STORYING MULTIPOLAR CLIMES OF THE HIMALAYA, ANDES AND ARCTIC

Anthropocenic Climate and Shapeshifting Watery Lifeworlds

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Introduction

Climate change is recognized as one of the key challenges of our time. From the international perspective, which is to say within the United Nations Framework Convention on Climate Change (UNFCCC), the understanding of climate change and its implications is represented in the many reports from the Intergovernmental Panel on Climate Change (IPCC). The IPCC is divided into three working groups representing physical science, impacts and adaptation, and mitigation. Despite the broad scope of the problem, there has long been criticism of the fact that the experts are mainly drawn from only a subset of the social sciences (with a heavy focus on economics), and hardly at all from the humanities (Bjurström and Polk 2011; Corbera et al. 2016). It is then perhaps no surprise that the international community's collective response to the climate crisis reflects this technocratic perspective (Hulme 2009). The UNFCCC Paris Agreement of 2015 is widely seen as a crucial turning point in that response, but the novelist-scholar Amitav Ghosh's interpretation is otherwise (Ghosh 2016, 156): "…the [Paris] Agreement's rhetoric serves to clarify much that it leaves unsaid: namely, that its intention, and the essence of what it has achieved, is to create yet another neo-liberal frontier where corporations, entrepreneurs, and public officials will be able to join forces in enriching each other." Ghosh is suggesting not only that climate change is a consequence of colonialism (both past and ongoing; see also Ghosh 2021), but that the international response to climate change may further entrench it.

Clime as a dictionary term is sometimes seen as synonymous with climate but has a more affective implication. Within the environmental humanities and anthropology, the word has been adopted as referring to the cultural experience of climate, as discussed by Hulme (2009) and by Bristow and Ford (2016).

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This might seem like a world apart from the technocratic nature of climate science represented by the IPCC. However, there is an older historical tradition in climate science which is more readily aligned with the concept of clime, and a recent development of storyline approaches to climate science. Together these offer a meeting point. Despite differences of perception, there is a shared physical reality out there, which all forms of being are experiencing, albeit in different ways. Only by finding ways to bridge between these different ways of knowing (Bristow and Ford 2016) and between climate change and daily lives (Dilling and Moser 2007) will it be possible to take up the challenge raised by Ghosh of resisting and indeed fighting back against a technocratic approach to climate-change "solutions" (Hulme 2009). The call for interdisciplinarity in this endeavor is hardly new; recent references are Coen (2021) and Schipper, Dubash, and Mulugetta (2021). The purpose of this particular piece—co-authored by a climate scientist and an anthropologist—is to contribute to this wider enterprise by drawing on the various scholarly traditions and concepts in climate science and in anthropology within the context of storylining climes. The piece is thus "multipolar" from an epistemic perspective.

Why consider high altitudes and high latitudes together? From the perspective of climate science, there are interesting parallels between the two kinds of regions. This follows from the simple fact that atmospheric temperature decreases both with increasing altitude and with increasing latitude. Although these temperature decreases occur for different reasons, they have similar consequences, because lower temperatures imply drier and more stable air, and the possibility of creating and maintaining frozen forms of water. These features in turn make the regions particularly sensitive to climate change. Basic physics implies that, all else being equal, the warming from increased greenhouse gases is greatest in the coldest parts of the climate system. (The Antarctic is an exception because the Antarctic ice sheets are so massive that they keep the continent cool.) Moreover, the melting or thawing of frozen forms of water which occurs with warming can change the very landscape of a region. As part of these landscapes of vastness and intricate interconnectedness, diverse human communities have demonstrated, through daily practice and oral tradition, the finest of their wisdom in adapting to their challenging environments and their changes over time. In this piece, we, therefore, choose case studies from both the Himalaya and the Arctic to illustrate the connections between altitudinal and latitudinal highlands and the complexity and challenges that local communities in Nepal and Alaska are facing while navigating unprecedented and accelerated changes. The piece is thus also "multipolar" from a geographical perspective.

We (a word we use exclusively to describe ourselves, as authors) start by reviewing relevant recent developments in both climate science and anthropology, to lay the table for our subsequent discussion. We then discuss our two case studies, which represent stories of loss, intertwining the climate-science and anthropology aspects. We do not pretend to be shedding any light on those two stories; our knowledge is entirely second-hand, obtained through published accounts.

Their purpose within our piece is to demonstrate how naturally the different perspectives of climate science and anthropology can be weaved together in particular contexts. Our final section provides a synthesis, where we identify several conceptual threads which, in our view, provide promising opportunities for creative dialogue between the social sciences, humanities, and natural sciences, within the context of climate change.

Storylining in Climate Science

As with many of the natural sciences, climate science has two distinct historical traditions. One tradition may be said to be descriptive, and is generally called "climatology." In disciplinary terms, climatology falls within physical geography but is also often linked with agricultural sciences because of the importance of climate for agriculture. This tradition is anchored in observational data and there is a strong focus on statistics and spatial mapping. The second tradition may be said to be explanatory. In this case, the focus is on general (or abstract) principles anchored in the laws of physics, and the mathematics involved is that of analysis rather than statistics. The latter distinction is significant because analysis and statistics have been largely separate mathematical disciplines, often housed in completely separate academic departments. While the word "explanatory" suggests a role for observations (as the thing to be explained), it is understood that for a natural (rather than an experimentally controlled) system, theoretical predictions will only be loose approximations of reality. As a result, there is a large element of subjectivity within the explanatory tradition in what is to be explained, and in what constitutes an explanation. Yet it has generally been the explanatory tradition which has claimed the mantle of objectivity (Hulme 2013b).

Both traditions seek to make sense of climate, but in very different ways: the descriptive tradition by a detailed understanding of the essential properties of different locations, and the explanatory tradition by an appeal to abstract physical laws. Both traditions have surely existed in some form for millennia. Within the West, the descriptive tradition particularly flourished from roughly the middle of the nineteenth century to the middle of the twentieth century, enabled by advances in meteorological instrumentation and in the field of statistics. It was also very much enabled by empire (Mahony and Endfield 2018). For example, Coen (2018) describes how the Habsburg (or Austro-Hungarian) Empire used climatology as a way of unifying its diverse political components, separated by history and language and with considerable local autonomy. It did this by showing how the climate of the different regions could reflect local differences while at the same time being interconnected (and interdependent) across spatial scales. The British Raj in South Asia had a different agenda, using climatology to support agricultural development and to predict year-to-year variations in the monsoon circulation, whose failure could lead to drought and famine (Amrith 2020).

The modern era of the explanatory tradition in the West can be traced back somewhat earlier, to the rise of mathematical physics beginning with Newton's laws in the late seventeenth century (Lorenz 1967). The perspective at that time was very much global and again was linked with empire insofar as a key explanatory target was the pattern of the trade winds, so important for imperial commerce in the days of sailing ships. The basic structure of the large-scale atmospheric circulation in the tropics, inferred from physical principles by George Hadley in 1735, bears his name and remains a central theoretical paradigm even today. However, the application of the laws of physics to fluid dynamics can only be performed by hand for steady (time-independent) flows, which severely restricted their applicability to climate for several centuries (in contrast with, for example, the motion of the planets). In the interim, the descriptive tradition reigned supreme. But with the advent of the digital computer in the middle of the twentieth century, the field of climate modeling was born. That development, together with the emergence of the pressing scientific question of anthropogenic climate change around the same time, rapidly changed the face of climate science. Martin-Nielsen (2015) chronicles this transition in the UK, as reflected in the experience of Hubert Lamb, a leading expositor of the descriptive approach to climate and its intimate link to history (Lamb 1995).

The descriptive tradition is far from dead: the annual "State of the Climate" report produced by the American Meteorological Society in collaboration with leading climate scientists around the world, which is entirely descriptive, runs to nearly 500 pages. However, the questions around anthropogenic climate change involve causation, and climate scientists agree that in order to establish causation, it is necessary to perform counter-factual, or "what-if-things-were-different?," calculations. And that requires a mathematical theory expressing the relevant cause-effect relationships, which climate models solve numerically, and which can be manipulated to perform counter-factual calculations. This is the main source of climate models' authority in the public sphere (Hulme 2013b). An accessible description of climate modeling is provided by Saravanan (2022), covering both its historical development and its strengths and limitations. The challenge for climate modeling is fundamentally two-fold. First, the equations can only be solved very approximately (because they only represent the relevant physical processes in a coarse-grained way). Second, the solutions provide single realizations of the simulated climate system (analogous to the single realization we experience of the real climate system), and due to a phenomenon known as chaos (Lorenz 1995), these simulated realizations do not track the real system and can only be meaningfully analyzed statistically, in terms of their aggregate properties (Shepherd and Sobel 2020).

The conundrum is that despite the replacement of a descriptive approach to climate by an ostensibly explanatory approach, one is thrown back on description. This is because the laws of physics solved by the models govern nearest-neighbor interactions (in both space and time), such as conservation of energy and momentum, yet the aspects of climate to be explained are emergent properties (for example, the South Asian monsoon) which are extended in both space and time, and without any direct connection to the nearest-neighbor interactions.

In particular, it is very difficult to understand why different climate models (which implement these nearest-neighbor interactions in slightly different ways) produce different statistical descriptions of climate. Some climate scientists try to understand these cross-scale connections using phenomenological theories, but all such theories are subjective and controversial. For the most part, climate scientists just abandon such attempts at understanding and combine ensembles of simulations from different climate models into a grand ensemble, for example, in the IPCC assessment reports. In the language of Hastrup (2013), the mode of configuration of knowledge has gone from narration to simulation to counting. Along the way, a thick description has been replaced by a very thin one. This procedure is presented as the climate science community's best answer to the relevant counter-factual questions regarding anthropogenic climate change, but is very ad hoc and is widely accepted to be fundamentally flawed. It only persists as the community standard because of the lack of any consensus on an alternative, and because it has the pretense of objectivity (colloquially referred to as "one model, one vote").

If the virtual climates simulated by the models were close to the observed climate, and their responses to anthropogenic climate change were similar, then this pragmatic approach might be acceptable. However, that is not the case (Shepherd 2014). The aspects of climate known as "thermodynamic" are robust: increasing greenhouse gases warm the climate system, which melts ice and causes sea level to rise. Those general consequences are enough to justify taking action to limit climate change. But the aspects of climate known as "dynamic" (namely those to do with winds and circulation systems) are neither particularly well simulated nor do they respond robustly to increasing greenhouse gases. This leads to considerable uncertainty in regional aspects of climate change, including extreme events (Shepherd 2019). While the climate models are slowly improving, the progress is very slow indeed, and most of the increased confidence in statements from the IPCC assessment reports over the years has come from a lengthened and deepened observational record, rather than from the climate models. But this raises the question of what is considered to be an observational record, which leaves many gaps around the world (Figure 8.1).

One of the reactions to this rather embarrassing situation has been to argue that in the face of such scientific uncertainty, and with such high stakes, climate science cannot be left to the scientists alone. The situation has been described as "post-normal" science (Funtowicz and Ravetz 1993), and so far the discussion has largely been carried out on the margins of climate science (Krauss, Schäfer and von Storch 2012; Hulme 2013a). This perspective aligns with the growing view among philosophers of science that purely epistemic values are not determinative of what constitutes good scientific practice, and that contextual values can and should enter in (Kuhn 1977; Douglas 2009). Acknowledging different contextual values is key to understanding why people disagree about climate change (Hulme 2009, 92): "Detached from its cultural anchors, climate change becomes a malleable envoy enlisted in support of too many rulers." The fact that Working Group

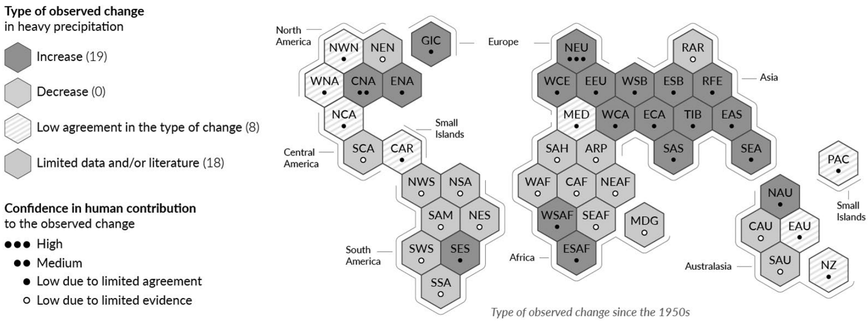

FIGURE 8.1 Synthesis of assessment of observed change in heavy precipitation and confidence in human contribution to the observed changes in the world's regions. Each hexagon corresponds to one of the IPCC AR6 WGI reference regions. Note there are no instances of Decrease.

Source: From Figure SPM.3 of IPCC (2021b).

I of the IPCC (representing physical climate science) has recently acknowledged this view creates a potential opening, although the "value-free ideal" provides useful cover for climate scientists and the working practice of climate science has yet to respond to this challenge (Pulkkinen et al. 2022).

Another reaction has come from within the climate science community, through the development of so-called "storyline" approaches to the representation of climate information (Shepherd et al. 2018). Such approaches navigate the uncertainty landscape by providing conditional explanations, either of the past or of a plausible future, through the device of *contingency*. By contingency is meant that while certain causal factors may not be predictable a priori, they can either be known (from observation) or hypothesized (from some kind of mechanistic theory); and that once these factors are prescribed, one can make sense of the situation of interest. The storyline approach—which we call "storylining"—represents a paradigm shift from the physics-based explanatory tradition in climate science, which aims for unconditional explanations (or, for the future, predictions) based on spatio-temporally invariant laws of nature (Shepherd and Sobel 2020). Yet it has a strong parallel with narrative-based or historical approaches that play a prominent role in other branches of the natural sciences, e.g., evolutionary biology (Shepherd and Lloyd 2021). Through the device of contingency, storylining provides a bridge between the descriptive and explanatory traditions in climate science discussed earlier. The term "physical climate storyline" is now part of the IPCC Working Group I Glossary (IPCC 2021a, 2250), which means it can be considered mainstream.

Storylining also aligns well with a decision-making perspective. Stirling (2010) has argued that when knowledge is uncertain, experts should resist the pressure (or temptation) to over-simplify the situation by framing their information in a "single, definitive" form. Instead, they should frame their information in a "plural, conditional" form, in order to adequately reflect the complexity of the situation. Such a framing also addresses any concern that a narrative approach to science might lead to "just-so stories," as multiple possibilities are articulated and can each be assessed as to their plausibility (Shepherd and Lloyd 2021). Finally, storylines engage an emotional element which has been shown to be a necessary ingredient for human decision-making (Damasio 1994). Storylines thereby provide a connection "between what we know and how we feel, between our affective, discursive and epistemological selves" (Bristow and Ford 2016, 6), which is essential for meaningful communication about climate change (Dilling and Moser 2007).

Enlivening and Worlding in Anthropology

Description, or detailed descriptive accounts, has always been part and parcel of anthropological craft since anthropology became an independent field of inquiry in the 1920s. Anthropologists of a large part of the twentieth century were traditionally concerned with human cultures of diverse societies, most oftentimes non-Western and studied as if these cultures or societies had not been altered by the colonial expansion from the West. Operating within the school of thought within which an anthropologist was trained, s/he would conduct a year-long ethnographic field research in a relatively small-sized community and produce an ethnographic monograph documenting its ways of life, showing how that society worked or how its culture would make sense to its members. However, the postmodern critique in the 1980s, about the same time as the advent of chaos theory and post-normal science, shook up social sciences, including anthropology (Marcus and Fischer 1986). The ways in which indigenous cultures had been altered, corrupted, and distorted by European imperial and colonial power, and how indigenous populations saw themselves through the eyes of the colonial Others, or "worlding," became central concerns of social-cultural anthropologists. The latter thus joined the postcolonial scholarship in giving voice to colonial "subjects," or the subaltern (Spivak 1988). Anthropologists thereby became more self-reflexive, with an increased awareness of how both the context of investigation and the context of explanation shape their anthropological accounts. Under the influence of post-structuralism, this recognition of the contextualization of knowledge laid the foundation for subsequent anthropological analyses of science, policy, and public discourse.

Over the last four decades, there are two streams in anthropological inquiry that are relevant for the purpose of this chapter. One is a movement toward an extension of difference beyond human societies and cultures. In this ontological turn, difference is not just within and between various societies and cultures of humanity, but also between worlds of beings—human and other-than-human beings (O'Gorman and Gaynor 2020). In this world of many worlds, not only nonhuman living beings such as plants, animals, and multitudes of species but also other beings such as water, rivers, mountains, etc., have their own part to contribute to the interaction and intra-action, regardless of human observations.

To this end, ethnography, or "lively ethography" as van Dooren and Rose propose, is seen as an appropriate concept-making genre that would enliven other-than-human actors and give voice to their accounts which would not otherwise be heard (Kirksey and Helmreich 2010; van Dooren and Rose 2016). A sociological concept of agency, understood as the capacity of individuals, human and other-than-human alike, to make their own choices and decisions and take action, is brought to the fore with a newly acquired intellectual advocacy.

The other stream is a development from an earlier branch in anthropology called "human ecology," looking at social and political systems from a materialist perspective, and encompassing technology and ecology. Seeking to maintain the relevance of their field, anthropologists have kept abreast of contemporary issues and issues of change: from development to globalization, from environmental degradation to climate change. Discovering interconnections, interdependencies, and possible causal linkages at the trans-local or global scale that underlie these changes marks the move away from descriptive documentation of local observations toward counter-factual explanatory accounts in anthropology. With the signature advantage of ethnographic field research at the local scale, anthropological studies that take up climate change phenomena as topics of inquiry demonstrate how locally embedded knowledge would be of significant scientific and political relevance (Dove 2014). Scholars of political economy and political ecology offer a unique contribution from their critical perspectives on power relations and inequity at the global scale as these are experienced by local communities (Pettenger 2007; Oliver-Smith 2012). The focus on power and politics helps anchor the ontological turn and make it an opening: instead of turning to difference-for-the-sake-of-difference, ethnographic storying as becoming-witness invites both response-ability and responsibility (Rose and van Dooren 2017). Humanities scholars under this influence further the postcolonial concept of "worlding" to unmake the colonial (human beings') universe and move toward conceptualizing a pluriverse, a world of many worlds, where all beings not only have their agency, intentionality, and sentience (Blaser and de la Cadena 2018), but also co-constitute these complex, cross-cutting, and intertwining worlds (O'Gorman and Gaynor 2020).

Ethnographic insights, historical perspective, and a holistic view are three distinctive contributions of anthropology to the study of climate change (Barnes et al. 2013). Since the millennium, anthropology of climate change has become a fast-growing branch of the field (Strauss and Orlove 2003; Crate and Nuttall 2016). A productive conversation between anthropology and climate science has started with a thorough examination of the social construction of climate change and climate change knowledge (Pettenger 2007; Hastrup 2013). The call for interdisciplinarity as a necessary, if not mandatory, approach for global change research has also been put forth among climate change anthropologists (Castree et al. 2014). However, a multitude of disciplines differs significantly from a built-in integration across disciplines or a genuine dialogue between disciplines, of which examples remain rare. An innovative duography—a pair of studies that juxtapose two complementary perspectives on climate change—by Boyer (2019) and Howe (2019) is a welcome experiment in reconciling global versus local and human versus nonhuman dichotomies and hints toward a multi-scalar and interdisciplinary endeavor. However, so far, the level of participation by indigenous communities in climate fieldwork has been patchy (Figure 8.2).

One way to make the global-local linkages productive for the anthropological inquiry of climate change is a recently refreshed take of "clime" by environmental historians and scholars of environmental humanities (Carey and Garone 2014). As climate serves to stabilize the perception of weather (Hulme 2015), the notion of clime points to the way in which climate is as much a socio-cultural construction as it is a scientific construction. Scholars working in this line seek to uncover the agency of climate through place-based lived experience and memories of extreme weather events or disasters. This enlivening ethnographic approach bears witness to clime, letting it speak for itself and thereby storying clime.

There would seem to be an opportune moment of conjuncture between the physical climate storyline approach and the recent ontological opening in social sciences and humanities, in particular the distinctively anthropological writing genre—thick-description ethnography, in the tradition of Geertz (1973)—when it is applied to place-based clime. Climate science storylining and enlivening ethnography converge in their questioning of objectivity based on a single and constant source (truth) and in their conviction of the contingency or conditionality of knowledge. This outlook goes back to Thomas Bayes for the former, and Friedrich Nietzsche for the latter. The storylining approach bridges between the descriptive and explanatory traditions in climate science, employing a combination of quantitative and qualitative elements in interpreting and giving meaning to data. Enlivening ethnography connects multiple agencies, human and other-than-human alike, within a co-constituted spatio-temporal platform where voices and actions can be heard and visualized. Storylining returns single, definitive forms of knowledge to their plural, conditional framing; enlivening

FIGURE 8.2 Patterns across space: global distribution of field sites classified by levels of indigenous community participation.

Source: From Figure 4 of David-Chavez and Gavin (2018).

ethnography, through the device of storying clime, allows multiple possibilities to emerge as imaginable if not plausible, through narrative. Storylining works well with past events pivoting toward plausible future pathways; storying clime focuses on the here and now of the experience of as many involved agencies as possible. Storylining seems to readily lend itself to facilitating engagement in conversation between diverse communities of scientists, social scientists, and humanities scholars, as well as practitioners. Storying clime may find storylining its desirable companion in the realization of response-ability and responsibility.

A Story of Loss: The Melamchi Flood Disaster

Administratively, Melamchi is only nine years old, since it was made into a municipality in 2014. It is located in the southwest of Sindhupalchowk District in the Bagmati Province of Nepal, about two hours' drive, or 69 km, from Kathmandu. In 2017, as part of the administrative restructuring under the new federal constitution of 2015, four villages and a part of Shivapuri Nagarjun National Park were added to the original seven villages that made up the municipality, covering an area of about 160 km^2 (A-NOT 2018) and inhabited by approximately 53,000 people. The name comes from the Melamchi Bazaar, a centuries-old trading center serving the ethnically diverse population of the district.

The Sindhupalchowk District is spread between mid-hills and high-hills/mountain terrain, from well below 1,000 m to Loenpo Gang peak at 6,979 m above mean sea level. This vast elevation difference results in diverse flora and fauna reflecting tropical, sub-tropical, and temperate climates. The average annual rainfall in the Melamchi basin is approximately 2,800 mm, concentrated during the monsoon season from mid-June to mid-September, and varying considerably by location within the valley, with higher rainfall amounts at the higher elevations (Office of Melamchi Municipality 2019). Melamchi River, a tributary of the Indrawati, originates from the Jugal Himal at 5,875 m elevation. It runs 41 km southward and meets up with the Indrawati at Melamchi Bazaar. The Melamchi Water Supply project, which was started in 1998 and completed in 2021, was designed to divert 170 million liters of water per day to supply the capital city of Kathmandu.

Melamchi inhabitants are made up of various ethnic and caste groups: 34% are Tamang, 24% Bahun, and 16% Chhetri. Hindu culture, practiced by the Bahun and the Chhetri, dominates the lowland settlements of the valley, while Buddhist culture, practiced by the Tamang and other ethnic groups, is prevalent in the mid-hills and high-hills villages. Among caste-ethnic groups, the Dalit—a marginalized caste previously known as "untouchable"—remain the most socio-economically disadvantaged. Agriculture accounts for 94% of the economically active populations, with cultivated land occupying about 65% of the total watershed area (Neupane and Rai 2018). Paddies are cultivated by the Bahun and the Chhetri cultivate irrigated fields in the lowland, while millet and maize are major crops of the Tamang in the mid- and high-hills. Agricultural land is the major physical asset for the lowland groups and agriculture is traditionally viewed as a superior occupation in local culture. Vegetable farming, livestock and poultry, fisheries, wage labor, and services supplement livelihoods. However, with the increase in the cash economy, out-migration, and international remittances, the caste-occupation-based hierarchy that followed elevation has started changing: the poorer upstream groups have tended to migrate more and thus earn greater remittances, which are displayed in local consumption patterns. As a result, the Tamang, who used to depend on the Bahun or Chhetri for cash or wage labor, have started redefining their identity (Pokharel 2010).

In 2015, a major earthquake, referred to as the Gorkha earthquake, hit Nepal. Sindhupalchowk was one of the districts worst-affected, recording the highest magnitude aftershock of 6.7. The casualties in Sindhupalchowk (3,057) account for one-third of the Nepal total (8,964). Research is yet to confirm whether the 2015 earthquake made the district's landscape more prone to landslides (Kincey et al. 2021; Marc et al. 2019), but more frequent landslides were reported during the three years following the earthquake and local communities seem to have been aware of increased risks. On 14 August 2020, a landslide claimed eleven lives with twenty-seven reported missing in the Jugal Rural Municipality of Sindhupalchowk. A local resident recalled that "There were foreboding signs for weeks, and small landslides had been breaking out above the village" (Bushal 2021). The memorandum the community submitted to the District Disaster Management Community requesting help a week before the landslide struck was not acted upon (Tiwari 2020).

And then came the June 2021 flood event. (We draw on Maharjan et al. 2021 for the following details.) The monsoon of 2021 started around 10 June, with heavy rainfall in the headwaters of the Melamchi river. It had been preceded by heavy snowfall from two cyclones, leading to snowmelt and a rain-on-snow situation, which is conducive to heavy streamflow. On 16 June, a flash flood from the two converging rivers—the Melamchi and Indrawati—hit Melamchi Bazaar, claiming the lives of five people with another twenty missing, and bringing heavy damage to the Melamchi Water Supply project as well as to numerous individual homes and assets. Two days later, a landslide occurred on the slope of the left bank of the Melamchi River, setting in motion a chain of events which buried the farmland in the valley with debris (Figure 8.3).

From a geophysical perspective, the Melamchi flood event is an example of what is called a compound event, with cascading hazards. The temporal sequence of events is not known precisely, and may not be ever known, because of the patchwork nature of the physical evidence: human reporting (including photographs), digital records from a small number of weather stations, and images from satellite instruments (but with large gaps in time). Nevertheless, an overall narrative can be put together. The spring snow cover was a precondition for heavy streamflow once the monsoon commenced. Earlier landslides had created natural dams, which were then overtopped by the heavy streamflow. This discharged a high-speed flow of water within the narrow valley, hyper-concentrated with

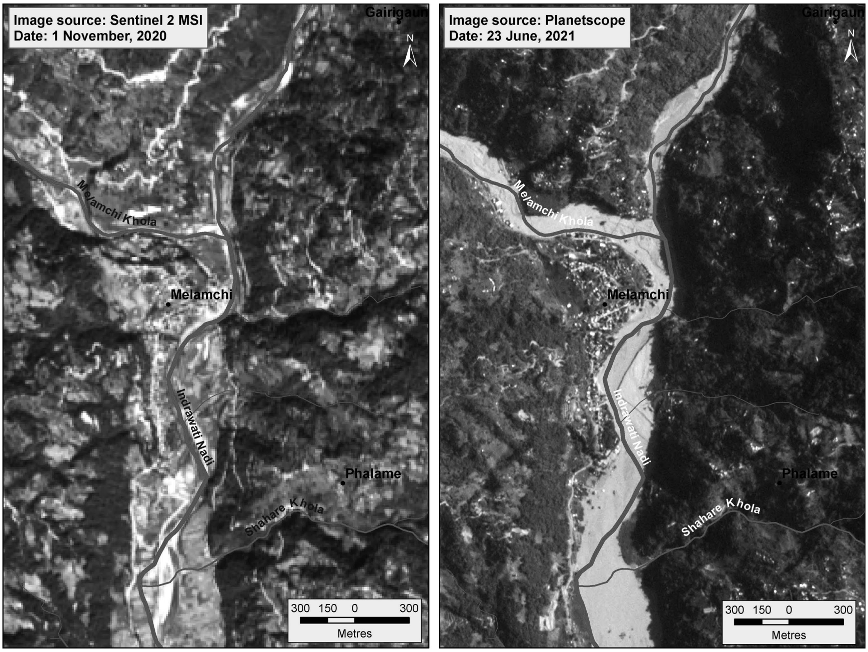

FIGURE 8.3 Debris deposition as seen from satellite images taken before (left) and after the Melamchi event (right).

Source: From Figure 14 of Maharjan et al. (2021).

debris, leading to numerous riverbank collapses and further landslides and ultimately depositing a massive amount of sediment downstream, inundating the farmland in the valley. The immense power of these cascading processes came from the vertical drop, which is a source of potential energy. But it was also a compound event from a human perspective. Upstream communities had no warning and suffered heavy casualties where multiple small landslides occurred during the event. Downstream communities were warned by the upstream communities and were able to take sufficient precautions; families along the riverbank in Melamchi Municipality had evacuated before the flood reached them, and thus no life was lost in these communities. However, the permanent loss of irrigated farmland made it more challenging for the downstream communities, whose livelihoods relied predominantly on agriculture, to rebound following the event.

Cascading events of a similar scale are not rare in the Hindu Kush Himalaya. Earlier the same year, in February 2021, a massive rock and ice avalanche from an elevation of 6,063 m rapidly transformed into an extraordinarily large and mobile debris flow descending the Ronti Gad, Rishiganga, and Dhauliganga Valleys in Chamoli, Uttarakhand, India (Shugar et al. 2021). The cascade of events caused more than 200 deaths or missing persons and damaged infrastructure, including two hydropower projects. Unfortunately, local people on site had little to no warning.

There is much agency in how the Melamchi event unfolded, and much contingency. Landslides and debris flows are natural phenomena in this region, but are expected to become more frequent with climate change because of destabilization of landscapes from warming, heavier precipitation, and more rain-on-snow events (Krishnan et al. 2019). The evolution of any particular event depends on the history of previous events, through legacies in the form of natural dams from past landslides, and moraine dams. In this case, the 2015 Gorkha earthquake may also have played a role in further destabilizing the landscape. The Melamchi event gained the attention it did in part because of the fact that it affected the Kathmandu water supply, and that the impact was so visually dramatic. The history of ethnic-caste hierarchies in the region meant that the wealthier downstream communities suffered fewer casualties because of the warning from the poorer upstream communities, but were more affected in the long term. Indeed, the landscape change for the downstream communities is essentially irreversible, and has completely altered their future by depriving them of their home and livelihood. All of this is explainable, but none of it was predictable from abstract theory, nor did it have to happen.

A Story of Loss: Usteq

The curves of Kuskokwim River, filled with sediment-rich dark brown slushy water, contour the boreal forests, swamps, and tundra in multiple shades of green, dotted by icy blue lakes of the Yukon-Kuskokwim Delta in southwest Alaska (Figure 8.4). The expansive, windswept subarctic Delta, one of the largest deltas in the world (500,000 sq. miles), has an almost triangular shape, with the Yukon River as its northern border, Kuskokwim to the southeast, and the Bering Sea to the southwest. It is the home of approximately 25,000 people, 85% of whom are Alaskan Natives, the Yup'ik, and the Athabaskan.

The Yup'ik live in small villages with less than a thousand inhabitants, and practice a subsistence-based lifestyle, that they term *yuuyaraq* (our way of life), consisting of hunting, gathering and fishing, with employment and a small cash economy limited to urban areas. Yup'ik folklore records the experience of change, both in their environment and in society. Indeed the Yup'ik name for the city of Quinhagak, *Kuinerraq*, means "new river channel" and the Yukon River itself, as the collective memory recalls, was narrower hundreds of years ago than it is today. Periodic relocation was part of community experience in search of peace from tribal wars during the pre-contact period (Lim et al. 2021). Relocations due to changes in water and land also took place in the past, and memories of such relocations can still be recalled. The elderly share a long-held popular belief of the Quinhagak community having to relocate five times before finding a permanent settlement. A combination of remote sensing and ethnographic inquiry reveals settlement sites of a recent past, with some of the relocations due to changes in nature such as a lake becoming dried up (Lim et al. 2021).

The Arctic is the most rapidly warming part of the world, and Alaska is warming particularly rapidly (Taylor et al. 2017). In contrast to mountainous regions

FIGURE 8.4 Kuskokwim River, in southern Alaska. This aerial photo was taken by scientists on a NASA DC-8 “flying laboratory” in their mission to study how thawing permafrost affects hydrology in the landscape by measuring the elevation of rivers and lakes.

Credit: Peter Griffith, NASA. https://climate.nasa.gov/climate_resources/159/kuskokwim-river/, accessed August 12, 2022.

like the Hindu Kush Himalaya, Arctic inhabitants live in direct proximity with the frozen components of the climate system, and indeed rely on them either for the stability of the land under their feet (permafrost) or for transportation and hunting (perennial lake and sea ice) (Singh, also Andersen, this book). As the climate warms, the permafrost thaws, which leads to riverbank erosion and landform collapse. Moreover, the ice-free summer season becomes longer, which not only adversely affects transportation and hunting, but prevents the formation of land-fast ice in coastal regions, thereby exposing coastlines to storm surges. The rapidity of Arctic warming means that these changes are occurring at unprecedented rates, most dramatically when storm surges combine with permafrost thaw in coastal regions. As a result, landscapes are changing before people’s eyes, with meters of land collapsing into the sea in a single night (Climate Justice Resilience Fund 2019). The fact that the Yup’ik had to create a new word to describe the phenomenon, *usteq* (roughly translated as “surface caves in”), documents its unprecedented nature.

In a US government report published nearly twenty years ago (GAO 2003), the danger posed by *usteq* was estimated to have affected at least 86% of 213 Alaska Native communities as evidenced by 190 disaster emergencies recorded in the last quarter of the previous century. A number of subsequent reports and assessments—the Alaska Climate Impact Assessment (2008) and the Alaska Baseline Erosion Assessment (2009)—documented the lack of progress in either the state of knowledge or action to assist affected communities (GAO 2009).

Ten years after the 2009 GAO Report, the Denali Commission Report of 2019 surveyed 187 of Alaska's rural communities and evaluated individual threats to public infrastructure associated with erosion, flooding, thawing permafrost, and the compound threats imposed by interactions between the three. It proposed an analytical process in scoring and ranking communities' risks. The Denali Report identifies thirty-eight communities facing immediate and serious threat from flooding, and seventy-nine under immediate serious threat from compound vulnerabilities. The Report also classifies scales of "time to damage"—with the most urgent damage possibly occurring in the next five years, compared to erosion which occurs slowly over twenty years. This evaluation of risks by a panel of multiscientific experts, however, does not characterize the actual status of risk faced by the concerned communities, nor does it capture the perceptions of risks by the local people. The Report acknowledges that uncertainty is directly correlated with the quality and quantity of available data and the rankings are only to be used to identify communities requiring additional investigation (University of Alaska Fairbanks Institute of Northern Engineering 2019).

In response to this challenge, some communities are considering co-relocation, a process in which the population of an entire community relocates to a new site where residents can continue to practice their subsistence lifeways (Ristroph 2017). As early as the late 1990s, residents from three of the most-at-risk rural communities, Newtok, Kivalina, and Shishmaref, took the initiative in planning to co-relocate their entire community with the assistance of the government. They met with many difficulties, including expense, delay, lack of leadership among state and federal agencies in facilitating relocation, and confusion between the laws and institutions related to relocation and climate change. It took twenty-five years for Newtok, a village of 375 residents located by the Ninglick River in Southwest Alaska, to relocate to a new site, Mertarvik, 14 km away on higher, volcanic ground. With an average rate of 20 m of shoreline loss every year, Newtok faced a slow-moving disaster (Cole 2018). Lack of investment in public works due to the prolonged uncertainty during the more than two decades of negotiation and planning left residents without plumbing and sanitation. In exchange for the costs of relocation, the people of Newtok will eventually relinquish their lands to the Yukon Delta National Wildlife Refuge (Welch 2019). In the meantime, many other communities who remain in between protect-in-place and relocation continue to experience multiple forms of uncertainties. In Quinhagak, which is on the coast and at the mouth of a river, there has been contamination from the sewage lagoon, inaccessibility of the only functional dock, and a housing crisis due to subsidence and subsequent mold and rot. In Nunapitchuk, which is about 12 km inland from the coast and built on three riverbanks, there has also been contamination from the sewage lagoon and dumpsites, the failure of foundations of important buildings, and the removal of the power plant to the nearby village of Kasigluk (Bronen et al. 2020).

In the absence of a methodological and governance framework to evaluate climate change impacts, there have been noteworthy efforts to develop monitoring and assessment tools that are led by indigenous researchers and communities (Bronen et al. 2020). This approach engages community members as equal partners in the design and implementation of research that incorporates indigenous knowledge and addresses their needs. Such an adaptive governance framework, as a result of multi-year work with the two communities, Nunapitchuk and Qingagak, has integrated indigenous science and Western science in the co-production of knowledge and planning for the course of action that makes sense to the people themselves.

However, the process to prepare and implement community adaptation plans takes place against the backdrop of complex legal context and changing socio-economic conditions in Alaska. Climate-change-induced environmental changes are not the only challenges Native Alaskan—the Yup'ik, Athabaskan, and Inupiat—are facing: a socio-economic system that is no longer sustainable, lack of ownership and control over land or associated natural resources that could be used for adaptation, the high costs of living and limited access to jobs and health care due to distance from urban centers, the decline of population in some areas, youth unemployment, substance abuse, and domestic violence (Ristroph 2017). While there is no one-size-fits-all package of solutions for any combination of these issues, three keys to sustainable development have been identified: practical self-rule, capable governing institutions, and cultural match (Cornell and Kalt 2003). Self-rule is found to promote citizen engagement, put the development agenda in indigenous hands, and link decisions and their consequences. Effective institutions of community self-governance, institutional integrity, and practical action may pave the way for productive economic development. Lastly, institutions have to resonate with and build upon indigenous political conceptions if they are going to deliver the common goods.

Sweetgrass-Braiding

The two stories of loss—one of high altitude, one of high latitude; one extremely fast-paced on a human timescale, one relatively slow-paced, yet still occurring within living memory—give us windows into the two climes to be storylined (Figure 8.5). In Melamchi, the instability of landforms, and the man-made infrastructure, local media, government, and the scientific community, all had or could have had some role in the unfolding of the events. In Alaska, the pace at which *usteq* occurs, the existing experience in regard to relocation of each of the at-risk communities, their internal coherence and relationship with external agencies, all may shape that experience quite differently from one community to another. Singh (2021) argues that to develop a justice-centered pedagogy of climate change, it is helpful to view climate change through three transdisciplinary meta-concepts: balance-imbalance, planetary boundaries and limits, and complexity. All three are exemplified in our case studies. Climate change arises from imbalance in the Earth's energy budget, and leads to imbalance in cryospherically affected landforms. Limits are breached when these landforms collapse.

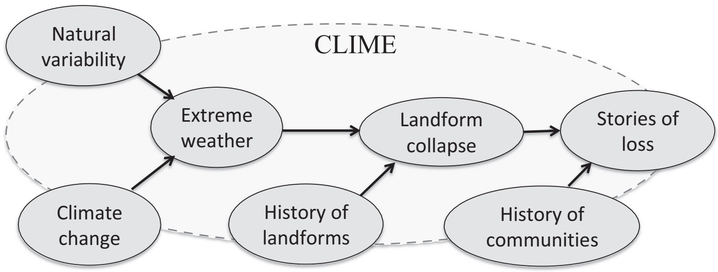

FIGURE 8.5 Storylines of our two case studies, represented together in the form of a causal network (Shepherd and Lloyd 2021) depicting the various actors in the events.

Complexity is evident in the intertwined history of weather, communities, and landforms, together representing clime.

No story ends just when or where the story-teller stops narrating. Six months after the Melamchi flood, Dalit communities from the upstream regions had still not received any relief support from the government. "[T]elling our stories of pain is useless," said a community member, expressing his frustration to a journalist and telling the visitor to come back in the next monsoon season to see if he were still alive (Bushal 2021). In Alaska, Newtok was the first community that made its move; two or three other villages are planning theirs. The way in which each community can tell its story in the face of climate change-induced and other socio-economic challenges will vary from one community to another and will depend on the extent to which their knowledge and perceptions are incorporated in the adaptation and resilience-building process.

Our two stories of loss illustrate through concrete example how climes can be storylined. We recognize that these stories could have been told quite differently. While some portion of the vignettes might have been left out without our intention, we have brought together strands of experiences and understandings that in another account might have been overlooked. We now step back to reflect on how the current moment in both anthropology and climate science provides an opportunity for productive and creative engagement between the humanities, social sciences, and natural sciences. In this respect, we can already identify several potential threads for this dialogue.

The first is the role of *time*. In climate science (as in physics), time is a continuum, and there is no fundamental distinction between past and future. Time only acquires meaning through physical imbalances in the climate system, but for the most part these imbalances are time-reversible. The present is essentially meaningless because it is only a snapshot in time, while climate by definition consists of long-term statistics (the classical definition in climatology is thirty years). Conventional anthropology is essentially the opposite; it deals with the here and now. Climate science is challenged by the here and now and by contingency, and anthropology is challenged by imbalance and temporal change;

in both cases, the ontologies are stretched. History deals with the past, with the present projected remotely as a mental canvas for the moral of the story to be inscribed. Sub-branches within anthropology and humanities have cross-fertilized and experimented to make the temporal dimension more productive. Anthropologists of climate change have started familiarizing themselves with anticipation and anticipating nature (Strauss and Orlove 2003; Hastrup 2013; Salazar 2017); Whyte (2021) has argued that indigenous peoples have represented climate-change time in terms of changing kinship relationships. Andersen (this book) describes how in the tundra of West Greenland, climate and social change have led to a responsive and relational pluriverse of "deep, accelerated, and troubled times." Our stories of loss show how in the world-as-lived, the past, present, and imagined future come together through intertwining compatible concepts in both climate science and anthropology.

The second thread is the nature of *agency and intentionality*. From a climate science perspective, agency is closely linked to causality and counter-factual reasoning, which is in turn linked to imbalance, as an intervention in the normal functioning of a system. In conventional anthropology, agency resides in the human domain and there has been a reluctance to consider the agency of climate lest it lead to the pernicious concept of "climate determinism," which is an instrument of colonialism. Yet a factor can be influential without being determinative. Enlivened anthropology has substantially widened the cast of actors with speaking parts in the drama. By providing voice to the South Asian monsoon, Amrith (2020) similarly provides an "enlivened history." Ghosh (2016) argues that literature needed to be enlivened by allowing climate change to have agency within the narrative, and further argues (2021) for its intentionality, suggesting that Earth is "fighting back" against what humans are doing to it. The latter appeals to the "Gaia hypothesis," broadly understood as the notion that the Earth is a living entity, which was first articulated by the atmospheric scientist Lovelock (1972). Although the Gaia hypothesis has been highly controversial among climate scientists, the objections would seem to rely on an overly anthropomorphic view of intentionality. One can accept the Gaia hypothesis while remaining within a conventional scientific paradigm, provided one accepts that emergent phenomena can arise in ways that are not immediately apparent from reductionist mechanisms (the nearest-neighbor interactions discussed earlier). In this respect, Karen Barad's relational ontological notion of "agency [as] an enactment, a matter of possibilities for reconfiguring entanglements," offers a way of thinking about causality and response-ability in complex systems (Dolphijn and van der Tuin 2012, 54, 55).

The third thread is *chaos*. During the last two decades of the twentieth century, anthropologists working within structuralist or post-structuralist traditions started drawing on chaos theory for inspiration (Wagner 1991; Strathern 1995; Appadurai 1996). Most of chaos theory (Lorenz 1995) describes *temporal chaos*, namely that even in a deterministic system, small differences in the state of a system grow in time until the two states are completely different. But there is also the concept of *spatial chaos* (Nowak and May 1992), namely that complex quasi-steady patterns can arise in a system, which are unpredictable yet which exhibit a coherent structure. Traditional climate science averages over all the chaos (Shepherd and Sobel 2020), but there are two problems with this. The first is that in a chaotic system, even the average behavior is highly sensitive to the specification of the system, which is why modeled climates can differ in significant ways from the observed climate. The second is that the observed realization of climate is subject to both temporal and spatial chaos. History can be thought of as describing a process of temporal chaos. Anthropology can be thought of as describing a process of spatial chaos. Both depend on contingency for their explanations. This extends to climate science, where storylining is a way to make sense of the observed record, and of the differences between climate models, through the device of contingency. Contemporary anthropology is attracted to chaos theory's notion of contingency precisely because of its power of contextualization (Mosko 2005). This helps close the loop at the meeting point with the ontological opening where emphasis is placed on the relations and intra-actions of human and other-than-human beings instead of beings as entities-unto-themselves.

The fourth thread is the *two ways of knowing* which probably permeate any scholarly discipline. What we have called the "descriptive" tradition in both climate science and anthropology would seem to be well aligned with attributes such as concrete, differentiated, ritual, and spatial. And what we have called the "explanatory" tradition would seem to be well aligned with attributes such as (respectively) abstract, aggregated, narrative, and temporal. One way may dominate the other at any given time, but there is invariably an ebb and flow between them within any discipline, and between disciplines. If they are seen as a strict dichotomy then it is a false dichotomy, since both ways are needed for balance. Other dichotomies are more ambiguously placed. In climate science, abstraction is perceived as more objective than description, but in anthropology it would be the opposite; this reflects Karen Barad's observation that "objectivity is a matter of responsibility and not a matter of distancing" (Dolphijn and van der Tuin 2012, 57). And where episodic knowledge (stories) and semantic knowledge (facts) fit within this framework will also differ between disciplines. Similar to the relation between storying and clime, storylines represent a "concrete abstraction"—a form of thick-description ethnography—that can be put to work by bridging between the two strands, or "climing" in the usage of Paerregaard (this book). In *Braiding Sweetgrass*, Kimmerer (2013) describes how indigenous Native American knowledge of plants can be combined with the Western science of botany to yield a productive synergy. Related to the theme of water, she points out (55) that the Ojibwe word for a bay, *wiikwegamaa*, is a verb rather than a noun, indicating that water is "being" a bay at that moment in time. As with Amrith's (2020) depiction of the South Asian monsoon (see also Amrith and Smyer Yü, this book), this more dynamic, or enlivened, representation of water is well aligned with the climate-science concept of the water cycle (Dorigo et al. 2021). We adopt sweetgrass-braiding as a metaphor for how different ways of knowing can be brought together by storylining climes (Figure 8.6).

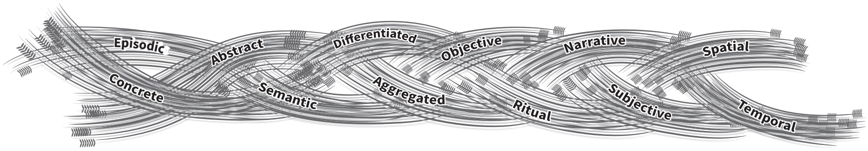

FIGURE 8.6 Sweetgrass-braiding of epistemic dichotomies, in the spirit of Kimmerer (2013). One strand reflects "descriptive" ways of knowing: concrete, differentiated, ritual, spatial. Another strand reflects the contrasting "explanatory" ways of knowing: (respectively) abstract, aggregated, narrative, temporal. A third strand contains more ambiguous dichotomies: episodic vs. semantic, and objective vs. subjective.

The novelist Wendell Berry describes the following dichotomy (Berry 2017, 182, 184):

> The Rational Mind is motivated by the fear of being misled, of being wrong. Its purpose is to exclude everything that cannot empirically or experimentally be proven to be a fact.
>
> The Sympathetic Mind is motivated by fear of error of a very different kind: the error of carelessness, of being unloving. Its purpose is to be considerate of whatever is present, to leave nothing out.
>
> The definitive practical aim of the Sympathetic Mind is to adapt local economies to local landscapes. This is necessarily the work of local cultures.

This is yet another expression of our two ways of knowing, and one can easily see on which side Berry is leaning. Yet even this dichotomy has a scientific interpretation: in that language, the Rational Mind is afraid of so-called Type 1 errors (a false alarm), while the Sympathetic Mind is afraid of so-called Type 2 errors (a missed warning). Climate science has tended to prioritize the former, but storyline approaches prioritize the latter (Lloyd and Oreskes 2018).

We are reminded of Lévi-Strauss's (2021, orig. 1962) "pensée sauvage"—an untamed, intuitive state of mind as distinct from a purposeful mind, the latter cultivated with an aim to yield a return. In a circumstantial world where a universal package of solutions is a guarantee of failure, scientists and social scientists, policy makers, and communities of a particular clime may find a bricoleur's way sensible: rendering knowledge useful and usable through joint interpretation of it. Thus, it is not one or the other: sweetgrass-braiding is possible and bricolage is necessary. In this process, all scholarly disciplines are challenged. Rodrigues and Shepherd (2022) challenge climate science by repurposing the economist E.F. Schumacher's *Small is Beautiful* (1973) to ask how climate-change science might look if it were structured "as if people mattered." In their multilayered unpacking of the phrase "climate change is all about us," Bristow and Ford (2016, 7) similarly challenge the humanities: "Like lichens and coral reefs, the disciplines of the humanities may also be considered as climatically sensitive forms. Climate change is all about us not least as a cascade of collapsing and outmoded philosophical and scholarly categories."

Berry's evocation to "be considerate of whatever is present, to leave nothing out" is nothing other than a plea for enlivening, and is echoed by Ghosh (2021, 76) who discusses the "loss of meaning that is produced by the vision of world-as-resource." Kimmerer, too, emphasizes that the rational needs to serve the sympathetic, rather than the other way around (as, for example, in the use of traditional knowledge to provide commodities). Ghosh sees anthropogenic climate change as the manifestation of colonialism, both historical and present-day, in which only a small subset of humanity is seen to have a legitimate voice. Against this, enlivening ethnography would allow one to stay tuned to the voices that would not have been heard or the existence that would not have presented of various beings, be they a river or its banks, steep slopes, or valleys. The Anthropocene Himalayan and Arctic land-and-waterscapes have already been transformed by the local and the non-local, including by the scientific community itself, to the point of no return. Enlivening ethnography by storylining clime would open ways for human and other-than-human beings to narrate their experience of worlding and of bearing witness of others in their co-constituted pluriverse. In the words of Ezra Pound (1993, orig. 1948),

> Pull down thy vanity, it is not man
> Made courage, or made order, or made grace,
> Pull down thy vanity, I say pull down.
> Learn of the green world what can be thy place…

Note

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References

Alaska Baseline Erosion Assessment. 2009. Elmendorf Air Force Base, Alaska: U.S. Army Corps of Engineers.

Alaska Climate Impact Assessment Commission. 2008. *Final Commission Report, Alaska Climate Assessment Commission*. Juneau, AK: Alaska State Legislature.

Amrith, Sunil. 2020. *Unruly Waters*. London: Penguin Books.

A-NOT Architecture and Architects. 2018. *Land Pooling Feasibility Study of Bahunepati Area*. Melamchi Municipality, Office of the Municipal Executive, Melamchi, Sindhupalchowk.

Appadurai, Arjun. 1996. *Modernity at Large: Cultural Dimensions of Globalization*. Minneapolis: University of Minnesota Press.

Barnes, Jessica, Michael Dove, Myanna Lahsen, Andrew Mathews, Pamela McElwee, Roderick McIntosh, Frances Moore, Jessica O'Reilly, Ben Orlove, Rajindra Puri, Harvey Weiss, and Karina Yager. 2013. "Contribution of Anthropology to the Study of Climate Change." *Nature Climate Change* 3: 541–544.

Berry, Wendell. 2017. *The World-Ending Fire*. London: Penguin Books.

Bjurström, Andreas, and Merritt Polk. 2011. "Physical and Economic Bias in Climate Change Research: A Scientometric Study of IPCC Third Assessment Report." *Climatic Change* 108: 1–22.

Blaser, Mario, and Marisol de la Cadena. 2018. "Proposals for a World of Many Worlds." In *A World of Many Worlds*, edited by M. de la Cadena and M. Blaser, 1–22. Durham and London: Duke University Press.

Boyer, Dominic. 2019. *Energopolitics: Wind and Power in the Anthropocene*. Durham, NC: Duke University Press.

Bristow, Tom, and Thomas H. Ford. 2016. "Climates of History, Cultures of Climate." In *A Cultural History of Climate Change*, edited by T. Bristow and T. H. Ford, 1–14. London: Routledge.

Bronen, Robin, Denise Pollock, Jacquelyn Overbeck, DeAnne Stevens, Susan Natali, and Chris Maio. 2020. "Usteq: Integrating Indigenous Knowledge and Social and Physical Sciences to Coproduce Knowledge and Support Community-Based Adaptation." *Polar Geography* 43 (2, 3): 188–205.

Bushal, Ramesh. 2021. "Six Months after Melamchi Floods in Nepal, No Respite for Displaced People." *The Third Pole*, December 7, 2021, accessed January 26, 2022. https://www.thethirdpole.net/en/livelihoods/melamchi-floods-in-nepal-six-months-on/

Carey, Mark, and Philip Garone. 2014: "Forum Introduction." *Environmental History* 19: 282–293.

Castree, Noel, William M. Adams, John Barry, Daniel Brockington, Bram Büscher, Esteve Corbera, David Demeritt, Rosaleen Duffy, Ulrike Felt, Katja Neves, Peter Newell, Luigi Pellizzoni, Kate Rigby, Paul Robbins, Libby Robin, Deborah Bird Rose, Andrew Ross, David Schlosberg, Sverker Sörlin, Paige West, Mark Whitehead, and Brian Wynne. 2014. "Changing the Intellectual Climate." *Nature Climate Change* 4: 763–768.

Climate Justice Resilience Fund. 2019. "There Is No Coming Back from Disappearing Coastlines." *Climate Home News*, July 23, 2019, downloaded January 26, 2022. https://www.climatechangenews.com/2019/07/23/no-coming-back-disappearing-coastlines/

Coen, Deborah R. 2018. *Climate in Motion: Science, Empire, and the Problem of Scale*. Chicago and London: University of Chicago Press.

Coen, Deborah R. 2021. "A Brief History of Usable Climate Science." *Climatic Change* 167: 51.

Cole, Dermot. 2018. "How Newtok's Relocation Efforts Could Be an Example for Other Climate-Threatened Northern Communities." *Arctic Today*, April 29, 2018, accessed January 25, 2022. https://www.arctictoday.com/newtoks-relocation-efforts-example-climate-threatened-northern-communities/

Corbera, Esteve, Laura Calvet-Mir, Hannah Hughes, and Matthew Paterson. 2016. "Patterns of Authorship in the IPCC Working Group III Report." *Nature Climate Change* 6: 94–99.

Cornell, Stephen, and Joseph P. Kalt. 2003. *Alaska Native Self-Government and Service Delivery: What Works?* Cambridge, MA: The Harvard Project on American Indian Economic Development.

Crate, Susan A., and Mark Nuttall. 2016. "Introduction: Anthropology and Climate Change." In *Anthropology and Climate Change: From Actions to Transformations*, edited by S. A. Crate and M. Nuttall, 11–34. New York: Routledge.

Damasio, Antonio. 1994. *Descartes' Error*. New York: Putnam.

David-Chavez, Dominique M., and Michael C. Gavin. 2018. "A Global Assessment of Indigenous Community Engagement in Climate Research." *Environmental Research Letters* 13: 123005.

Dilling, Lisa, and Susanne C. Moser. 2007. "Introduction." In *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*, edited by S. C. Moser and L. Dilling, 1–27. Cambridge: Cambridge University Press.

Dolphijn, Rick, and Iris van der Tuin. 2012. "'Matter Feels, Converses, Suffers, Desires, Yearns and Remembers': Interview with Karen Barad." In *New Materialism*: *Interviews and Cartographies,* 48–70. Ann Arbor, MI: Open Humanities Press.

Dorigo, Wouter, Stephan Dietrich, Filipe Aires, Luca Brocca, Sarah Carter, Jean-François Cretaux, David Dunkerley, Hiroyuki Enomoto, René Forsberg, Andreas Güntner, Michaela I. Hegglin, Rainer Hollmann, Dale F. Hurst, Johnny A. Johannessen, Christian Kummerow, Tong Lee, Kari Luojus, Ulrich Looser, Diego G. Miralles, Victor Pellet, Thomas Recknagel, Claudia Ruz Vargas, Udo Schneider, Philippe Schoeneich, Marc Schröder, Nigel Tapper, Valery Vuglinsky, Wolfgang Wagner, Lisan Yu, Luca Zappa, Michael Zemp, and Valentin Aich. 2021. "Closing the Water Cycle from Observations across Scales: Where Do We Stand?" *Bulletin of the American Meteorological Society* 102: E1897–E1935.

Douglas, Heather E. 2009. *Science, Policy, and the Value-Free Ideal*. Pittsburgh, PA: University of Pittsburgh Press.

Dove, Michael. 2014. "Introduction: The Anthropology of Climate Change. Six Millennia of Study of the Relationship between Climate and Society." In *The Anthropology of Climate Change: An Historical Reader*, edited by M. Dove, 1–36. Malden, MA: Wiley Blackwell.

Funtowicz, Silvio O., and Jerome R. Ravetz. 1993. "Science for the Post-Normal Age." *Futures* 25: 739–755.

Geertz, Clifford. 1973. "Thick Description: Toward an Interpretive Theory of Culture." In *The Interpretations of Cultures*, edited by C. Geertz, 3–30. New York: Basic Books.

Ghosh, Amitav. 2016. *The Great Derangement*. Chicago and London: University of Chicago Press.

Ghosh, Amitav. 2021. *The Nutmeg's Curse*. Chicago and London: University of Chicago Press.

Government Accountability Office (GAO), U.S. 2003. "Alaska Native Villages: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance." Washington DC: U.S. Government Accountability Office.

Government Accountability Office (GAO), U.S. 2009. "Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion." Washington DC: U.S. Government Accountability Office.

Hastrup, Kirsten. 2013. "Anticipating Nature: The Productive Uncertainty of Climate Models." In *The Social Life of Climate Change Models: Anticipating Nature*, edited by K. Hastrup and M. Skrydstrup, 1–29. London: Routledge.

Howe, Cymene. 2019. *Ecologics: Wind and Power in the Anthropocene*. Durham, NC: Duke University Press.

Hulme, Mike. 2009. *Why We Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity*. Cambridge: Cambridge University Press.

Hulme, Mike. 2013a. *Exploring Climate Change through Science and in Society*. London: Routledge.

Hulme, Mike. 2013b. "How Climate Models Gain and Exercise Authority." In *The Social Life of Climate Change Models: Anticipating Nature*, edited by K. Hastrup and M. Skrydstrup, 30–44. London: Routledge.

Hulme, Mike. 2015. "Climate." In *Living Lexicon for the Environmental Humanities*, Vol. 6. Durham, NC: Duke University Press.

IPCC. 2021a. "Annex VII: Glossary." In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, 2215–2256, doi:10.1017/9781009157896.022. Cambridge and New York: Cambridge University Press.

IPCC. 2021b. "Summary for Policymakers." In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, 3–32, doi:10.1017/9781009157896.001. Cambridge and New York: Cambridge University Press.

Kimmerer, Robin Wall. 2013. *Braiding Sweetgrass*. London: Penguin Books.

Kincey, Mark E., Nick J. Rosser, Tom R. Robinson, Alexander L. Densmore, Ram Shrestha, Dammar Singh Pujara, Katie J. Oven, Jack G. Williams, and Zuzanna M. Swirad. 2021. "Evolution of Coseismic and Post-Seismic Landsliding after the 2015 Mw 7.8 Gorkha Earthquake, Nepal." *Journal of Geophysical Research: Earth Surface* 126: e2020JF005803.

Kirksey, Eben S., and Stefan Helmreich. 2010. "The Emergence of Multispecies Ethnography." *Cultural Anthropology* 25 (4): 545–576.

Krauss, Werner, Mike S. Schäfer, and Hans von Storch. 2012. "Introduction: Post-Normal Climate Science." *Nature and Culture* 7 (2): 121–132.

Krishnan, Raghavan, Arun B. Shrestha, Guoyu Ren, Rupak Rajbhandari, Sajjad Saeed, and Jayanarayanan Sanjay. 2019. "Unraveling Climate Change in the Hindu Kush Himalaya: Rapid Warming in the Mountains and Increasing Extremes." In *The Hindu Kush Himalaya Assessment—Mountains, Climate Change, Sustainability and People*, edited by W. Philippus, A. Mishra, A. Mukherji, and A. B. Shrestha. Cham, CH: Springer Nature, Switzerland AG.

Kuhn, Thomas S. 1977. "Objectivity, Value Judgment, and Theory Choice." In *The Essential Tension: Selected Studies in Scientific Tradition and Change*, edited by T. Kuhn, 320–329. Chicago: University of Chicago Press.

Lamb, Hubert H. 1995. *Climate, History and the Modern World*, 2nd ed. London: Routledge.

Lévi-Strauss, Claude. 2021. *Wild Thought: A New Translation of La Pensée Sauvage*, translated by Jeffrey Mehlman and John Levitt. Chicago: University of Chicago Press.

Lim, Jonathan S., Sean Gleason, Warren Jones, and Willard Church. 2021. "Nuna Nalluyuituq (The Land Remembers): Remembering Landscapes and Refining Methodologies through Community-Based Remote Sensing in the Yukon-Kuskokwim Delta, Southwest Alaska." *Archeological Prospection* 28: 339–355.

Lloyd, Elisabeth A., and Naomi Oreskes. 2018. "Climate Change Attribution: When Is It Appropriate to Accept New Methods?" *Earth's Future* 6: 311–325.

Lorenz, Edward N. 1967. *The Nature and Theory of the General Circulation of the Atmosphere*. Geneva, CH: World Meteorological Organization.

Lorenz, Edward N. 1995. *The Essence of Chaos*. Seattle, WA: University of Washington Press.

Lovelock, James E. 1972. "Gaia as Seen through the Atmosphere." *Atmospheric Environment* 6 (8): 579–580.

Maharjan, Bikash Sudan, Jakob Friedrich Steiner, Arun Bhakta Shrestha, Amina Maharjan, Santosh Nepal, Mandira Singh Shrestha, Birendra Bajracharya, Ghulam Rasul, Maxim Shrestha, Miriam Jackson, and Nishikant Gupta. 2021. *The Melamchi Flood Disaster: Cascading Hazard and the Need for Multihazard Risk Management.* International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Mahony, Martin, and Georgina Endfield. 2018. "Climate and Colonialism." *WIREs Climate Change* 9: e510.

Marc, Odin, Robert Behling, Christoff Andermann, Jens M. Turowski, Luc Illien, Sigrid Roessner, and Niels Hovius. 2019. "Long-Term Erosion of the Nepal Himalayas by Bedrock Landsliding: The Role of Monsoons, Earthquakes and Giant Landslides." *Earth Surface Dynamics* 7: 107–128.

Marcus, George E., and Michael M. J. Fischer. 1986. *Anthropology as Cultural Critique.* Chicago: University of Chicago Press.

Martin-Nielsen, Janet. 2015. "Ways of Knowing Climate: Hubert H. Lamb and Climate Research in the UK." *WIREs Climate Change* 6: 465–477.

Mosko, Mark S. 2005. "Introduction: A (Re)turn to Chaos: Chaos Theory, the Sciences, and Social Anthropological Theory." In *On the Order of Chaos: Social Anthropology and the Science of Chaos*, edited by M. S. Mosko and F. H. Damon, 1–46. New York: Berghahn Books.

Neupane, Madhu Krishna, and Dhyanendra Bahadur Rai. 2018. "Diversification of Livelihood Strategies in Melamchi Valley, Sindhupalchok District, Nepal." *The Geographical Journal of Nepal* 11: 113–126.

Nowak, Martin A., and Robert M. May. 1992. "Evolutionary Games and Spatial Chaos." *Nature* 359: 826–829.

O'Gorman, Emily, and Andrea Gaynor. 2020: "More-Than-Human Histories." *Environmental History* 25: 711–735.

Office of Melamchi Municipality. 2019. *Preparation of Municipal Transport Master Plan of Melamchi Municipality.* Melamchi, Sindhupalchowk, Nepal.

Oliver-Smith, Anthony. 2012. "Disaster Risk Reduction and Climate Change Adaptation: The View from Applied Anthropology." *Human Organization*, 72 (4): 275–282.

Pettenger, Mary E. 2007. *The Social Construction of Climate Change: Power, Knowledge, Norms, Discourses.* Aldershot, UK: Ashgate.

Pokharel, Binod. 2010. "Changing Relations between High Castes and Tamang in Melamchi Valley." *Dhaulagiri Journal of Sociology and Anthropology* 4: 65–84.

Pound, Ezra. 1993. "Canto LXXXI." *Poetry Foundation,* accessed August 12, 2022. https://www.poetryfoundation.org/poems/54320/canto-lxxxi

Pulkkinen, Karoliina, Sabine Undorf, Frida Bender, Per Wikman-Svahn, Francisco Doblas-Reyes, Clare Flynn, Gabriele C. Hegerl, Aiden Jönsson, Gah-Kai Leung, Joe Roussos, Theodore G. Shepherd, and Erica Thompson. 2022. "The Value of Values in Climate Science." *Nature Climate Change* 12: 4–6.

Ristroph, Elizaveta Barrett. 2017. "When Climate Takes a Village: Legal Pathways Toward the Relocation of Alaska Native Village." *Climate Law* 7 (4): 259–289.

Rodrigues, Regina R., and Theodore G. Shepherd. 2022. "Small is Beautiful: Climate-Change Science as if People Mattered." *PNAS Nexus* 1: pgac009.

Rose, Deborah Bird, and Thom van Dooren. 2017. "Encountering a More-Than-Human World: Ethos and the Arts of Witness." In *The Routledge Companion to the Environmental Humanities*, edited by U. Heise, J. Christensen, and M. Niemann, 120–128. London: Routledge.

Salazar, Juan Francisco. 2017. "Speculative Fabulation: Researching Worlds to Come in Antarctica." In *Anthropologies and Futures: Researching Emerging and Uncertain Worlds*, edited by J. F. Salazar, S. Pink, A. Irving, and J. Sjorberg, 151–170. London: Routledge.

Saravanan, R. (Ramalingam) 2022. *The Climate Demon*. Cambridge and New York: Cambridge University Press.

Schipper, E. Lisa F., Navroz K. Dubash, and Yacob Mulugetta. 2021. "Climate Change Research and the Search for Solutions: Rethinking Interdisciplinarity." *Climatic Change* 168: 18.

Schumacher, Ernst F. 1973. *Small is Beautiful: A Study of Economics as if People Mattered*. London: Blond & Briggs.

Shepherd, Theodore G. 2014. "Atmospheric Circulation as a Source of Uncertainty in Climate Change Projections." *Nature Geoscience* 7: 703–708.

Shepherd, Theodore G. 2019. "Storyline Approach to the Construction of Regional Climate Change Information." *Proceedings of the Royal Society A* 475: 20190013.

Shepherd, Theodore G., and Adam H. Sobel. 2020. "Localness in Climate Change." *Comparative Studies of South Asia, Africa and the Middle East* 40 (1): 7–16.

Shepherd, Theodore G., and Elisabeth A. Lloyd. 2021. "Meaningful Climate Science." *Climatic Change* 169: 17.

Shepherd, Theodore G., Emily Boyd, Raphael A. Calel, Sandra C. Chapman, Suraje Dessai, Ioana M. Dima-West, Hayley J. Fowler, Rachel James, Douglas Maraun, Olivia Martius, Catherine A. Senior, Adam H. Sobel, David A. Stainforth, Simon F. B. Tett, Kevin E. Trenberth, Bart J. J. M. van den Hurk, Nicholas W. Watkins, Robert L. Wilby, and Dimitri A. Zenghelis. 2018. "Storylines: An Alternative Approach to Representing Uncertainty in Physical Aspects of Climate Change." *Climatic Change* 151: 555–571.

Shugar, Dan H., et al. 2021. "A Massive Rock and Ice Avalanche Caused the 2021 Disaster at Chamoli, Indian Himalaya." *Science* 373: 300–306.

Singh, Vandana. 2021. "Toward a Transdisciplinary, Justice-Centered Pedagogy of Climate Change." In *Curriculum and Learning for Climate Action: Toward an SDG 4.7 Pathway for Systemic Change*, edited by R. Iyengar and C. T. Kwauk, 169–187. UNESCO-IBE: Brill.

Spivak, Gayatri Chakravorty. 1988. "Can the Subaltern Speak?" In *Marxism and the Interpretation of Culture*, edited by C. Nelson and L. Grossberg, 271–313. Urbana: University of Illinois Press.

Stirling, Andy. 2010. "Keep It Complex." *Nature* 468: 1029–1031.

Strathern, Marilyn. 1995. *The Relation: Issues in Complexity and Scale*. Cambridge: Prickly Pear Press.

Strauss, Sarah, and Ben Orlove. 2003. "Up in the Air: The Anthropology of Weather and Climate." In *Weather, Climate, Culture*, edited by S. Strauss and B. Orlove, 3–14. New York: Berg.

Taylor, Patrick C., Wieslaw Maslowski, Judith Perlwitz, and Donald J. Wuebbles. 2017. "Arctic Changes and Their Effects on Alaska and the Rest of the United States." In *Climate Science Special Report: Fourth National Climate Assessment, Volume I*, edited by D. J. Wuebbles, D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock, 303–332. Washington, DC: U.S. Global Change Research Program. https://doi.org/10.7930/J00863GK

Tiwari, Anish. 2020. "We Had Long Been Asking the Authorities to Move Us to Safer Location." *Kathmandu Post*, August 15, 2020, accessed January 25, 2022. https://kathmandupost.com/province-no-3/2020/08/15/friday-s-landslide-a-preventable-tragedy-sindhupalchok-villagers-say

University of Alaska Institute of Northern Engineering. 2019. Statewide Threat Assessment: Identification of Threats from Erosion, Flooding, and Thawing Permafrost in

Remote Alaska Communities. Report Prepared for the Denali Commission. Report #INE 19.03

Van Dooren, Thom, and Deborah Bird Rose. 2016: "Lively Ethography: Storying Animist Worlds." *Environmental Humanities* 8 (1): 78–94.

Wagner, Roy. 1991. "The Fractal Person." In *Big Men and Great Men: Personification of Power in Melanesia*, edited by M. Godelier and M. Strathern, 159–173. Cambridge: Cambridge University Press.

Welch, Craig. 2019. "Climate Change Has Finally Caught Up to This Alaska Village." *National Geographic*, October 22, 2019, accessed January 25, 2022. https://www.nationalgeographic.com/science/article/climate-change-finally-caught-up-to-this-alaska-village

Whyte, Kyle. 2021. "Time as Kinship." In *The Cambridge Companion to Environmental Humanities*, edited by J. J. Cohen and S. Foote, 39–55. Cambridge: Cambridge University Press.