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World Environmental History

EL NIÑO IN WORLD HISTORY

Richard Grove and
George Adamson

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El Niño in World History

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For Edwin Grove

Preface

It is not hard to appreciate the influence that Richard Grove has had on historical and environmental scholarship in the twenty-first century. At the time of writing the Centre for World Environmental History, at the University of Sussex, that Richard founded has sixty-eight members, associates and graduate students from around the world. In the last two decades Richard's ideas have informed the 'cultural turn' in climate science, which incorporated physical climatologists as much as historians and social scientists.[1] The Palgrave Series in World Environmental History, in which this book is published, derives from Richard's vision. New networks such as the ACRE (Atmospheric Circulation Reconstructions over the Earth) and IHOPE (Integrated History and future of People on Earth) are taking this vision in new directions.

This book derives originally from Richard Grove's work on the environmental history of the British Empire and his increasing awareness during the 1990s that climate extremes in diverse locations could be explained by the El Niño Southern Oscillation (ENSO) phenomenon. Richard commenced his pioneering project to uncover the 'millennial history of El Niño' after the devastating El Niño of 1997–98, a project designed to trace El Niño's impact from first appearance in the mid-Holocene to the end of the twentieth century. This became Richard's life work, resulting in peer-reviewed journal publications in *Nature* and the *Medieval History Journal*,[2] as well as five book chapters[3] and an edited book with John Chappell entitled *El Niño: History and Crisis*.[4] Tragically Richard was never able to finish the project. Whilst in Australia in late-2006 Richard suffered a severe car accident that has since left him unable to work. The monograph that was to underpin this project remained dormant.

My involvement in this project began in 2012 when I was working as a postdoctoral research assistant on a research network *Collaborative research on the meteorological and botanical history of the Indian Ocean*, a network created by Richard and coordinated by his partner, the environmental historian Vinita Damodaran, on the natural history collections of the British Empire. The network built on the extensive international contacts that Richard had developed during his career as an environmental historian and represented a continuance of his vision to generate an environmental history of the world. The diversity of researchers involved reflected Richard's wide interdisciplinary interests: geographers, anthropologists, climatologists, art historians, archivists, digital archivists, librarians, NGO-workers and environmental activists. Whilst working on the project I was humbled to be offered the opportunity by Vinita to finish the manuscript, due to the interest shared by Richard and me in the history of El Niño and its effects on the Indian subcontinent and southern Africa.

I had first become aware of Richard Grove when researching for a Ph.D. at the University of Brighton in 2009. His writings have had an incredible influence on my work, particularly his 1997 monograph *Ecology, Climate and Empire*. It is not an exaggeration to say that Richard's work has changed the way that I regard climate and what is possible from historical climate research. In particular, Richard has demonstrated the overwhelming potential of the East India Company archives, seeing them as not merely the dry bureaucratic records of a colonial state or trading company but as a remarkably diverse set of writings on meteorology, botany, environment, demographics, trade, history, language and culture, written by an organisation whose desire for knowledge was almost as strong as its appetite for revenue and power.

More fundamentally, Richard has also shown—through articulate and well-reasoned argument derived from a number of geographical and historical contexts—that climate cannot be detached from context. Or, to adopt a terminology that has become more common during the last decade, climate has a dyadic relationship with *culture*.[5] Climate is not just a set of physical processes for individuals to respond to: it is loaded with cultural meaning and this meaning is as important in informing the way people respond to variability as is the intensity of a drought or flood or the dynamics of a socio-political system. This has had profound implications both for the way we understand how societies responded to the climates of the past and the challenges posed by climate today.[6]

It is this element of the culture of climate that I have chosen to explore in my contributions to this book. It was an early decision of mine not to try to 'finish' Richard's work. I would not like to second-guess what his final ideas were for the project, and neither would Richard have approved if I had. I have instead framed my contributions as a complement to Richard's, attempting to elucidate in more detail society's understanding of the El Niño phenomenon. Some of these contributions have built directly on sections that Richard had planned or partially completed, including the introduction, a section on El Niño in the twentieth century, and the history of El Niño's scientific discovery. My final section—on El Niño in the public imagination—is entirely new. The narratives provided by Richard and me are designed to be complementary and I hope that any tension between chapters strengthens the book rather than diminishing it.

One area of science that has moved on significantly since 2006 is the reconstruction of past El Niño behaviour. This is the only area where I have made alterations to Richard's draft. In general the new evidence for El Niño's behaviour in the past overwhelmingly supports and strengthens Richard's arguments on El Niño's role in human history. In these cases I have referenced the new evidence as appropriate but left the narrative the same. In one or two cases new evidence has suggested that events previously considered to be related to El Niño were in fact caused by other factors. Here I have adjusted Richard's writing accordingly, but these adjustments are rare and very minor. Otherwise I have left his contributions as they were.

I hope this book proves to be a worthy addition to Richard's important legacy.

February 2017 George Adamson
London, UK

Notes

1. See for example M. Hulme (2009) *Why We Disagree About Climate Change* (Cambridge: Cambridge University Press); J.B. Thornes (2005) 'Cultural Climatology', *Encyclopedia of World Climatology*, 308–309; J.B. Thornes (2008) 'Cultural Climatology and the Representation of Sky, Atmosphere, Weather and Climate in Selected Works of Constable, Monet and Eliasson', *Geoforum*, IXL, 570–580; N. Stehr and H. von Storch (1995) 'The Social Construct of Climate and Climate Change', *Climate Research*, V, 99–105; H. von Storch and N. Stehr (2006) 'Anthropogenic Climate Change: A reason for concern since the eighteenth century and earlier', *Geografiska Annaler*, LXXXVIII, 107–113.
2. R.H. Grove (1998) 'Global Impact of the 1789–93 El Niño', *Nature*, XCDIII, 318–319; R.H. Grove (2007) 'The Great El Niño of 1789–93 and its Global Consequences: Reconstructing an extreme climate event in world environmental history', *The Medieval History Journal*, X, 75–98.
3. R.H. Grove (1997) *Ecology, Climate and Empire* (Winwick: White Horse Press); R.H. Grove, V. Damodaran and S. Sangwan (1998) *Nature and the Orient: The environmental history of South and Southeast Asia* (Delhi: Oxford University Press); R. Grove (2002) 'El Niño Chronology and the History of Socio-economic and Agrarian Crisis in South and Southeast Asia 1250–1900' in Y.P. Abrol, S. Sangwan and M.K. Tiwari (eds.) *Land Use—Historical Perspectives: Focus on Indo-Gangetic Plains* (New Delhi: Allied Publishers Pvt. Ltd.), pp. 133–172; R.H. Grove (2005) 'Revolutionary Weather: The climatic and economic crisis of 1788–1795 and the discovery of El Niño' in T. Sherratt, T. Griffiths and L. Robin (eds.) *A Change in the Weather: Climate and culture in Australia* (Canberra: National Museum of Australia Press), 128–140; R.H. Grove (2007) 'Revolutionary Weather: The climatic and economic crisis of 1788–1795 and the discovery of El Niño' in R. Costanza, L.J. Graumlich and W. Steffen (eds.) *Sustainability or Collapse: An integrated history and future of people on Earth* (Cambridge: The MIT Press), pp. 151–169.
4. R.H. Grove and J. Chappell (2000) 'El Niño Chronology and the History of Global Crises during the Little Ice Age' in R.H. Grove and J. Chappell (eds.) *El Niño History and Crisis: Studies from the Asia-Pacific region* (Cambridge: The White Horse Press).
5. This relationship has been articulated recently by Mike Hulme in M. Hulme (2015) 'Climate and its Changes: A cultural appraisal', *Geo: Geography and Environment*, II, 1–11.
6. M. Hulme (2016) *Weathered: Cultures of Climate* (London: Sage).

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Richard would like to thank Rohan D'Souza, Jack Golson, Kate Golson, Mark Elvin, John Chappell, Graeme Snooks, Janet Copland, Tom Griffith, Robert Wasson, Kuntala Lahiri Dutt, John McNeill, Lonnie Thompson, James Knerr Wilson and finally George Adamson. All these individuals have made enormous contributions to the book in various ways and the final product is a result of many conversations and emails across continents and via networks of intellectual and social exchange over two decades or more.

George would like to thank Michael H. Glantz, Julia Miller, Eleonora Rohland, Matt Hannaford, Lisa Dilling, Ben Orlove, Sarah Dry, Greg Cushman, Martin Mahony, Steve Rayner, Georgina Endfield, David Nash and Nick Drake. Nuala Morse has provided continued support and many suggestions throughout the writing processes. Bill Johncocks went far beyond what is expected for an indexing process. There are also many others who have provided support, inspiration and stimulating conversation that have underpinned this book and they are too many to mention. Special thanks must however go to all affiliated with the Centre for World Environmental History and the networks *Collaborative research on the meteorological and botanical history of the Indian Ocean* and *Anthropology of weather and forecasting*.

Finally, thanks go to Richard for continuing inspiration to many, including the second author, which will long outlast this book.

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CHAPTER 1

Introduction

George Adamson and Richard Grove

There is a debate occurring within climate science. It is an argument between scientists: esoteric disagreements played out in discussions at conferences and on the opinion pages of scientific journals. It may look, on the surface, of little interest beyond the academy. Yet it speaks to a broader question that should interest all with a stake in climate, or natural disasters, or even global geopolitics. It is a question of relevance to researchers across disciplines, to journalists involved in the multifaceted and contradictory world of science communication, and to the political worlds of development and risk management. Most importantly it speaks to millions of people whose livelihoods are threatened by drought or flood or cyclones the world over. What exactly *is* El Niño?

To understand this debate we must look back at the most severe El Niño event to have been recorded. The 1997–1998 El Niño saw record-breaking sea temperatures, the so-called 'climate event of the century'. El Niño was, at this point, considered to be a phenomenon that was well understood. Its codification at the turn of the twentieth century had precipitated decades of research—slowly at first, then from the 1980s onwards in huge quantities—on the global climate anomaly, on its mechanisms and impacts, why it was formed and how it developed, where it produces rainfall and where it leads to drought. Of the latter issue one of the most heavily studied areas was El Niño's impact on the Indian monsoon, a relationship that had been postulated in 1932 and explained in the 1980s.[1] Long-term El Niño forecasts introduced in the late 1980s had allowed the 1997–1998 El Niño to be the first 'severe' event to be correctly forecast 6 months in advance,

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enabling policies to be implemented across the world to prepare for anticipated hazards. In India this meant the planting of drought-resistant crops. In Zimbabwe development loans usually provided to farmers against the collateral of forthcoming harvests were refused in anticipation of poor harvest.[2]

Meteorological anomalies in 1997 and 1998 were severe. In Peru and California, devastating floods caused destruction to property and infrastructure and multiple deaths. In Mexico and Indonesia, drought caused wildfires that could be seen in neighbouring countries, and which briefly raised Indonesia to the highest per capita global emitter of carbon dioxide.[3] Rainfall in India and southern Africa, however, remained around average, and drought-resistant crops yielded poorly. Indeed, during the early part of the Indian monsoon in 1997 rainfall was slightly above average. Neither did the expected droughts materialise in Australia, with the exception of parts of the east coast.

Why did rains in India not fail when the relationship between El Niño and the monsoon was apparently so clear? Why then again did drought occur in 2002 and 2004, years technically classified as El Niño but so weak as to barely register under accepted scientific definitions?[4] No drought was forecast in India during these years, yet drought did occur, with devastating impacts on food supplies and cascading effects across the Indian economy. Perhaps inevitably, given current climatic anxieties, the explanations first provided for this apparent ‘breakdown’ in the relationship between El Niño and the monsoon concerned anthropogenic climate change (an idea that was subsequently dropped).[5] Dr. K. Krishna Kumar of the Indian Institute of Tropical Meteorology posited another explanation in 2006. Through statistical analysis he suggested that there were in fact *two* El Niños, with quite different global impacts. These were the El Niño ‘flavours’: the classic El Niño such as 1997–1998, which did not produce drought in India, and the alternative El Niño such as 2004 which did. The differences in their characteristics related to the location of Pacific warming: mostly to the east or mostly in the equatorial centre. Subsequent authors called these flavours Central and Eastern Pacific El Niño, or El Niño and El Niño *Modoki*, the latter a Japanese word meaning ‘similar but different’.[6]

At the time of writing this debate is still ongoing. Have we been defining El Niño wrongly for the past 100 years, when we should really be talking about two El Niños, or even more? Counter arguments continue: whether El Niño *Modoki* is a ‘partially-formed’ or weak El Niño;

whether it is expedient to develop separate indices for El Niño and *Modoki*; whether *Modoki* is simply a statistical anomaly or the outcome of bad mathematics.[7] The debates are characterised by the intricacies of complex statistical analyses. No doubt they will continue into the future.

The El Niño Southern Oscillation

Despite widespread media coverage, the El Niño Southern Oscillation (shortened to ENSO in this book) has actually been understood for a relatively short period of time. The oceanic component of ENSO—the El Niño current—was discovered in the 1890s. The atmospheric the Southern Oscillation was first isolated in the 1920s; yet the two were not linked until the 1960s and the global significance of the phenomenon not appreciated until much later. Only a relatively few El Niños have been observed in detail, a factor that has created the confusion over the exact dimensions of the phenomenon. The three severe events that have been observed—1982–1983, 1997–1998 and 2015–2016—demonstrated a climatic event that can exhibit unpredictable behaviour, but one which has unusual severity and global influence.

As with many scientific phenomena, the accepted definition of El Niño has emerged through scientific consensus. Although now considered to be a global system with global effects, the El Niño that was first identified and researched was the manifestation of the global phenomenon off the coast of northern Peru. This is a region of unusually cold water and a shallow thermocline, which allows cold, nutrient-rich bottom water to upwell to the surface, supporting marine plankton blooms and rich anchovy fisheries. The predominant ocean direction is from the south, caused by the southerly Humboldt Current, which brings further cold water from the southern tip of the continent. This combination of factors limits evaporation and hence rainfall making coastal Peru one of the driest regions on Earth.[8]

The term 'El Niño' was first used in scientific literature in the 1890s to apply to the occasional years when the direction of ocean flow reverses and unusually warm surface water flows in from the north. During these years native fish species migrate southwards and tropical crab and fish species arrive from the north. Seabirds migrate westwards to follow their anchoveta catch and can sometimes die in large numbers. Populations of seal and penguin around the coast and nearby Galapagos Islands can decline dramatically. Moisture evaporating off the unusually warm water causes heavy rain, which is fundamental to the desert ecosystem but can be destructive to crops, property and infrastructure. This phenomenon was named 'El Niño' in Peru as it arrived around Christmas and was associated with the Christ Child, a term taken from local fishermen (although its original meaning was somewhat different).[9]

The Peruvian scientists who first analysed the El Niño phenomenon considered it to be a local event and it was considered as such for around 50 years after its discovery. Later scientists studying the phenomenon after the Second World War—equipped with observations from ocean vessels, buoys, weather balloons, satellites and complex computer models—realised that the event is a local manifestation of a Pacific-wide phenomenon with global effects. In 1969 the climatologist Jacob Bjerknes linked the El Niño with the Southern Oscillation, a 'see-saw' pressure relationship between the Indian and Pacific Oceans that had been identified by the British meteorologist Gilbert Walker in the 1920s. The whole phenomenon was named the El Niño Southern Oscillation or ENSO,[10] with El Niño one extreme of the system and the opposite—where the ocean is unusually warm in the western Pacific and the eastern Pacific unusually cold—called La Niña.[11]

During the last five decades the El Niño Southern Oscillation has become one of the most heavily studied climatic phenomena in the world. It is now considered the most important source of year-on-year 'natural' meteorological variability, its mechanism understood to be related to the position of the thermocline, the ocean region that marks the transition between warmer surface waters and the colder deep waters. In most oceans this is located around 100 m below the surface, but in the equatorial Pacific easterly trade winds drive the surface water westwards creating a huge 'basin' of warm water near Indonesia known as the Pacific Warm Pool. Here the thermocline is unusually deep and the surface waters particularly warm. Off Peru the thermocline is located at the surface and the waters are unusually cold. This differential in thermocline depth and surface temperature causes distinct climatic variability. Near Indonesia and Australia, warm sea surface temperature causes evaporation, heavy rainfall and high humidity. Evaporated air moves eastward in the upper atmosphere and descends over the South American coast, where the region is a desert. Thus the whole system is stabilised and self-maintaining, comprising an enormous 'conveyor belt' of air across the equatorial Pacific called the Walker Circulation.[12]

El Niño events—in so far as they can be called events—are related to the breakdown of this circulation. This can be caused by minor fluctuations in the trade winds, cyclones in the western Pacific or random changes in water currents. Once occurring, such minor changes can be self-reinforcing. Reduction in the strength of the trade winds causes the Pacific Warm Pool to flow east and the thermocline to depress, the area of low pressure moving correspondingly eastward. This further reduces the west–east pressure gradient and the intensity of the trade winds, allowing the warm water to flow even further east. During a developed El Niño phase, the region of evaporation can move to the central or eastern Pacific, which brings unusual rain to these regions. Indonesia and Northern Australia experience drought and often forest fires, and Peru and Ecuador serious floods. El Niño episodes occur approximately once every 3–7 years, often followed by La Niña as the rapid return of the Walker Circulation creates 'extreme normal' conditions (Fig. 1.1).

The El Niño Southern Oscillation is not the only global climatic mode of variability but it is considered unique in the scale of its influence. The Walker Circulation is one of many interlinking circulation patterns across the Earth and a change in its position can result in a major redistribution of tropical convective regions. El Niño has been associated with unusual rainfall in southern (and sometimes Sahelian) Africa, Ethiopia, South and Southeast Asia, parts of China, Australasia, Central America, northeast Brazil and Amazonia.[13] It can result in low river discharge in the Nile,[14] the Senegal, the Orange River, the Indus, the Narmada, the Murray-Darling and the Amazon, amongst others. In New Guinea and southeast Australia El Niño is associated with increased incidences of severe frosts. There are even some indications that El Niño is associated with forerunning cycles of cold winters in Europe and inner Asia.[15] When other less frequent physical influences on global climate, such as large volcanic eruptions, add their impact to pre-existing El Niño effects, climatic variability can be even more marked.

In other parts of the world El Niño produces above-average rainfall. In Peru and central Chile rainfall can be particularly intense. Similar effects occur in northern Vietnam and southern China, in Japan and the South Island of New Zealand, Sri Lanka, north and east Africa, some of central and Western Europe, California, and in the Great Basin and Gulf regions of the United States. In the Caribbean region and North Atlantic, hurricane frequencies are reduced, but in the Pacific they are increased. During periods with La Niña conditions these global impacts

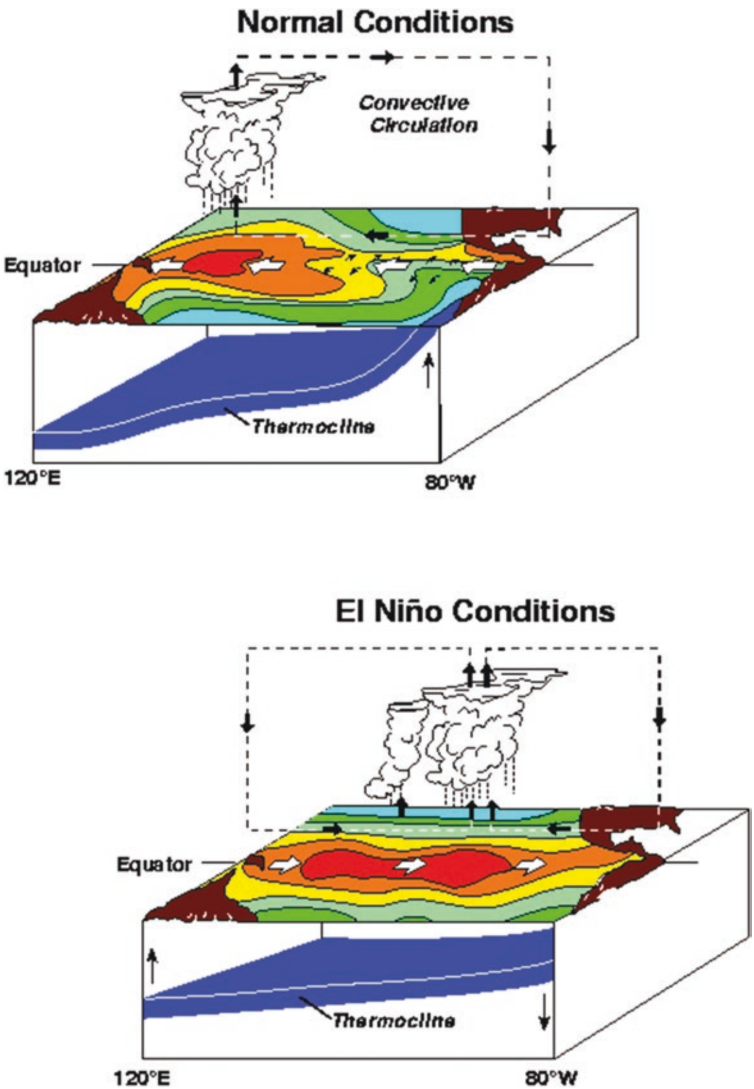

Fig. 1.1 Conceptual diagram of the Walker Circulation under neutral and El Niño conditions. Image courtesy of NOAA Pacific Marine Environmental Laboratory

are usually reversed, although the inverse relationship is not uniform. River discharges are generally high and inland lake systems, especially in Australia, experience marked pluvial phases. Both phases of El Niño and La Niña tend to cause corresponding regional air temperature changes, which may be very severe in some seasons. These weather patterns often vary from one El Niño event to another, sometimes very greatly. It is thus necessary to refer to the historical record for detailed knowledge of the variations to the general pattern.[16]

El Niño in World History

The severity of the El Niño of 1997 and 1998, and the La Nina episode that followed on from it, tempted some observers (both journalists and scientists) to suggest that the event was the worst known in history.[17] Similar hasty claims had been made for the El Niños of 1982–1983 and 1991–1995.[18] Yet the historical as well as prehistoric records of El Niño tend to suggest otherwise.[19] Historical evidence suggests that, even in the last thousand years, several El Niños of equal and arguably stronger intensity may have been experienced globally.[20] Moreover, in the preceding four millennia before that, even more severe and more protracted events may have taken place.

The reconstruction of historical El Niño in the past has been one major advance in El Niño science during the last two decades. Whilst the exact dynamics of El Niño are still being established, significant developments have been made in understanding the patterns of El Niño variability over long periods. This has been established from the written record,[21] or revealed in the growth bands of trees or corals, or snow in deposits preserved in glaciers. This work is revealing important information on the long-term variability of ENSO, which is itself affecting understanding of El Niño dynamics, particularly teleconnection patterns and variations in strength. For most of the period of instrumental weather observations after about 1870 the El Niño Southern Oscillation appears to have operated on very short climatic time-scales, individual events lasting typically about one year.[22] El Niño events of much longer duration may have occurred as recently as the end of the eighteenth century. Detailed evidence is presented in this volume, for example, for a number of global El Niño events, in particular for an extended El Niño episode or series of linked events that ran from 1790 to 1794.

Such long-term climatic trends have been too frequently dismissed by a large number of meteorologists, climatologists and global climate model-builders, who often confine their analysis to data generated during the period of instrumental record keeping. Apart from the inherent problems of instrument representativeness,[23] the very short period of this climatic record, when compared with what we now know from longer-run data, means that excessive reliance placed on instrumental data collected since 1870 can prevent a proper understanding of the long-term dynamics of El Niño. In summary, the El Niño phenomenon and its historic impact can only be meaningfully understood, and its behaviour predicted, by reference to the very long-run record held in both documentary and physical archives.

The research of the last few decades to uncover traces of past El Niños has opened up a new opportunity for historians to explore how extreme events associated with El Niño impacted on societies in the past. The survival of preindustrial societies had a great deal to do with climate, yet this survival related not so much to the ability to withstand long term variation in average conditions but the ability to adapt to variability involving extreme conditions. Because of this, the sudden climatic shock of a global El Niño or La Niña was probably more important than processes of climatic change or variability that operated more slowly. Extreme weather events such as those associated with El Niño or La Niña could plunge a society into great difficulties, radically reduce population numbers, or even destroy it altogether. Adaptation to El Niño has of course been possible; indeed it has been central to the development of many societies in affected regions.[24] Yet large or recurrent El Niños could cause significant disruption and in some cases even contribute to political change. Periods where the El Niño Southern Oscillation as a whole moved from low to high activity also created sudden climatic variability that some societies would have found difficult to adjust to.

Until recently the history of such shocks was sometimes known, but the existence of a global weather system linking them was not understood. What is now being realised is that in many parts of the world the whole history of society and of political events cannot be fully or properly understood without a serious appreciation of the impact of global El Niño events. During the last 5000 years about 20 of these events appear to have been so severe as to have radically affected the history of many societies in quite different parts of the world in a year or within a very few years. This book is intended to constitute a brief guide to these relationships, revealed between documented historical and economic change and El Niño-caused extreme events. The book is envisioned as a stimulus to new approaches to the explanation of economic periodicities and historical problems that have long troubled and puzzled scholars and the public alike.

This is not, however, the only history of El Niño included in this book. Whilst a picture of El Niño dynamics in the past is beginning to emerge, as is demonstrated by the story of El Niño *Modoki* described above, El Niño science is still developing. At various times since its discovery, El Niño has been understood as an ocean current, an atmospheric oscillation, a Pacific-wide quasiperiodic event, a global climate mode, and a complex phenomenon with multiple 'flavours'. Moreover, the ways that societies have understood the phenomenon have always changed and this understanding has itself had implications.

To present a full picture of the role of El Niño in world history, it is therefore necessary to address both the effects of El Niño on society and the changing ideas of what El Niño constitutes. This book sets out to elucidate both of these histories, with the two histories represented broadly by the writings of the two authors. In Sections I and III, Richard Grove discusses the role of El Niño on economic and political changes in history and the human cost of the phenomenon. In Sections II and IV George Adamson discusses the different ways that El Niño has been understood and researched. These two histories are contingent upon each other: reconstruction of historical El Niños is reliant upon the scientific understanding of El Niño at the time that the reconstruction was undertaken, and new insights into the behaviour of El Niño in the past shape cultural understandings of El Niño in the present. They are also occasionally competing, but they cannot be read in isolation.

The first section of the book is written by Richard Grove and is entitled *A Millennial History of El Niño*. This section is comprised of four chapters. Chapter 2, 'El Niño in Prehistory', discusses the evidence of El Niño's impact on society in the deep past. In particular the chapter focuses on three periods of severe El Niño activity associated with prolonged droughts in El Niño teleconnection regions: around 4200, 3200 and 1300 years ago. All of these periods were associated with profound social changes, including the climate crises of the ancient riverine societies of the Middle East and Asia around 2100 BCE (Before Common Era), the global impacts of droughts around 1200 BCE and the role of El Niño in major social changes in South Asia and Central America