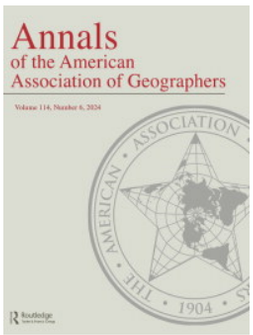

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For an Environmental Ethnography in Human and Physical Geography: Reenvisioning the Impacts and Opportunities of El Niño in Peru

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In 2017 El Niño Costero devastated the northern coast of Peru. This article seeks to learn from this experience for future large central and eastern Pacific-driven El Niño events. It directs attention away from dominant disaster narratives to reflect on the opportunities that El Niño rains have generated for desert livelihoods over time. We make a call for and set out the key elements of a historical geographical ethnography approach in environmental geography, which, as well as examining climate dimensions (paleoclimatology, dendrochronological, and atmospheric changes) of El Niño, also aims to consider its impacts on the livelihoods and management strategies of desert communities over time. We take as a starting point the responses of people who themselves come directly into contact with environmental change, yet whose agency and experiences are often marginal in knowledge production about El Niño. Responding to recent calls for qualitative geography researchers to be more explicit about how data are collected and analyzed, we explain how and why it is important to compare stakeholder interviews and climate records with newspaper archives and community memories of the 1983 and 1998 El Niño events. We illustrate that for desert populations in northern Peru, El Niño can represent abundance as well as disaster and make visible their role in managing change after El Niño flooding. *Key Words: climate change, El Niño, livelihoods, Peru, synthetic geography.*

The El Niño-Southern Oscillation (ENSO) is the single largest source of climate variability on the planet. El Niño—the warm phase of ENSO—causes distinct temperature and precipitation changes over land, with its strength linked to sea surface temperature (SST) anomalies across the equatorial Pacific (McPhaden, Santoso, and Cai 2020). On 26 March 2017, after a sustained period of intense rainfall driven by anomalously warm SSTs (4–5 °C warmer during February and March) directly off the northern coast of Peru, the River Piura exceeded its banks. As a result, surface water levels in the city of Piura and the town of Catacaos rose by 1.8 m, invigorating the hydrological cycle that led to the rejuvenation and infilling of playa lake systems with water and sediment. The waters of the River Piura flow into the Sechura Desert, forming lagoons, which, during periods affected by El Niño events, unite, creating the large La Niña Lagoon. At its peak this lagoon stretches 600 km^2 across the desert and is clearly visible in the before and after March 2017 Sentinel II satellite images in Figure 1.

By the end of that same month, the Civil Protection Agency of Peru reported there had been ninety-seven deaths, 184,000 people displaced, more than 30,000 homes destroyed, and a further more than 180,000 homes damaged associated with rainfall-related flooding. As we explain in more detail later, the phenomenon driving the 2017 rainfall event, which topped three times the mean average values, and dubbed El Niño Costero (Coastal El Niño) was unique. The last recorded El Niño Costero–type event was in 1925 and is still considered the most intense of

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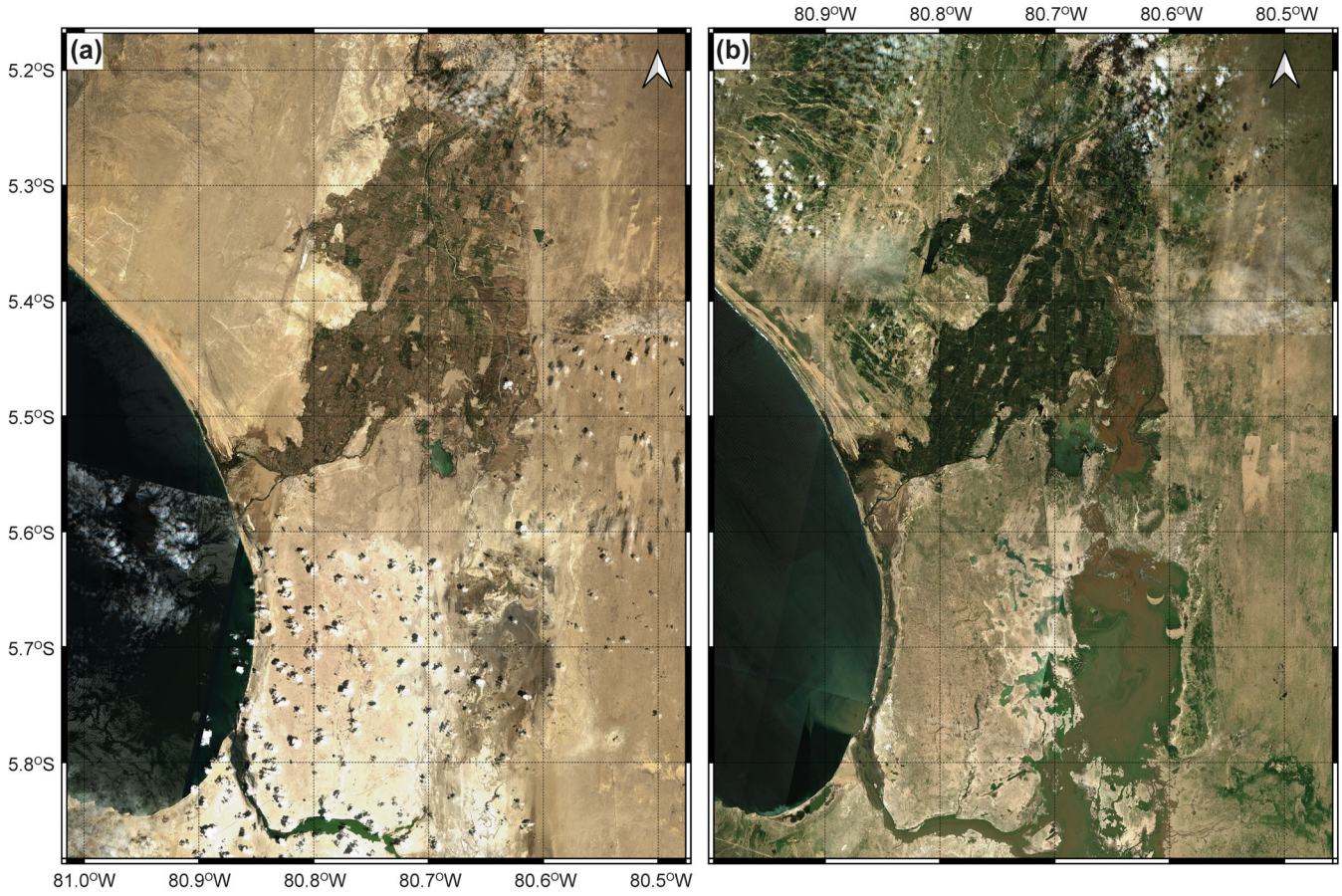

Figure 1. ESA Sentinel-2 natural color satellite images (bands four, three, two) of Piura and the Sechura Desert. (A) image captured on 27 January 2017 prior to El Niño Costero; (B) image captured on 30 March 2017 after El Niño Costero. Images were processed using the semiautomatic classification plug-in (Congedo 2021) in QGIS (QGIS Development Team 2022).

the twentieth century, surpassing the extreme El Niño events of 1982–1983 and 1997–1998 (Takahashi and Martínez 2019).[1]

How do we make sense of such an extreme El Niño event, specific in place and time, in the context of accelerating climate change? Like El Niño, climate change is at once both local and global in its expression. The complexity of the relationship between these two scales is shaped by site-specific and lived experiences, which in some contexts vie for attention in adaptation planning scenarios and dominant popular and policy narratives. In this article we argue that investigating the nuances of these struggles and highlighting lesser known examples of adaptation benefits from the synthetic offer of geography as a discipline. At the same time, our premise is that field-based empirical case study research is also strongly influenced by where research starts both in terms of locations in time and place and the interests of the varied stakeholders who live and make El Niño adaptation experiences.

Unlike El Niño, which is a quasi-cyclical phenomenon occurring approximately every two to seven years, climate change is a long-term perturbation and it affects the evolution of El Niño. In their book *El Niño in World History*, Grove and Adamson (2018) argued that "the narrative of ENSO has also become inexorably bound up with the idea of anthropogenetic climate change" (182). Christidis, Betts, and Stott (2019) examined the influence of human-induced climate change on extreme rainfall events in Peru using probabilistic event attribution methodology and they concluded it plays a key part in increased wet extremes:

> When the effect of large positive SST anomalies similar to 2017 is factored in, wet extremes are estimated to be at least 1.5 times more likely to happen (or 2–3 times for more rare events) compared to pre-industrial times. The coastal El Niño is estimated to increase the likelihood of extremes 3–6 times (best estimate), or more than 10 times for rarer events. (S34)

Grove and Adamson (2018) argued, however, that modeling future scenarios for El Niño based on the General Circulation Models (GCMs) used to project climate change is not fully reliable. Despite improvements in representations, they outlined several weaknesses, including "[t]he magnitude of the phenomenon and the degree of spatial variability can also vary considerably between models" (Grove and Adamson 2018, 219). Therefore, the characteristics of climate change and El Niño and the associations between them pose significant methodological challenges for research. These issues raise cross- and interdisciplinary concerns about what methodological approaches, scales (space and time), and sites are best suited to discerning the intersecting temporal and geographical dimensions of climate variability and extreme weather. How do we understand the different roles that diverse knowledges, norms, and averages play in the configuration of both? These questions are forming a crucial agenda for environmental geographers as popular demands grow for explanations of what people around the globe are increasingly witnessing in their everyday lives.

Origins of the Study: "Placing" a Call for Greater Engagement with Historical Geographic Ethnography in Environmental Geography

Our research on the impacts of El Niño on desert livelihoods started in 2014 during a short field season taking sediment samples of Lagunas Ramón and Ñapique in the Sechura Desert. One of the authors (Andrew C. G. Henderson) had undertaken a previous month-long field visit with a colleague[2] to Peru in 2013, which included a plan to use a boat to take a sediment core from Laguna Ramón lake bed, which appeared as a huge expanse of water on both their paper map and satellite imagery. When they arrived at what the Global Positioning System (GPS) reading said was the center of the lake, the land was dry as far as the eye could see. The local men they met told them they were fishermen but had turned to farming when the lake dried up several years before. This story was the topic of a chance corridor conversation between colleagues in Newcastle University about El Niño and climate change. Nina Laurie, a human geographer and experienced Peru field researcher, was somewhat skeptical about the switch in livelihoods given how close to the Pan American highway, with access to the city of Piura, the field site was. This suggested the community had probably long relied on a mixture of informal links to the city rather than only fishing or farming. This comment sparked an invitation to join the team on their return visit in 2014. Her role was to scope local archives and to ascertain what was available in relation to El Niño with a view to developing a joint funding proposal. The UK team made contact with climate scientist Rodolfo Rodríguez Arismendiz at the University of Piura, whose dendrochronological work pioneered a chronology of El Niño in coastal Piura based on *Algarrobo* (*Prosopis* sp.). This article is the story of their joint research journey and aims to contribute to methodological debate in environmental geography that seeks to work across human and physical geography.

Although such debate coalesces around climate change, the form it takes today is in some ways new, as it places issues of social justice at the heart of modeling discussions (e.g. Colven and Thomson 2018), yet the human and physical question remains at the center of how the discipline has sustained and rejuvenated itself over time (Massey 1999; Lane 2001; Harrison et al. 2004; Cox 2021; Kesteloot and Bagnoli 2021). In contributing to this debate our article highlights the need for a greater role for historical geographic ethnography in environmental geography.

Drawing on a place-based analysis of the ENSO in northern Peru, we sketch out the main tenets of such an approach rooted in cross-disciplinary, cross-sectoral research in and about scale and specific places. The intention at this point is not to provide a comprehensive historical geographic ethnography of El Niño in Peru (or even northern coastal Peru) but rather to outline an approach that is responsive to the localized or diffuse nature and intersection of El Niño–climate change relationships. We make a case for the benefits of such a historical geographic ethnography focus by pinpointing some empirical details and preliminary analyses of key touchdown moments in our cross-cutting research process. In so doing, we respond to two recent methodological calls to geographers. The first is Vincent's call for greater critical appreciation of what coproduction of knowledge through research, collaboration, and engagement with a range of data and approaches can offer

development geography and climate change scholarship and what opportunities will be lost if it becomes diluted (Vincent 2022). The second is Adamson's (2022b) call for "a new research agenda on the critical geographies of ENSO research practice" (877). Our approach highlights the importance of juxtaposing and weaving together distinct methods and types of data across physical and human geography to interpret extreme events. We argue that this is an urgent agenda for phenomena of a cyclical nature, like ENSO, under pressure from climate change as increases in CO_2 levels affect the severity of El Niño (Sarachik and Cane 2011) and its frequency grows due to rising greenhouse gas emissions (International Union for Conservation of Nature 2017) resulting from ocean warming (Laffoley and Baxter 2016; Cai et al. 2022).

Our focus is on the example of Peru because it has become an iconic site for research on ENSO (Seiner 2001). Extensive research has documented the destructive impacts of El Niño with a focus on learning lessons from the 1982–1983 and 1997–1998 events. It has generated detailed accounts by sector and region (Corporación Andina de Fomento 2000) and explored the role of nongovernmental organizations (Mannucci 2000), early warning systems (Zapata and Broad 2000), willingness to pay for mitigation (Fernández et al. 2007), and the limitations of executive power structures in responding to emergency situations (Zapata and Sueiro 2000). Lessons from the more recent 2017 El Niño Costero are currently being used to strengthen disaster response measures in Peru (Burbano, Chávez Cresta, and Villalobos 2018), including in disaster education (Laurie et al. 2023; Bell et al. 2024). El Niño research has a long history in Peru dating back to when fishermen first identified the phenomenon in the late nineteenth century (Pezet 1896). Cai et al. (2020) cited observations by Carrillo (1892), who noted how a warm current appeared off the northern Peruvian coast bordering Ecuador around Christmas time, "disrupting local fisheries and bringing torrential rains to the normally arid coastal plain" (Cai et al. 2020, 215). Both the Pezet and Carillo papers were published in the *Boletín de la Sociedad Geográfica de Lima*, indicating how a disaster narrative around El Niño has long been established in Peruvian science and geography. Such academic lineage makes this narrative hard to decenter and over time renders positive experiences less evident to scholars and policymakers. In this article, however, like Grove and Adamson (2018, 200) we question dominant framings of El Niño, "as a universal scourge that brings nothing but destruction" around the world. They argued that such depictions are not only inaccurate in terms of El Niño–related mortality in the contemporary period, but more important from the perspective of this article, they also serve to marginalize specific groups of people.

In our analysis we bring marginalized people's experiences center stage and aim to draw attention to sites where El Niño can bring abundance and not only disaster. Even though positive experiences of the benefits of El Niño are less widespread in Peru, they have the potential to serve as important reference points as the need for adaptation to future climate change increases (Bell et al. 2024). In global terms, Goddard and Dilley (2005) argued that the "positive benefits of ENSO extremes should be more carefully documented, yielding a more complete appreciation of the socioeconomic impacts of El Niño and La Niña events" (661–62). We argue for the importance of paying greater attention to sites of potential benefit as climate change shifts weather patterns and alters where livelihoods can flourish. Seiner (2001) made a similar point about Peru in his historical reflection on the presence and impact of El Niño from the sixteenth century onward. He suggested that, although in economic terms the panorama of destructive impacts in Peru is wide reaching, "without doubt it is also pertinent to point out and highlight the positive effects that the phenomenon brought" (13).[3] Such an emphasis has not been taken up widely in research, however, despite its current relevance to Sustainable Development Goal agendas on climate action (e.g., UN 2016).

Looking from the perspective of marginal desert communities, a historical geographic ethnography framework has the potential to destabilize homogenizing, calamitous understandings of El Niño in Peru. By investigating how knowledge about El Niño is produced, where and by whom, it makes visible the sources of information that are left out as perceptions of disaster overshadow stories and experiences of abundance. As El Niño events in Peru and elsewhere look set to become more intense in coming years (UN 2016; Office for the Coordination of Humanitarian Affairs 2017), our intervention in geographical and methodological debate is timely.

The first section of the article describes the climate and hydrological characteristics of ENSO in northern Peru. We outline the literature covering the challenges of using Holocene sediment records for pinpointing climate variability and El Niño events in this region. We contrast this work with the rich evidence of ENSO-related changes found in research on archaeological and historical records. Here researchers have used diverse sources to explain El Niño–related shifts in economy and production. Next, we draw on our own empirical research in the Sechura desert region of Piura[4] to highlight the importance of an approach that also engages with more recent archival and ethnographic site-specific data. We showcase how a dominant disaster narrative for El Niño is constructed through the popular press in Peru, drawing inspiration from recent literature on how climate change and disease are constructed in such sources (Mahoney and Randalls 2020; Chakrabarty 2021). We emphasize the importance of a historical geographical ethnography approach that probes where this narrative comes from and the value of comparing dominant disaster representations with hitherto unheard voices from the desert region. Influenced by how storytelling traditions and entangled narratives shape research on the transformation of environments into social landscapes in anthropology (see Cruikshank 2005), we argue for greater use of ethnography in "ground truthing" social and physical findings on extreme events in environmental geography. In the conclusion we call for researchers to be more explicit about the role of collaboration and engagement between themselves and other sector actors "in place" to move toward more coproduction of research on extreme events.

El Niño/Southern Oscillation in Northern Peru

The ENSO dominates modern climate variability, and to understand its response to elevated greenhouse gases considerable research has gone into understanding its modern dynamics and history (e.g., Moy et al. 2002; Cobb et al. 2013; Cai et al. 2022). Despite agreement between models about changes in Pacific climate mean state, the link between ENSO and the underlying climate mean state remains elusive. Emerging evidence points to a nonlinear evolution of ENSO, with no two El Niño events being alike.

Peru is intimately linked to popular imaginaries and histories of the El Niño phenomenon. The two most extreme El Niño events on recent record, in terms of warming SSTs in the far eastern Pacific, occurred in 1982–1983 and 1997–1998, and the most recent El Niño in 2015–2016 exhibited the strongest warming in the central-eastern Pacific (Santoso et al. 2019). During the 1982–1983 and 1997–1998 events, Piura, a city in the coastal Sechura Desert in northern Peru, and the wider province and region called by the same name, experienced devastating floods because of a greater than ten times increase in the discharge of the River Piura (see Figure 2). As the extent of flood-driven standing waters increased, the incidence of vector-borne diseases spiked in northern Peru. There was a malaria epidemic in 1982 and 1983, and a resurgence of cholera formed part of a cluster of multidisease risk (an "ecosyndemic") that affected the Piura region following the 1997–1998 El Niño (Ramírez, Lee, and Grady 2018). Unlike the 1982–1983 and 1997–1998 El Niño, SST anomalies of the 2017 El Niño Costero (and the 1925 one) are confined to just the eastern Pacific coastal zone, resulting in higher magnitude rainfall and flooding over the adjacent landmass in northern Peru, rather than more widely along coastal Peru as in previous event years (Takahashi and Martínez 2019; see Figure 3).

To put the detail of these temporal comparisons into perspective, during the 1997–1998 El Niño, the city of Piura experienced annual rainfall amounts equivalent to the other forty rainiest years combined, and Peru suffered direct losses of $1 billion of which $800 million was from the northern Pacific Coast, reducing the country's gross domestic product (GDP) by 12 percent. This single event is on par with the recent impact of the country-wide COVID-19 pandemic in Peru that reduced GDP by 11.1 percent in 2020 (Instituto Nacional de Estadística e Informática 2021).[5] Whether through the retelling of such major financial losses or longer term archaeological accounts that link the rise and fall of pre-Colombian societies to ENSO events (Nials et al. 1979; Craig and Shimada 1986), the dominant representation of El Niño in Peru is firmly established throughout history as one of a common frame of disaster, a motif that has meant different things to different people, in different places over time in Peru.

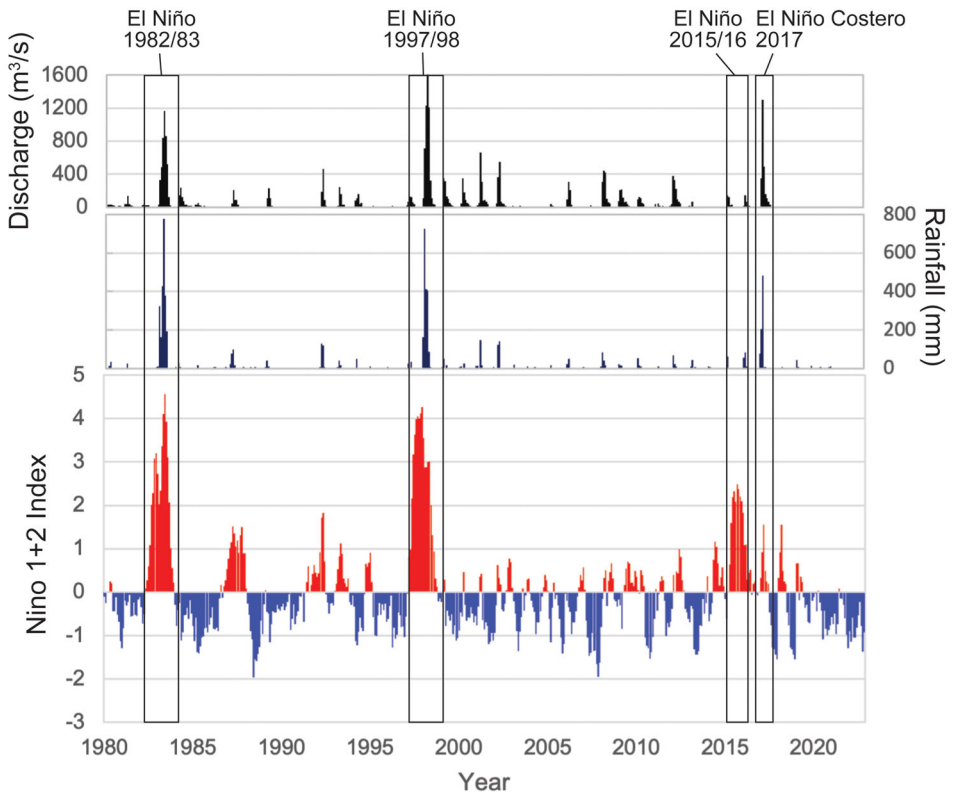

Figure 2. (A) River Piura discharge since 1980 recorded at the Sanchez Cerro Bridge in Piura City. (B) Rainfall since 1980 recorded by the University of Piura weather station. (C) The Nino 1 + 2 index (Reynolds et al. 2002), representing sea surface temperature (SST) anomalies in coastal Peru calculated as average SST between 0°–10°S and 90°–80°W. Data downloaded from NOAA/ESRL Physical Sciences Laboratory, Boulder Colorado (http://psl.noaa.gov/). Recent El Niño events have been highlighted.

El Niño Flood Dynamics and Records in the Piura Basin

The Piura River basin (2,000 km^2) in Peru is an important site for understanding the dynamics and hydrological impacts of ENSO. The river drains from the Western Escarpment of the Andes (at 3,600 m a.s.l), with a number of prominent transverse streams that drain into the main trunk channel at ~200 m a.s.l. It then flows through the city of Piura and into a lower basin mud flat (Laguna Ramon and La Niña) in the Sechura Desert, and out into the Pacific Ocean (see Figure 4).

Precipitation in the headwaters is controlled by the position of the intertropical convergence zone (ITCZ) and the subtropical jet (easterlies; Garreaud, Vuille, and Clement 2003). During austral summer (December–February), the southerly location of the ITCZ promotes upslope transport moisture from the Amazon. In austral winter (March–November) the ITCZ is further north, and westerlies dominate, reducing the amount of precipitation. The flow in the Piura River reflects this wide seasonal fluctuation, ranging from 5.72 m^3s^{-1} for about ten months of the year to 200 m^3s^{-1} in the rainy season, but during an El Niño year this rises to ~500 m^3s^{-1} under moderate conditions, and a peak flow of ~1,600 m^3s^{-1} under severe conditions (Fernández et al. 2007). The links between River Piura discharge, rainfall, and underlying index for coastal SST anomalies (the Nino 1 + 2 index) show a strong coupling during the 1983–1983 and 1997–1998 El Niño events but during the most recent El Niño event in 2015–2016 despite the increase in the Nino 1 + 2 index there is not the equivalent discharge driven by rainfall (Figure 2). Although the 2015–2016 El Niño was one of the strongest observed since the 1950s—it was exceptional in terms of its anomalous warmth in the western, central, and eastern central Pacific—the SSTs in the eastern Pacific zone of Niño-3 and Niño 1 + 2 (see Figure 3 for zonations) were cooler than the 1982–1983 and 1997–1998 events (see Figure 3). As a consequence, coastal Ecuador and Peru did not

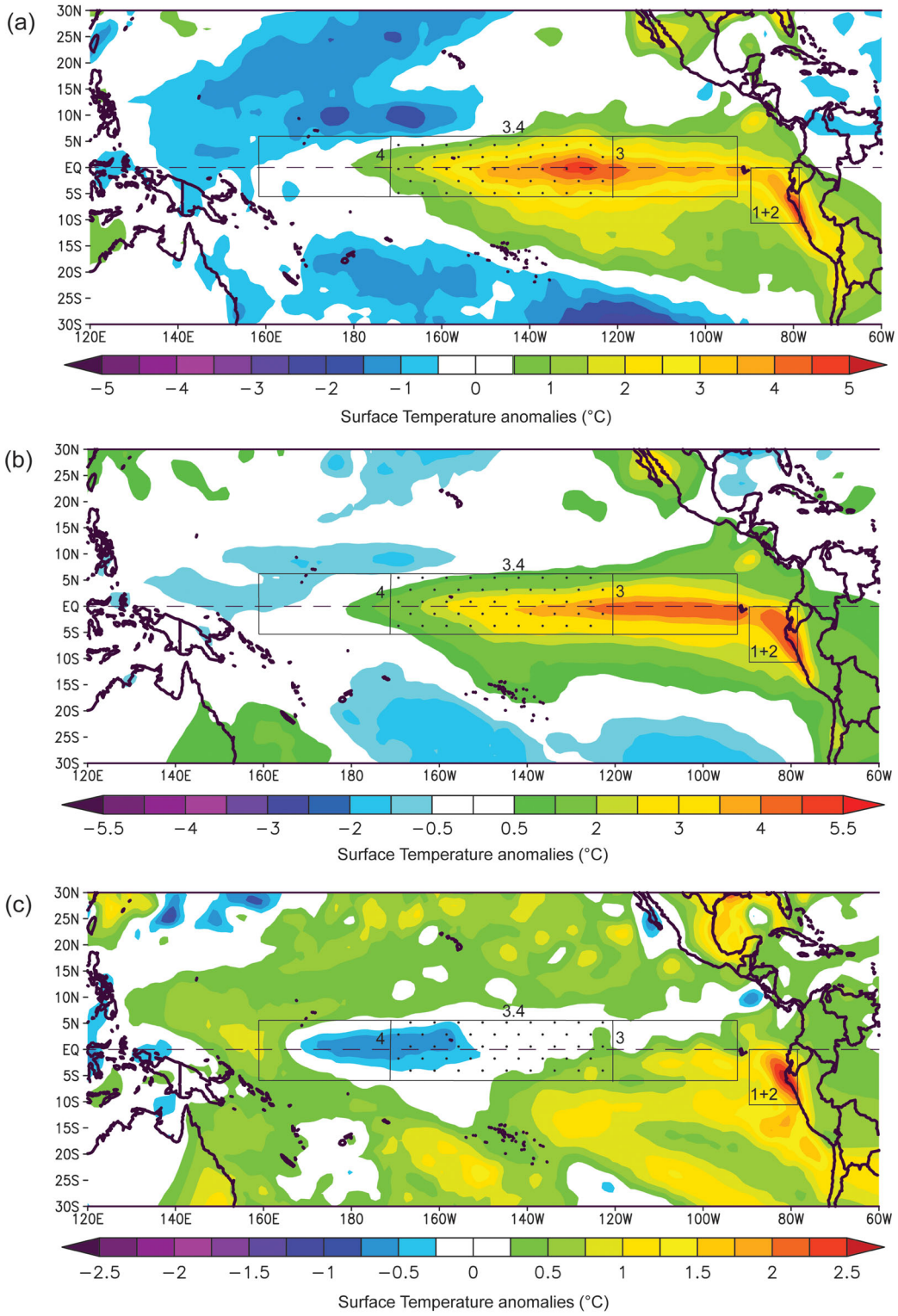

Figure 3. Surface temperature anomalies across the tropical Pacific (120°E–60°W) for three different El Niño events in (A) 1982–1983; (B) 1997–1998; and (C) 2017. Numbers on the maps represent different El Niño temperature indexes: (1 + 2) is the Niño 1 + 2 region corresponding to coastal South America and where El Niño was first recognized; (3) is the Niño 3 region; and (4) is the Niño 4 region, which has been the focus of monitoring and predicting El Niño until research showed that the key region for El Niño-Southern Oscillation changes is further west and it defines the Niño 3.4 region (stippled area; Trenberth 1997). Images plotted using the NOAA OI v2 SST data set from the NOAA/ESRL Physical Sciences Laboratory, Boulder, Colorado (http://psl.noaa.gov/).

experience the devastating increased rainfall recorded during the 1982–1983 and 1997–1998 El Niño events (L'Heureux et al. 2017). When warming was observed in the Niño 1 + 2 region and neutral temperatures occur in the Niño 3.4 region during 2017, there was increased rainfall in northern Peru and Ecuador, which defined an "El Niño Costero" (Echevin et al. 2018). The cause of this localized "El Niño" remains under debate (Martínez and Takahashi 2017; Echevin et al. 2018; Adamson 2022a).

The sediment response of a catchment is a complex function of climatic and geomorphological processes. El Niño has a strong influence on stream flow, largely related to El Niño–influenced precipitation trends, and in turn a direct geomorphic and biogeochemical impact on a river basin. A number of studies have investigated the tributaries in the upper catchment of the River Piura (Schneider, Schwab, and Schlunegger 2008; Mettier et al. 2009; Abbühl et al. 2010). Taking different approaches (landscape evolution modeling, remote sensing, ^{10}Be-derived denudation rates) these studies all highlight a central role for ENSO in controlling the River Piura discharge and landscape. They established (1) storminess (linked to El Niño) influences the production and transport of sediment on hillslopes and in channels (Schneider, Schwab, and Schlunegger 2008); (2) seasonal easterly precipitation is responsible for initiating the production of sediment through weathering and hillslope processes, but it is the highly episodic El Niño that causes export of sediment through channelized sediment transport down to the coastal basin, suggesting a climate-driven coupled sediment production–delivery system (Mettier et al. 2009); and (3) downstream decreases in channel gradient spatially coincide with the reaches of highest precipitation rates during El Niño, suggesting that Holocene landscape evolution is controlled by long-term climate (Abbühl et al. 2010).

Holocene records of El Niño variability are critical to understanding equatorial Pacific climate change and ENSO dynamics but currently few long-term data sets exist on which analyses can be based. Significant progress has been made using a range of proxy records derived from coral, speleothem, and some lake and marine sediment archives (Rein et al. 2005; Sachs et al. 2009; Cobb et al. 2013; Conroy et al. 2014) but no single continuous archive of ENSO exists from coastal northern Peru. The range of natural and historical paleoclimate archives (flood deposits, beach-ridge, tree-ring, biological, archaeology, and ethno-history data) in the northern coast of Peru and the Sechura desert region specifically, however, means that the region has real potential as a site for ENSO reconstruction (Macharé and Ortlieb 1993).

Building an Approach to Understanding Long-Term Human Integration with El Niño

Even though a gap in Holocene sediment archives currently exists, the same is not true for records of human experience of ENSO. There is a rich archaeological literature documenting the activities of coastal civilizations in the north and linking these to specific El Niño events. From the renewal and expansion of temple architecture in the second millennium BC (Nesbitt 2016), to the complex systems of trunk and branch canals built by the Moche culture to take advantage of El Niño flood water in the desert, there is ample evidence in the north that "[a]ncient farmers treated the El Niño phenomenon as part of the norm" (Caramanica et al. 2020, 24127). The Sechura Desert provides an important site for studying human subsistence in response to the environmental stresses of aridity and limited land resources (Goepfert et al. 2014). It has been occupied for at least 5000 years and excavations from marine terrace settlements dating from 200 BC to AD 600 and AD 600 to 1000 indicate a complex, specialized site for fishing, fish preparation, and transport routes into the mountains existed in the desert. According to Goepfert et al. (2014), this is "unprecedented for the region and the period." Their analysis of fish vertebrae remains in middens suggests that this system relied on lagoon creation associated with ENSO. They argued that the high-intensity El Niño events, which coincided with settlement occupation between AD 547 and 766, enabled "the perennial flooding of the sandy plain that separates the site from the current shoreline and therefore the entry of marine fish." In current times, El Niño flooding in the Sechura Desert has similarly facilitated the inflow of marine fish species such as lisa (mullet: *Mugil labrosus*, and *Mugil cephalus*), mojarra (*Andinoacara rivulatus*), and tilapia (*Oreochromis niloticus*).

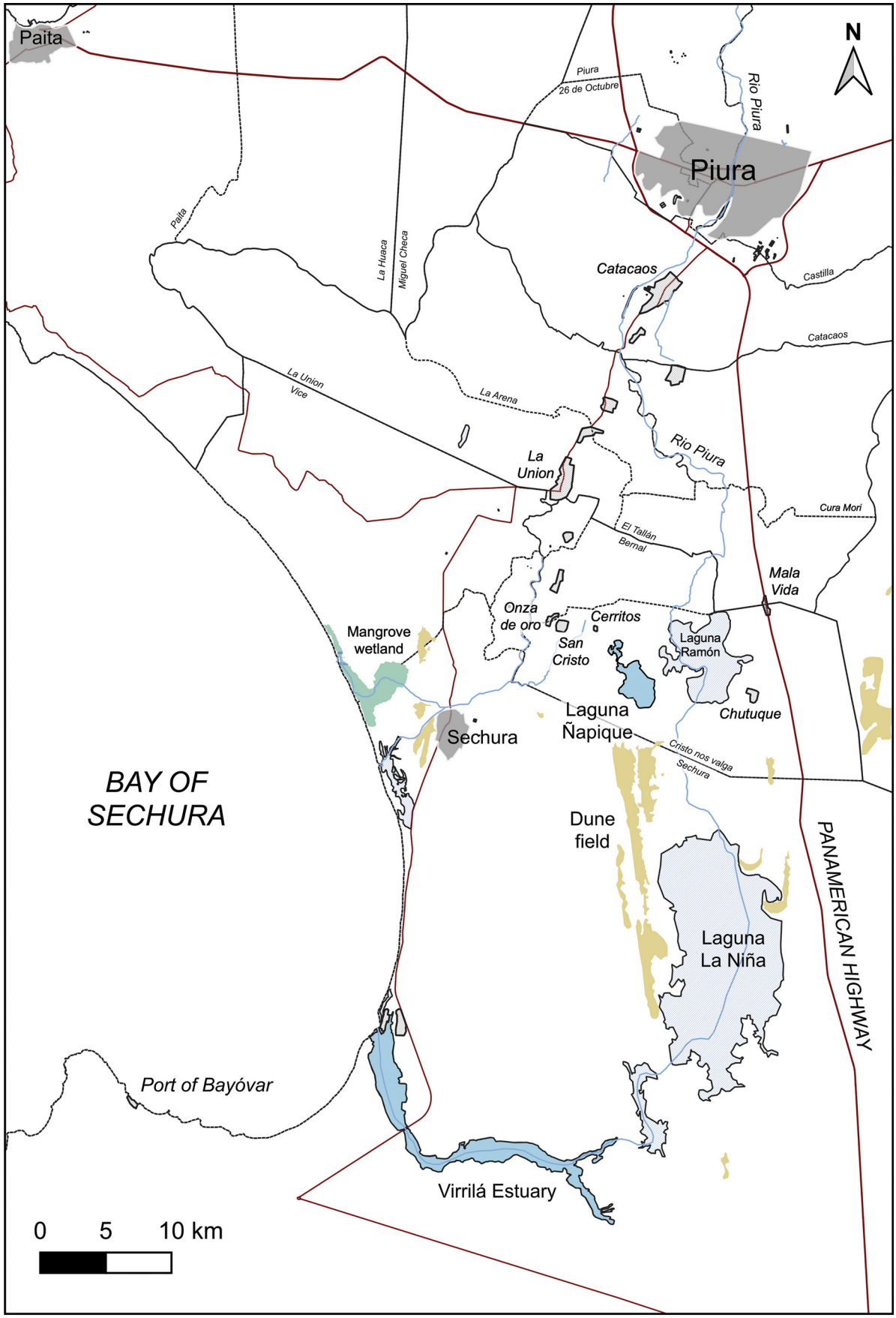

Figure 4. Location map of Piura and Sechura in northern Peru. Major cities, towns, and villages discussed in the text are labeled, as well as the course of the River Piura and the location of ephemeral lakes that fill with water (Lagunas Ramón and Niña) after an El Niño event.

Scholars seeking evidence of ENSO-related changes in economy and production during the colonial Viceroy period (1542–1824) and early republican era (1824–1879) have also examined a range of archival material. Seiner (2001) cited sources that describe how insect and animal plagues in 1578 and 1701 negatively affected crop production, also referencing a chronicler from the eighteenth century who mentioned the positive benefits of El Niño on soil fertility and crop yields in the Trujillo region. He also highlighted some positive effects of El Niño on economy and production in the nineteenth century between 1870 and 1895, a period that experienced four very strong El Niño events (Seiner 2001). He cited Eguiguren (1894), who described how the unpopulated area of Sechura flourished with *algarrobo*, sisal and local fruits, and medical plants (*zapotes vichayos* and *palo santo*) during this period. Such historical approaches based on eyewitness testimonials are complemented by the work of Schlüpmann (2003), who explored the potential of using records of tithe payments ("taxes" levied, often in the form of produce) to trace patterns of climate change in Piura between the seventeenth and nineteenth centuries. Their findings point toward a sustained increase in agricultural production between the seventeenth and eighteenth centuries. This peaked during the second half of the eighteenth century in Piura, with a subsequent decline discernible for the early years of the nineteenth century (Schlüpmann 2003).

Whereas Schlüpmann's work illustrates how periods of drought affecting the region during the colonial era can be identified through tithes, attempts to reconstruct a timeline of El Niño events based on pinpointing specific periods of heavy rains are more contentious. Based on an analysis of the key sources used by scholars for the period from 1532 to 1891, Hocquenghem and Ortlieb (1992) questioned the interpretation of some periods of abnormal heavy rains and their association with El Niño. They revised the chronology of El Niño occurrences put forward by Quinn, Neal, and Antunez De Mayolo (1986, 1987) arguing that some El Niño events did not occur and others were less intensive than originally suggested. In the seventeenth century, for example, they argued that only two El Niño periods of intense rains can be identified (1624 and 1686) rather than the eleven previously identified. They called for scholars to extend their examination of sources to include unpublished archives in private hands to gain a clearer picture of events.

Extending the search for historical sources in general, however, is not straightforward. The case of northern Peru illustrates this challenge well. A decade on from their original critique of efforts to construct an El Niño chronology, Ortlieb, Vargas, and Hocquenghem (2002) noted that, within the key areas where the most reliable ENSO impacts are felt (Piura and Tumbes), "only discontinuous chronicles and anecdotal data are available" (16). Ironically, the main reason for the lack of municipal archives with data on past ENSO events is the destruction of documental evidence caused by El Niño flooding in 1983. Seiner (2001) also questioned the reliability of Quinn, Neal, and Antunez De Mayolo's (1986, 1987) indexes of El Niño appearances and intensity over a four-century period. He argued that of the eighty El Niño events registered from the sixteenth century, across three levels of intensity, only nine offer data that would lead to confirmation of both high levels of intensity and a strong probability of an El Niño occurring at the same time. His critique of Quinn, Neal, and Antunez De Mayolo's (1986, 1987) original register relates to an overreliance on evidence from the north of Peru only, and in the case of older sources especially, concerns that such evidence is usually confined to local and space-specific accounts. There is little mention of unusual events in other parts of Peru coinciding with heavy rains on the northern coast (Seiner 2001, 6). Such challenges in using archives for climate reconstruction in northern Peru highlight the wider limitations of single-source approaches to climate and extreme weather event reconstruction, a point widely and commonly made in the literature on historical sources for reconstructions of climate. In recent decades, geographers have been at the forefront of responding to these limitations by developing multisource approaches to environmental reconstruction.

Reconstructing past environments through a combination of archival and paleoclimatological data is now a well-established approach in geography. It gained prominence in research on Latin America in the mid-1990s, when physical geographers (O'Hara and Metcalfe 1995) working in Mexico brought the abundance of historical documentary sources to the attention of Holocene scientists. Their study used a combined analysis of colonial archives and lake-bed samples to pinpoint regional differences in climate variation, which they suggested could be explained

by the differentiated influence of ENSO events on prevailing climate conditions. Such a dual-source approach has since been widely adopted in ENSO research on drylands by geographers working in other world regions (see, e.g., Nash and Endfield 2008 on the Kalahari). Subsequent work has made use of diverse documentary sources, ranging from missionary archives (Endfield 2010) to newspapers, letters, reports, and diaries (Nash et al. 2019), and in a colonial context, maps and surveys (Garden 2009). Geographers have long championed the call for more critical approaches toward the relationship between environmental stress conditions and civilizations' collapse, as evidenced by the rich tradition in U.S. cultural geography from Sauer (Demenocal et al. 2005) onward (Wynn 2020; Colten 2021). Francophone tropical geography has also been centrally concerned with this relationship (Bowd and Clayton 2019). Such work questions the dominance of apocalyptic scenarios. As a result, some argue for a greater engagement with social science agendas on collapse that emphasize more nuanced understandings of social cultural processes (see Endfield 2008; Butzer and Endfield 2012; Endfield and Mahony 2018).

The cross-fertilization between historical geography and paleoclimatology is a vibrant field, but triangulation with more contemporary sources can also help address persistent and challenging gaps in archival and paleo-records. Here ethnographic and qualitative data—interviews, intergenerational oral histories, and community-based participatory approaches—can play an important role in recalling and illuminating recent environmental memory and culture. Policy-focused research also recognizes the value of such a melding of approaches. A World Bank analysis, "Transitioning to Climate Resilient Development" in Peru (Sperling et al. 2008), combined an analysis of quantitative climate and SST data with community-based participatory processes to elicit information on perceptions of exposure to what they called environmental "risks and hazards" (Latrubesse 2010). In cross-cultural contexts care is needed in the use of such a language to avoid perpetuating what Rivera (2020) termed "disaster colonialism,"[6] but it is useful to cite this report in this article because it highlights how embedded a dominant disaster narrative, based in a language of risks and hazards, is in wider perceptions of El Niño in Peru. El Niño events featured highly when participants were asked to recall episodes they considered to have been a major disaster for their community, due to its significant effects on human health, infrastructure, or production systems. In Piura, two of the case studies are drawn from the Sechura Desert region, one inland and the other on the coast. Of particular interest are the details concerning how residents "remember" ENSO events. The study points out that it is usually only what the residents perceive as the most disastrous events that are recognized as being ENSO episodes, whereas local populations do not usually associate less severe events with El Niño, despite them being part of the same ENSO phenomenon. Such findings support the argument that a dominant disaster narrative around El Niño exists in Peru. Such narratives serve to obscure other, site-specific experiences of what the World Bank terms "resilience" and we call livelihood opportunities that a historical geographical ethnography approach would also aim to make visible.

"Placing" Local Records of the Physical and Social World: A Historical Geographical Ethnography for an Environmental Geography of El Niño

In 2009 Peru's first carbon offset program was in the dry forests of the northern coast of Peru, aiming to sequester 600,000 tons of CO_2 equivalent (Sabelli 2011). Many tree species in these forests record growth responding to rainfall associated with ENSO events in their tree rings (Rodríguez et al. 2005). Located in this wider ecological region, the Sechura Desert is dominated by dry forest *algarrobo* (carob) trees (*Prosopis pallida*) that are protected under forestry laws. Extreme rainfall events, associated with ENSO, are largely responsible for their establishment and growth; consequently, these trees are very useful in reconstructing past climate change as they indicate high levels of sensitivity to water availability (López et al. 2005; Rodríguez et al. 2018; Salazar et al. 2018). In the context of limited livelihood opportunities in the desert (Bell et al. 2024), the trees are a source of carob essence extraction, and the carob fruit has a high nutrient content.[7] In socioeconomic terms, however, the drylands are marginal areas, categorized as peripheral in comparison to the rich coastal, wider irrigated plains and uplands of Piura where political power is centered

(Ministerio de Desarrollo e Inclusion Social 2013). These provincial, marginal desert communities seldom figure as protagonists in regional development forums. This includes in relation to ENSO agendas where they have a unique perspective to offer that challenges disaster narratives.

Responding to recent calls for human geography to be more explicit about how qualitative data are collected and analyzed, we next flesh out the details of a historical geographic ethnography approach. We provide the "scratch notes and back stories" (Hitchings and Latham 2020, 975) concerning our El Niño data and describe the wider context in which our ethnographic methods were developed and used. We aim to show that such a historical geographic ethnography approach is especially pertinent to methodological debate in environmental geography, where the combination of multiple sources of different types of data, as discussed earlier, has much to offer.

"Scratch Notes and Back Stories": Reconstructing El Niño from the Margins

On arrival in Peru in September 2014, the UK team hired a 4 × 4 vehicle in Lima to transport their equipment north to Sechura, a journey of two days. Once in the Piura region, they liaised with climate science team members at the University of Piura and visited the local district municipality to ask permission to core for samples before starting field work. There, the district mayor offered to accompany and guide them across the desert, as he needed to visit some of the more marginal communities on the other side of the Pan American highway. Without crossing the desert, the journey is a circuitous one requiring travel back north, nearly as far as the main city, Piura, before coming south again.[8] This journey became what Hitchings and Latham (2020) referred to as a "[m]agical ethnographic moment," an example of a "turning point[s] in the data collection process when working assumptions are suddenly called into question" (174–75). It resulted in redirecting research toward investigating El Niño as abundance, and a potential opportunity, rather than only as a disaster. In the following vignette we elaborate on the detail of the field practices that allowed the observation that it outlines (the "magical moment") to take place. We present the account in "travel log" style in the first person, as if it were an extract from a field diary written by Nina Laurie:

> Although only covering a distance of about 14 km over sandy tracks, our journey across the Sechura desert lasted several hours because we stopped frequently at small, scattered settlements. Each time the mayor got out, shook hands, and introduced my male scientist colleagues, as a woman, and perhaps because I was as social scientist, I was almost invisible in that setting. As is often the case in ethnographic encounters, however, this situation proved to be an advantage. In making conversation from my backseat position, I started to ask about the desert around us, which at this point in September 2014 was completely dry. I saw absolutely nothing beyond sand, the occasional carob trees and some skinny looking goats trying to find shade. When I asked the mayor about the devastation caused by El Niño, which I had been reading about in a local newspaper archive in Piura, he became animated. He said: "Well you know for us El Niño is not disaster señorita, it's 'abundancia' (abundance)." He described how the desert turned green with the rain, providing plenty of pasture for animals. In this context people can raise cattle as well as goats, and graze more mules, and donkeys used for drawing wooden carts to transport both people and goods. Large lagoons appear and so people can also fish. As we drew closer to the Pan-American highway, we saw a welcome sign marking the boundary to the district of Cristo nos Valga, as if painting the picture he had described, it depicts the area as a resource for tourism, for fishing, for livestock, and for agriculture (Figure 5).

This unexpected journey across the desert sowed the seed for the research that followed. Although we did not press the mayor about his observation at the time, we became curious as to whether he had exaggerated, and if what we had been seeing in the archives was only a partial version of events. Such reflections about our "magical ethnographic moment" follow a long tradition of anthropological and cultural geography work where the emphasis is on there being a variety of "rains" and impacts (see Schnegg 2021 for a recent contribution in this field). In this vein, our reflexivity was as much about questioning our own understanding of El Niño across human and physical geography and current climate science in Peru, and how we should practically go about studying it, as it was about questioning the mayor's specific version of events.

Dialoguing Between Archives and Ethnography

Over a period of five years (2014–2019[9]) we gathered oral testimonies and analyzed more than 6,000 newspaper cuttings from an archive in Piura.[10] The

Figure 5. A hand-painted sign welcoming travelers and visitors to Cristos nos Valga in the Sechura Desert. Note the depiction of full water bodies and agricultural production. Photo by Nina Laurie.

initial newspaper analysis, undertaken before the encounter with the district mayor, followed standard development sector categories: social development (housing, education, and health), economic indicators (production, infrastructure, and economy), and political categories such as governance (local, regional, national, and international) conflicts and scandals. Attention was given to whether the spaces referred to were "rural" or "urban," which mapped onto long-standing administrative distinctions in the region and province (lowland, highland, and metropolitan Piura). Whereas these sectoral categories and geographical boundaries reflect what Scott (1998) termed "seeing like a state," a set of indicators of high modernism that render societies legible through uniform languages and measures, the oral histories were less constrained. Gathered via semistructured interviews with stakeholders (fishers, farmers, merchants, lorry drivers, fish processors, local government, and civil society representatives), they also included impromptu conversations with individuals and groups of people while we were in the field collecting sediment samples and climate data.[11] Taking a course of their own, conversations frequently detailed and contrasted the experiences of the different El Niño events, and any distinction in national and regional newspapers' coverage of 1983 and 1998 was purposefully noted to ascertain whether the disaster narrative and the different elements that constituted it differed over time and distance. We do not have the space here to detail the results of this work, but we draw attention to the potential insights gained from generating dialogue between these two sets of findings. Such a methodological approach is useful in the context of Grove and Adamson's (2018) observation that the 1997–1998 event was a turning point in representations of El Niño globally. The evolution of topics was tracked across both events in each data set. In this way, the architecture of our historical geographic ethnography was forged as we sought to find a broader context into which we could locate our physical geography research. Akin to the Latin Americanist regional geography tradition inspired by

Sauer in the mid-1920s, we sought to understand how cultural landscapes are made up in and through engagement with the physical environment. We triangulated our sources and emerging findings and, as research shifted following our "magical moment," we aimed to establish whether the mayor had been exaggerating.

In observational settings and through interviews we asked desert dwellers to recall what impacts El Niño had and has on their livelihoods. We talked to adults of different ages and genders; we included those who were mainly farmers but who also undertook artisanal fishing in the lagoons when they appeared, as well as professional fishers who usually made their living in the coastal shellfish industry, always badly affected by El Niño (Estrella and Swartzman 2010). Heeding Hitchings and Latham's (2020) call for qualitative researchers to provide more details about processes of analysis and choices in data presentation, the following interview extracts were collected and analyzed over the course of three visits between 2018 and 2019 when memories of the 2017 El Niño Costero were still fresh. They were selected because, like the mayor, they suggest that farmers and fishers living in the Sechura Desert see El Niño in terms of abundance.

> We become joyful when the rain comes because the rivers fill up with water and it fills lagoons like La Niña with small mullet nursery fish. (Professional sea fisherman, fifty-year-old man, Onza de Oro,[12] 2018)

An older male respondent, a farmer and occasional artisanal fisher, drew out the mutual benefit of fishing and farming. A good harvest can provide funds for tools for fishing, he said, and when there is a good catch of fish, fertilizers can be purchased.

> With El Niño, after the rains pass the soil remains damp, we plant crops, we grow corn, watermelon, other crops such as beans. We grow everything because with those damp soils we can harvest, we harvest everything. … It's mutual, so there is always something. Sometimes when there is a good harvest from the farm that's when I buy tools to go fishing and also when there is good fishing, we want things for the farm. (Small-scale farmer and artisan fisher, seventy-two-year old man, Cerritos,[13] 2019)

What is being emphasized is that for several years after an El Niño event it is possible to plan more easily and use the income from one activity to supplement the other. In this setting a complex fishing and food system operates that makes livelihoods more sustainable for a period. Fishers make camps and remain on the shoreline for up to two to three weeks at a time, and drivers take refrigerated lorries to the lagoons and stay there up to three days.

> To obtain the fish, in the first place we take the fishers and their rafts and we drop them off at the Lagoons. They go out with their nets and they leave them there for about five to six hours. When they return, they collect the fish that are caught in the net and they bring them ashore where we are waiting with barrels. We go with refrigerated lorries full of ice for the fish processing. When the fishers arrive at the lorry, he washes the fish with water from the lake, when they are very well washed, he dresses them in ice and stows them in the lorries. (Lorry driver in his sixties, Sechura, 2019)

They fish from small artisanal rafts like those that have been used by inshore coastal fishers for centuries. Each lorry carries between 400 and 500 large plastic fish boxes that hold up to 20 kg. Once stored in the sealed lorries, the catch is taken as far as the market in Ventanilla, Lima, or closer, down the coast, to the city of Chiclayo. Some local traders also take small quantities of salted fish up to towns in the nearby *sierra* (mountain region), and women and wholesalers sell in the local market in La Union.

These stories of innovation and flexibility, of taking advantage of moments of abundance, did not reflect the version that appeared in the newspapers. Our analysis of approximately 6,656 newspaper cuttings covering the 1983 and 1998 El Niño events found almost no mention of their positive influences on the livelihoods of desert communities. In this sense it follows closely the findings of previous analyses of media coverage of the 1997–1998 El Niño where "memory of the highly destructive El Niño of 1983 was still fresh in their minds" (Zapata and Broad 2000, 11). After our conversation with the mayor and as ethnographic data emerged, we adopted an iterative approach to data analysis that looked across the archive material and testimonials. This was not a linear process; we did not concentrate on one and then the other, but by organizing field work around all sources, sediment coring, collecting climate data, newspaper analysis, and ethnographic engagement, we held them in dialogue, cross-refencing back and forth to check out points. To core, we first looked at where water existed and persisted. These sites influenced the focus of ethnographic study, which in turn identified other

potential coring sites. Our follow-on funded work moved from San Ramón to Laguna La Niña because it floods and so has the possibility of providing an El Niño record. Yet, there are no guarantees in the record that the floods preserve and, in this case, a hard cap made coring difficult and no clear record was present. More recently, our paleoclimatic data collection has shifted to an archaeological site, Chusis, near Sechura, where an exposed sediment profile promises evidence of multiple El Niño events. This area, however, was badly damaged by Cyclone Yaku in March 2023, indicating that like the loss of regional documentary paper archives in the 1983 El Niño mentioned earlier, sedimentary records are also vulnerable to the phenomenon they preserve.

Our sequenced field seasons meant that although we used the same categories established in 2014 to analyze the newspapers, in later visits to the archive we were able to pay greater attention to where different types of stories appeared (in supplements or specific sections of the newspapers, on the front page, etc.). We specifically looked for any evidence of the communities and desert area we had visited with the mayor and took note of what types of imagery were associated with which sorts of stories. In total we recorded 13,198 mentions of when any category was covered in an article as often a single story came under more than one label and a topic was often covered in multiple newspapers. Elsewhere Clayton has used the phrase "'circumlocutory geographies' to describe this to-ing and fro-ing of ideas and information" (Lester 2003, 287).

The category that dominated newspapers' coverage of both the 1983 and 1998 events was infrastructure and its destruction, due in large part to El Niño's impact in urban areas and on urban infrastructure, and a long-standing elite urban-centric bias in the media. Its prevalence, however, also reflects what French et al. (2020) argued is the "extensive exposure and vulnerability of Peru's population and infrastructure [to] high levels of disaster risk" (2212) more generally, when combined with the geophysical characteristics of El Niño. In broad brush terms, this topic amounted to 21.65 percent of all coverage across all categories. Reporting largely addressed infrastructure impacts in the city with transport dominating.[14] Very few articles focused on the impact of El Niño on agriculture or fishing. Only 5.68 percent of reporting mentioned agriculture and in these the destruction of irrigation infrastructure or farming land, rather than the impact on agricultural livelihoods more broadly, was the focus. Given the importance of artisanal fishing in the region (Gozzer-Wuest et al. 2022), it was a surprise to find that this only generated 0.95 percent of the coverage (discussed only 126 times). In summary, from extensive flooding to the severe disruption of regional and national infrastructure, the big-picture story told in the newspapers about El Niño was one of disaster, which raised challenges for our research approach.

Infrastructure Inflections: Mobilizing a Disaster Narrative for Development in Peru

Although we struggled to find evidence of the abundance that people making their livelihoods in the Sechura Desert spoke about, we did find a small number of local stories that fitted with the dominant disaster narrative. These short articles in national newspapers in 1983 spoke of the ways in which communities came together to tackle the negative impacts of El Niño on infrastructure. In 1983 one newspaper (*Correo*) specifically mentioned the desert settlement of Cerritos in Cristo nos Valga. It told the story of how its residents worked together with *pico* (pickaxe) and *pala* (shovel) to clear the way to the road by hand, as machinery had not yet arrived from the municipality. No picture was provided but the local community leader, Sr. Manuel Chunga Flestas, was quoted as saying that the *faena* (Spanish word for a required communal community labor task) was carried out in *trabajo typo minga* (work in the style of a *minga*) ("A Punto de Pico" 1983). Another national tabloid newspaper, in the section labeled "provincial" news, featured a photograph of a long line of men pictured with spades digging out a channel to divert flood waters, alongside the title, in capitals: "*PIURAROS REVIVEN LA MINKA*" (People from Piura revive la Minka) followed by a subtitle: "*Milenario Sistema de Trabajo Comunitario para Salvar Campos de Cultivos*" (Thousand years old system of community labor is to save cultivated lands; "Milenario Sistema de trabajo comunitario" 1983). The imagery and wording in both articles are interesting because they invoke a motif from pre-Inca times. *Minga* is the Hispanicized version of *Minka* or *Mink'a* in Quechua that refers to a form of group work where, under communal systems of reciprocity, individuals provide labor on the promise of help in return (Mayer and Alberti 1974). In the

Inca empire, *Minka* was the basis for the way in which work was carried out in communities. In Piura, however, the first region to be colonized by the Spanish in what became Peru,[15] less than 5 percent of the population speak Quechua (Hornberger and Coronel-Molina 2004).[16] This raises questions about the cultural, historical, and geographical stereotypes being mobilized in disaster narratives about El Niño in the country.

Writing about a similar context, that of monsoons in India, Morti (2015) highlighted the significant role that the print media (and now, increasingly televisual and social media) can play in constructing and controlling a disaster narrative, especially for state ends. The narrative evident in these two stories from Peru in 1983 implies that the people living in the north, in "the provinces," are somehow trapped in the past, distant from contemporary imaginaries of development. This is a curious contradiction, however, given the central role that this region plays in the link up of large-scale infrastructure corridors across the tropics (Bebbington et al. 2020). An important corridor stretches from Amazonia to the northern coast of Peru where oil is exported through the port of Bayovar in the Bay of Sechura, along with phosphates from the Sechura Desert. The region's long-standing engagement in these activities, we would argue, goes a long way toward explaining the emphasis given to infrastructure in the national disaster narrative about El Niño. Most important, this emphasis obscures other "provincial" stories about the livelihoods and ecological stability that Bebbington et al. (2020) argued are being eroded by current infrastructure-led development.

Such development imaginaries are a pressing agenda in northern Peru, as reconstruction currently underway following the 2017 El Niño Costero is concentrated on new large-scale infrastructure projects being carried out in partnership with the UK government (Department for International Trade 2020). These projects aim to protect urban areas, commercial agriculture, and resource extraction by channeling flood waters directly out to the sea. In this way, mitigation strategies look set to undermine the benefits that El Niño rains have brought to desert food systems and livelihoods for thousands of years. In the north of Peru and in the coastal areas, forecasts suggest rainfall will increase with climate change, whether because of ENSO events, specifically, or higher levels of rainfall in the northern mountains more generally as climate patterns shift. Over the last thirty years the arid areas of Piura have seen an increase in rainfall from nine to fourteen millimeters per year during summer (Ministerio del Ambiente 2010). According to the World Bank's (2024) Climate Change Knowledge portal, "Peru is vulnerable to the impacts of climate change, especially from natural disasters: earthquakes, flash flooding, landslides and volcanic activity, among others especially with majority of its population residing along the coast." Thus, there is a real imperative in this context to think about how food systems can be propagated within fragile environments.

Conclusion

Our examination of El Niño in the context of the increasingly urgent agendas around food security and climate change emphasizes the importance of the long and multisited view. We have set out the case for a historical geographical ethnography methodology in environmental geography based on multisource analysis across human and physical data. Our cut through time has included discussion of paleoclimatological data and pre-Colombian livelihoods coupled with a comparative analysis across El Niño events in living memory—specifically those of 1982–1983 and 1997–1998. Our "magical ethnographic moment" with the mayor of Cristo nos Valga underlines the importance of paying attention to coproduction in research, which as Vincent (2022) reminded us, is especially important for current research on climate change. Although this article is about introducing an innovative cross-over and triangulation of knowledge about El Niño, it nevertheless follows a conventional geographical approach. We start with physical geography, move to human geography, and end by blending both. Such a specialist-synthesis approach (Turner 1989) has been established in Latin Americanist regional geographies since the emergence of the Berkeley School of Geography and continues to shape current wider calls to reimagine geography beyond the Anthropocene (Gibson-Graham 2020). In today's climate-urgent context, an environmental geography led by a physical geography profile has proved to be useful in fostering collaboration between (sub)disciplines as well as with other sector stakeholders, as our ethnographic account illustrates. As Castree et al. (2021) reminded us, though, despite geography's "historic pedigree" in "people–environment relationships," this

field is now firmly embedded in other science and social science disciplines, provoking some in geography to bemoan its lack of "exemplars of 'integrated analysis' that make a virtue of the many specialists we have working side-by-side in the same departments" (3). What can we learn from a historical geographical ethnography about ways to unfix what we have come to normalize in our research practice?

Science-led blended approaches to global environmental challenges have gained greater legitimacy in recent years in some settings. For example, the rollout of the Overseas Development Aid, £1.6 billion Global Challenges Research Fund (GCRF) in the United Kingdom in 2016 benefited the synthetic appeal of geography, which experienced somewhat of a comeback by drawing "a much broader cohort of people into doing 'development geography'" (McKay 2022, 187–88). In her analysis of the awards data in the UK Research and Innovation (UKRI) platform, McKay showed how GCRF grants to geographers have been dominated by single-country case studies, based largely on the legacies of the discipline's area studies expertise. In promoting a historical geographical ethnography for environmental geography, we welcome an emphasis on in-depth case studies, and would encourage an ideographic approach toward engaging with and working in places where researchers have an appreciation of area studies and an understanding of the languages spoken (idioms as well as those of diverse professions; see also Pollard et al. 2009; Laurie et al. 2023). In the light of the burgeoning work in this field, however, we also suggest that as geographers we can go further in forging the type of coproduction that Vincent (2022) called us to. It is important to mix up and cross over subdisciplines, to reorder the sequence of human and physical geography methods and approaches, and to be more open to new starting points for research considering "magical moments" from unexpected sources. These actions, too, are insufficient. Vincent (2022) also reminded us that "[t]here is not always dedicated commitment to identify and confront the embodied power relations nor the hegemonic knowledge systems among the participants in the process" (890). Taking this point seriously, we end by reflecting on a final element in our methodological journey, a second "magical ethnographic moment."

During our shared 4×4 journey across the desert with the mayor, he recounted the story of how the year before a team of researchers had come from a university in Lima also to dig holes in the desert. He said that they had not asked for permission, but with our visit he understood that they were probably doing the same thing as us. Later, back in our accommodation after our long day in the desert, we realized that he was probably talking about us.[17] We had recognized the area he had pointed out as being the site of the previous year's coring that had subsequently prompted our new collaboration across human and physical geography. We were mistaken for "a university from Lima" because we were unknown outsiders, our University of Piura climate science colleagues were not with us that day, and on the previous visit we had gained permission from the local community leaders in the nearby village rather than the more distant municipality. What would our research have looked like if our collaboration and coproduction with other sector stakeholders had been there from the start rather than encountered along the way? Given McKay's reflections on what geographers have written about the nature of GCRF networking (notably Noxolo's [2017] critique of the colonial legacies active in shaping what is studied and the identity of those who do research), it might not have been much different. The rollout of collaborations (including ours) that the short turnaround of GCRF time scales fomented necessarily relied on already established networks, in our case with the University of Piura and coauthor Rodolfo Rodríguez Arismendiz. If the starting point had not been academic and instead the conversation with the mayor had shaped the research question and design from the start, it is possible to envisage other questions driving our agenda such as these: Are the mayor and the interviewees on the same page with respect to what "opportunity" means? Do they see it at different scales—that of their families, their livelihoods, their localities, the level of the regional and national state (and its support for marginal communities)? Would El Niño mean that the mayor had to be less worried about providing support and that the interviewees were in less conflict with the mayor because they were better able, however temporarily, to meet their own needs more successfully? How would these questions have dictated where and how we would have taken sediment samples and climate data from and what we would have aimed to do with it? Would we have changed our approach and have decided to adopt other physical geography methods using different sources (e.g., remote sensing GIS)? What type of analysis would we have conducted and

how would our results have been used and by whom? Such questions fed into the research design of subsequent, larger projects that responded to new cross-disciplinary UKRI calls with broader teams, some of which were more successful in securing funding than others.[18]

Methodically and perhaps epistemologically, however, the question and challenge remain the same: Can a blended approach be adopted from the start or is it necessarily only something that can emerge over time? As funded projects come to an end, what are their legacies in terms of how we approach environmental geography and the value the discipline places on working across human and physical geography? Although we cannot answer these questions here, we hope that by making our historical geographical ethnography process explicit we honor the appeal from the desert to see El Niño in terms of abundance and to acknowledge the potential opportunities these rains can bring to some livelihoods in such regions as our climate changes. In so doing, in the spirit of the resurfacing question of synthesis in geography, we recognize the need to take serious heed of context and to be alert to the diverse, unexpected, and otherwise magical moments that make up environmental geography research.

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Notes

1. In Piura city the very strong El Niño events of 1982–1983 and 1997–1998 brought 2,273 mm and 1,640 mm, respectively. Both episodes lasted about six months with strong impacts on the population and the terrestrial and marine ecosystems in the wider Piura region. During the "coastal" El Niño of 2017, however, it reached 780 mm and the rainy season lasted just two months.
2. Mario Morellon Marteles.
3. "Sin embargo, también es pertinente señalar y destacar los efectos positivos que el fenómeno acarreaba."
4. "Constraining the timing and extent of Holocene El Nino-Southern Oscillation variability with high-resolution lake sediment records from coastal lowland Peru," Royal Society 2013 (RG120575); "Fingerprinting 'El Nino Costero': A unique opportunity to document the signature of an extreme flood event in northern Peru," 2017–2018, NERC NE/R004528/1; "Fishing and farming in the desert? Understanding the impact of El Niño on marginal communities in northern Peru." Scottish Funding Council, 2019; AHRC 2019–2022 "'Fishing and farming in the desert'? A platform for understanding El Niño food system opportunities in the context of climate change in Sechura, Peru,"AH/T004444/1AH.
5. Contrasting with these abrupt shocks, over a much longer period, the attrition effect of the long-running Peruvian civil war led by Sendero Luminoso lowered GDP by 45 percent across the first eight years of the war (1980–1988; Centro de Estudios y Promoción des Desarrollo 1989).
6. Rivera's concept of disaster colonialism is an extension of environmental colonialism. The idea "is proposed to explain how procedural vulnerability is deepened through disasters and subsequently leveraged to deepen coloniality" (Rivera 2020, 126). Her analysis of hurricanes in Puerto Rico shows how a focus on the singularity of disasters as events can serve to shift attention away from the types of structural violence resulting from colonialism that lay the ground for repeated poor disaster planning.

7. See https://www.rgs.org/schools/resources-for-schools/el-nino-phenomenon-of-opportunities for video accounts of livelihoods prepared and filmed by students from I. E Daniel Alcides Carrión, Mala Vida, Sechura.
8. During the rainy season, normally January to March, it is not possible to cross, as the River Piura is in full flow with water coming down from the highlands in upper Piura.
9. Five field visits of between three and six weeks.
10. The project Web site (https://elninophenomenon.wp.st-andrews.ac.uk) provides access to an extensive range of original video, testimonial, and interview material from the research, as well as presentations and teaching resources codeveloped with Peruvian educational partners and young people as part of the research process (see Healy, Laurie, and Hope 2023; Laurie et al. 2023; Bell et al. 2024; and https://www.rgs.org/schools/resources-for-schools/el-nino-phenomenon-of-opportunities). The newspaper archive we analyzed is held by the nongovernmental organization CIPCA in Piura, a project partner on the AH/T004444/1AH funded research project.
11. Twenty-three men, eight women, two married couples, and one cross-generational family group of three women participated in recorded interviews and conversations. Other observations were noted in field diaries and discussed with the research team as the project evolved.
12. A community made up almost exclusively of sea fishers.
13. A mixed economy community located close to Napique lagoon, a permanent water body, which fills during El Niño events but provides fishing and links into irrigation channels for agriculture at other times.
14. The subcategory "transportation infrastructure" represents 10.70 percent of all mentions across the board and 49.41 percent of mentions within the infrastructure umbrella category. Next comes the subcategory of "housing infrastructure," making up 4.86 percent of all mentions and 22.43 percent of mentions within the infrastructure umbrella category.
15. The city of Piura was founded in 1532, two years before Trujillo to the south and three years before Lima.
16. *La Crónica* is a Lima-based tabloid newspaper source. In other parts of Peru where Quechua is more prominent, the term *minka* is used to refer to communal labor in general, including by people who do not identify as campesino or Indigenous. Field observation and follow-up personal communication with project partners in Sechura, however, suggests that although *faena* is an often-heard term, the Quechua minka is not in use in Bajo Piura.
17. The mayor's comments point to the complexity of the scalar power dynamics within and outside the communities occupying the desert space. We had been granted permission from the authorities in the local villages where we were working to collect sample cores. The mayor of Cristo nos Valga is one of a number of district mayors within the larger provincial municipality of Sechura.
18. See "2021–2022 AHRC El Nino a phenomenon with opportunities: Learning history and valuing community assets for an empowering digital curriculum in northern Peru" (AH/V012215/1).

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