, the document suggests that:

> All people, including the poor and vulnerable, have the capacity to respond in an adaptive (as opposed to reactive) way to current and future climate risks. They will have many choices, feel secure, and will be willing and able to invest in improving their livelihoods. Formal and informal institutions will reinforce the abilities of individuals to predict, prepare for, and recover from climate shocks. They will learn to monitor and respond to changing conditions in a timely, flexible and efficient manner. Practitioners and policy-makers will be equipped with the knowledge, tools, enabling policies and sustained funding needed to implement decision in a manner that increase resilience. (NPC 2011: 24)

The Approach Paper to the NPC's Thirteenth Plan (Fiscal Year 2013/14–2015/16) that set the development agenda and approach mentions that the objective of pursuing 'environment and climate change' by the NPC is to 'adapt to the adverse impacts of climate change as called for under the principles of green development' (GoN 2013: 115). Climate change is presented as an agenda item separate from (though alongside) the environment.

Climate Change through the Lens of National Policy

Nepali climate-change policies reveal biophysical understandings of climate change that focus on predetermined adverse effects, in which human systems are considered separate from natural systems, and people are treated as apolitical passive recipients and primarily as if they lived in rural regions (Nightingale and Rankin 2014). The policies consider adaptation activities that are resistant to adverse climate-change effects, including green development, as solutions to the problem of climate change. Adaptation is defined in terms of development interventions that target the most vulnerable, who live in rural regions. Although vulnerability in urban centres has been well documented (Shrestha et al. 2015), climate-change policies ignore them in favour of the 'more vulnerable' as defined in terms of residence, a perspective in which those who live in rural Nepal are presumed to be homogenously poor. This approach to climate change has underpinned the formulation of climate policies 'pre-empting the space for democratic representation of vulnerable groups' and 'avoid[ing] meaningful debates over what it might mean for Nepal to adapt to climate change' (Ojha et al. 2015).

The case of Nepal, as Nagoda and Nightingale (2017) highlight, is one in which the voices of the most marginalized, whose participation is mandated in the institutional design of adaptation programmes, are excluded at the local, district and national levels, revealing the inherent challenges of participatory development in climate-change adaptation. 'Women' in climate policies appear as a separate vulnerable area for adaptation intervention (Nightingale 2015; Nightingale and Rankin 2014) rather than as effective members of society with complex lives.

Climate-change vulnerability assessments conducted during the NAPA preparation process were instrumental in guiding the development of the NAPA and subsequent climate policies and programmes (MoE 2010; NCCSP 2018). These policies have focused on what Nagoda (2015) sees as 'outcome vulnerability approach', where vulnerability is regarded as an outcome of climate-change effects rather than of pre-existing contextual factors that affect some people more than others (O'Brien et al. 2007). Social dynamics that cause differential vulnerabilities between people and over time (Nagoda and Eriksen 2015) remain unheeded in climate policies.

While vulnerable social categories such as 'women' and 'dalits' are targeted (GoN 2011b), the intersectionality of the various factors that contribute to the differential vulnerability of individuals within these categories remains unexplored. In the southern part of the Mount Everest region, for example, the ways in which individuals perceive climate change, and how vulnerable a household is to the effects of climate change, is determined by gender, age, occupation and residence on or off the main tourist trail (Sherpa 2014). An older male Sherpa farmer living off the main trail could be more vulnerable than a young female Sherpa hotel owner living on the main trail. National climate-vulnerability assessments and policies currently do not consider such intersectional positioning of individuals.

Furthermore, vulnerability has also been defined in terms of predetermined risks for different regions by policy-makers, making the assessment remiss of a variety of climate risks (Ojha et al. 2015). In Dolakha, where the threat of Tsho Rolpa GLOF was identified as a climate risk, recent experiences had caused local people to consider landslides to be the primary climate-change-induced hazard (Khadka 2011). Similarly, despite Humla being listed as having no or very low GLOF risk, villages in northern part of the district were affected by a devastating GLOF in 2011 and continue to face such threats today (Hovden 2012). This approach of attending only to predetermined risks comes at the expense of exploring present and future climate risks and preparing for them. Climate risks for Humla continue to be narrowly defined in terms of food insecurity, and for the Dolakha and Solukhumbu (where Mount Everest lies) districts, it is conceived in terms of potential GLOFs.

Local Vulnerabilities and International Influence

Biophysical, technomanagerial and apolitical approaches to climate change are extant in Nepali climate policies (Helvetas and RRI 2011; Nagoda 2015, Nightingale 2015; Ojha et al. 2015). The second national communication to the UNFCCC (GoN 2014) presents a case in point. It follows the Intergovernmental Panel on Climate Change (IPCC) Assessment Report-3 (AR) definition of vulnerability, which refers to the degree a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. It thereby considers vulnerability as a function of the character, magnitude and rate of climate variation to which a system is exposed. This communication document recognizes agriculture, crop productivity and livestock production as areas where the adverse impacts of climate change are experienced. It highlights awareness raising, capacity-building and technology transfer as useful adaptation and vulnerability reduction measures, without disclosing what these would entail or how the objectives would be met.

Ribot points out that 'adaptation' and 'vulnerability reduction' seem synonymous but hide great differences in the way the relation between risk and response is understood. He observes that the climate-change community emphasizes adaptation that focuses on the present, and how we adjust to it, without sufficiently attending to the causes of vulnerability and their correction (Ribot 2017). Studies (Nagoda 2015; Nagoda and Eriksen 2015) have shown that ignoring the drivers of local vulnerability risks reinforcing existing vulnerability patterns and may even reduce the adaptive capacity of the most vulnerable. Climate-change adaptation forms part of the broader vulnerability context that determines the options that people have in the process of adapting to change. Adaptation can even produce new sources of vulnerability, as unintended consequences, when project benefits go mostly to those who are already well connected or when new projects are exploited through political means (sometimes through threats of violence), resulting in further exclusion of the poorest (Nagoda and Nightingale 2017: 91).

Within the documents, Nepal's climate-change policies (GoN 2011a, 2011b) recognize the most vulnerable and intend to seek their input. The ideal of 'working with representative bodies and insisting that these bodies incorporate local needs and aspirations into the design of projects and policies' (Ribot 2017: 239) is pursued, so as to ensure the influence of those most in need. However, in practice, it has been revealed that even when the most vulnerable are targeted, powerful actors are still able to assert their interests within climate programmes (Nagoda and Nightingale 2017: 86). Local politics expressed through unequal social (and power) relations play a dominant role in determining how climate-change adaptation will unfold (Nightingale 2017). Adaptation projects, knowledge flows and institutional interventions into livelihood dependencies can encounter attempts at control from networks of powerful elites and well-connected political actors (Nagoda and Eriksen 2015; Regmi, Star and Filho 2016; Sherpa 2015; Yates 2012) that push the most marginalized even further from being able to access institutional benefits. Thus, Nagoda and Nightingale aptly ask 'how are ambitions to promote local participation and to incorporate the needs of the most vulnerable into policy formulation and project implementation at different levels limited by pre-existing power relations across scales?' (2017: 85).

The institutional design for LAPA was novel in that it created spaces for local communities to assess their vulnerability and identify climate risks and adaptation measures. The effort involved in localizing global climate science and improving representation through the mandated participation of specific categories of vulnerable people in adaptation processes has been lauded as an important innovation (Ojha et al. 2015). However, assessment of LAPA implementation in several VDCs in Nepal has made it clear that despite the emphasis on local participation, those most in need of institutional support for climate adaptation and vulnerability reduction remain under-represented and little heard. The influence of donor agencies in largely aid-driven LAPA preparation and implementation has been observed (Ojha et al. 2015). Ojha et al. contend that the process of moving down from NAPA to LAPA has not been straightforward and 'the politics of science and aid continues to undermine the politics of representation in the adaptation policy cycle' (2015: 421). The framework for local-level institutional climate-change activities designed at the national level has failed to understand the political questions surrounding implementation across different levels (Nagoda and Nightingale 2017). The treatment of LAPA and other climate policies as if they were immune to ongoing political changes in the country (Adhikari 2014; Jha 2014; Lawoti 2014), and the lack of political debate surrounding the preparation of climate policies have been described as depoliticization (Ojha et al. 2015). Since power and politics are embroiled in all aspects of the climate-policy chain, 'making power constitutive of adaptation rather than an externality that requires post-implementation management' (Nightingale 2017: 12), depoliticized climate policies are limited in terms of their capacity to make adaptation programmes available to all.

The technomanagerial approach to climate policies and programmes has its roots in donor-recipient development culture. The availability of the Climate Fund after the Kyoto Protocol served as an impetus for the national government to formulate core climate policies in 2010 and 2011, after three to four years of preparation (Helvetas and RRI 2011; Ojha et al. 2015), and to subsequently bring climate-change policies into the mainstream. In western Nepal, LAPA programmes are supported and run by district government offices under the donor-funded NCCSP (Nagoda and Nightingale 2017). In other parts of Nepal, different sets of donors and service providers are implementing climate-change-related projects either jointly or in parallel with district governments (Khatri et al. 2015: 41). Similarly, the national-level climate-change activities are funded by international donor agencies. The donor-recipient culture emphasizes intervention (identifying and solving problems within a given period), the continuance of which depends on the donors' confidence in the process. The impact of this culture on climate-change adaptation processes has been that it has limited focus on the long-lasting effects and transformational changes in social and power relations that would support those most in need (Nightingale 2015). Nagoda and Nightingale (2017: 91) mention that some NGOs want to work on long-term projects, but that they are frustrated by the institutional limitations deriving from the short timelines LAPA imposes in order to produce quick and measurable results. As Nagoda and Nightingale (2017: 91) discovered, issues of power and politics[7] are also inadvertently abandoned when humanitarian INGOs and donors avoid promoting social inclusion in climate-change adaptation processes so as to sidestep the thorny issues of 'imposing Western values' or 'interfering in international affairs'.

Conclusion

A couple of days after my visit to Ram Dai's village, I went to the LAPA office in Simikot. My research associate and I walked into a dimly lit corridor full of villagers waiting for their turn to speak with the LAPA officers. Each of them had walked for hours, some even days, to submit assistance requests or ask questions about adaptation activities. After exchanging pleasantries, the officers informed me about the climate-change adaptation activities they had been overseeing in 'highly vulnerable' villages. Based on the LAPA framework, the limited agricultural productivity and economic capacity of the villagers were used as indicators of their vulnerability. The officers recounted that the lack of road and transportation facilities have created an additional challenge for their programme, making it difficult to reach its constituents regularly and operate smoothly. The year I visited Humla coincided with the end of the first phase of the NCCSP and it was unclear at that point if and when the second phase would begin. Humla had just began to see the results of their adaptation activities after years of hard work in developing and implementing LAPA.

The next day, I met a group of villagers from a LAPA implementation site. These villagers had come to Simikot to receive their share of subsidized rice. In the meeting, a man described regretfully that his big family would not have enough to eat later in the year. While LAPA adaptation activities to increase agricultural productivity were active in their village, the benefits had been limited and were not sufficient to reduce their vulnerability to food insecurity. The man was particularly frustrated that day about the artificial shortage of subsidized rice in the market. He explained that he would now have to buy the same rice at a higher price with money he did not have. 'It would be better if there were no subsidized rice', he claimed. At least then he would not have to come all the way to Simikot only to return empty-handed and humiliated one more time. His fellow villagers agreed.

Considering the everyday lives of people at the local level, researchers have asked whether the institutional climate-change response in Nepal is a 'missed opportunity' (Wong 2020) for governmental policies to address climate change effectively or if it represents an emergence of new discourses but the same old development approaches (Nagoda 2015) that fail to bring transformational changes to assist the most marginalized. The guiding principle for climate-change adaptation in Nepal resembles Ribot's suggestion of 'moving people away from the threshold of destitution by building their assets, livelihoods, and options [to] dampen their sensitivity, enhance their flexibility, and enable them to flourish in good times, sustain through stress, and rebuild after shocks' (2017: 239). However, people are treated as one homogeneous apolitical block. Instead of benefiting from the lessons learned through decades of development projects engaging with local communities (Bista 1991; Whelpton 2005), climate-change programmes continue to use traditional development practices of: (1) treating local recipients as a rural, passive and homogeneous unit (Pigg 1992); and (2) using the knowledge of stakeholders at the national and international levels to define institutional priorities, with virtually no meaningful participation at the local level. At the same time, climate change is positioned as a new field in the development industry. The goals and tools of climate-change policy documents and programmes set them apart from other environmental issues. The local implementation of climate-change programmes, for instance, is conceived differently from the pre-existing cross-scale institutional models, such as forestry and conservation programmes (Ojha et al. 2014).[8]

An exploration of the national climate-change cultural world reveals how certain aspects of climate change have gained prominence at the expense of others. The way in which policies depict the problem of climate change limits our understanding of its multidimensionality (Barnes and Dove 2015). The availability of new livelihood opportunities as a result of climate-change effects, and indigenous adaptation measures to the changing climate, remain unexplored within the policy context. Predetermined climate-change effects for different regions, selected at the national level without consulting robust local-level science (Nightingale 2015), leave Nepali climate-change programmes unable to understand the full range of climate-change effects (Devkota 2016; Gentle and Maraseni 2012; Smadja et al. 2015). This limits the state's capacity to deal with disasters and makes the country more vulnerable to climate change (Khatri et al. 2015: 40). While climate-change policy-making initially emerged as a potential transformative opportunity to reach the most vulnerable, assessments have shown that, conceived within the donor-recipient culture, it privileges biophysical understandings of climate change over local knowledge and pursues technomanagerial approaches as found in the policy documents explored here.

Finally, a stunted conception of 'human dimensions' (Castree et al. 2014: 764), which posits that people and the biophysical world can best be analysed and modified using similar concepts and protocols, is reflected in Nepal's climate-change policies. Such a conception risks intellectual partiality and political complicity (Castree et al. 2014). Partiality arises because key concerns of environmental social sciences, and of humanities disciplines more generally, pertaining to human dimensions are absent, and complicity arises when the full range of values, means and ends that might guide human responses to environmental change are refused, and questions about societal status quo are neglected and thereby implicitly endorsed (Castree et al. 2014). Adaptation efforts would have to involve more understanding across epistemological differences instead of including selected cases of indigenous knowledge, which in turn would require explicit discussion of what those differences are (Yeh 2015). However, before indigenous knowledge can have any significant influence, the validity of indigenous knowledge in general would require greater recognition at the national level (Tanner and Allouche 2011: 11). In its existing form, Nepal's climate-change policies fail to recognize how Nepalis have already been adapting to the everyday realities of climate change or how they (re)produce vulnerabilities. If inclusion is to be promoted, as Nepal's climate-change policies claim to do, scale politics and mismatch between scales of knowledge (Ahlborg and Nightingale 2012) need to be addressed. Nightingale (2018) points out that it is not climate change that poses the greatest risks to Nepal as external observers believe, but the socionatural entanglements and boundary-making processes that shape who governs change and with what consequences for inclusion, exclusions, and state transformation. This spotlight on Nepal's climate-change cultural world shifts our analytical gaze from the local people on to the risks Nepalis face.

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Acronyms

AR:	Assessment Report
CCA:	Climate Change Adaptation
CPP:	Climate Policy Paradigms
COP:	Conference of the Parties
DDC:	District Development Committee
DEECCS:	District Energy, Environment and Climate Change Section
DFID:	Department for International Development
DRR:	Disaster Risk Reduction
EU:	European Union
FCPF:	World Bank's Forest Carbon Partnership Facility
FY:	Fiscal Year
GHG:	Greenhouse Gas
GLOF:	Glacial Lake Outburst Flood
GoN:	Government of Nepal
INGO:	International Nongovernmental Organization
IPCC:	Intergovernmental Panel on Climate Change
LAPA:	Local Adaptation Plan of Action
LDC:	Least Developed Country
MoE:	Ministry of Environment
MoFLAD:	Ministry of Federal Affairs and Local Development
MoFSC:	Ministry of Forest, Soil and Conservation
MoPE:	Ministry of Population and Environment
MoSTE:	Ministry of Science, Technology and Environment
NAPA:	National Adaptation Program of Action
NAST:	Nepal Academy of Science and Technology
NCCKMC:	Nepal Climate Change Knowledge Management Center
NCCSP:	National Climate Change Support Programme
NGO:	Nongovernmental Organization
NPC:	National Planning Commission
REDD:	Reducing Emissions from Deforestation and Forest Degradation
REDD+:	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

REDD IC: REDD Implementation Center
RPP: REDD Preparedness Plan
RRI: Rights and Resources Initiative
SfAA: Society for Applied Anthropology
UNDP: United Nations Development Programme
UNFCCC: United Nations Framework Convention on Climate Change
VDC: Village Development Committee
WHO: World Health Organization

Notes

1. The National Framework on LAPA is also referred to as simply LAPA. The LAPA documents created at the local level generally have the name of their site, usually Village Development Committee (VDCs), attached – for example, the Khumbu LAPA.
2. Ram is a pseudonym for the person I call *dai*, an elder brother.
3. 'Imperia' (the plural of *imperium*, the Latin word for command over others) is used to refer to rule by an individual or rule by an elite few (Bodley 2003: 4).
4. The MoE is now the Ministry of Science, Technology and Environment (MoSTE).
5. 'Country Index', Notre Dame Global Adaptation Initiative. Retrieved 16 March 2021 from https://gain.nd.edu/our-work/country-index/rankings.
6. The VDC is a governmental administrative unit in Nepal.
7. Nagoda and Nightingale (2017: 86) consider 'politics' not just as the work of politicians, but as expressed in everyday activities and struggles that are shaped by social and power relations and through contestations and negotiations between actors to influence decision-making processes.
8. That is, community forestry (CF) and CF user groups (CFUGs).

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Part IV

Climate Politics

Chapter 10

Down to Air

Palestinian Memories and Practices of Weather Relatedness

Mauro Van Aken

Shatti ya dinya shatti, shatti 'aqar'it sitti
[Rain oh world, rain on the bold head of my grandmother]

—Proverb[1]

Among Palestinian refugees in the Jordan Valley (Jordan), the memory of a weather calendar known as *murba'nia* – a winter 'rainy season' – persists in the face of displacement, despite its seeming irrelevance in the era of intensive irrigated agribusiness. Strikingly, when these refugees lost their land and villages, they took their 'weather' with them, as a pattern of engagement with, and knowledge of, the air. This serves them as a guide to rain-fed agriculture in a semi-arid environment and as a source of pride and cultural independence related to their identity as *fellah* (peasant) against the backdrop of a broader marginalization process.

In the West Bank, on the hills where *murba'nia* originated, this meteorological knowledge system is nowadays seldom spoken about and is generally excluded from modernization narratives. Yet it continues to be a vital component of the skills required for family farming, which – in the circular economy of the Bethlehem area's *habba'il* (terraced gardens) – still rests on the relatedness of resources.

Murba'nia consists of a complex classification of increasingly rainy/wet/cold periods, a 'rainsphere' to be skilfully navigated with a view to saving as much moisture as possible for the longer dry and hot summer. By engaging with the historical unpredictability and variability of rain, *murba'nia* offered, and offers, a means of framing uncertainty, and of attaining familiarity and intimacy, not with equilibrium or fixed seasons, but with erratic, unpredictable and uncertain patterns of fluctuating rainfall. This in turn helped to organize strategically the work of rain-fed farming, which demands skilful management of water and moisture.[2]

Of course, the historical legacy of this weather knowledge, a looking up to and engaging with the weather that informs 'down to earth' practices, is in strong contrast to the political and ecological context, where lands have come under occupation via fencing and bordering, and provide an 'unstable' foundation – a further departure from the relatedness of ancient weather practices under a shared sky. The 'facts on the ground' that have driven change in this small region have become disconnected from the 'facts in the air': a contemporary form of change that is not unique to these intensely contested lands and is at the heart of the contemporary attempt, in an overheating global atmosphere, to seek new frames and knowledge of weather relatedness (see Figure 10.1).

Refugees' Rooting of Themselves in the Air, and Palestinian's Loss of Ground

In 1995, when I was conducting ethnographic fieldwork among Palestinian refugees on the Jordanian east bank of the Jordan Valley,

Figure 10.1. Prickly pear in Battir (photograph taken by Mauro Van Aken)

the lack of water in this torrid depression was clearly a key issue for an agribusiness sector that had radically transformed environmental and social patterns in farming. While living in this low-lying and scorching region, I got used to waiting for the evening east wind to blow, so that I could cool down after the long hot summer days, and to hoping for the coming rainy season, on which water supplies and the next harvest depended. At that time, I recorded Abu Ziad Amin Kanaan Turkmani – a 1948 refugee from the Haifa region – giving his account of an agricultural weather calendar that he still used to orient his way through the clouds and rain of the winter months, conserving it in his social memory as one of those traditions that refugees essentialize in displacement. This calendar was known as *murba'nia* and consisted of a set of phases making up the much-anticipated but erratic rainy season, which corresponded to specific work practices and enabled farmers to recognize the different types of wind and rain, the pattern of intensifying cold and frost, and the activity of other nonhuman ecological sentinels as snakes, specific insects or wild-plant development. *Murba'nia* helped to determine the timing of the strategic tasks to be performed in preparation for the wished-for greenness of spring. At that time, I categorized this ancient memory as part of the refugees' nostalgia for their past, denying what has recently become more self-evident: that knowledge of the environment has always been a component of local savoir faire. This, in turn, is closely bound up with knowledge, in contrast to certainties, about the weather and its unpredictability, and with the embodied experience of its historical patterns. Although my research concerned water as a key medium (Van Aken 2003, 2012), I then generally understood weather conditions as remaining outside of, or above, the environment. In addition, *murba'nia* had become 'out of place', given that regional modernization schemes had caused farming to be redefined as unlimited intensive irrigation,[3] and water issues had been hidden away in distant water-control stations designed to capture every available drop for commercial agriculture and urban development. However, Abu Ziad, like many of his peers, recalled *murba'nia* not only out of nostalgia for his lost land (and air), but also to describe and explain his family's work as sharecroppers on fields that were still rain-fed or at least less systematically irrigated.

The displaced Palestinian refugees of 1948, and later those of 1967, not only brought with them what material things they could, along with their material-cultural and agropastoral knowledge, but also travelled with the 'air' of their homelands: a highly volatile, flowing, immaterial knowledge that nonetheless represented a key component of their social belonging and way of dwelling, a 'solidarity' with a weathered place

(Hulme 2017: 16) that persisted even in a strikingly different ecological and economic context.

Murba'nia wisdom about the weather and its historical variability informed agricultural practice and, indeed, represented a key component of knowledge about farming in arid areas. It supplied a template for reducing the risks associated with potentially extreme weather events and erratic rains, which formed the cornerstone of ancient semi-arid rain-fed agriculture and food making.

While 'down to earth' is a terrestrial metaphor that aptly depicts the material conditions of farmers, it deflects attention from the patterns whereby cultures weather (Hulme 2017) and their everyday landed practices. These comprise collective and active atmospheric engagements of looking up into the air, a multisensory experience that guides them in ploughing, sowing and mitigating risk or, in particular, water stress. Hence, like any weather-knowledge system, *murba'nia* is more appropriately understood as a 'down-to-air' form of knowledge and practice, in which on-the-ground dynamics are closely interrelated with dwelling in an atmosphere, via an empirical set of action and relations (Strauss and Orlove, 2003; Vannini et al. 2012).

Climate change is driving the revisiting of the disconnection between human activities and nonhuman agents, and especially between an environment viewed as solely terrestrial and the weather in which it is enmeshed. Cultures are 'weathered' (Hulme 2017), in that they have always inhabited dynamically shifting weathers, so that having to deal with an overheating global atmosphere brings the relationship between weather and society back into focus, this time within a crisis framework. *Murba'nia* is a legacy of seasonal and generational relatedness, which today is again proving to be crucially important – even while this is strongly denied in contemporary cultural models.

In recent years, while conducting research on family farming in the Bethlehem area (the West Bank), I once again came across the memory of *murba'nia* among the older generations of *fellahin* (peasants), although for many it has now fallen into oblivion. Current versions of *murba'nia* vary somewhat in terms of their classification of the phases of the calendar, yet in one form or another, the *murba'nia* is still present in rain-fed family gardens and practices. This is even more the case in mountain areas, where *murba'nia* is remembered and valued for its emphasis on the variable and limited availability of water, an issue that in the high-tech, colonized setting of the last half-century has only had the effect of exacerbating distress and anguish.

Both the fragility and the potential inherent in this ancient relatedness to water and weather rest on the key historical distinction between a long hot and rainless summer (*sef*) interrupted by a hoped-for, unpredictable and changeable winter rainy season, known as *shitta* (not by chance, the same word used to indicate 'rain'). From a local, peasant perspective, the year is inevitably and sharply divided into a variable and internally complex rainy season and a lengthy rainless phase.

While the study of Palestinian peasant history has been important in relation to the struggle for autonomy and the defence of the land, attention has rarely been paid to local knowledge and on-the-ground farming practices, which have been overshadowed by theories of modernization, the transformation of the backward peasant into a 'modern' farmer (Van Aken 2012), and the expropriation of land and water within the ongoing colonial integration of the West Bank into Israel. One exception is the historic investigation into weather knowledge conducted a century ago by the anthropologist Dalman (1928), whose exploration of *Work and Customs in Palestine* primarily focused on local systems for understanding rain in light of strongly variable fluctuations in precipitation: 'The end of the year is the end of the summer' (1928: 24). His account of local material 'traditions' examined local relatedness to the weather in terms of proverbs and farming practices, which were presented as tools for dealing with the unpredictability of weather and for interpreting patterns of rain, wind, frost and dew.

Facts on the Ground, Facts in the Air

Today, the occupied West Bank represents a tragic laboratory for land expropriation, deterritorialization, fencing and the bordering of contiguous communities. In short, there is a set of harsh, contested 'facts on the ground' that are amplified by nationalist ideologies of land and nature arising in the context of Israeli nation-building and the military control of land and resources in the West Bank. Conditions that are peculiar to this setting, yet reflect experimental techniques for framing disconnections of contiguous territory that are increasingly spreading around the world. In this scenario, land has become the unstable basis for a daily sense of crisis, so that environmental issues and climate change are just two distant problems among more tangible, urgent and immediate emergencies arising within the colonial encounter.

Murba'nia poses a strong challenge to our own contemporary models of understanding the air and weather, and to our disconnection from the environment. As Hulme (2017) has shown, the ambivalence of weather as the most sensitive yet invisible environment and the culturally engagement with/in it have led to a lack of conceptual frameworks for weather relatedness. Yet, cultures are weathered and *murba'nia* is a good example of this kind of local legacy. First, it is a weather knowledge derived from interaction, embodied experience and engagement with the winter as a 'rainsphere', and thus based on highly concrete and on-the-ground experience. Second, its shared patterns of knowledge provide a basis for making sense of, predicting and conducting rituals around weather conditions. They offer a means of constructing a 'down-to-air' sense of stability and solidarity, in contrast to the emotional anguish of the inability to make sense of extreme and unfamiliar weather conditions that characterizes our time.

Furthermore, in local cultures, weather is domesticated as opposed to dominated. Knowledge of experienced and anticipated seasonality translates into an active relationship with a 'weather world' (Ingold 2010), which in Palestine has meant interacting with fluctuating levels of humidity in an essentially arid setting: an attempt to navigate volatile weather conditions via recognition of the winds, patterns of humidity, types of cloud, seasons and the action of multiple living agents. *Murba'nia* thus represents one of the 'diverse cultural interpretations of humans' sensory experience of the atmosphere's restless weather' (Hulme 2017: xiii) and an instance historically related to the affordances of rainfall. What today is an icon of the ephemeral and of volatile uncertainty has always been part of a cultural attempt, via symbolic and material interaction, to create models of everyday living and farming, as well as a pattern of 'dwelling' in the atmosphere (Ingold 2007: 531).

Rediscovering this weather relatedness, even in a modernized and colonized context that suffers daily crises due to political disorder, helps us to understand our relations with weather change: above all, the dynamics of denying environmental relatedness, and the lack of shared cultural models for facing uncertainty, the 'unthinkable' as Ghosh terms it (2016). For when we are disconnected from our environment, climate change becomes radically and emotionally unsettling, undermining our sense of familiarity and trust, and amplifying the uncanny effects (Weintrobe 2013) of being unable to make sense of atmospheric relations. At core this comprises a weather weirding, an unsettling of previously familiar relations to weather change.

The *murba'nia* calendar traditionally represented a strategic and cultural pattern of recalling the past to anticipate the future, in a way that provided defined timeframes and ritualized annual cycles with moral, political and economic implications linked to a sense of belonging. Cultures are rooted in the air, and peasants have experienced this uncertainty by fully engaging with the limits and affordances of local seasonality.

As elsewhere, in the West Bank of today, the air has become a locus of risk (Sloterdijk 2016): it is the space of colonial visual control, helicopter discipline and attacks, and drone surveillance. Indeed, Israeli colonial architecture has created two separate 'vertical landscapes' (Weizman 2002), whereby the surface of the land is juridically divided from its underground dimension (water and archaeological resources) and, crucially, from the air above (air control, radio and networks) – a technical but schizophrenic fragmentation of sense of place, effected by means of multiple technologies and shifting military borders. In this context, it is interesting to note the recent use of weather metaphors by the Israeli Defence Forces to describe their military operations, in an overturning of atmospheric meanings: Operation Rainbow (2004), Operation Summer Rains (November 2006), Operation Autumn Clouds (November 2006), Operation Hot Winter (March 2008) and Operation Sea Breeze (May 2010). Here, the traditional shared cultural investment in rain makes a comeback, but as a human affair, while the 'hot winter' metaphor is well suited to the dynamics of overheating that we are currently experiencing at the global level.

Despite this new human disciplining, *murba'nia* reminds us that weather cannot be bordered and that local 'weathered' knowledge remains a resource for all, because of the relatedness that it reproduces. However, while current changes in the weather bring to light 'the troubling boundaries of the material and the immaterial' (Ingold 2007: 525), this aspect is obscured by the instability affecting territory: ideologies of land and the fencing of territories overshadow the patterns of relationships that shaped the Palestinian hills.

Weather changes challenge our understanding of the cultural relations between the terrestrial environment and the atmosphere; therefore, an exploration of key meanings of land can lead us forward in our analysis.

Land Imagination and Farming Ideologies

While disconnection from weather worlds is currently a global issue, in the context of the West Bank, it is related to the new realities of the material and borders that are here clearly under experimentation. In the last few decades, the West Bank has been a tragic laboratory of walled futures – a space in which we may observe novel techniques of territorial colonization and segregation, contiguous separateness, and confined categorizations of humanity. Indeed, scholars have analysed the accelerating and modern quality of land discipline in the high-tech colonial encounter (Temper 2009; Weizman 2002), bringing to light two key aspects: first, a 'troubling' materialism and attachment to the land, which is viewed as disconnected from the atmosphere; and, second, a nationalistic politics of nature.

Indeed, the materiality of land is 'difficult to imagine' from an exogenous perspective or from within the colonial experiences elsewhere in the last century: arbitrariness and disconnection characterize the perceptions of territory, with Israeli colony cities forming the borders of Palestinian neighbourhoods, and the colonists' networks and logistics constituting fences around Palestinian territories and movement. It is an integration through exclusion, in which 'one man's imagined community is another man's political prison' (Appadurai 1990: 32).

The West Bank has been integrated into Israel through a process of segregation that rules out any future sense of territorial contiguity, let alone autonomy. Since 1967, the militarily controlled Area C has contained most of the farming land and water resources, and is inhabited by 300,000 Palestinians, who are fenced in and surrounded by settlements housing 325,000 Israeli colonists. In this territory, farmland owned by Palestinians is continuously at risk of being denied access to underground water resources, or of arbitrary expropriation when this appears linked to ensuring the security or expansion of a nearby colony. Indeed, Palestinian communities may be better visualized as disconnected islands in a sea of military control and separated neighbouring colonies. In this material framework, it is normal for a field of olive trees to be secretly ploughed by mules at night because a farmer is not allowed to work land that has been reclassified as a 'security area'. Similarly, it is common to see rows of small olive trees planted in aubergine fields. This crop combination that has nothing to do with historical relationships among local plants, but rather is a form of 'defensive agriculture': in the case of military expropriation, only the presence of olive trees provides tentative legal grounds for appealing the decision to a military court (Braverman 2009: 130). For generations, and even more so over the last two decades, land has come to represent the material risk of losing the 'ground from under one's feet'; rather than solid stability, land now constitutes a surface of arbitrariness and a lack of control over the material.

As Ingold has observed, 'the equation of materiality with the solid substance of the earth has its roots in a tendency, deeply sedimented in the canons of western thought, to imagine that the world is presented to human life as a surface to be occupied' (2010: 103), a surface that here is also 'occupied' militarily and is disconnected from a shared atmosphere overhead.

In this context, modernization narratives are coupled with biblical narratives of land and with the invention of a desert to be redeemed using techno-fix solutions (Mitchell 2000; Worster 1985), and this is in keeping with the contemporary myth, which is widespread throughout the Middle East, of 'letting the desert bloom'. The notion of controlling resources so as to restore 'biblical nature' as an authentic reality is at the core of symbolic values and nationalist ideologies. The physical land is overlaid with religious ideologies of land that have been reproduced in the secular nationalist planning of the territory. The politics of nature is a further, and related, factor that has contributed to the reshaping of the idea of environment within Israeli national narratives. Specifically, the Promethean ideologies that see humanity as controlling nature have informed new national meanings of farming and planting, leading trees to be assigned a special role within Zionism (Braverman 2009). Agricultural ideologies of redeeming supposedly abandoned territory have served to root the 'new Jewish man', and a new national and religious community, in the returned-to 'Promised Land' after the Holocaust. Politics are planted along with pine forests (Cohen 1993), and attachment to the land has been naturalized through farming. Such symbolic meanings of agriculture are present in many cultures, but are here condensed in an extremely small region. In this context, however, rooting one community through farming and forests has meant derooting Palestinian communities and olive trees, while also obscuring the political nature of the process. Indeed, the national policy of pine-forest development was intended, since the creation of Israel, and even more so since the 1967 incorporation of the West Bank, to cancel out the lost Palestinian landscapes and villages, hiding a community and its territorial signs with the aid of the fast-growing pine. Within the nationalist Zionist narrative, protecting and managing 'nature' confers totemic value on the pine tree: a flag planted to mark the conquest of land, which simultaneously serves to erase contested Palestinian lands. In short, national construction has been based on an arboreal imagination of roots coincident with a denial of the Other.

On this battlefield of planting ideologies, the Palestinian peasant has become both an icon of national resilience in the face of occupation and an anchor to the land of a reified Palestinian cultural authenticity. The idealization of the local *fellahin* has been paralleled by a historical process of depeasantization and the proletarization of cheap labour in Israel, the collapse of local agropastoral systems, and the ongoing loss of land and water autonomy, though this has not eliminated residual farming and the reproduction of patterns of kinship solidarity in the midst of wider social mistrust.

Indeed, the *fellah* has acted as a 'national signifier' 'that unites and mobilizes by virtue of the fact that it dissimulates past and present differences within the national movement, in the interests of a leadership with particular class interests' (Swedenburg 1990: 25). While on the one hand, the *fellah* continues to function as the soul and root of national identity, on the other hand, small traditional farmers have received little developmental aid and limited assistance from the Palestinian National Authority, both of which prioritize urban planning and intensive farming. Notwithstanding the reification of the *fellahin* (to the detriment of the Bedouin pastoral tradition), not much is known about the historical changes in, and current reality of, their local knowledge and relationship with the environment, a 'construction of ignorance' underpinned by colonization of the land, but also amplified by Palestinian modernization policies that have overlooked local rural systems and knowledge. It is understandable that the *murba'nia* has been largely forgotten, along with other knowledge about the circularity of resources that forms part of the legacy of local *fellahin* systems and that today only survives within extended families (*'ailat*). The outcome is, as the local expression goes, 'agriculture without peasants', and contradictory processes such as aid modernization of agriculture in the absence of territorial autonomy, the development of market agriculture despite market dependency on Israeli food imports and so on.

Murba'nia was a local meteorological knowledge shared by both coastal and mountainous agricultural areas, with the latter forming the main source of seasonal rainfall for the West Bank. However, the Palestinians lost access to the sea, along with their sea-merchant culture, and today are fenced into high-lying areas of the West Bank. As argued by Tamari in a book significantly entitled *Mountain against the Sea*, being cut off from the sea has amplified the historical 'emergence of the cultural divide between mercantile and cosmopolitan coastal communities and mountain-dwelling smallholder peasants' (2009: 1), enclosing Palestinians and the failed possibility of an autonomous state in this mountain region that has historically been home to an autonomous peasantry that formed the basis for agricultural production.

From a territorial perspective, the mountains have lost the sea, yet in the terms of the *murba'nia*, weather still unites these bordered and divided-off areas: the land has been fragmented, fenced and oversignified, but this all takes place underneath a shared weather system. *Murba'nia* offered meanings of ecological relatedness that have been absorbed into social communication at the local level, beginning with rain and water: 'Christians, Muslims and Jews display similar attachments to popular saints … as we witness, for example, in rain processions in periods of drought' (Tamari 2009: 105).

Murba'nia: Weathering Land and Meanings

As stated earlier, *murba'nia* stands for a complex schedule of winter rains, broadly classified as a ninety-day season that is closely bound up with the need for water in an arid environment and agropastoral economy. This weather-knowledge system places special emphasis on the beginning of winter as the beginning of the new year, as a signal that the dry, rainless weather of the hot summer is about to be interrupted, thereby prompting the *fellahin* to time and define their work practices strategically, in line with highly variable winter weather that demands flexible management.

Their calendar for working the land has been organized around the rains, delimiting time and space as a rainsphere, which requires the flexible deployment of farming skills to save as much water as possible for the longer, dry, hot summer season, or to protect the land from excesses of rain that might cause the erosion or destruction of terraced slopes. The scheduling of farm work was not previously determined by market prices, the current political and economic confinement or aid funding to grow unsustainable market-oriented flowers, but by a more ancient cosmology that was intimately familiar with the unpredictability of the weather and the associated 'fluxes' of water. This involved recognition of the different types of rains and their 'proper timing' (Dalman 1928: 117) in terms of quality and quantity, in combination with patterns of frost, snow, dew, moisture, and the activity of multiple nonhuman agents on the ground, such as types of wind, insects and wild plants.

The *shitta* (the term for both winter and rain) lasted ninety days, beginning on 21 December. The most strategic tasks were carried out over the first forty days: land and seed were prepared and work-cooperation patterns activated in advance of the rains, the *murba'nia.* Over the following fifty days – from 1 February to 21 March – the rain and cold would gradually intensify, and this second period was divided into ideal phases lasting 'twelve-and-a-half days' each. The first time that I recorded an oral account of this calendar, I was struck by this apparently excessive quantification of phases into half days, but realized that rather than a rigid prediction, it was intended to encourage flexible management of what is actually a potentially disorienting variability in rainfall, in terms of timing and location – as aptly expressed in a proverb recorded by Dalman: 'One hour rain, one hour sun' (1928: 122).

The entire calendar year is divided into seven fifty-day periods, termed *khamsinat*, which 'are based not on star constellation but on the feasts of Christian calendar' (Dalman 1928: 51). Among these, the crucial fifty days of rain and cold are subdivided into four phases, known as *sa'd*, 'literally the four fortunes' (Qleibo 2009: 13). This weather model was informed by animist beliefs about Baal, the ancient god of fertility and rain, with weather rhythms incorporated into religious feasts as social markers of both atmospheric events and common farming knowledge. The rain variability is not only borne out by rainfall statistics, but is also strongly reflected in Palestinian proverbs such as '*Murba'ania* is a burning sun or a submerging rain!' (Kurzom 2012: 12).

The first phase of *murba'ania*, named *sa'd al dhabih* (Capricorn), lasted from 1–'12.5' February and was characterized by an initial spell of intensifying cold, sometimes preceded by the east wind as an 'arouser of rain'. This was followed by *sa'd al sau'd* (Aquarius), running from '12.5'–25 February and marked by the *khamsin* wind blowing from the western Badia (arid land), a cold but dry air current that contained less humidity than the east wind sweeping in from the sea. Indeed, February was often referred to as 'the harbinger of summer', as the increasing cold also preceded the end of the rainy winter and the initial growth of the newly sown crops in the fields.

Next came *sa'd al bala* (25 February–'8.5' March), a period that was strategically interrelated with Mustaqrida'att (25 February–4 March) when the land 'warmed up' and 'drank' or absorbed the rainwater. A final cold wind characterized this shift towards increasing warmth, notwithstanding the possibility of heavy rain and mud in the fields. Given that the last rains before the long rainless summer were often critically important, if water was scarce during the shortest month of February, it was hoped that some might be 'lent' to March, thereby 'prolonging the [winter's] age' (Kurzom 2012: 12). Last, but not least, there was the period of *sa'd al khabaieh* ('8.5'–21 March), 'when snakes and scorpions (*khabaieh*) come out after their winter sleep', characterized by further warming up of the land, the onset of milder temperatures and key end-of-winter farming activities.[4] The entire climate calendar, in apparent contradiction with the provision of a precise time schedule, has many different variations, which are probably related to the model's contextual dependence (with sensitivity to factors such as a given mountain valley's distance from the sea or nearness to the Jordan Valley depression), in contrast with the context-free models of contemporary modernized farming.

The end of this liminal rainy period of 'suitable' versus risky rain is often depicted as a radical shift from aridity to luxuriant blossoming 'greenery'. *Khudra*, which bears the multiple meanings of the colour 'green' – 'vegetables', 'green' plant growth and more generally the 'greenness' of the landscape – is also the name for the start of the summer. 'The fertilizer of the year is March. March is its fertilizer, but also its barrenness' (Dalman 1928: 308) – an ambivalence played out yearly around rain variability and farmers' skills in working with it. This is the period when 'the land warms up', as an old farmer in Battir used to tell me, a process that demands the preparation of the soil to retain moisture, collection of rainwater, adoption of measures of protection against any late frosts, and flexibly in coping with fluctuating weather patterns. In sum, in this model, weather is not conceptualized as an indoor phenomenon under human control (as in greenhouse cultivation), but as related, with generations of adaptations, to the unruly outdoor fluxes of the atmosphere. The 'local saying … "move hard with your land work, peasant, for there is no more time to count before the winter sets in", reminds the peasant that the countdown for winter is over' (Qleibo 2009: 13).

The names of the phases refer not only to a weather world, but also to a cosmology, which was later assimilated into Islam, as well as the other two monotheistic religions that developed from this land and its weather. This pattern of syncretism has been absorbed into religious rituals, such as the Palestinian rites of spring and the Thursday of the Dead (Qleibo 2009: 18). In short, this 'weather world' (Ingold 2010) established, in both moral and pragmatic terms, the collective and individual work that needed to be done, as well as a complex set of shared meanings that have made the seasonal greenness of these hills a much-admired sight.

This traditional Palestinian weather calendar can be of use to us today in reading the relationship between cultures and weather environments, in light of key themes such as global warming, water scarcity and social resilience to climate change. First, it represents a historic social pattern of coping with extreme changes and unpredictability in weather. In these regions, 'emergency' periods have featured in farming knowledge and practice since antiquity. Second, it offers knowledge of the weather based on the interplay of uncertainties, and on engagements in practical multisensory recognition.

These lands have been obliged to relate to the variability of the winter rain and to cope with uncertainty across generations as a means of making place and food. Their weather calendar, far from providing certainty and a basis upon which to predict the weather reliably, above all highlights the flexibly required in navigating one's way through the rains, given that 'rain is unpredictable in its occurrence or absence' (Dalman 1928: 313). In short, it offered an approach to monitoring, and responding to, the erratic 'coming and going' (Dalman 1928: 117) of atmospheric flux that took into account the risk of premature rain, of frost and snow, and the strategic use of dew or shade in building farming spaces.

One of the main actors in weather is undoubtedly the wind, but it is increasingly forgotten, not only in irrigated agriculture and in our 'indoor' models, but also in 'indoor' greenhouse cultivation that allows crops to be grown out of season to meet the demands of a (closed) open market.[5] Yet, as Ingold writes, 'to feel the wind, then, is to experience this commingling' as 'fluxes of the medium' (2007: 529), whereby our relationship with the weather is not based on 'mutually exclusive hemispheres of sky and earth, separated by the ground' (Ingold 2007: 519). *Murba'nia* indeed defined weather as a medium for the social world on the ground, in which farmers could work to the best of their ability: it was a means of being 'perturbed' in the positive and active sense of this term, a collective and generational experience that took place not only on land but also through the atmospheric medium.

Working 'Down to Air'

While 'down to earth' is a good metaphor for how we care practically for the landed environment in which we are entangled, it reproduces an implicit disconnection from the weather world above us as a medium for human action. 'Down to air' is a closer metaphorical representation of what we experience daily and of what the *murba'nia* has represented for centuries: the rooting of knowledge and experience in the air above, and its relatedness with dwelling and farming on the ground. Today, denial of such entanglement is leading to global anguish, because it is accompanied by a void of meaning, and the loss of a guide to practice, a lack of 'familiarity' that stands between our living and our consuming on the earth. We are confronted by troubling issues with our materialism, which is seen as disconnected from both nonhuman agents and the upper environment. The landmass and the cultures rooted on it are viewed as bases for certainty, stability and a sense of permanence, yet *murba'nia*, as in other cases of local meteorological knowledge, shows that uncertain and flexible stability is rooted in strategically following the rhythms and phases of the 'local' weather.

Murba'nia speaks about relations: symbolic meanings, farming practices and relatedness with water. It prescribed three main down-to-earth practices for rooting plants with adequate humidity: harvesting water, understood as 'harvesting weather'; reproducing and planting rain-fed *baa'li* seed via 'exposure' to rain; and ploughing the land accordingly. Although today there appears to be no place for *murba'nia* in a context of intensively irrigated agriculture and politically disconnected lands, it remains an active part of local savoir faire in family gardens.

Cultivating Relatedness

The *habbai'l* in Battir are terraced tracts of land that receive irrigation thanks to the survival of one main source of spring water. Today, they are used to produce family food supplies against a backdrop of decreasing resources, land confiscation and market closure that mean that cultivating one's 'own food' is often perceived as a crucial symbol of 'freedom'.

Local environmental knowledge and expertise, which have generally been substituted by a mix of colonial and aid-driven modernization patterns within an overall devaluing of agriculture, remain entrenched in these domestic, terraced and irrigated gardens, where a strong emphasis on the relatedness of resources is retained. The main components of this surviving local savoir faire are an awareness of the limits and flexibility of resources; a circular exchange of ecological resources in which 'nothing is wasted' (Van Aken 2016); the local reproduction of ancient rain-fed seeds (*ba'ali*), which have otherwise been substituted by intensively irrigated crops produced for the market; and the renewal of soil fertility as the basis for sustainable home production.

These gardens are spaces of intensive production, with a diversity of vegetables (summer and winter crops) and fruit trees, domesticated herbs and key wild herbs (crucial to the local diet and for medicinal use). Families weed by hand, which allows them to separate valued wild herbs from fodder for a few residual sheep and goats, whose manure is still prized as the best fertilizer.

'Cultivating chaos' would be an appropriate way to define this cultural investment, due to the unpredictability of the shifting colonial setting, in which a tract of land may be expropriated at any time under Israeli military law. But there is a positive quality to the apparent irrational confusion of these promiscuous and seemingly disorderly vertical gardens: grass is left in the fields in order to retain humidity during specific periods or to protect young plants from the sun; or selected crops are left unharvested in the gardens to mature for seed production. The key emphasis in these marginal gardens is on doing the work by 'our [the farmers'] own hands', so as to reproduce skills that are meaningful not only in relation to the gardeners' past but also to their future: making resources available for the years to come, or passing on knowledge to the future generations by teaching mule-drawn ploughing techniques to young children at weekends. Such skills, as embodied practices enacted in the environment, are not often verbally articulated. Yet, for these Palestinians, 'knowing how to do' is connected, in their highly disciplined context, with being *horr* (free), as is 'knowing how to move around' (for example, when going out at night to search for *zattar*, a well-known wild herb, now designated as 'protected' by military order). Furthermore, gardening remains key to local economic coping strategies.

These gardens are a 'family affair'. Inhabited places of hospitality, they replicate cooperative arrangements on a smaller scale. Seeds are planted to cater for the family's culinary preferences and to produce ritual dishes in advance of Ramadan exchanges. The sharing of crops reinforces family ties in the *aila* (extended family) or of the otherwise fragmented *hamula* (tribe). Only in the event of a surplus will a small amount of cash income be earned at the Bethlehem market. These intensive spaces of production are characterized by investment in diversity and relatedness, by means of crop rotation, fallow cultivation, the management of crop combinations and relations (those that are positive and those to be avoided), and the strategic use of shade or the special preparation of the soil to capture the summer dew.

Atmospheric Seeds: Ba'ali *and Wished-for Fertility*

Ba'ali, or rain-fed seed, has been reproduced in these specific weathered conditions by generations of farming people. The land where this seed was planted was defined as *ard ba'al* ('exposed to rain' – Dalman 1928: 194), with the concept of exposure clearly expressing the system's rootedness in weather. However, *ba'ali* in recent decades has been perceived as unsuited to the market and has acquired, in the contemporary colonial setting, the meaning of local, or *baladii* ('of the village'), and, via metonymic transfer, has also become an icon of the 'organic' and naturalness. *Ba'ali* seed is context- and practice-dependent: it was born and has been reproduced within the *murba'nia* system of relatedness. As was well expressed by one nurseryman, '*baladii seed* is a daughter of the place'. Born of the affordances and related work practices of the air, rain, clouds and winds of the winter,[6] *ba'ali* is weather-dependent and weather-sensitive, needing to 'drink less' than other varieties, adapted to the caprices of the winter rains and well suited to ad hoc techniques of deeper planting so as to leave a greater portion of the stem in contact with the ground moisture.[7]

Interestingly, the name of this seed derives from the previously mentioned rain and fertility divinity of antiquity, Baal, a deity of fundamental significance in the Canaanite religion of the Ancient Near East (Botica 2013: 97). This connection reflects the close set of relations among weather cycles, agriculture, fertility, and belief systems. Baal was 'the bringer of rain', whether weather conditions were stormy, rain was bountiful or the land was drought-stricken. This meant that rain was a sacred blessing and drought a judgement. Today, *ba'ali* seed is not just a form of biodiversity that has survived in the home gardens; it has also been shaped in relation to the local weather world in a way that allows small farmers to retain their local and family food supply. This is synonymous with being 'free' (see Figure 10.2).

Harvesting Water, Harvesting Weather

'*Al muhimm al bire*! [the most important thing is the cistern!]' is a commonsense rule for any person farming in the West Bank: it refers to the need to store as much water as possible in a specially constructed cement cistern that represents a major cost for small landowners, but that is critical in the face of increasing diversion of water away so as to serve the Israeli colonies. Hence, the current political reality forces farmers to rely on the rainy season to harvest water even more than they had done in the past. *Murba'nia* has historically encompassed a set of practices and techniques for harvesting water (that is to say, for harvesting weather – wind, humidity, rain and storm) and storing it. These include maintaining, repairing or building terraced land (*senasil*) to avoid sliding and erosion in the case of heavy rain, and laying out the land so as to conduct rainwater to a common storage pool, where it is purified and kept for the work of

Figure 10.2. *Fellahin* hands showing a local *ba'ali* aubergine from Battir (photograph taken by Mauro Van Aken)

the long summer. In the past, a *bire* was a water basin dug into rock and covered to prevent evaporation (see Figure 10.3).

Techniques of water harvesting denote a historical intimacy with water drops based on local proverbs and the landscape, as observed almost one century ago by Dalman: 'Limited reserves in the cisterns and wells, a modest or bad harvest, an inadequate yield of grapes, figs and olives, are a certainty and one has to be careful to use water sparingly' (1928: 306). In the same period, El Ezari Vulcani, a Polish agronomist who was later to become the Israeli national icon of modern agronomy and the scientific founder of colonial farming, also praised the *fellah*'s relationship with water: 'the secret of his improvement is the skilful storing of the water in the layers of the earth, and the economic use of it' (Vulcani 1930: 15). Vulcani was conducting an applied study on 'modern farming' when he came into contact with 'primitive' Palestinian dry farming in what subsequently became Israel and the Occupied Territories. Informed by an evolutionary understanding of the native population, he condemned the 'fellah's primitive farms', yet in this encounter, he could not help admiring their work patterns and savoir faire:

> The whole farm of the Fellah forms an organic unity. Everything is produced in it by its own powers: he is not dependent on any external economic factors … His world is not governed by the principle of time is money, but by the

Figure 10.3. An ancient *bire* in a side valley of Battir (photograph taken by Mauro Van Aken)

> principle of 'preservation of matter'. He allows nothing to go to waste. Everything which appears to be lost returns to him after various transformations. (Vulcani 1930: 40)

Rather, this depiction of local skills was based on a recognition of the Other that in the contemporary era tends to be denied. Vulcani deemed that these aspects should be preserved in the new experimental modern farming systems. Today, climate change and agroecology are once again bringing the importance of such weathered skills to the fore, in that they express the relatedness of human action to weather and fragility in these lands.

Collecting water has traditionally constituted (and even more strongly so in the last few decades) against a backdrop of intensifying competition for water, a harvesting of rain and weather by preparing the land network to store as much water as possible for the future summer season. The *murba'nia* rain calendar made this very clear by specifying the required preparatory work practices and framing them as a moral obligation. Of course, local knowledge of weather has apparently become irrelevant in the new cosmology of intensive irrigated indoor cultivation, which relies on aid funding, having distanced itself from local weather worlds.

Ploughing is another technique that is exploited to harvest humidity and optimize its absorption and storage deep in the ground. Hence, the ploughing calendar is also informed by the timeframe of the *murba'nia* and was designed to take weather fluxes into account. The mule-drawn plough vis-à-vis the modern tractor is an icon of *fellah* primitivism, but notwithstanding this orientalist stereotype, it remains the superior technique for preparing the land in small and fragile terraced fields. Thus, it is still in great demand among small farmers, and even among the Israeli colonists who recognize it as the most appropriate method for limiting damage to the terrain. Ploughing stands, in the midst of dispossession and arbitrary land control, as an icon of autonomy, of knowing 'how to do things': ploughing at night to get around the Israeli army's prohibition of it, ploughing as solidarity among families and ploughing as a crucial source of seasonal income.

The arrival of the rainy season is linked to the strategic timing of ploughing and techniques for the optimization of humidity absorption for the dry season. For many vegetables, the first ploughing is termed *shkak*, 'opening up the land', and takes place before the first rain in November, and is followed by *itsara*, 'taking out the grass', in March. In between, we find *al-ithnaia*, 'allowing the land to drink' after the first rainfall, at the height of the *murba'nia*, and, if necessary, *fakkus*, for the plants that need most water. Interestingly, the second main ploughing is carried out in a perpendicular direction to the first, facilitating greater absorption of moisture.

These agricultures, in their heterogeneity, far from being frozen or ideal, are contemporary testimonies to the patterns of co-production of culture and environment in which the symbolic meaning accorded to human relatedness to other agents plays a crucial part in local productivity. The capability of local systems and networks to adapt to change so as to take into account the complexity of a garden highlights the key contemporary need, in facing uncertain futures, for institutional flexibility and ways of relating to the environment that deny neither relatedness nor change.

Conclusion

As aptly commented by Ghosh, 'a broader imaginative and cultural failure … lies at the heart of the climate crisis' (2016: 8): the failure implicit in denying environmental relatedness, born out of cultural models that have constructed a managed nature at human disposal, and that are now confronted by the distressingly unfamiliar and uncanny character of climate change, which is all the more unsettling for the new dynamics originating above us, in the air and atmosphere. Where we expected order and regular seasons, we realize that 'everything changes', hence the unthinkable character of the current environmental scenario. We are continuously obliged to de-animate what we cannot understand, or experience, within our relations with weather and environmental agents.

The historical legacy of *murba'nia*, which survives in oral tradition and the savoir faire of some local farmers, denotes an imaginative and cultural capability to dwell in an atmosphere viewed not as ordered equilibrium, but as a succession of unpredictable arid and wetter periods, in which the seasons are actually made up of change. Its pattern of shared meanings and work calendar illustrate how cultures can attribute meaning to erratic living forces and dwell in weathered environments: in particular, they imagine weather as familiar and domesticated, and as part of a system of limits and affordances that also contributes to defining belonging, even in displacement.

This local knowledge of a weathered world challenges our own ambivalent model whereby we manage the material as a stable fundament and view the dynamism of the immaterial and aerial as mere instability, invisibility, confusion or turbulence. Thus, Palestinian peasant memories and down-to-earth savoir faire in the fields invite us to adopt 'down-to-air' perspectives and practices of relatedness, all the more so in the midst of increasing land borders.

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Notes

1. Quoted in Dalman (1928: 202).
2. My fieldwork in Jordan spanned the years between 1998 and 2004, while I conducted my ethnographic work in Battir, in the Bethlehem (West Bank) area, during different seasons in 2014 and 2015.
3. The practice of irrigation was implemented on a larger scale by channelling water from the Yarmouk River on the Syrian border. However, this has led to the current water-stress scenario and the 'construction' of water scarcity (Van Aken 2003).
4. In some accounts, the *khamsin* wind arrives during this last phase, which leads into the first fifty days of summer.
5. Proverbs have been the main tool for reproducing the savoir faire concerning the different types of wind: 'The south wind says: "How many strong walls have I destroyed?" The west wind says: "How many streams have I made flow?" The east wind says: "How many branches have I bent?" The north wind says: "How many youths have I made cry?"' (Dalman 1928: 527).
6. *Sefia* (summer crops) and *shittia* (winter crops) correspond to two main categories of seed that are neither cultivated out of season nor indoors, but in concert with the dynamic and seasonal weather patterns and outdoor weather. Thus, the latter need cold while the former crave heat.
7. These varieties are also associated with *mahshuf* (open) cultivation, as opposed to the irrigated indoor agriculture of greenhouses, which are actually covered off from potential rainfall.

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Chapter 11

Imagining Nations and Producing Climate-Change Knowledge in Brazil

André S. Bailão

Anthropogenic climate change is represented in scientific narratives as a series of global phenomena studied and assessed through transnational scientific networks. While extreme events are observed locally, their causes and consequences are globally distributed in uneven and different ways. One side of this narrative pertains to a recurrent imagery of modern scientific knowledge as the production of universally valid laws and theories that transcend any given location of production or authorship (Shapin 1998). Another side of climate-change science relates to the 'global', through the use of General Circulation Models (GCMs), which simulate patterns of global atmospheric and ocean circulation using a combination of equations and data generated around the world (Edwards 2001, 2010). This 'global' imagery of climate change is a product of late twentieth-century science and follows the constitution of data-gathering networks around the planet, an international infrastructure of science and technologies to understand and visualize the global climate (Miller 2004). This climate-imaging process was related to and coeval with the production of images and imaginations of the planet understood as a 'whole' and as threatened by the perils of environmental change (Jasanoff 2001).

Fears of unpredictable and possibly catastrophic changes in climate patterns across the planet create the need for shared discourses and practices, for implementation and debate via international treaties and organizations, that transcend or even challenge national politics (Lahsen 2004; Mahony 2013). However, according to Whitehead, Jones and Jones (2007), even as debates on environmental change emphasize transnational issues, nation-states and national discourses continue to play a central role in knowing and ordering 'nature'. There is a recent literature in the social studies of science that tell us stories of how imaginations of the 'local' and the 'national' are still being produced by environmental-change science and how central the geopolitics of science are for understanding this production (see Mahony 2013, 2017).

To say that there are 'local' aspects being produced in climate-change knowledge, discourses and imaginations is insufficient, as 'local' can be framed and qualified in many different ways. Therefore, one question that will guide this chapter is: how can these different aspects of the 'local' in climate-change science be described? In my assessment, I draw from my own research between 2012 and 2014, an anthropological project aimed at describing the network formation of climate-change science in Brazil (Bailão 2014), and from the literature on climate-change science in the Global South (Lahsen 2004, 2009; Mahony 2014; Matthews 2015; Miguel 2017; Miguel, Escada and Monteiro 2016; Miguel and Monteiro 2015; Monteiro, Seixas and Vieira 2014; Monteiro and Rajão 2017).

This chapter discusses recent developments in Brazilian climate-change science and how national imaginations of the Brazilian territory were produced in relation to it. A second goal is to explore the difficulties and possibilities posed by the production of 'locality' in science and in its description by anthropologists, historians, geographers and sociologists (see Livingstone 2010). To this end, I present differences between two common idioms of Science and Technology Studies (STS) and their methodological treatment of 'locality' – the co-production idiom and actor-network theory (ANT) – as both of them have dealt with these issues in considerable detail.

The so-called 'co-production' idiom privileges descriptions of conflicts and associations between scientists and decision-makers, and highlights the way in which knowledge and power results from this (Jasanoff 2004a, 2004b). ANT, on the other hand, privileges thick descriptions of how facts are produced along material networks and focuses less on the disputed territorial and political imaginations of nation-states (Callon 1986; Latour 1983; Law 1986). I claim that these categories are also imagined and produced by scientists, not only in places where decision-making and knowledge production meet and clash, but also within the locations where scientists act: laboratories, fieldwork, conferences and reports. I start by shortly reviewing the problem of 'locality' in this literature.

Locality in Relation to Universality and Globalism

Actor-network theorists have focused on the specific locations where facts are produced, aiming to reconnect 'science in the making' with the immanent, material and local networks of relations between human and nonhuman agents – against a definition of science as abstract, transcendent and universal ideas (for a summary, see Law and Mol (2001)). Theories and objects circulate and become 'facts' after a great deal of effort and dispute, in order to maintain the stability and reproducibility of their production in other conditions. 'Universality' in science, constantly produced in the form of laws and facts, is always under threat whenever technoscientific networks spread into new settings, facing different frictions, tests and controversies. To describe 'locality', according to ANT, is to follow a narrow and unstable association of elements connecting what scientist do inside a laboratory to the connections they create with other people, things and settings.

Following the 'co-production' idiom, STS accounts describe how certain configurations of power and knowledge arise from associations of science and governmental sectors, and create policies, images, technologies and understandings concerning territories, which in turn produce 'sociotechnical imaginaries' (Jasanoff 2015). The enchantment with the globalization imagery in science and technology, especially regarding climate change, according to Myanna Lahsen (2004), obscures the geopolitics of science and the conflicts behind it. Specifically, in the Global South, in countries such as Brazil and India, there have been accounts describing how researchers and governmental agents frame global climate science as biased and as created in highly disputed international arenas, while simultaneously advocating for local knowledge on both global and local aspects of climate change (see Mahony 2014; Miguel 2017).

There is nothing particularly new in stating that nation-building and science are co-produced, and co-produce one another. In the nineteenth century, meteorology and climatology, which were dependent on costly technology and infrastructure, were actively engaged with by nation-states, which funded, promoted and coordinated expensive research centres, and networks of data collecting and measurement in their territories (see Coen 2018; Edwards 2010; Jankovic, Coen and Fleming 2006). In this chapter I argue that, in a similar manner to weather and climate sciences in the nineteenth and twentieth centuries, climate-change knowledge is deeply connected to national sociotechnical imaginaries.

Climate-Change Science from, in and about Brazil

When I started my research project in 2012, my goal was to investigate Brazilian scientists working on the attribution of the causes and effects of climate change. Inspired by readings of ANT, especially Callon (1986), Edwards (2010) and Latour (1983), I wanted to understand what researchers defined as 'anthropogenic climate change' and what sorts of mixed narratives of nature-society were produced by them (Strathern 1996).

My investigation took me to oceanographers, atmospheric chemists and physicists who develop or work on computer simulations of the climate system, as recently described by STS analysts (Edwards 2010; Lahsen 2005; Shackley and Wynne 1996; Shackley et al. 1998; Sundberg 2007, 2009). In Brazil, the climate-modelling community largely works at the Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research) (INPE), which has its headquarters in the city of São José dos Campos, 100 km from the city of São Paulo, and public federal and state universities, such as the University of São Paulo (USP), the leading research institution in the country (see Miguel (2017) for a summary in English).[1]

This community has been working on the different atmosphere-ocean coupled computer models that have been imported from the United States and Europe since the 1970s (see Miguel, Escada and Monteiro 2016). However, one of the most important events during my investigation was the creation of the first national GCM, called the Brazilian Earth-System Model (BESM). It is the first coupled atmospheric, oceanic and land-surface global (rather than regional) model produced entirely in Brazil and the Global South (Nobre et al. 2013). Some of the scientists I interviewed were involved in the development of the Brazilian model and those who were not involved worked on adaptations of imported models.[2] Due to budgetary and human-resource restrictions in Brazil, most researchers work in different projects simultaneously: collecting chemical, physical, oceanic and meteorological data in the field; analysing and re-analysing data; and simulating climate in the future, present and past (for example, in correlation to past El Niño events).

This aspect of 'locality', the production of imagery, discourses and knowledge on the 'nation-state' and the national territory, is relevant to the practices and discourses of these scientists. It is familiar for them, just as it is for governmental agents and decision-makers – it is not an external term imposed on them and what they do by the descriptions of social scientists.

As the historian of science and geography Charles Withers asked (2007: 6) concerning the Enlightenment in the eighteenth century, if science takes place in and over space, and sometimes also about it, what does thinking geographically, about these different aspects of locality, involve? In the following sections I describe different situations, drawing from public events, scientific conferences, interviews with scientists and analysis of scientific literature, in order to illuminate the recent history of production of different aspects of 'locality' and climate change knowledge – knowledge from, in and about Brazil.

Climate-Change Knowledge from the Nation: Creating a Brazilian Model, without Reinventing the Wheel

In 2013, I attended two scientific events held by the Brazilian climate-change scientific community.[3] The first was a workshop to launch the BESM. The second was the first national climate-change conference, which gathered researchers to present the results from the previous five years to the broader public. At both events, there were also journalists, policy-makers in the areas of science and technology and the environment, and even a few social scientists.

According to the scientists I interviewed, the situation changed completely after the mid-2000s, as Brazilian climate-change science moved to a more mature and modern stage, with more national and international visibility. During the second term of former President Luiz Inácio Lula da Silva, between 2007 and 2010, public funding directed towards research increased considerably. This was a moment of increased public control over the deforestation of the Amazon through the direct involvement of INPE (Monteiro and Rajão 2017).[4]

The approval in 2008 of the National Policy on Climate Change and the National Plan on Climate Change made possible the creation of several institutes and research programmes focused on climate-change science in Brazil (see Bailão 2014; Miguel 2017). At both the federal level and that of the state of São Paulo, there were new developments, which included the CLIMA Network (Rede CLIMA), the National Science and Technology Institute for Climate Change (INCT-MC) and the São Paulo Research Foundation Programme for Global Climate Change Research (PFPMCG). In order to concentrate and stimulate projects, grants and infrastructure, these programmes combined existing and new research groups at universities and public research institutions, such as INPE and others dedicated to agriculture research or studies of the Amazon. Also, in 2008, the Ministries of the Environment (MMA) and Science, Technology and Innovation (MCTI) called for the creation of the Brazilian Panel of Climate Change (PBMC), a national panel that mimics the Intergovernmental Panel on Climate Change (IPCC), in which researchers gather to review the scientific literature on climate change that either concerns Brazil or that is produced in the country.[5]

Attending both events were members of the leading climate-change scientific community in São Paulo, the focus of my investigation and the focal point of a large part of the Brazilian climate-change scientific networks. Both the state and the city of São Paulo, because of their economic power inside Brazil, centralize important research infrastructure and funding, including supercomputers and oceanographic ships. The BESM, for example, was the culmination of thirty to forty years of creating institutions and infrastructure, and training scientists, engineers and technicians in the state of São Paulo, after a long period of importing models from Europe and the United States, and developing local components at INPE and by research groups at other institutions.[6]

Producing their own simulations from GCMs is not a simple effort for most countries, as they demand high levels of state investment for a long time in order to purchase supercomputers and train scientists and technicians (Miguel 2017: 5). This is something that both researchers and policy-makers in countries such as Brazil, with limited science funding in comparison to the Global North, struggle to achieve. Therefore, the context of the BESM is different from that which Myanna Lahsen (2004) described for the late 1990s and early 2000s, when she investigated Brazilian scientists and policy-makers. Back then, national science was still poorly funded and the country could not afford, or was not inclined to invest in, expensive computer modelling of future scenarios. At that time, Brazilian researchers perceived that their position in international debates would change if only they had the resources to generate local contributions.

Between 2008 and 2014, for example, a new oceanographic ship, *Alpha Crucis*, was purchased for the University of São Paulo to conduct research in the South Atlantic Ocean, and *Tupã*, a R$50 million (US$30 million at 2011 rates) Cray supercomputer financed by the São Paulo Research Foundation and the Ministry of Science and Technology was installed at INPE in order to run data-heavy models (Marques 2012).[7]

Therefore, rhetoric at both events was abundant with celebratory discourse on the production of 'state-of-the-art technology' in climate modelling, which in turn inserts the country as one of the major players in international debates, including the IPCC, despite the enormous differences in budgets and human resources between Brazil and the European Union, Japan, the United States and the United Kingdom. Researchers celebrated a national achievement in a global setting that was perceived as unequal. This rhetoric is common among Global South researchers when they compare themselves with, or are compared to, their colleagues in the North, or when they perceive international scientific arena as biased (Lahsen 2004; Miguel 2017).[8]

Other than just chauvinist discourse, there are important processes involved in the creation of a national model, and thereby contributing in creating and training a national community of scientists. For example, at the workshop, different scientists said:

> Australia, for example, decided to aggregate its research to British models, which were already developed. Brazil could have done something similar, and there would be no problem with it, but the lack of national scientific structure guided the discussion towards developing a national model in order to create [and train] a national community, a national network of modellers and specialists. (Scientist A)

> We wanted to create a model for society to use as a tool, incorporating knowledge produced here in other projects on Brazil, such as the [Large-Scale Biosphere-Atmosphere Experiment in Amazonia], for example; providing scientific foundations for adaptation and public policy projects; in sum, creating a new generation of Brazilian scientists. (Scientist B) [9]

Models are produced from an association of institutions and older models, a process that requires vast financial, political and institutional efforts. Models in turn also create and aggregate different things and people, forming new specialized researchers and technicians, and creating new networks of technologies, infrastructure and research groups.

It is also important to scrutinize what these discourses at public events obscure. The public imagery of the peaceful and successful creation of scientific networks and technologies hides conflicts and problems that only appear through sociological and anthropological investigation. After his ethnographic research among climate modellers at INPE, the Brazilian STS researcher Jean Carlos Hochsprung Miguel showed how research institutions have been dismantling older climatological and meteorological research groups, relocating funds and human resources in order to concentrate them into new Earth-system modelling (see Miguel 2017; Miguel, Escada and Monteiro 2016; Miguel and Monteiro 2015). If networks of institution, funds, scientists and decision-making create models, models also create networks by cutting others out (Strathern 1996).[10]

The development of a model is not only associated with a nationalist self-image or the achievement of respect among international colleagues, but also with the material and symbolic production of knowledge over the territory. Brazilian scientists generate a kind of knowledge that is comparable to, and even better than, knowledge from the Global North, at least when it concerns the specific physical processes of the Brazilian territory, such as the role of the Amazon rainforest or the South Atlantic Ocean in both global and regional climate dynamics.

There is a clear production of 'national' imagery in climate-change science, coexisting with the more common rhetoric of 'globalism', as climate-change actors from the Global South try to impact and change intermediate international scientific debates by creating knowledge different from the Global North (Lahsen 2004; Mahony 2014). But when discussing the co-production of climate-change knowledge and narratives regarding the nation and the territory in relation to and in contrast with the 'global', STS description stops short in the places and spaces where decision-makers and researchers meet. I want to draw attention to how scientists themselves produce narratives on the nation.

The nation is a charged category, collectively imagined by people to exist as a bordered unit spanning towards the past and into the future. According to Benedict Anderson (1991), this imagination, rather than a mental state, is materially produced through museum displays, monuments, educational systems, censuses and maps, which provide efficient ways to visualize and manage the territory. Science has intensively created means to visualize and understand nation-states, what they are comprised of and their desired (or undesired and to be resisted) futures. These are what Sheila Jasanoff (2015) has called 'sociotechnical imaginaries', the ideas, politics and the materiality of science and technology that shape and frame our collective lives. The researchers in my study deal with both global and local aspects when producing models, scenarios and analyses, and by doing so create new ways of visualizing the nation and of imagining what the future holds for its territory. When scientists discuss the importance of national research, not only is this knowledge produced from Brazil, by Brazilians rather than researchers from the Global North, but it is also knowledge intimately related to the way in which the territory is understood, one that is produced in and about Brazil.

Why spend large sums of taxpayers' money in order to produce another climate model when North America and Europe already produce them? One researcher involved at the creation of the BESM gave an answer to this question that went beyond the formation of local human resources mentioned above:

> FAPESP [the São Paulo Research Foundation] and the Ministry of Science and Technology bought the supercomputer to support and improve environmental research in Brazil. By that time, we started to think about creating a Brazilian model, but not to reinvent the wheel, but rather to stimulate the development of Brazilian research, with emphasis in local concerns and local issues. (Scientist A)

The rationale is not the reproduction of work done by researchers elsewhere, nor is it in the rhetoric about the geopolitics of science or the development of national science, but it is the production of knowledge that is relevant to material dimensions of locality as exhibited in local physical processes, which is the subject of the next section.

Creating Knowledge in and about the Nation: 'Tropical Rain Isn't the Same Thing as British Rain'

The Amazon is a key area for climate-change science. As the world's largest rainforest, it plays an important role in global and regional climates, and meteorological and biological processes, all of which are directly affected by deforestation and anthropogenic changes (Monteiro and Rajão 2017; Monteiro, Seixas and Vieira 2014). This argument has motivated many of the major research projects conducted in the region, such as the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) (see Lahsen 2004). On the relevance of a Brazilian climate model to international debate and simulation of the Earth system, Brazilian researchers usually highlight the important role the Amazon rainforest plays in global and regional climate dynamics, and the local research on natural processes and human influences in the environment of the region.[11] As one researcher stated during one of the conferences:

> There are many local issues in environmental and climate change research with which Brazil could contribute to global science: issues concerning deforestation of the Amazon forest, natural fires in the Amazon and the savannah, cloud and aerosol formation in the Amazon, megacities, tropical rivers, South Atlantic Ocean dynamics, El Niño and La Niña oscillations – local issues, particularities from here. (Scientist C, conference presentation, 2013)

Being a country the size of a continent, there is a perceived need for more detailed knowledge of the physical processes in Brazil in order to improve both regional and global climate models. For example, one of my interlocutors, Scientist D, works both as a modeller in an institution in the state of São Paulo and as a field researcher in the Amazon with a research group studying rainforest atmospheric physics and chemistry. His research is conducted as part of an international collaborative project in the Amazon, funded by Brazilian, European and American institutions, aimed at understanding and modelling the relationship between the forest and the atmosphere, regional and global climate, and anthropogenic environmental change. His group also collects and generates data related to urban pollution in the Amazon, natural and anthropogenic aerosols, dust and fires in order to understand how clouds and rain are formed, as well as the ways in which natural and anthropogenic processes impact them.

Back in the state of São Paulo, Scientist D and his colleagues also work on programming, developing parameterizations of these processes for improving GCMs, including the BESM and regional climate models, and simulating medium- and small-scale physical processes of the region. According to him, one of the major sources of uncertainty comes from the fact that physical processes in the Amazon rainforest and the South Atlantic Ocean are poorly represented in current models due to insufficient long-term research or rarefied networks of data, with few measuring stations and buoys in the region and not so robust sets of climatological and oceanographic data.

Scientist D says that the global models, equations, global datasets that Brazilian researchers work with, and the instruments responsible for producing and measuring them are developed mostly in and for the Global North, and are better suited for temperate phenomena. However, 'tropical rain isn't the same thing as British rain', as he once told me. Rain, cloud and river processes are phenomena that can hardly be universalized in any simplistic way, even as their names refer to similar things. How they are formed, how they perform and how they interact with other phenomena is different for different locations, and has a direct impact on how climate is modelled and the way that simulations perform.[12]

Problems multiply in the field and in data and modelling centres when researchers deal with the tropical world – the so-called 'frictions', following the definition used by Paul Edwards (2010), meaning the struggles encountered by scientists and engineers in transforming raw data into computational data. Many scientists I interviewed mentioned satellite sensors as problematic because, being developed in the North, they cannot properly visualize or represent tropical rain or the rainforest, with its particular physical, chemical and biological characteristics. They also tell stories of measurement instruments deployed in the field malfunctioning when soaked in tropical rain because they were built for temperate climates. Climate theories, models, equations and instruments have to overcome countless frictions, trials, struggles and resistances.[13]

During an interview, Scientist D opened on his computer a high-resolution satellite image of the Amazon forest and zoomed in on a region where he does his research. In this image, only the rainforest could be seen, divided by large serpentine rivers and covered by clouds:

> Rivers in the Amazon, for example, complicate things too much. Look how clouds gather above the forest, but not above rivers … Rivers in the Amazon are so large they produce breeze, because of the temperature difference – because the radiation absorption is different between the forest and the river,

> just as it happens in the coast between the land and the sea. Radiation is altered, because clouds above the forest reflect solar radiation with different intensity than rivers, as rivers are dark and absorb more radiation [than trees]. In low-resolution models, grid cells do not represent rivers when plotting the Amazon. They are too small for the grid and only the forest is represented. But they are too important for the climate. And this generates a huge difference in simulated results [in relation to observation] … Models have to bridge between many different scales and you can't advance if you don't have good information from the small scale. (Scientist D, interview, December 2012)

Therefore, scientists have to develop new parameterizations and improve climate models if they want to account for the physical processes of Amazonian rivers, clouds and wind patterns. Otherwise, simulations of the future climate will be deficient with regard to the Amazon, either unreliably representing the impacts of climate change on this biome or underplaying the effects of local physical processes and environmental change in other regions.

Researchers, for example, have recently pointed to intimate connections between the Amazon rainforest and rain patterns in the densely populated areas in southeastern Brazil and the Southern Cone, more than 3,000 km away, a region with more than 130 million inhabitants, where the largest South American metropolitan areas are located, such as São Paulo, Rio de Janeiro, Buenos Aires and Montevideo (for a summary, see Nobre (2014)). According to current climate theories, simulations and observations, the disruption of Amazon physical processes due to deforestation could impact and disrupt not only rain patterns within the forest, but also those in these distant places.

It is important to state that while the 'local' is central to climate-change debates, the framing of them as 'universal' or 'global' is not a false interpretation created by Northern scientists. Brazilian scientists aim at creating universally valid science as much as their colleagues on the other side of the equator. As they told me, even though they only trust their models if they have enough reliable information from the local scale, their models function with 'the same physics' as those developed in the North, and their aim is to make the physics and data of local issues as 'global' as the representations of their 'Northern' colleagues.

Better understandings and descriptions of local phenomena can be achieved regardless of scientists' institutional origins or places of birth. Foreigners also wish to improve their models, instruments and data measurements of regions such as the Amazon as much as Brazilian researchers.[14] To frame what my interlocutors do as simply 'nationalistic' is to reduce its complexity. Transnational networks are desired as much as the strengthening of national research centres. Brazilian climate-change researchers circulate in international arenas; many of them are trained overseas and constantly generate knowledge by sharing and coworking with foreigners (see Lahsen 2004).

Far from being antagonists, 'universality', 'globalism' and 'locality' are interconnected and show the geographical complexity of climate-change knowledge production (Mahony 2014). That said, we might still ask how national imaginations are created in relation to global and local climate-change research. To answer this, we have to ask what they do with this knowledge and for whom they do it.

Concepts of the Nation and the Conflicts of Trying to Guide Public Policy with Them in Brazil

There has been increasing production of global and regional climate scenarios for the Brazilian territory since the mid-2000s (e.g. Ambrizzi et al. 2007; Marengo 2006, 2007; Nobre et al. 2013; PBMC 2014). The aim of the researchers is to influence public debate and policy-making on climate change, acting as 'concerned citizens', as Monteiro and Rajão (2017) have described for scientists at INPE researching deforestation.[15]

Generally, scenarios are produced according to multiple 'narrative storylines' that imagine different patterns of technological, natural and societal change for the future – often called 'optimistic' or 'pessimist', according to whether they predict higher or lower increases in greenhouse-gas concentration. Each narrative reduces the complexity of social-technical-natural interrelations and factors to a limited number of indicators in order to be deemed operational.[16] Researchers involved in the production of these scenarios run atmosphere-ocean (and sometimes atmosphere-ocean-land) coupled models that extrapolate increases in greenhouse-gas concentrations, using, for example, the IPCC's special scenarios for the twenty-first century, the so-called Special Reports on Emission Scenarios (IPCC 2001; see Hulme 2009). The resulting simulations, physical-mathematical outputs of models, are then translated into other 'stories' in the form of analyses, reports, maps, graphs and images, all of which are to be read by other scientists, policy-makers and the general public, following the international practice of producing reports summarizing analyses and results for a broader audience.

In Brazil, these scenarios project and narrate dangerous futures, with the possibility of parts of the Amazon turning into savannah or even disappearing altogether, and other future disruptions of nature and society in the rest of the country. As one modeller said, 'it is already possible to witness the future we are modelling', downplaying the uncertainty factor present at every simulation (see Bailão 2015; Lahsen 2005; Shackley and Wynne 1996; Taddei 2012). Nevertheless, the number of extreme climate events has increased considerably in the country, The Amazon had record droughts in 2005 and 2010, the state of Rio de Janeiro was hit by severe storms in 2011, producing the worst weather-related catastrophe in the history of the country, with over 900 deaths, and the state of São Paulo suffered with a water crisis after a long drought in 2013–15, and Hurricane Catarina hit the southern coast of Brazil in 2004.[17]

On the last day of the national conference in 2013, one of the presenters, in the presence of representatives of federal agencies, commented on how important public investment in national science had been for the co-production of knowledge and policy in the previous years, in comparison with the situation before 2008, when Brazilian climate-change science was underfunded:

> We had reached the conclusion that climate change is a major problem, but we didn't have enough detail to inform decision makers of what would happen at the local scale. Now the results we are showing are relevant to this country's sovereignty. We are producing knowledge for the national scale … With the knowledge we have, we have the responsibility to think about how we can change the future of our nation. … This is something that bothers me, how can we influence policy-making? … You cannot imagine the treasure that Brazilian climate-change science has presented us with, these concepts of Brazil, knowledge that is comparable to what is being produced in developed countries. But how can we guide policy with this knowledge? (Scientist E, conference talk, September 2013)

Engaged researchers such as Scientist E justify what their work is in terms of what the government and society can do with its results, framing their knowledge production as a powerful tool for social action. Scenarios turn these climate modellers into spokespersons of past, present and future imaginations of Brazil, turning climate change into a new way to comprehend what the territory is, what it is comprised of and what it may become. Extreme climate events, through the narratives of climate modellers, are connected to rainforest and land management, forest-fire control, and the ensuing major economic, social and political choices in a country driven by commodity exploration and agribusiness. For them, the country cannot continue devastating the Amazon, overexploiting oil resources and not investing enough in renewable energy sources when their models show the connections of global and local climate change to increases in the number and severity of disasters. How we represent the world is connected to the ways we choose to live in it (Jasanoff

2015), and climate models play a role in national knowledge making by producing new ways of seeing the country (Mahony 2014: 125).

When these imaginaries circulate, these 'concepts of Brazil', in Scientists E's words, are tested against, and have friction with, competing and counter-imaginaries that these researchers are not capable of controlling. Celebratory rhetoric about the recent success of national climate-change research often fades away into one of outcry that their efforts are not producing the desired results in the face of the competing policies of land management dominated by the agribusiness sector.

As successful as they have been in building their networks, drawing governmental interest and funds to their research, that has not precluded important failures, such as in their participation in congressional hearings in 2013, for example, when the National Congress approved a new, less conservationist, forest protection code under pressure from the agriculture lobby (*Reuters* 2018). For these scientists, according to the global and regional models they use, as well as observations and field research in the Amazon, this new forest code seems likely to worsen climate and environmental change in Brazil (for a summary of this, see Nobre (2014)).

The executive branch of the Brazilian federal government has increased investment in oil production and thermoelectric power since the mid-2000s, with low investment in renewable energy sources, such as wind and solar power, and weakened environmental protection, with deforestation levels increasing since 2016. As this chapter was being revised, former President Michel Temer, in office after the impeachment of Dilma Rousseff in 2016, and current President Jair Bolsonaro, elected in 2018, have vastly decreased public funding in education, science, technology and environmental protection (see Watts 2017). President Bolsonaro has appointed several climate change deniers to his cabinet and reduced INPE's power in monitoring and controlling deforestation in the Amazon region, which became a diplomatic crisis in 2019 (see Sandy 2019).

Conclusion

Brazilian climate modellers have recently been producing knowledge from, in and about Brazil, revealing how 'local' aspects of sociotechnical imaginaries of climate change are as important as the more common globalizing and universalizing ones.

In recent years, they celebrated the advancement of national research and knowledge produced from Brazil, as they perceive the international scientific arena to be deeply biased. This happened after an intense state-led investment in the creation of different infrastructures and institutions, the training of human resources after 2008 and the development of a Brazilian climate model, the first GCM of the Global South. Beyond its use in nationalist rhetoric, researchers' defence of the need for a national GCM is based on the importance they give to research done in and about Brazil, as current models produced in the Global North do not account for specific tropical physical processes and phenomena as well as they do for 'Northern' ones. They only trust their own models to take account of knowledge concerning the specificities of the local scale, though their models work with the 'same physics' as their counterparts in the other side of the equator. Their goal is to make their 'local issues' – such as creating a national community of science, and producing reliable and sound science in and about local physical phenomena – 'global', meaning that there is an interplay between 'global', 'universal' and 'local' aspects of science rather than only a contraposition.

Scenarios generated from national research produce (and are produced for) intense imaginaries of the national territory and its future. These scientists are engaged in circulating their research to, and debating it with, broader audiences, aiming at influencing public debate concerning climate patterns and environmental change, especially with regard to the Amazon rainforest and its deforestation. But sociotechnical imaginaries of the Brazilian territory are still a matter of controversy in the face of recent political changes in Brazil, and the question remains as to whether climate-change researchers will be able to compete with opposing political forces, such as the agribusiness sector.

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Acronyms

ANT:	Actor-Network Theory
AR4:	The IPCC's Fourth Assessment Report
BESM:	Brazilian Earth-System Model
CAPES:	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel)
CNPq:	Conselho Nacional de Desenvolvimento Científico e Tecnológico (Brazilian National Council for Scientific and Technological Development)
COP15:	2009 United Nations Climate Change Conference in Copenhagen
FAPESP:	Fundação de Amparo à Pesquisa do Estado de São Paulo (São Paulo Research Foundation)
GCM:	General Circulation Model
INCT-MC:	Instituto Nacional de Ciência e Tecnologia para Mudanças Climáticas (National Science and Technology Institute for Climate Change)
INPE:	Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research)
IPCC:	Intergovernmental Panel on Climate Change
LBA:	Large-Scale Biosphere-Atmosphere Experiment in Amazonia
MCTI:	Ministério da Ciência, Tecnologia e Inovação (Ministry of Science, Technology and Innovation)

MMA: Ministério do Meio Ambiente (Ministry of the Environment)
PBMC: Painel Brasileiro de Mudanças Climáticas (Brazilian Panel of Climate Change)
PFPMCG: Programa FAPESP para Pesquisa em Mudanças Climáticas Globais (São Paulo Research Foundation Programme for Global Climate Change Research)
STS: Science and Technology Studies
USP: University of São Paulo

Notes

1. I obscure researchers' identities, gender and institutional affiliations, as the climate-change community in Brazil is small. I have interviewed researchers who develop or work on global and regional GCMs at public institutions in the state of São Paulo, attended workshops and conferences and read their research projects and articles. The limited time period for my Master's studies (2012–14) and the sheer size of Brazil did not allow me to do research in the rest of the country. See note 6 below.
2. The differences between 'imported'/'produced' or 'users'/'developers' can hide agency in knowledge production (Lahsen 2005; Sundberg 2007, 2009). Models are complex ensembles of equations, parameters and methodologies, and 'users' take decisions as what to include and exclude in them, changing the original model and developing specific parameterizations of processes that are relevant to their research. Parameterizations are equations that represent physical phenomena that are not resolved by models, being too small for the model's resolution, unknown or not well represented by current knowledge. While core equations are the same in every model, modellers chose parameterizations that seem to best fit the simulation they want to perform or the specific region they want to model. Parameterizations are one of the main sources of dispute among climate modellers and pose challenges to any attempt to create 'global' or 'universal' knowledge (see Edwards 2010; Sundberg 2007).
3. They were both organized by FAPESP, the second-largest research foundation in Brazil, an agency that funds research in the state of São Paulo. The largest was at that time the CNPq, an institution associated with the Ministry of Science and Technology that provides funding for research at the federal level. FAPESP is the oldest and largest of all the state research foundations in the country, and since São Paulo is the wealthiest state in the country, its budget in 2013 was almost the same size as those of all the other state foundations combined and almost half of the national research budget. A third of all research in Brazil is generated in São Paulo. See http://www.fapesp.br/en/about, http://cnpq.br (retrieved 17 March 2021). See also note 6 below.
4. The Brazilian government also took a more aggressive position in climate-change policy internationally. President Lula's diplomatic and scientific mission at the 2009 United Nations Climate Change Conference (COP15) in Copenhagen set a historical precedent by presenting carbon emission reduction goals and results from a Global South nation (see Barros-Platiau 2010).

5. This is different from what Mahony (2013: 117) has described for India, where an 'Indian IPCC' was created to offer independent research from northern ones. In Brazil, geopolitics plays a lesser role and the existence of the PBMC is not to counteract foreign research, but rather to congregate state-of-the-art research produced in and about Brazil in order to influence national decision-making on climate change.
6. There is a strong rhetoric among Paulistas on their leading role in Brazilian science and technology – invoking the narrative of 'the nation's locomotive', as many people from São Paulo call their state. Quoting scientists on the role of São Paulo in Brazilian climate-change science at both events: 'Environmental science has advanced in Brazil, we are at a more mature and modern stage in national science, with national and international visibility … São Paulo's scientific community is part of this milestone. It is a well-established and recognized scientific community' (Scientist A); 'FAPESP is a watershed in Brazilian science. In 2006, before the famous [IPCC's AR4], FAPESP was already organizing itself, and its scientific director gathered a small but relevant number of climate change researchers in São Paulo … Brazil is now amongst the major players of scientific research' (Scientist B). These statements were selected to show how researchers from São Paulo easily equate their state with the whole nation, overlooking historical structural and financial inequalities inside the country. It is important to keep this in mind when reading the rest of this chapter. I thank Renzo Taddei for his remarks and comments on this issue. For his research among meteorologists in northeastern Brazil, see Taddei (2012, 2013). The IPCC's AR4 was the Fourth Assessment Report written in 2007, providing the physical science basis of climate change and based on scientific literature on the subject, including datasets, analysis and modelling. See: http://ipcc.ch/report/ar4/wg1 (retrieved 17 March 2021).
7. The supercomputer was named after the native Tupi nation's god of thunder, following a tradition starting in the nineteenth century of silencing indigenous populations, while simultaneously creating official nationalist memory from stereotypical indigenous elements and names from certain nations, especially the Tupi-Guarani (Schwarcz 2004: 132–50). Climate-change science, as with the majority of modern scientific endeavours, does not consider indigenous peoples as a source of knowledge. To mention one example during my research, during a debate on the PBMC at the national conference in 2013, someone in the audience asked about the place of traditional and local knowledge in climate-change science, which prompted the memory of a controversy surrounding the IPCC's AR4 report, which contained erroneous predictions on melting of Himalayan glaciers (see Mahony (2013) for details on how the case impacted the climate change debate in India). One of the scientists reacted to the idea of 'local knowledge: 'There is no such thing. It is either scientific knowledge or it's not … Climategate happened because non-scientific data was used to discuss the Himalayas and that gave the IPCC a huge headache. Cultural traditions don't have scientific tradition, so they were excluded from the PBMC Report, so we wouldn't get attacked.' A second debater intervened and tried to relativize, but went on to justify the first: 'We are not questioning traditional knowledge, especially given its importance regarding local changes of soil and forest and ecosystem management. The CNPq even called for a group to work on this. For this time, however, the PBMC excluded [traditional knowledge], but maybe it will change in the future. The goal was to revise scientific peer-reviewed literature.'
8. The perception of a North-South divide is not exclusive to the natural sciences. As a student in the Global South, I constantly heard from professors how Northern anthropologists treated Brazilians as suppliers of ethnographic data, while they actually produced theories – just as the IPCC is sometimes perceived as an arena where scientists from the North provided models and theories, while scientists from the South provided data (at best).

9. The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) is an international multidisciplinary research project conducted by Brazilian, North American and European institutions. One of its aims is to understand how the Amazon rainforest functions as a regional integrated unity (see Lahsen 2009).
10. According to Scientist F (interview, August 2013), one week prior to the national conference on climate change, 'even with the increase in science funding, there is a major lack of planning. The older prediction centre is being dismantled to relocate researchers to the new earth-system and natural disaster centres, because there are just not enough people to be specialist in climate science in Brazil. Doing science in Brazil is still very difficult'.
11. It is important to notice how the Brazilian savannah (the 'Cerrado'), covering over 20 per cent of Brazil, has been historically understudied, underprotected, undervalued and over-exploited, especially in comparison to the Amazon (see Lahsen, Bustamante and Dalla-Nora 2016).
12. There was no implication that Northern scientists did not understand this, especially given that an international consortium funds his project. International scientific networks spend a great amount of human, material and financial resources in the Amazon, as it is considered a key area to earth-system science and natural sciences in general.
13. According to Edwards, every effort in producing climate knowledge involves friction: 'Climatology requires long-term data from many locations, consistent across both space and time. This requirement implies a lengthy chain of operations, including observation, recording, collection, transmission, quality control, reconciliation, storage, cataloguing, and access. Every link in this chain represents an information interface subject to data friction' (2010: 84). What scientists in Brazil are saying is that the production of climate knowledge in the tropical rainforest or more generally in the Global South involves extra layers of friction, which I explored above.
14. There is a long history of connections between Brazilian natural and human sciences, and foreign research missions in the country, going back to the nineteenth century, when several foreign naturalists travelled around the territory and some of them occupied important positions at public institutions, and well into the twentieth century during the foundation of public universities.
15. See Monteiro and Rajão (2017) for a discussion on how the Brazilian researchers at INPE that are detecting and monitoring deforestation of the Amazon have been involved in broader controversies, and policies towards environmental change and protection during the last three decades. Monteiro and Rajão describe how scientists, in their practice, were concerned with technicalities of interest to the scientific community as well as the way in which other social actors would read their results and analyses on deforestation.
16. What counts is a matter of great controversy and dispute. 'Human dimensions' in these stories are metonyms, referring to activities related to industrial-urban-agricultural processes that can be translated into chemical concentration rates and their variations (for more on this, see Malm and Hornborg (2014)).
17. Hurricane Catarina was the first of its kind in the South Atlantic Ocean, as climatological factors do not favour the formation of tropical storm systems in this region.

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Chapter 12

Embanking the Sundarbans

The Obfuscating Discourse of Climate Change

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Bangladesh is often portrayed as a 'climate-change victim' in popular media narratives. The country gained significant international attention following the cyclonic events of Sidr and Aila in 2007 and 2009, respectively. The country's low-lying topography and coastal landscape have been cast as particularly vulnerable to the effects of global warming, as the frequency of tropical storms and tidal surges are expected to increase along with rises in sea level. Alarming images like that given in Figure 12.1 have been pivotal in attracting hundreds of millions of dollars in development funding towards climate-change adaptation and mitigation (Global Climate Change Alliance+ 2012).

However, as Zaman points out, the complete elimination of flooding in Bangladesh is undesirable 'for flood is intricately linked with the very survival of the people in this delta country' (1993: 987). Despite well-meaning intentions, images like that in Figure 12.1 conflate regular beneficial monsoon floods with sea-level rise, portraying floods as solely caused by climate change. Such a narrative of climate vulnerability ignores the fact that there are three types of floods in Bangladesh: *borsha* (annual monsoon rains), *bonna* (irregular destructive floods in the wake of cyclones and storms) and *jalabaddho* (waterlogging).[1] Figure 12.1 is a typical image of *jalabaddho*, when during the monsoon the water is unable to drain out through the embankment back into the river. In a state of nature without any humanmade infrastructure, the *borsha* rainwater merges with the silt-laden river water to deposit silt on the floodplains. The silt raises the land levels and promotes processes of organic decomposition that make the deltaic lands fertile. These inundated wetlands provide breeding grounds for hundreds of spawning fish species, while irrigating *aman dhan* (rice planted during monsoon season). In light of this, the narrative that all floods must be prevented is highly problematic. Indeed, the complexity of the local ecology and the distinctions between *borsha*, *bonna* and *jalabaddho* floods are lost in portrayals of Bangladesh as a 'climate-change victim' where floods are solely caused by climate change.

Mike Hulme (2015: 297) suggests that climate change has acquired powerful agency as an explanation of change and causation in the contemporary world. He suggests that this has resulted in a new variant of climate determinism that reduces the complexity of interactions between these spheres to produce what he terms 'climate reductionism'. Climate reductionism, he argues, is the increasing trend to ascribe all changes in environment and society to climate change (Hulme 2011: 255–56). This chapter combines long-term ethnographic fieldwork and archival research to complicate current discussions of floods to show that embankments were built long before climatic change was identified as a problem. It shows the ways in which climate reductionism works alongside a long history of development interventions that ignore local context by means of simplification (see Scott 1998), and illustrates how the colonial state simplifies local ecology in order to expand land-based infrastructure such as embankments, railways and roads, replacing waterways as the main mode of transport. I argue that narratives of improvement, whether through railways, flood protection or climate-change adaptation, have the potential to enable simplification in ways that increase the financial interests of particular actors, both within state

Figure 12.1. Screenshot of *Huffington Post* article on 'climate change refugees' in Bangladesh (Nikitas 2016) (© Probal Rashid)

administrations and international organizations, at the cost of environmental concerns.

I first discuss anthropology's role in deconstructing the knowledge production of climate change in development projects, and the importance of historically grounded ethnographies to counter simplified narratives. Climatic change involves changing temperatures and variabilities in precipitation and humidity – effects that are already becoming known in Bangladesh as monsoon patterns are shifting. However, in a deltaic region known for its heavy sedimentation, attributing all floods to rising sea levels due to melting ice caps caused by climate change is problematic. I use archival research and oral histories to trace the environmental history of embankments (sea walls) and to highlight the ways in which embankments changed from 'salinity-protection' infrastructure during the East India Company deforestation of the Sundarbans to 'flood-protection' infrastructure from the 1850s onwards, and the ways in which they have contributed to damaging floods in the coastal zone.

I conclude that the current reading of coastal Bangladesh as a 'victim of climate change' requiring higher and wider embankments is unsustainable, as it ignores the way in which these very embankments exacerbate siltation and increase the risk of damaging flood. Climate change in Bangladesh, so far as many international experts are concerned, is about rising sea levels causing floods, but as this chapter demonstrates, floods in Bangladesh are not just about rising sea levels (cf. Barnes 2015: 143).

Ethnographically Exploring Climate-Change Knowledge Production

Anthropogenic global warming is a real material phenomenon and constitutes a key global challenge of our time. It is inextricably linked to the advent of capitalism, which reduced both human beings and the natural environment to pure commodities (Polanyi 1957). Capitalist land use and industrial practices have not only contributed to long-term climatic change through greenhouse-gas emissions, they have also resulted in significant localized environmental degradation. In the *Annual Review of Anthropology*, Crate (2011: 185) suggests that anthropologists in the era of contemporary climate change ought to replace 'environmental ethnography' with 'climate ethnography' to denote the urgency of localized experiences of weakened livelihood capacities and to advocate climate justice at global policy levels.

However, as anthropologists, we must also pay attention to detail and complexities. Although Crate acknowledges multiple stressors and other environmental factors affecting livelihoods, 'climate ethnography' assumes that climate change causes all the problems local people are experiencing. In order to holistically understand climate risks in Bangladesh, we must engage with the fact that the country is situated in a hydrologically active delta with constant processes of erosion as the Ganges, Brahmaputra and Meghna Rivers meander, while a billion tonnes of sediment flow from the Himalayas to the Bay of Bengal each year (Islam et al. 1999). In a state of nature, the silt deposits through accretion during annual monsoon floods and creates new land. In the 1960s, funding from the World Bank and the United States Agency for International Development (USAID) was used to construct 136 'flood-protection' embankments. These were based on Dutch polders and obstructed monsoon flooding, and thereby contributed to the silting up of the delta that results in the *jalabaddho* seen in Figure 12.1. Thus, an anthropological approach that replaces 'environmental ethnography' with 'climate ethnography' may risk losing a holistic understanding of localized processes tied to context-specific anthropogenic land-use practices, environmental degradation and social issues that affect livelihoods. The use of 'climate ethnography' may thus play a reductive role in describing human–environment interactions and increase the risk of 'climate reductionism', i.e. the ascribing of all changes in environments and societies to the climate (Hulme 2011).

Mike Hulme has researched climate-society relations since the 1980s: he worked on the United Nations Intergovernmental Panel on Climate Change (IPCC) and founded the Tyndall Centre for Climate Change Research. He points out that until the 1990s, global warming was often associated with 'climatic change', an index of change in the climate system to which interannual variations in weather would contribute. He argues (Hulme 2015: 290) that during the 1990s, the term 'climatic change' was increasingly replaced by 'climate change', a discursive shift from an adjective to a noun that denotes the role of climate as the main causative agent of interannual weather variation. Hulme's concept of climate reductionism is an important tool for understanding that although climatic change is indeed happening, the discursive power of climate change can be used to deflect closer, local examinations of causality.

Recent ethnographies increasingly deconstruct climate-change-knowledge production, pointing to the importance of understanding climate change as a depoliticizing discursive phenomenon. For example, Zink's (2013) ethnography of environmental policy and the social embeddedness of knowledge production in Vietnam highlights how real climatic change coincides with 'discursively and socially constructed climate changes'. In addition, the ethnographies in Barnes and Dove's (2015) *Climate Cultures: Anthropological Perspectives on Climate Change* go beyond climate reductionism and unpack the complex relationships between society and climate. Orlove et al. (2015) take a historical approach to human perceptions of climatic change and deconstruct the production of knowledge (and ignorance) and discourses of climate change at both the local and global levels. By pointing to the dramatic images of melting ice caps and the associated rising sea levels that will drown small-island nations, they consider how certain climate-change impacts come to be prioritized over others. They argue that sea-level rise due to climate change is presented more as a pressing climate-change issue than those affecting mountains and deserts, and deflects responsibility for the latter (Orlove et al. 2015: 77). Similarly, in her ethnography of climate change and water in Egypt, Barnes (2015) finds that though climate change is not the only factor that will shape water availability in Egypt in the coming years, the political decisions about water allocation and access are neglected when Egypt's water future is discussed through the lens of climate change. She shows how variously positioned actors attach different weight to climate change as an explanatory variable. By doing so, she demonstrates how anthropologists can engage with climate change by deconstructing the production of knowledge about it.

The remaining sections of this chapter apply the concept of climate reductionism to the development industry in Bangladesh by using historical material to illustrate the complex causal processes behind 'floods' and how they have, ironically, become exacerbated by 'flood-protection' embankments. Such an account, historically grounded and deconstructing dominant narratives of climate change, is increasingly important as considerable development funding continues to be directed towards 'climate-change adaptation' (Barnes and Dove 2015). Anthropologists have an important role to play, not only in relating local community experiences of adaptation to climate change to global policy levels, such as that of the IPCC (Crate 2011), but also in analysing particular discourses of climate change in development projects as sites of a power struggle, of competing interests, conflicting agendas and divergent conceptions of the very notion of climate change. By doing so, we can appreciate how policy discourses may work as instruments of governance to 'identify the mobilising metaphors and linguistic devices that cloak policy with the symbols and trappings of political legitimacy' (Shore and Wright 1997: 3).

The Environmental History of Sundarbans' Embankments

Deforestation and Embankments as 'Salinity Protection': Before the 1850s

In their historically grounded ethnography of deforestation and environmental degradation in southern Guinea, Fairhead and Leach look at different 'readings' of the forest landscape by policy-makers, scientists and local inhabitants, and argue that '[p]olicy-makers may have been misreading the landscape by looking at history backwards' (1996: 3). The common reading of Bangladesh as a 'victim' of climate change assumes that as global warming increases, ice caps will melt, sea levels will rise, low-lying Bangladesh will drown and people will have to flee due to floods and increasingly frequent disasters (cyclones and tidal surges), thereby becoming climate-change refugees. Based on such a narrative, the World Bank is justifying the expansion of embankments along coastal Bangladesh through the discourse of 'climate-change adaptation'. However, as mentioned earlier, floods in Bangladesh are not solely caused by climate change and the portrayal of embankments as 'climate-change adaptation' constitutes a misreading of the coastal Bangladeshi landscape and the processes behind floods.

Embankments were constructed long before climatic change was identified as a problem for Bangladesh, and they were not originally intended to prevent floods. Instead, the earliest recorded forms of embankments in Bengal were built to protect newly created arable land – made from deforested coastal mangroves – against seasonal salt tidewater incursion. This, in turn, highlights how floods in Bangladesh are not solely about sea-level rise caused by climatic change (Auerbach et al. 2015; Brammer 2014). In order to comprehend the complexities of different types of flood in Bangladesh, it is important to understand the history of embanking the Sundarbans forest in Bengal and how it was interlinked with the deforestation of mangrove wetlands to convert them into arable land.

Deforestation of the Sundarbans dates back to the thirteenth century, during Turkic Sultanate rule, and later took place in the Mughal rule, from the sixteenth to eighteenth centuries, before continuing during the British regime. When the East India Company first seized the right to collect revenue in Bengal and Bihar in 1765, the unpopulated Sundarbans mangrove forest was used for profitable salt production, in which the Company's Salt Department upheld a monopoly (Phillimore 1945: 50–51). Its headquarters were in Culna, a small port situated at the northern boundary of the Sundarbans forest, as illustrated in Rennell's (1779) *A Map of the Sunderbund and Ballagot Passages* from 1779 (Figure 12.2).

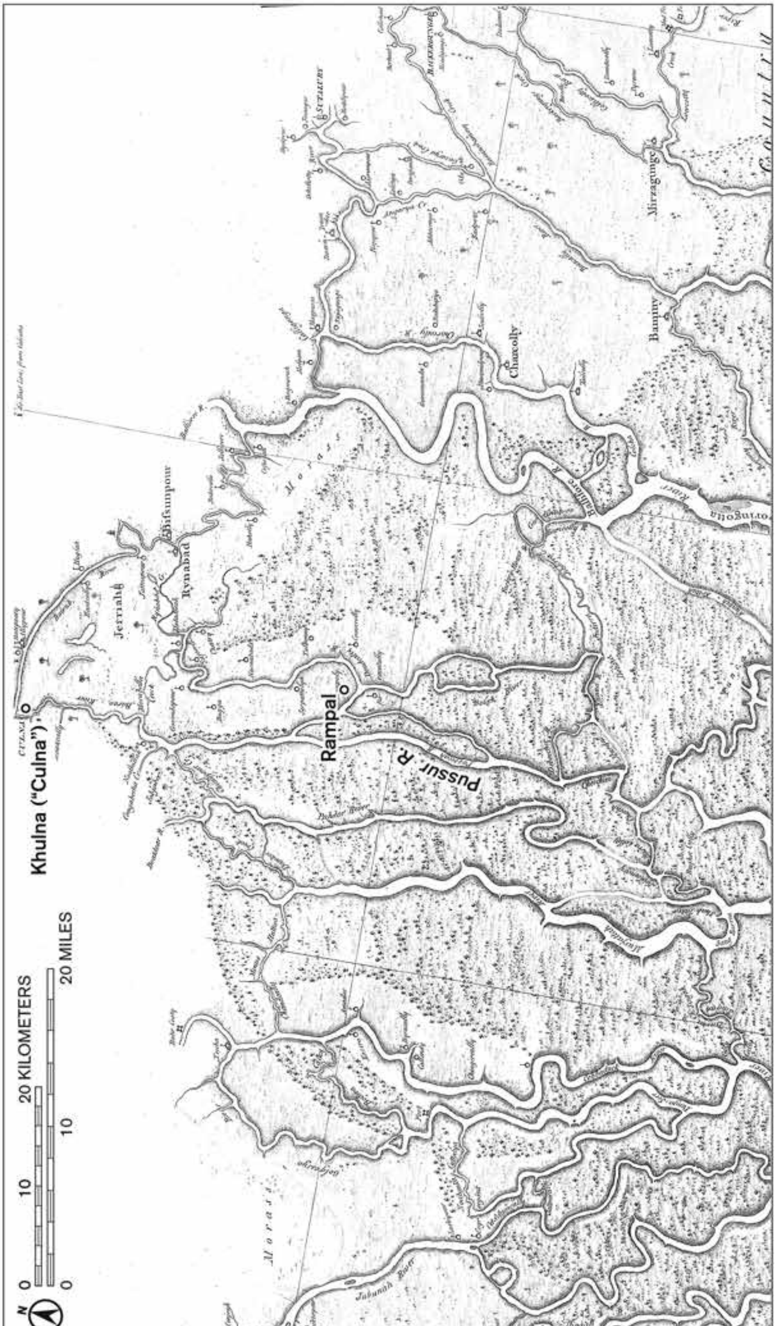

Figure 12.2. Map of the Sunderbund Passages (© The British Library Board. Source: Rennell 1781, Maps 25.b.8)

However, the Company's salt production was increasingly replaced by the 'reclamation' (deforestation) of mangrove wetlands into arable, revenue-generating crop lands. British deforestation entailed the most rapid destruction of the Sundarbans that Bengal had experienced to that point (Gadgil and Guha 1992; Richards and Flint 1990; Sivaramakrishnan 1999) and was therefore different from the slower-paced conversion of forest into arable land during the Turkic Sultanate and Mughal rules (Eaton 1990). Two thousand square kilometres of land, i.e. 70 per cent of the Sundarbans, was cleared between 1830 and 1873 (Richards and Flint 1990).

Figure 12.3, the 1874 Maps of Jessore District (Thuillier 1874), shows how Culna/Koolna is no longer at the frontier of the Sundarbans, while the many named locations on the map illustrate how vast deforestation has resulted in both cultivation and habitation in the southernmost populated boundary. Gastrell (1868) notes how the swamps from Rennell's *A Bengal Atlas* (1779) are now dotted with villages and converted into 'first-rate rice lands'. The rapid pace of deforestation under the British colonization of Bengal (1765–1947) entailed the establishment of new arable lands and settlements into increasingly low-lying parts of the southern Sundarbans that were subject the salt tides from the Bay of Bengal, necessitating embankments or 'bunds' (*bandhs*), small earthen dykes raised above the land that is adjacent to rivers so as to protect agricultural rice fields from saline tidewater during the dry season (Lahiri 1936: 39). The early and low Sundarbans *bandhs* were purposefully breached by cultivators each year to enable monsoon *borsha* floods, for irrigation and the deposition of silt from the rivers; they were not built to prevent floods. The early colonial administration in Bengal lauded *borsha* floods as a 'blessing of fertility'. Rennell (1764, cited in La Touche 1910: 27) and Gastrell (1856) describe how 'inundations' during the monsoon were a natural part of the landscape and how they deposited nutrient-laden silt from the rivers that were key to the fertile lands of Bengal.

After the monsoon, cultivators repaired the *bandhs* to prevent brackish tidal water from spilling into arable land when freshwater recedes upstream in the dry season, starting in January. Such 'salt protection' *bandhs* enabled colonial civil servants like Henckell and the Morrells to convert the 'salty marshes' of the Sundarbans into arable paddy land (Hunter 1875a, 1875b; Lahiri 1936; Westland 1871). Without annual repairs of the *bandhs*, the salinity could ruin crops and thereby risk the reversion of the deforested lands back into mangroves (Hunter 1875b: 183). The necessity of salt-water-prevention embankments made the British deforestation of Sundarbans mangroves in the Bay of Bengal different from any of the other deforestations in British India (Cederlöf 2008; Guha 1991; Sivaramakrishnan 1999).

Figure 12.3. Map of Jessore District (© The British Library Board. Source: Thuillier 1874, IOR/X/1176)

The British Raj (1850s–1947): Centralizing Administration, Simplifying Nature

The 'raising of *bandhs*' was essential for the deforestation and cultivation of the Sundarbans. During the East India Company rule of India from the 1770s to the 1860s, the responsibility to erect and maintain them belonged to the holder of the grant to 'reclaim' forest into land. Ingles (1911: 46–7) in his review of embankment policy and legislation in Bengal suggests that the laws under the Company 'were so elaborate that they were unworkable – and were thus often uncompensated': the decentralized construction and repair of embankments resulted in little to no state compensation to the cultivator. Indeed, irrigation and its maintenance were predominantly neglected under Company rule (Mosse 2003; Washbrook 1988; Willcocks 1930).

The British Crown gained control of the subcontinent from the Company in 1858. In contrast to the decentralized approach of the Company, the British Raj sought to take more responsibility towards its subjects through centralizing policies and regulation, and created the Indian Civil Service (Mosse 2003: 246). In terms of embankments, the state increasingly took responsibility for them under the justification that this was to protect 'life and property' from damaging floods (Ingles 1911). This shift away from lauding *borsha* inundations as a blessing of fertility for Bengal in the Company period (Gastrell 1856) to seeing floods as damaging to life and property under the British Raj was connected with the replacement of temporary earthen *bandhs* with permanent 'watertight' embankments (Willcocks 1930: 23–24). Centralized management entailed that the colonial state took charge of the costs of annual repairs of *bandhs*, which were breached each year. The Indian civil servant Westland (1871) lamented that 'much money continued to be spent upon the [maintenance of] embankments'. Casting monsoon *borsha* inundation as destructive was a way to justify the colonial administration's endeavours to prevent and/or repair breaches to the embankments. As *bandhs* broke easily and required considerable repair, this period saw the introduction of 'watertight' embankments that prevented 'wholesale breaches' and thus reduced annual repair costs (Willcocks 1930).

However, in contrast to *bandhs*, 'watertight' embankments obstructed flooding during the monsoon, thereby hampering irrigation required for paddy cultivation. Willcocks (1930: 22–23), in his study of the earliest 'watertight' embankments in the north-central and western parts of Bengal since the 1840s, points out that *zamindars* (responsible landowners) and their tenants secretly cut and made breaches (*kanwaz*) to the Damodar embankment northwest of the Sundarbans to facilitate flooding as it would have during earlier periods of earthen embankments: 'It never seems to have struck anybody that the breaches were made secretly by the peasantry for irrigation' (Willcocks 1930: 22–23). The way in which *zamindars* and their tenants resisted the centrally planned 'watertight' embankments highlights how the colonial intervention did not consider the complex hydrological and ecological processes of a deltaic flood plain, with its many meandering rivers and the seasonal variation of tidal inundation filled with salt and silt, or the importance of monsoon floods for rice irrigation.

Instead, 'watertight' embankments were cast as 'better' than local earthen *bandhs* (Willcocks 1930). This new type of embankment, easier to control and requiring fewer repairs, was promoted as a scientific technology that would modernize Bengal. The centralized expansion of 'watertight' embankments' was interlinked with the expansion of colonial railways, which were similarly portrayed as a colonial exemplar of 'progress' and 'modernity' in contrast to the 'traditional' waterways of Bengal. 'Watertight' embankments and railway bridges were built across the many criss-crossing rivers of Bengal, and facilitated the construction of colonial railways and roads atop them, simultaneously enabling considerable capitalist interests to extract resources from its colonized territories. This infrastructure divided the delta into 'innumerable compartments' as a means to control nature and floods (Iqbal 2010: 15). However, this was to have wide-ranging ramifications that we still see today: worsening siltation and drainage congestion upstream, as the fluid routes of waterways were increasingly replaced by roads.

The creation of 'watertight' embankments under a centralized colonial state gives credence to James Scott's (1998: 4) theory of why many well-intended schemes to improve the human condition have failed due to the combination of four factors: state simplification as part of administrative ordering to make both society and nature legible; high-modernist ideology based on the belief of the superiority of Western science and technologies; the collusion of the state with capitalist interests legitimized through high-modernist ideology; and a weak civil society unable to resist these plans. This new type of embankment simplified the dynamics of floods and monsoons. The British Raj promoted 'watertight' embankments as a scientific technology that would modernize Bengal, highlighting how state simplification and high-modernist ideology are entwined. Furthermore, this new infrastructure was tied to considerable capitalist interests working together with the colonial administration to expand profitable roads and railways in Bengal, which were used for colonial extraction. While we can certainly see how embankments correspond with the first three elements of Scott's theory – simplification, modernization and promotion of capitalism through collusion with state-cum-colonial administration – the archival resources provide little information on the extent or form of civil-society resistance in this period.

Many of the archival documents highlight logistics and matters related to revenue and communications. Prior to 1850, there were no railways and few roads in Bengal, and water transport was preferred to land carriage (Bentley 1925). In 1875, riverine traffic was extensive in the coastal areas, with boat routes connecting the entirety of Bengal (Hunter 1875a). Traditional waterways were affordable and accessible to local people; it was the main mode of transport. Boats and river traffic were so well developed that there were a considerable number of people living on boats in the rivers, making it difficult for census enumerators to estimate the size of the boat population (Census of India 1883). Sir Arthur Cotton was a famous British irrigation engineer with five decades of experience of India's irrigation systems, including restoring Mughal irrigation works such as the Godavari Canal System. In 1872, he proposed a scheme for navigable canals that was submitted to a Parliamentary Committee in London. He argued that India 'demanded water carriage', which was considerably more cost-effective than railways, and suggested that the preference for railways comes from 'utter ignorance of India and her needs' (Majumdar and Datta 1970: 863). However, Cotton's scheme was rejected due to the opposition of vested railway interests (Majumdar and Datta 1970: 863), who were involved in considerable financial malpractice in the expansion of colonial railways (Sweeney 2015). This illustrates how capitalist interests in London worked together with the colonial administration to harness 'high-modernist ideology' to expand railways in a way that undermined the strong objections of colonial officials with local knowledge, such as Cotton.

The ideology of railways as bringers of modernity was powerful. It left a postcolonial legacy in which the British Raj is perceived to have 'modernized' India and in which the sites of the railway became nodes for the expansion of 'modern institutions, including law, bureaucracy, police, schools, the military, science, industrial technologies and nationalism' (Ludden 1999: 180). Railways not only connected ports to interior centres along lines of commercial investment and resource extraction, enabling the transportation of export goods (Ludden 1999: 180), but also played an important role in transporting landless wage labourers (former peasants adversely affected by the over-extraction of agricultural surplus by elites) to wherever there was a labour shortage in the colonial economy (van Schendel 1981: 288).

Railways also served a military purpose. In 1853, the British Governor-General Lord Dalhousie argued that building further railways 'would enable the Government to bring the main bulk of its military strength to bear upon any given point, in as many days as it now requires months, and to an extent which is at present physically impossible' (Headrick 1988: 63, cited in Kaijser, van der Vleuten and Högselius 2016: 189). After the Indian Rebellion against British rule in 1857, building railways became a high priority for the Raj. By 1872, Britain had built more than 8,000 km of railroads in India (Headrick 1988: 65). A significant quantity of resources was shifted towards the expansion of the railways to replace waterways as the main mode of transport. Between 1872 and 1881, 525 miles (845 km) of railways were constructed in Bengal and Bihar alone. Railway construction commenced in the deltas of East Bengal in the 1890s, and by 1925 there were 3,000 miles (4,828 km) of railways in Bengal (Bentley 1925: 27–33).

The expansion of railways in India may have supported colonial economies and military power, but it had several negative consequences for the ecology of the Bengal Delta. First, the prioritization of funds towards railways resulted in the neglect of inland navigation, as Cotton had warned. Second, embankments that were secure against breaching stopped the annual monsoon *borsha* floods from depositing their fertile silt on the flood plains:

> and in consequence flood water was shut out from the country, the natural system of deltaic irrigation was interrupted, drainage was impeded and the network channels which used to be formerly fed by the silt water from the great rivers became silted up and in many cases entirely destroyed, rendering boat traffic difficult and in many cases impossible. (Bentley 1925: 20)

Unlike the breakable earthen *bandhs* used during early Sundarbans reclamation, the permanent 'watertight' embankments used for roads and railways resulted in a total disruption of free-flowing water systems (Bentley 1925: 20). Furthermore, as environmental historian Iftekar Iqbal (2010: 131–40) points out, the colonial development of railways in the fluvial landscape of the Bengal delta was ecologically unsustainable and led to disastrous consequences for agrarian Bengal.

By 1921, the delta is described as thoroughly embanked and suffering from siltation. Due to vast amounts of silt in the rivers, many water bodies were rapidly filling up, with some turning completely dry during the summer (Census of India 1923). The once great Kabadak River no longer received fresh water from the Ganges, as its tributary had silted up. In embanked areas, the silt-laden river water, once able to inundate, and deposit on, the vast floodplains, was now confined to the rivers. This had the result that the silt was instead depositing on the riverbeds and in the canals (Census of India 1923). A decade later, the Presidency

Division, which encompassed what is today the southwest coastal zone of Bangladesh, was described as a region of dead or dying rivers (Census of India 1933: 10). As the water bodies were filling up with silt, they could no longer retain the same amount of monsoon rain. Instead, the rainwater would become trapped inside the embanked floodplains, unable to flow out to the rivers due to the elevation difference between land and the raised, silted riverbeds outside. This came to be known as *jalabaddho* floods (waterlogging). By the 1920s, embankments contributed to longer lasting *jalabaddho* floods that spoiled *aman* paddy and disrupted natural fisheries (Bentley 1925: 33).

The accounts of the state of the delta as described in the Census of India reports (1923, 1933) mention 'floods' as increasingly damaging to 'life and property'. While early colonial accounts such as those of Rennell and Gastrell in the eighteenth and nineteenth centuries mention monsoon 'inundations', these later reports do not distinguish between beneficial *borsha* floods and damaging *jalabaddho* floods caused by the disruption of drainage in the delta. The shift from perceiving the annual inundation of silt as a blessing to flooding as a damaging event is interlinked with the colonial government's objective of centralizing its control over rivers and embankments so as to expand railways, while reducing annual maintenance costs.

Despite dissenting voices warning of the negative ecological effects of compartmentalizing a hydrologically active delta, the construction and expansion of 'watertight' embankments continued and may serve as an example of how an 'armchair' imperial science tended to prefer to maintain its ignorance of local knowledge and needs (Mosse 2003: 246). The centralized colonial administration imposed such infrastructure despite its inappropriateness for a delta best suited for waterways. These colonial 'watertight' embankments were predecessors to current technological interventions, which repeat past mistakes and exacerbate environmental damage.

The 1960s Coastal Embankment Project and 'Development'

The Sundarbans region south of Khulna did not form part of any railway route that was essential for the colonial state. Despite several legislative attempts to include the region's embankments within centralized management since the 1880s (Government of Bengal 1914), they were mostly left alone during the British Raj (Ingles 1911: 46–47). Indeed, contemporary accounts suggest that government embankments did not exist in the Sundarbans until the Coastal Embankment Project (CEP) of the 1960s (Brammer 2004; Elahi and Rogge 1991; Zaman 1993). Due to neglect by the state, the responsibility of annual repairs continued to fall on various constellations of *zamindars*, tenure holders, subtenure holders and tenant farmers (Das Gupta 1935; Ingles 1911; Lahiri 1936).

Sadhu Kaka, an 85-year-old farmer, describes the *aushtomashi bandhs* (eight-month embankments) of his childhood as small temporary earthen dykes made with the excavated soil on the side of the floodplain. After the harvest of *aman* rice in mid-January (*magh* in the Bengali calendar), the *zamindar* coordinated the villagers (four to five people from each household working together) in the construction of these *bandhs* on the sides of the river to protect against saline incursion from the Bay of Bengal during the dry season. In mid-August, they breached the *bandhs* along the various canals connected to the river so as to facilitate monsoon *borsha* floods of rain mixed with sediment-laden river water to irrigate paddy fields. This system prevented saltwater intrusion in the dry season, while allowing for the fertile silt inundation in the monsoon season. Sadhu Kaka and many of my interlocutors depicted this as a dynamic system adapted to the active flows of the delta. The continuation of *aushtomashi bandhs* in this area highlights how local ways of organization continued in some places, despite attempts at colonial centralization.

However, the partition of 1947 separated Bengal and the Sundarbans into India and East Pakistan. Many Hindu landlords in Khulna migrated to West Bengal, and the *zamindari* system was formally dismantled through the 1948 East Bengal State Acquisition and Tenancy Act (Lewis 2011: 60–61). In addition, the colonial irrigation office and its revenue funds all but disintegrated. The combined gap left behind by *zamindars* and colonial irrigation officers coincided, or resulted in, the neglect of *bandhs* that by the 1950s were in a severe state of disrepair (Huq 1957). Huq lamented how this vacuum resulted in extensively broken embankments causing saltwater intrusion during the dry season and reduced crop yields. He suggested that the Irrigation Department should take responsibility for the embankments to prevent salinity intrusion and to ensure the agricultural productivity of the land. The publication of Huq's report overlapped with the floods of 1954, 1955 and 1956 that led a US-funded United Nations study (by the name of the Krug Mission) to recommend government intervention in flood protection. This resulted in the creation of a state engineering agency to overtake water management responsibilities in Bangladesh (United Nations 1957). The Krug Mission advised that large-scale embankments based on Dutch dykes be constructed to 'control damaging floods'. In 1961, USAID (Chadwick and Datta 2003) and the World Bank (Islam 2006) funded the CEP, which commissioned the newly created irrigation agency – now known as the Bangladesh Water Development Board (BWDB) – to construct 4,000 km of embankments, that resulted in 136 enclosed polders, across the entire coastal belt of Bangladesh (FAO 1985). Through this international development project, 1,566 km of permanent embankments and 282 sluice gates to regulate the flow of river water were constructed in the southwest region alone.

Hanlon et al. (2016) highlight how the Krug Mission was promoted by US interests and they suggest that technical assistance to (East) Pakistan was politically motivated because of its importance to the United States in the Cold War.[2] These geopolitical motivations were entwined with an ideology of 'development', the latest form of ideas of 'progress' and 'modernity' imposed on Bangladesh since the colonial era to justify interventions in environment and society. As Gupta (1998) suggests, many formerly colonized states sought to 'catch up' with the 'developed' world after the Second World War. The Bretton Woods Institutions, such as the World Bank and the International Monetary Fund, were officially created to facilitate the 'development' of 'underdeveloped' postcolonial societies, an ideology that helped secure strategic alliances through 'technical assistance'. As part of this paradigm, Western donors cast 'modern' technology and engineering works, agricultural productivity, urbanization and industrialization as essential components in the road towards 'development'. The 1960s CEP was thus part of a global process of promoting state-led 'development' through large-scale infrastructure projects in newly independent Third World countries. The ideology of essentially Eurocentric 'development' entailed 'technical assistance' for capital-intensive projects that employed mainly foreign engineering consultants unfamiliar with Bangladesh. Dutch-style 'polders', embankments, were a technical solution detached from local ecology and the active hydrology of a dynamic delta.

As with the 'watertight' railway embankments of the British Raj, the CEP embankments extended the obstruction of floods to the coastal region. Annually, over a billion tonnes of sediment, carried from the Himalayas in the river water, was unable to be deposited across the delta by the monsoon *borsha* inundation. The embankments thus confined the sediment to the rivers, silting up water bodies, raising riverbed levels and reducing water-retention capacity in the coastal rivers and canals. Furthermore, the CEP embankments were built in such a way that they only had a few sluices connecting canals to the rivers, resulting in many of the canals being cut off from their water sources and disappearing (Hossain et al. 1987; Iqbal 2010). Sadhu Kaka recollects the changes since the construction of the CEP embankments:

> This area was once filled with rivers and canals. If we wanted to go anywhere, we went by *nouka* [a small, wooden rowing boat]. It took only an hour get to Chalna and everyone had their own *nouka*. Due to these government roads/embankments, our canals have silted up and there is no longer any water transport between the villages and towns. This was better than road transport – they are useless during the monsoon as we are stuck to our knees in mud. (During fieldwork in 2014–15)

By the 1970s, the rivers were increasingly silted and less navigable. Forty-five miles of the Gorai – a main freshwater tributary of the Ganges – silted up to the extent that they were unfit for navigation, while many reaches of the distributary rivers were no longer navigable by waterways (Government of Bangladesh 1976: 3–4).[3] The once great Bhadra River, where steam boats could once pass, is now a mere silted canal referred to as the 'Mora Bhadra' (dead Bhadra) (Dewan et al. 2015).

Not only did the obstructed floods cause siltation of water bodies, but by depositing on the riverbeds outside the embanked floodplain, they raised the water level outside the polder to higher than that inside, trapping water inside the embankments and leading to impeded drainage and waterlogging (FAO 1985; Iqbal 2010: 133). The problems of the northern tracts of previously embanked Bengal in the 1880s onwards had finally reached the coastal Sundarbans (see Figure 12.1). The CEP embankments extended the problem of *jalabaddho* floods to the south-west coastal region, as water was unable to drain out from inside the embanked floodplain out to the river. It was perhaps unsurprising that local people in some places continued the practice described by Willcocks (1930) of intentionally breaching parts of the embankments through what Sklar and Dulu (1994) refer to as 'public cuts', which are used to drain the fields of stagnant water. Nevertheless, by the 1980s and 1990s, *jalabaddho* caused more than 100,000 hectares to be permanently flooded,[4] and became much more dangerous than monsoon *borsha* floods (Iqbal 2010) in their inhibition of cultivation, damage of crops and prevention of crop rotation (Adnan 1994).

The problems of *jalabaddho* floods in the 1980s were further exacerbated by low-frequency damaging *bonna* floods caused by tidal surges and cyclones. These brought international attention and significant funds for flood protection in Bangladesh (Adnan 1994), in a similar way to the 1950s floods in East Pakistan (Hanlon et al. 2016). While the technical assistance of the Krug Mission had helped gain the support of the Pakistan government of General Ayub Khan, the technical assistance of the Flood Action Plan (FAP) now helped donors gain the support of the autocratic regime of General Ershad in Bangladesh. The FAP consisted of several donor-funded studies on how Bangladesh could best manage floods.

Figure 12.4. The silted Bhadra 'river' outside Polder 31 (photograph taken by Camelia Dewan, December 2014)

Figure 12.5. Embankment with agricultural land to the left, and river to the right (photograph taken by Camelia Dewan, December 2014)

Note:

Figure 12.4 shows how the Bhadra 'river' has silted up to no more than a canal, while Figure 12.5 shows how the land inside the CEP embankment built in the 1960s–1970s is lower than the bank outside the embankment, which has been raised through annual silt deposits. This difference in elevation results in poor drainage during the monsoon period, when the rainwater inside the embankment is unable to drain out into the river, causing *jalabaddho* (waterlogging).

Like climate change today, 'flood protection' was at the receiving end of a significant portion of Bangladesh's development funding in the 1990s. Shaw (1992) argues that large-scale and high-tech 'flood-protection' projects, supported by donors like the World Bank and the relevant state agencies, favour capital-intensive and technical solutions. She suggests that the Ershad regime was enthusiastic over the prospect of expanding large-scale flood control and irrigation embankments as it provided a 'lucrative' opportunity. However, as I have described, the existing CEP embankments had proven ineffective in controlling floods, while worsening sedimentation and *jalabaddho*. This motivated Bangladeshi civil society to come together to protest against the FAP and express doubts that any similar investments would prove more effective (Adnan 1994; Boyce 1990; Clayton 1994; Elahi and Rogge 1991; Hofer and Messerli 2006; Hossain et al. 1987, 1992; Hughes et al. 1994; Rahman 1992; Shaw 1992; Sklar and Dulu 1994; Zaman 1993). Strong civil-society protests ensured that the FAP was not implemented. Shaw's (1992) paper on floods in Bangladesh in the 1990s reappeared in an identical version in the *Anthropology of Climate Change: An Historical Reader* (Shaw 2014). She criticized donors for harnessing 'flood protection' as a means of promoting capital-intensive development interventions. Her paper was written decades before climate change became a development priority and it is rather ironic the way this paper reflecting on 'flood protection' as a development buzzword has been repackaged as relevant to climate change.

Such repackaging is arguably what the World Bank is currently engaged in. It was one of the main actors behind the 1960s CEP, the 1990s FAP and now a 'climate-change adaptation' project entitled the Coastal Embankment Improvement Project (CEIP). The aim of this last project is to make existing embankments higher and wider, with the motivation that this will protect against the rising sea levels and increased frequency of cyclones as a result of climate change. The existing embankments are cast as ill-equipped to help Bangladesh adapt against climatic change and therefore as necessitating new infrastructure (World Bank 2012). By promoting capital-intensive technical solutions that mimic those of the problematic 1990s FAP, the project does not engage with over a century of experience on the problem caused by permanent 'watertight' embankments and the way in which they obstruct beneficial monsoon *borsha* floods.[5]

The resulting increase of siltation in the delta due to permanent embankments has reduced water-retention capacity in the water bodies, while raising the riverbeds outside the embanked floodplains. In fact, a recent study found that the areas in southwest Bangladesh enclosed by the CEP embankments in the 1960s have lost 1.0–1.5 m of elevation, compared to the neighbouring unembanked Sundarbans mangrove (Auerbach et al. 2015). Researchers attribute this elevation loss to the interruption of sedimentation inside the embankments, combined with accelerated compaction, removal of forest biomass and a regionally increased tidal range. They conclude that riverbed sedimentation in Bangladesh caused by direct human modification of the environment through the construction of 'flood-protection embankments' poses a greater threat of coastal flooding than does the predicted sea-level rise in the future (Auerbach et al. 2015). A narrative that promotes the expansion of flood-protection embankments as a form of climate-change adaptation can therefore arguably be seen as 'climate reductionist' (Hulme 2011), as its formal project rationale casts floods as caused solely by climate change, without reference to the environmental processes that are exacerbating coastal vulnerabilities, including siltation, waterlogging and riverbed rise.

The CEP, the FAP and now the CEIP highlight the ways in which donors such as the World Bank engage in similar 'simplifications' to those of the colonial state of the British Raj: both maintain ignorance of complex socioecological contexts and the ways in which embankments exacerbate siltation. The CEP, the FAP and the CEIP are internationally funded and capital-intensive projects using 'modern' technologies and highly paid Western experts. Scott (1998) argues that state officials collude with capitalist interests to bring high-modernist ideas into being. From railways to the CEIP, these large-scale, capital-intensive infrastructure projects provide lucrative opportunities (Shaw 1992) and bring various coalitions of capitalist interests and state officials together to implement these designs.

Although Scott's (1998) ideas of 'state simplification', 'high-modernist ideology', state collusion and a weak civil society may fit the examples in this chapter, there are limits to his theory. Cotton's critique of railway expansion in India and Bengal[6] highlights how there are often competing knowledges in the field of 'development', where some narratives are better at harnessing support than others, while furthering economic, (geo)political or administrative agendas. Narratives of improvement, whether through railways, flood protection or climate-change adaptation, have the potential to enable simplification in ways that increase the financial interests of particular actors, both within state administrations and within international organizations. Development schemes not only fail due to 'the state' and 'capitalist interests' colluding to use high-modernist ideologies to promote their interventions; rather, the 'state' as well as the World Bank are composed of actors with diverging agendas and beliefs who ally themselves with capitalist actors with specific interests.

Thus, the prevailing dominant narrative represents the outcome of internal organizational struggles regarding what is accepted as knowledge or science.[7] This is particularly relevant today because of the way in which 'state' simplification can be combined with climate reductionism to put forward particular interventions that might be at odds with local experience and knowledge. Although using climate change as an explanation for change allows for connections between ideas and events to justify project funding, it creates expectations of causality that do not match with current physical realities, as this chapter has demonstrated.

Conclusion: How Simplification Exacerbates Climatic Vulnerability

This chapter has problematized current narratives of Bangladesh as a 'climate-change victim' by pointing out that embankments were built long before climatic change was identified as a development problem for Bangladesh. The deforestation in the Sundarbans was different from that elsewhere in British India, as the lands cleared to be used for rice cultivation required temporary earthen embankments. These were constructed in the dry season to stop saline tidewater from the Bay of Bengal from ruining crops. Cultivators then breached these embankments each monsoon to facilitate *borsha* floods that inundated the land with silt-laden river water mixed with rain. The silt fertilized the soil and naturally raised land levels, while the flood irrigated the rice fields and provided a breeding ground for fish.

However, the annual cost of repairing these breaches before the start of each dry season was high. The British Raj's push for a centralized administration and reduction in annual maintenance costs saw a shift towards 'watertight' embankments that stopped the *borsha* floods. Over time, such embankments paved the way for roads and railways to replace the water carriage that was once so characteristic of the Bengal Delta. These 'watertight' embankments based on 'imperial science' prevented floods and thereby confined the silt to the rivers and raised riverbed levels, so that the rainwater during the monsoon could no longer drain out the river, causing damaging *jalabaddho* floods (waterlogging). Over the years, such silt filled many rivers and canals, and caused them to disappear.

The East India Company's view of silt and monsoon floods as a blessing of fertility was superseded by *jalabaddho* floods being seen as a curse by the British Raj. However, despite continuous dissent at the expansion of embankments and their negative ecological consequences for Bengal –

from Sir Arthur Cotton to Bentley, Willcocks, Lahiri and White, amongst others – colonial embankments progressed from being protection against floods to their current status of protection against climate change.

Capital-intensive embankment infrastructure helped simplify administration with little formal acknowledgement of the complexities of local history and ecology; from colonial railway embankments to the World Bank-funded CEP post-independence and the FAP amidst Structural Adjustment Policies. This is currently also the problem with projects funding climate-change adaptation in Bangladesh. The recent World Bank-funded CEIP seeks to build higher and wider embankments to protect Bangladesh against future rises in sea levels due to global warming, but it does not explicitly engage with the historical experience of how 'flood protection' exacerbates siltation, waterlogging and rising riverbeds (see World Bank 2012). A project narrative built around the idea that only climate change causes floods – while not acknowledging the ecological complexities of different types of flood and how embankments exacerbate them – is arguably an example of 'climate reductionism' (Hulme 2011). This illustrates how climate change as an idea rearranges events to create expectations of causality that legitimize particular development interventions (Mosse 2005). Thus, climate reductionism can be harnessed in ways that enable narratives suited to particular economic, political or administrative goals – in this case, building more embankments.

Bangladesh is at risk of climatic changes in terms of variable precipitation and temperature patterns, increased frequency and intensity of natural disasters, and long-term rising sea levels. Therefore, I do not set out to deny the existence of climatic change, but rather to challenge the popular conception of its impacts and its subsequent interpretations in specific projects promoted by the development aid industry. By creating mismatched causal explanations, these interventions may ultimately increase Bangladesh's future climatic vulnerability by exacerbating flood risks through higher and silted riverbeds, and by removing funding from other development activities. As Hossain et al. (1987: xii–xiii) pointed out almost thirty years ago, 'there is a fixed sum of money available for aid, and an emphasis on flood protection would automatically mean giving less priority to other types of activities'. Similarly, too great a focus on climate change means less attention to other problems prioritized by coastal populations, such as that of siltation and dying rivers. Historically grounded anthropology thus has an important role to play in deconstructing the knowledge produced about climate change.

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Notes

1. All non-English words in italics are in Bangla unless otherwise specified.
2. Pakistan was the main bulwark of land separating socialist India from its neighbouring communist states of the Soviet Union and China (Cohen 2004: 34, 302).
3. In the report, the main cause for this siltation was attributed to India's unilateral construction of the Farakka barrage and the consequential reduced inflow of freshwater into Bangladesh, and a billion tonnes of sediment unable to flood the plains. The historical evidence of sedimentation and embankments suggest that this transboundary issue is one of several causes of sedimentation.
4. In Jessore District, the largest problem is permanent *jalabaddho*. Experiments using local solutions to break the embankment in certain places have been used to remove

inundations and are currently referred to in development projects as 'Tidal River Management'.

5. The CEIP does not explicitly address the connection between 'flood protection' and the silting-up of important water bodies in its formal project documentation and technical reports (World Bank 2012).
6. See Majumdar and Datta (1970: 863).
7. Scott further suggests that interventions fail when there is a weak civil society. It is unclear what role civil society played during the colonial period, when voices like those of Sir Arthur Cotton were silenced. During the CEP, East Pakistan was ruled by West Pakistani and its people frequently protested top-down West Pakistani policies, culminating in the 1952 Bengali Language Movement and the 1971 Independence War. Despite the fact that the Ershad regime was a military autocracy, Bangladeshi civil society mobilized and strongly protested the FAP in the early 1990s to the extent that it was never implemented, showing the important role civil society played in protesting against top-down plans with significant environmental consequences.

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Afterword

David Shankland

Going right back to the very roots of the discipline in Britain, anthropologists have felt that their localized knowledge can and should contribute to better policy. The Ethnological Society of London (the precursor to the Royal Anthropological Institute (RAI)) was an offshoot from the Aboriginal Protection Society, which was seminal in its condemnation of colonial iniquities. A century later, at the founding conference of what became the International Union of Anthropological and Ethnological Sciences, it was precisely as field experts that anthropologists felt that they could be of use, claiming that they could leaven the imposition of central rule and encourage local variation in the administration of colonies (see, for example, the opening remarks by Raglan (*Congrès* 1934); see also Mills 2008; Urry 1993: Chapter 5). Nevertheless, the tension that this commitment to policy gives rise to when placed alongside anthropology considered as a knowledge-acquiring discipline, illustrated, for instance, by the difficulties encountered by Northcote Thomas (Basu 2016), has never really been resolved. The ongoing debate has become accentuated, nuanced, splintered and generalized, but remain it does.

This splendid volume of chapters, and the meeting that inspired them, enables us to revisit this defining issue within anthropology, but in a slightly different and to my mind liberating way. The parameters might be familiar, but the subject at issue is urgent and, above all, nonpolitical. Let me clarify this immediately. What I mean by this is that the fact of global warming is established. Its interpretation, attributing the causes or blame, and understanding its consequences and seeking its remedies may be steeped and infused inescapably with politics, but the core of the issue at hand – that the world is heating up – is not open to serious debate. This does not mean that there will not be climate-change deniers – there will be and there are – just as much as there are flat-earthers and those who claim that the moon landings never took place, and it is precisely one of anthropology's greatest strengths that it is so skilled at studying unusual cosmologies. However, those who deny that fact of its taking place can be treated as just that: as inhabiting counterfactual dialogues that we can puzzle through and try to empathize with, but need not regard as true.

Accepting, then, the reality and the urgency of the situation, how are we to go about our task of attempting to make a positive contribution? The introduction by Sillitoe lays out the options for practising anthropologists admirably. They are many, but amongst them we can and should revisit our current or early field researches and ask ourselves whether we have been remiss in the way that we have conducted those inquiries; we can be sensitive to the way that we may observe climate change occurring in real time, we can devote ourselves to facilitating wider knowledge of these changes and we can consider how we as a discipline can contribute towards their solution, however challenging this may be.

Each of these raises different issues. When social anthropology emerged as a distinct subject within anthropology more broadly, it did so, as has often been remarked, as a package (Jarvie 1964; for an overview, see Shankland 2012, 2019). It was never static and never as coherent as has sometimes been supposed. Nevertheless, one consequence was that it became unusual that social anthropological fieldwork would look at unfolding chronological sequences within a particular community. This was left to archaeology, whose practitioners developed increasingly sophisticated techniques, not only through the adoption of stratigraphic excavation, but also through typographic analysis, ethnobotany, dendrochronology, coring or carbon dating. Social anthropology therefore cut itself off, at a stroke, from the extraordinarily rich debates surrounding deep time that had characterized so much of the way in which anthropology had taken shape in the nineteenth century, debates that have recently been illuminatingly revisited by Clive Gamble (2021).

Equally, social anthropology came to define itself as being anti-evolutionary. It is not, of course, the case that evolution stopped being studied, but rather that just as the social anthropologists had left the unfolding of time to the archaeologists, they now left evolution to the biological anthropologists. Thus, social anthropologists cut themselves off from an immensely complex and still-burgeoning field for a second time, this time one that includes not only the unfolding relationship between climate, ecology and social change, but also the study and development of models of human behaviour.

There was a further, this time methodological consequence. Just at the point that social anthropologists began to define themselves, they began working almost entirely alone, often with very little funding. This gave them the immense advantage of flexibility and the possibility of staying with a community over time without causing them too much inconvenience. But this also had the downside that it became much more difficult to collect data in a systematic way. Social anthropologists were pretty busy accumulating a multitude of different information, often learning a new language as well as negotiating new relationships. Often, they had no motor vehicle. Typically disinclined, by now, in any case to collect quantitative scientific data with the meticulous, daily tabulation that this requires, they instead embraced the serendipity of everyday life in the field.

Archaeologists, on the other hand, maintained a strong ethos of data collection, but worked in teams. They benefit to this day from the flexibility that has given them: when a new area of archaeometric investigation opens up, they simply make contact with the specialist in that area and invite them to join their team. They may have to alter their protocols in order to absorb the new material, find somewhere for the new arrivals to stay in the dig-house and offer them a bite to eat, but in essence the new specialization is slotted in and the existing tasks continue, being adjusted as necessary to take into account the new data that it brings.

Social anthropology then, was almost by definition theoretically, practically and methodologically uniquely ill-equipped to study long-term climate change. This, however, need not have impeded its practitioners from the contemporary study of the understanding of the weather amongst the communities where they were staying, as Sillitoe remarks in the Introduction to this volume. His postulation that this is greatly due to the dismissal of a causal relationship between weather and culture is surely correct. Indeed, the Durkheimian principle, that the social must be explained by the social was extremely strong throughout much of the twentieth century. This meant that social anthropologists, by and large, looked at the relationship between the different aspects of social life; the way in which the kinship structure is related to ritual, ritual to religion, history to hierarchy, myth to ritual and so on. Cosmology, from this point of view, becomes a reflection of the social structure of a community, and ideas about the weather are therefore relevant only insofar as these can help in understanding the cosmology and, in turn, social relations.

I myself am guilty of precisely the lack of understanding that Sillitoe outlines. I have long regretted that I did not conduct an architectural survey of the indigenous buildings of the village where I conducted my fieldwork in the 1980s, a semi-transhumant community on the reverse slopes of the Pontus Mountains of the Black Sea coast. Only in the following decade after working with archaeologists in Konya did I realize that such a survey would have helped immensely, not least because the building materials and the trees used to construct the village houses changed quickly over time, as did the size of the timber available to them. Likewise, thereafter much sooner than I expected, subsistence agriculture ceased, the vast proportion of these houses were demolished by the villagers themselves, the timber logs were burnt or discarded, the wattle and daub with which they were covered was chucked away, and was replaced by brick and concrete. A great deal of information about the climate, and climate change went with them. Equally, I did not engage closely enough with the subsistence agricultural practices, then still pursued by most of the households in the village. From this, it would have been a straightforward step to an appreciation of the local understanding of the weather and the already changing ecoclimate in which they were farming.

Nevertheless, if we have been constrained by the intellectual paths that the discipline has taken, we do not need to feel ourselves so bounded today, in our much more intellectually pluralistic academic lives. On the contrary, a better understanding of these historical trajectories will help enormously in working out how we can change for the better. Nor is it the case that the way in which the discipline has taken shape need always impede our potential contribution to climate change discussions. A very big advantage of creating a similar social anthropology disciplinary practice, one that could operate globally, was that it became possible for social anthropologists to come together to discuss common aspects, things that they were experiencing simultaneously across their different fieldwork sites. The 1993 Association of Social Anthropologists (ASA) Oxford Decennial Conference is exactly one such instance, in that it drew attention in a pioneering way to the comparative cultural complexities of globalization (see, for example, Miller 1995). Likewise, today, we are in a unique position to share and synthesize information relating to the understanding of climate across cultures, as Rosengren proposes in his fascinating chapter on the peoples of the Peruvian Amazon.

It is precisely to seek this common ground and encourage disciplinary good practice on the study of climate change that we at the RAI decided to host a discussion on this issue. What, however, is striking about this from the methodological point of view is the extent to which creating this collective endeavour forces social anthropology to draw back from its founding tenets. We see here, for example, that in order to discuss climate change, we must become historical ethnographers – as analysis by Dewan of colonial interventions on the Bengal coast or again in the description of the Palestinian farmers of the West Bank by van Aken shows. It is surely from here only a short step to rejoin archaeology, with its emphasis on the way in which the material culture of the past helps us to understand the historical social ecology of a community.

It also forces a reconsideration of relativism, as several of the authors in this volume hint at. We cannot claim that different cosmologies are equally valid if we are dismissing those that are sceptical of climate change. Equally, we cannot understand, as Martin and Cometti note in their chapter, the way in which indigenous cosmologies are pushed to adapt by environmental change unless they have some explicit reference to a shared external world, the shared, causal constant being that it is warming.

This may not be as grave a problem as it first appears: it is often forgotten that the anthropology of morals and ethics, which at present is a growing subfield within social anthropology, was started by Westermarck in his great work *The Origin and the Development of the Moral Ideas* (1906–8). One of the reasons for this neglect appears to be that he, though a relativist, was what might be called a rational relativist. In other words, he believed that there is a plurality of ethical systems in the world that are contextualized within their respective cultural mores, and indeed derive from them, depending on the positive or negative connotations that social actions within them give rise to (Shankland 2018). For Westermarck, therefore, it was a fact that there are different ethical systems, and he regarded any search for universal ethical truth to be entirely invalid. Nevertheless, he based this relativistic assumption on the purely pragmatic, empirical grounds that it is possible to observe, and research that plurality if we seek it.

I believe that a solution along Westermarckian lines would work perfectly well for a comparative anthropology of climate change: it is fact that there are many different ways of understanding the weather and the way in which climate changes. However, this does not mean that reality itself is refracted and splintered, nor does it mean that there is an ineffable barrier to communication between different societies. The appeal for a more localized understanding, above all in appreciating the adaptations that are already being forced upon different communities, can be presented in this way, without assuming any greater epistemological complexity than is needed to communicate the tragic universality of climate-change induced-destruction.

Likewise, to work on climate change and to remain a single researcher, a lone fieldworker would appear to be exceptionally difficult. Climatic research needs statistics of some kind, whether in terms of the environmental changes that a community is experiencing or their perception of it, as Sillitoe and Alam illustrate in their chapter. Not only will social anthropologists potentially need to work together with other researchers even at the point of the ethnographic material being generated, but in order to be able to communicate the predicament that so many indigenous peoples of the world find themselves in, we will have to prepare ourselves again to work in teams, this time with the immensely complicated local, national and international bureaucracy through which climate change discussions are conducted, as the chapters here by Bailão, Sherpa, and Carabajal and Hidalgo illustrate.

However, there is a further and crucial barrier that needs to be overcome. We are potentially very good indeed at conveying comparative, sensitive ethnography on the predicament that climate change brings, whether in Patagonia (Marin), Indonesia (Winarto) or Austria (Nöbauer), and we are beginning to learn how to ensure that local voices become heard at the international level, as Walker-Crawford's example of an Andean claim on a German energy company illustrates.

Where we have conspicuously less successful is offering solutions that will potentially work at the global level. In order to do this, I feel that social and biological anthropology will need to be able to unite, not simply because of the models of ecological change that evolutionary biologists already are developing, working alongside archaeologists of the faunal and floral record to do so, but because any solution that is adopted must work, and it must be applicable across very swathes areas of humanity. To explain, convey and communicate localized problems is an absolutely essential part of the work that we should be doing, but we must also engage with the wider models of human behaviour that are inherent within the climate change solutions already being (perhaps unavailingly) adopted. Steve Rayner, whose untimely death prevents him from helping to develop the capacity that is surely so needed in this area, catches this issue precisely in the paper that he wrote with Prins, *The Wrong Trousers: Radically Rethinking Climate Policy* (2007), in which he concludes that the macrosolutions being offered are simply not working.

To conclude then. First, we will need to work within a unified anthropological framework. Ethnographic data about the areas of the world that we work in are just that: it doesn't matter who this is produced by, provided that the data help us understand the problem better and we work out ways to share it in a transparent fashion. At some point, it is likely to overlap with the work of archaeology and biological anthropologists on models of long-term ecological change, and that it does so should be embraced.

Second, we will need to learn to engage with policy-makers. To claim exceptionalism is self-defeating. It is only by learning how to share that we can communicate, persuade and convince others that our ideas are worth listening to. We cannot help the communities with whom we have worked unless we can show why, and how, climate change is affecting them. Above all, we cannot claim simultaneously that knowledge is unique to social anthropology and that the poorer people of the world are suffering most, for the second assertion is clearly intended as a universal truth claim and contradicts the first. Knowledge, then, will have to be accepted as being universal.

Third, we will have to learn how to think macro. It is certainly within our compass to do so. However, such creative solutions will require us to include future modelling alongside our empirical observations. The task, then, is a formidable one, but it is one that we should all contribute to as much as we can. We have to hope fervently that something can be done to avert this crisis. We need to have an answer when our grandchildren or their children ask us what anthropology did to help tackle the problem of climate change. It is in the writing and the study of works such as this that we will begin to obtain one.

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