Extreme weather and social vulnerability in colonial Antigua, Lesser Antilles, 1770-1890

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Dedication

To my grandparents, Josef (1912-2005) and Anna Kispal (1925-2007),

my inspiration for hard graft and pursuit of knowledge.

Nyugodjatok békében kedves, édes nagypapa és nagymama.

Abstract

This thesis presents an history of extreme climate events in Antigua, a former British colony in the Lesser Antilles, spanning the years 1770-1890. It employs a range of documentary sources from that period, including government, plantation, missionary and scholarly papers. Two major empirical elements are addressed: (1) reconstruction of the timing and magnitude of precipitation variability and tropical cyclone activity and (2) investigation of the implications of climatic hazards—principally droughts and hurricanes—for Antiguan society. On the basis of these analyses, temporal and social patterns of human vulnerability to hydrological extremes and storms are explored.

Established methodologies for analysing documentary climate evidence are used to reconstruct two major chronologies covering the study period, one of relative annual precipitation variations and one of tropical cyclones. The former, which is the first of its kind in the Caribbean, captures nine major phases of drought and six of precipitation excess and corresponds well with two series of instrumental data from the 1870s and 1880s. The latter records 42 tropical cyclones—including ten currently not listed in published storm datasets—with several peaks in event frequencies matching those in other reconstructions of North Atlantic cyclones. Connections between findings and known oceanic-atmospheric drivers of regional climate variability are considered. Assessment of the societal consequences of extreme events centres upon three case studies of climate-related disaster in the periods 1775-1783, 1834-1838 and 1860-1880. Each corresponds with historical developments of regional importance—respectively, the American War of Independence, the abolition of slavery in the British Empire and major deceleration of the colonial sugar economy. The ways in which precipitation extremes and tropical cyclones affected human livelihoods in these distinctive socio-economic contexts, as well as how different groups reacted to them, are examined in detail. Evidence from the full study period is also used to highlight longer-term trends of impact and response, as well as the possible linkages between extreme weather, disease outbreaks and social unrest.

Diverse structural factors shaping Antiguans' vulnerability are explored, ranging from local topography to economic dependence on plantation agriculture. Three broad thematic divisions of the study period are then proposed: (1) the late 1700s through early 1800s, when recurrent international warfare heightened vulnerability by disrupting maritime commerce; (2) the mid-1810s through 1840s, when relative geopolitical stability and economic success reduced vulnerability; and (3) the mid to late 1800s, when vulnerability was again amplified, this time by the rise of laissez-faire imperial policy in the midst of burgeoning competition in the global sugar market. Within the Antiguan populace, the distribution of socio-economic losses resulting from climatic stresses is shown to mirror patterns of material inequality inherent in the race- and class-based colonial hierarchy. Though failing to radically alter these relationships of power and vulnerability, slave emancipation is argued to have altered their finer dynamics in important ways.

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Contents

List of illustrations

Figures

Tables

Plates

List of abbreviations

AMO	Atlantic Multidecadal Oscillation
CR	Confidence rating
ENSO	El Niño-Southern Oscillation
GDP	Gross Domestic Product
GFDRR	Global Faculty for Disaster Reduction and Recovery
HURDAT	Hurricane Database (of the National Hurricane Centre)
IPCC	International Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
LACE	Lesser Antilles Accumulated Cyclone Energy
masl	Metres above sea level
NAO	North Atlantic Oscillation
NASH	North Atlantic Subtropical High
NHC	United States National Hurricane Centre
PDO	Pacific Decadal Oscillation
SSTs	Sea Surface Temperatures

Chapter 1

Introduction

1.1. Extreme events in the Lesser Antilles: present concerns and past insights

The Lesser Antilles of the eastern Caribbean represent a zone critically vulnerable to natural hazards. Owing to tectonic and climatic features, this arc of small islands is liable to diverse environmental perturbations, including earthquakes, volcanic eruptions, tsunamis, tropical cyclones and droughts. Meanwhile, the capacity of Lesser Antillean society to withstand and cope with associated threats is constrained by the limited size of local populations, economies and resource reserves, compounded by insularity and remoteness (Pelling and Uitto, 2001; Boruff and Cutter, 2007). Since the early 2000s, extreme weather events in the wider Caribbean basin have come to the fore in public consciousness amid mounting concern over the effects of global warming. Indeed, computer simulations evaluated in the most recent 'Assessment Report' of the Intergovernmental Panel on Climate Change (IPCC) have "generally projected a precipitation reduction over much of the Caribbean" by the end of the twenty-first century, with rainfall during the summer-autumn wet season set to decrease most significantly (Christensen et al., 2013: p.1261). Possible changes in tropical cyclone activity are less certain owing to low confidence in regional models. Globally, greenhouse warming is expected to see little change in event frequencies, but higher maximum wind and rainfall intensities (Christensen et al., 2013).

Future trends aside, droughts and tropical cyclones already pose a substantive threat to society in the tropical North Atlantic. One need only refer to Hurricane Katrina in 2005 for a vivid illustration of the potentially catastrophic consequences of the cyclones which traverse the region. Disasters stemming from periods of drought have typically been less publicised. However, that which affected the Lesser Antilles from 2009 to 2010 represents a noteworthy example. Precipitation scarcity prevailed across the archipelago for over half a year, resulting in crop losses of up to 50%, shortages of drinking water, food price increases and bushfire damages, the costs of which amounted to hundreds of thousands, if not millions, of US dollars for local governments (Farrell et al., 2010). While the ultimate financial toll of this episode is not known, it is estimated that the direct and indirect costs of weather-related disasters throughout the Caribbean totalled between US$700 million and 3.3 billion during the final three decades of the last century (Charvériat, 2000).

The potential for economic losses of this magnitude, not to mention risks posed to human life, highlights the importance of research into the physical characteristics and drivers of extreme climate events, as well as the dynamics of their environmental and

societal implications. Data on such subject matter is most abundant and sophisticated for the recent past. However, documentary records spanning many centuries also represent an invaluable source of climate- and weather-related evidence, the study of which is known as historical climatology (Brázdil et al., 2005). As will be discussed in Chapter 2, this approach in particular is essential for the very reason that instrumental weather records span a limited time period. Documentary archives enable the analysis of longer-term variability in climate and extreme events, which, in turn, is important for forecasting future trends. They can simultaneously expand insight into how and why different social and ecological systems are affected by and respond to climatic perturbations, thus helping to devise appropriate schemes for coping today (Jones and Mann, 2004; Brázdil et al., 2005; Mock, 2012). A critical aspect of this process is identifying areas, communities and systems that are especially vulnerable and the factors that make them so. The concept of vulnerability—also to be explained in Chapter 2—is recognised to be highly useful for addressing issues of this kind situated at the interface of 'nature' and 'culture,' as it accounts for both organic and inorganic, physical and cognitive dimensions of risk, threat and exposure (Pfister and Brázdil, 2006).

Despite a number of major advances in recent years (Nash and Adamson, 2014), historical climatology in the tropics has been somewhat limited in its spatial and theoretical focus. In the Caribbean, attention has centred overwhelmingly on tropical cyclones, including reconstructions of storm activity (e.g. Millás, 1968; Boose et al., 2004; Chenoweth, 2006; Chenoweth and Divine, 2008) and historiographic studies of their material and cultural consequences (e.g. Ortiz, 1947; Pérez, 2001; Mulcahy, 2006; Mock et al., 2010). Nevertheless, certain data sources and locations remain understudied in this research area. There have been but a handful of equivalent document-based investigations giving treatment to other hazards, such as drought (e.g. Chenoweth, 2003; Mendoza et al., 2007; Paar, 2009; Johnson, 2011). With very few exceptions (Lewis, 1984; Zahibo et al., 2007), the Lesser Antilles have been overlooked in the production of island-specific reconstructions and analysis of historical climate-society interactions spanning longer than a few years.

Expanding the scope of historical climate research in the Caribbean is not only of importance for the scientific and practical reasons noted earlier, but also for deepening understanding of a bygone society. From the sixteenth through nineteenth centuries, the Antilles were the theatre of a European imperialism that left well-studied cultural, demographic and ecological legacies. This was the age of slavery and sugar; of unprecedented human migration to an unfamiliar New World environment; of that environment's domination by the exploitative plantation complex; and of military campaigns that came to define Atlantic geopolitics. Quite justifiably, conventional narrations of this history have positioned humans and human processes at the centre of focus (e.g. Williams, 1970; Mintz, 1974; Sheridan, 1974; Green, 1976). However, as a

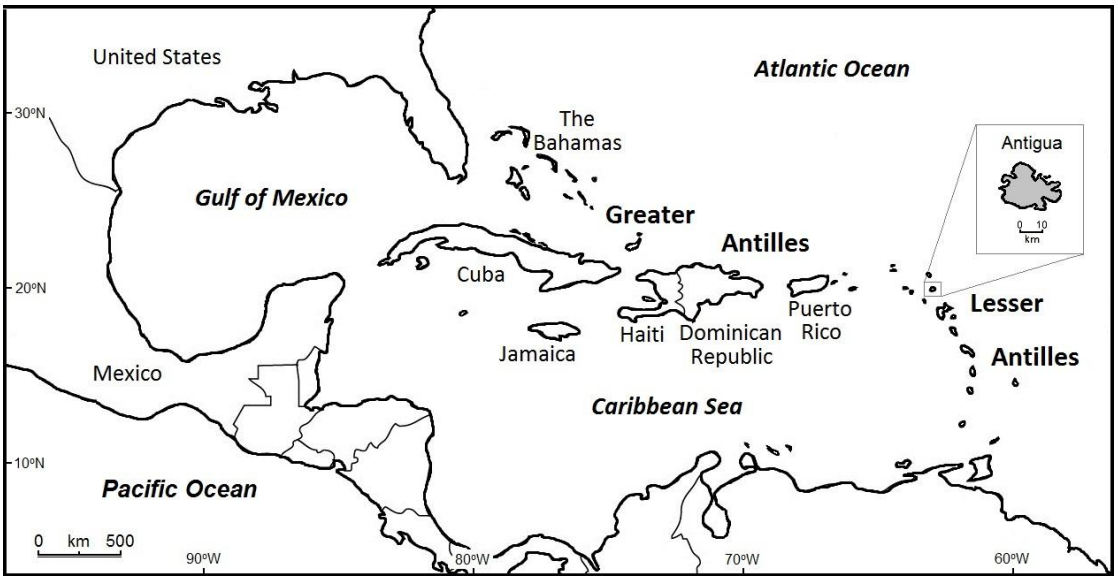

Figure 1.1. Map of the Caribbean and surrounding mainland.

few scholars have demonstrated (e.g. Pérez, 2001; Schwartz, 2005; Mulcahy, 2006; Johnson, 2011), employing climate as an analytical lens can offer novel insights on society, social processes and major historical events in the colonial West Indies.

1.2. The remit of this study

This thesis seeks to address some of the deficiencies of Caribbean historical climate research noted above, by focusing on the Lesser Antilles Island of Antigua (Figure 1.1). It forms part of a wider research programme involving an international team of palaeoclimatologists, archaeologists and historians investigating mid-late Holocene human eco-dynamics in what is today the dual-island state of Antigua and Barbuda.[1] In the present study, attention centres on Antigua owing to the rich archival heritage of the island. This stems from its status as an important economic and political hub in Britain's former West Indian empire and the fact that, unlike many neighbouring islands, it was administered continuously by the British from the 1600s until independence in 1981.

The aim of this thesis is to present a climate history of Antigua for the period 1770-1890 using a range of documentary sources. More particularly, it seeks to investigate the physical characteristics of extreme climate events, their societal implications and patterns of human vulnerability to them. The source material to be examined consists of primary manuscript archives pertaining to the island, in the form of governmental, missionary and plantation records, as well as a selection of eighteenth and nineteenth

[1] The foremost researchers and institutions participating in the project are named in the Acknowledgements section (p.iii).

century scholarly publications. Analysis focuses chiefly upon drought and tropical cyclone hazards, although episodes of excessive precipitation also receive some consideration. The thesis has three specific objectives:

1. To reconstruct precipitation variability and tropical cyclone activity in Antigua from 1770 to 1890, assessing the timing and intensity of major climate extremes and possible linkages with other climate reconstructions.
2. To examine the socio-economic effects of extreme weather events and the human responses that these generated, focusing on three case studies from disparate timeframes within the study period. Where possible, these will be supplemented by evidence from beyond the case study periods.
3. To explore patterns of social vulnerability over time and between different groups based on the findings generated as noted above.

It is worth briefly noting why the specified documentary archives and time period have been selected for study. All research into the past must, to some extent, be source-led (Baker, 1997). This is certainly the case here. Government, missionary and plantation materials present some of the richest and most continuous archival records from Antigua's colonial past that survive today. Unlike other abundant sources with established potential for historical climatology—namely newspaper reports and ships' logbooks (Chenoweth, 2006; Wheeler, 2014)—the aforementioned types of documentation have seldom been used for work in this field on the Lesser Antilles. The coverage they offer collectively is especially consistent for the years 1770-1890. This period has also been chosen because it overlaps with certain instrumental meteorological datasets, as well as several major historical developments, including the American independence movement, the abolition of slavery and the decline of the British West Indian sugar industry. These events have already been well studied by colonial historians, offering the opportunity for detailed exploration of time-specific socio-economic factors shaping human experience of, and vulnerability to, climatic hazards.

1.3. Thesis structure

Along with this introduction, the following three chapters establish the research context of the thesis. Chapter 2 considers its theoretical foundation, outlining core concepts relating to drought and tropical cyclone hazards, historical climatology and vulnerability. Chapter 3 describes the environmental setting under study, with a special focus on regional precipitation and tropical cyclone climatology, and provides a potted colonial history of Antigua. Chapter 4 introduces the documentary sources and archival research methods employed in the thesis.

Chapters 5 and 6 present the first empirical element of the study, which is climate reconstruction. They deal respectively with the assessment of precipitation variability and tropical cyclone activity throughout the period 1770-1890. The climate chronologies developed therein serve as a framework for the second major investigative agenda: exploring the societal implications of extreme weather events and patterns of human vulnerability to climatic stress. Chapter 7 serves as bridge between the distinct research areas mention above. It reviews the literature on historical climate-society interactions in the Caribbean, details the approach to their study adopted in the thesis and presents an overview of common environmental effects of weather extremes throughout the period 1770-1890. The subsequent three chapters offer detailed analyses of the socio-economic effects of climatic hazards and the human responses that these generated during three short case study periods. The three periods targetted—1775-1783, 1834-1838 and 1860-1880—are characterised by sequences of major weather extremes which culminated in crisis under highly distinctive social, political and economic circumstances.

Chapter 11 reviews major empirical findings and evaluates them with reference to previous scholarship. It brings together the diverse themes discussed in the case study and reconstruction chapters to return to a long-term perspective on the climate extremes, impacts and vulnerability. Chapter 12 concludes by addressing the research objectives laid out in Section 1.2 and also reflects on the significance of findings with respect to the matter of contemporary environmental change.

Chapter 2

Key concepts

2.1. Introduction

The aim of this chapter is to establish the theoretical grounding of the present investigation of historical climate variability and its societal consequences. It will do this by exploring the meanings, scope and relevance of a number of core terms and concepts. To begin, it describes the two principal hazards under scrutiny in the thesis: droughts and tropical cyclones. The basic physical features of these weather events are outlined, as well as the ways in which such features influence human experience and perception of them. Next, the nature, origins and methods of historical climatology are discussed. Key stages and figures in the development of the field, as well as its value and limits, are then considered. Finally, the chapter broaches the concept of vulnerability, with specific reference to climate change and natural hazards. Being complex and somewhat nebulous subject matter on which much has been written elsewhere, the focus will be on aspects of greatest relevance to this study, such as historical assessments of vulnerability. Related concepts of importance, including resilience, adaptation and differential social vulnerability, are also explained.

2.2. The nature of the hazard: droughts and tropical cyclones

Drought is a slow-onset or 'creeping' occurrence, the effects of which accumulate gradually over days to years. In contrast to many other iconic natural hazards, like earthquakes, storms and tsunamis, it is denoted by an absence, rather than tangible presence, of a certain environmental element or entity (Wilhite, 2000). It is perhaps for these reasons that the phenomenon lacks a single universally-recognised characterisation. Mishra and Singh (2010), for example, list eight definitions of drought offered by authorities ranging from the World Meteorological Organisation to the UN Commission on Food and Agriculture, all of which differ slightly if not considerably. For the purpose of this thesis, the following definition provided in the *Encyclopaedia of Climate and Weather* (Druyan, 2011: p.407) will be used:

> An extended period, a season, a year, or several years of deficient rainfall relative to the statistical multi-year mean for a region.

This corresponds to what is known as 'meteorological drought,' which views the phenomena as a negative anomaly in precipitation levels. There is, however, no

established threshold for an anomaly of this kind to be considered to be significant; it varies between different locations and climatic regimes. Other common classifications, such as 'agricultural,' 'hydrological' and 'socio-economic' drought, emphasise not the characteristics of precipitation scarcity itself, but its interplay with environmental or human systems that are dependent upon precipitation. Agricultural drought, for instance, is regarded as the insufficiency of natural soil water to support crop growth (Wilhite and Buchanan-Smith, 2005).

A lack of consensus on what constitutes drought, as well as its subtle, creeping nature, are recognised to be important obstacles to the study of the hazard and public engagement on the themes of risk and preparedness. Moreover, the stochastic nature of precipitation variability and gradual onset of drought conditions over time hamper the identification of precise starting and ending points (Wilhite and Buchanan-Smith, 2005; Mishra and Singh, 2010). These matters are yet more problematic when investigating the characteristics of historical droughts, for which evidence tends to be fragmentary (Mock, 2007). Nevertheless, research on drought, both past and present, is of great societal value, as the phenomenon affects almost all climatic regimes. Indeed, it is the number one natural hazard in terms of the number of people affected globally (Obasi, 1994; Hewitt, 1997; Wilhite, 2000) and, through association with a variety of disastrous ecological agents including crop failure, water shortages, wildfire and famine, has been at the root of some of the most severe humanitarian crises in twentieth century history (Mishra and Singh, 2010).

Quite unlike droughts, tropical cyclones are unmistakable, short-lived and discrete climatic hazards with a well-established set of basic characteristics. The United States' National Hurricane Centre (NHC) defines the storms as follows:

> A warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined centre (NHC, 2014a).

Once formed, tropical cyclones are maintained by the uptake of heat energy from the ocean and its export to the cool upper troposphere. Tropical cyclogenesis—the process of their formation—may occur where sea surface temperatures (SSTs) exceed 26.5^{o}C. Further prerequisites include a moisture-laden atmosphere, weak vertical shear of horizontal winds, sufficient Coriolis force to propel circular wind rotation and the presence of an atmospheric disturbance. The low pressure core or 'eye' of a tropical cyclone is characterised by minimum wind speeds and dry conditions. It is encircled by radiating bands of thunderstorms (Plate 2.1), with the strongest winds and heaviest rainfall experienced in the wall of the eye. Both winds and precipitation decrease from that point outwards. Tropical cyclones lose intensity gradually once the eye passes over land or areas of cooler SSTs (Elsner and Kara, 1999; Emmanuel, 2011).

Plate 2.1. Satellite image of Hurricane Andrew passing Cuba (bottom) in August 1992. Image available at http://www.nsof.class.noaa.gov/ (Inventory ID: 1998489, Dataset Name: NSS.HRPT.ND.D92236.S1231.E1243.B0663434.WI).

The preconditions for tropical cyclogenesis mentioned above give rise to relatively fixed geographical zones and seasons of storm formation (Figure 2.1), to some extent restricting the threat they pose. Nonetheless, powerful tropical cyclones—known in the Atlantic as hurricanes if their sustained wind speeds exceed 33 ms^{-1}—are associated with profound environmental and socioeconomic effects. The energy released by a fully-developed hurricane is calculated to be several-fold greater than that of a Hiroshima-sized atomic bomb (Gray, 2000). Impacts of these cyclones are associated not only with the force of their sustained winds, but also stronger gusts, the torrential rains that accompany them, the sea surges they generate on landfall and tornadoes occasionally spawned in the eye wall. It is likely because of the sudden coalescence of such forces, in combination with their capacity to travel thousands of kilometres, that six of the ten costliest natural disasters experienced in the United States between 1980 and 2010 were caused by hurricanes (Fulscher, 2011).

While any disaster may—subject to a range of social factors—become ingrained in collective memory, those stemming from sudden and dramatic hazards tend to leave particularly potent and enduring cultural legacies (García-Acosta, 1992; Pfister, 2009). For their part, Caribbean tropical cyclones are thought to have figured prominently in the symbolism and religion of diverse pre-Columbian societies, in European literature and folklore about the New World and in the success or failure of a number of military

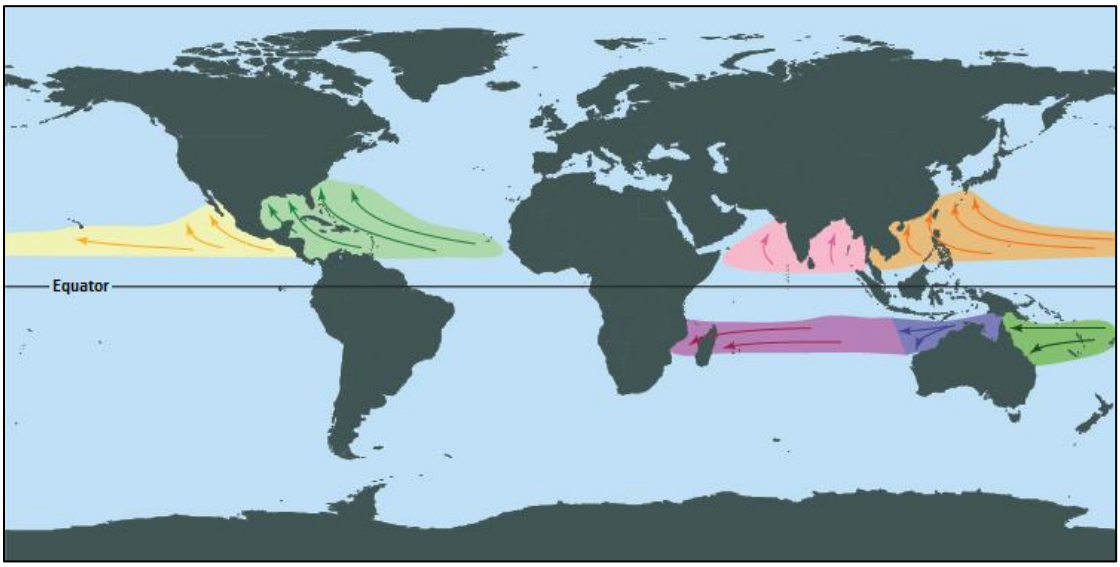

Figure 2.1. The seven zones of regular tropical cyclone formation. Arrows indicate typical storm paths. Image from: http://www.srh.noaa.gov/jetstream/tropics/tc_basins.htm.

and political campaigns since the earliest days of colonialism (Ortiz, 1947; Pérez, 2001; Hughes, 1987; Mulcahy, 2006). Though far less has been written regarding the cultural imprint of droughts, there is increasing evidence to suggest that these too have been influential in the human history and prehistory of the region (e.g. Hodell et al., 2007; Gil, 2008; Johnson, 2011). A review of the literature addressing the interplay between both of these climatic hazards and people in the Caribbean's colonial past is presented in Chapter 7.

2.3. Historical climatology

2.3.1. Focus and development

The research presented in this thesis falls under the umbrella of historical climatology, which, though once a marginal branch of palaeoclimatology, now represents a burgeoning and well-recognised sub-discipline. In recent years, it has commonly been framed as a fusion of climatology and environmental history, adopting the methodology of both disciplines and dealing primarily with historical documentary evidence. Historical climatology research is directed towards three main objectives: (1) reconstruction of temporal and spatial patterns of weather and climate prior to the period of standardised instrumental recording; (2) investigation of the effects of these upon societies and economies; and (3) exploration of their representation and conceptualisation by people in the past (Brázdil et al., 2005, 2010; Pfister, 2010; Pribyl, 2014). The source material studied in the field has been specified as the following: "a document, i.e. a unit of information such as a manuscript, a piece of

printed matter (book, newspaper etc.), [or] a picture or an artefact (e.g. a flood mark or an inscription on a house) which refers to weather or impacts of climate" (Brázdil et al., 2005: p.364). Naturally, the preservation and availability of such relicts are critical determinants of the potential for investigation. Detailed, long-term studies are often limited to the era of systematic record-keeping, which in the Americas spans the five centuries following European colonisation (Metcalfe et al., 2002). Further discussion of the nature of documentary climate evidence is provided in Chapter 4.

Brázdil et al. (2005) present a detailed review of the origins and development of historical climatology. The scientific study of historical climate evidence can be traced back to the late nineteenth century, with Swiss physicist Louis Dafour (1870) discovering that vine harvest dates could be used to infer past temperature variations and climatologist Alfred Angot (1895) compiling a catalogue of documentary climate information for France. Based on similar principles, a small number of pioneering studies were undertaken during the early-mid 1900s elsewhere in Europe (e.g. Hellman, 1921; Brooks, 1926; Easton, 1928). However, it was not until the seventies and eighties, through the involvement of both meteorologists and historians, that historical climatology began to emerge recognisably as the field it is today. French historian Emmanuel Le Roy Ladurie and British climatologist Hubert Horace Lamb were key figures at the time, producing landmark monographs that united a range of historical climate evidence to investigate climate changes in Europe over the past millennium (Le Roy Ladurie, 1967; Lamb, 1977, 1982). The work of Gordon Manley (1974), Hermann Flohn (1979, 1985) and Pierre Alexandre (1987) also deserves acknowledgement here. Prominent historical climatologists of the most recent two decades include Switzerland's Christian Pfister and Rudolf Brázdil of the Czech Republic. Focusing their efforts on the European mainland, Pfister and Brázdil have led the way in standardising methodological approaches, generating sophisticated multi-century reconstructions, undertaking wide-ranging climate impacts analyses and connecting disparate research programmes (see Brázdil et al., 2005, 2010 and references therein). In North America, the endeavours of Cary Mock and Michael Chenoweth have had a similar influence over the last decade (e.g. see Dupigny-Giroux and Mock, 2009; Mock, 2012).

Overall, it is noteworthy that considerably more work in the sub-discipline has focused on scientific reconstruction than investigation of historical climate-society dynamics (Carey, 2012). This has been attributed partly to association with environmental determinism—an approach thoroughly debunked since the early 1900s (Pfister, 2010). As noted by Carey (2012), several recent studies have, however, successfully redressed this association, examining the dynamic interplay between multiple environmental and societal factors in historical processes, rather than focusing solely upon the explanatory power of climate. Accordingly, historical

climatology today incorporates an increasingly rich spectrum of approaches, ranging from those of epidemiology and demographics to political science and cultural studies.

2.3.2. Contemporary relevance and limits

The past is key to understanding the present and future. This basic principle underpins the foremost arguments for the relevance of historical climate research made by social and natural scientists alike (e.g. Bradey, 1999; deMenocal, 2001; Endfield, 2008; Ford et al., 2010; Pfister, 2010). Yet historical insight cannot always translate into actionable climate knowledge in a straightforward manner. A significant barrier to such an interchange is the substantial organisational and technological differences that normally exist between societies past and present. On these grounds, the notion that the historical record affords direct analogies of the societal effects of current climate changes or events has been rejected (Ingram et al., 1981; Meyer et al., 1998; Howe, 2011). Furthermore, there is always the possibility that climate history may tend to assign disproportionate importance to weather-related shifts when explaining major societal events, such as collapse or warfare (Fan, 2010; Butzer, 2012). For example, the suggestion that climatic deterioration during the Little Ice Age was the principal driver of the Norse depopulation of Greenland (Diamond, 2005) has been criticised for sidelining contemporary economic and political developments (Ogilvie, 2010). As regards historical 'proxy' data used for reconstruction—which can range from sediment stratigraphies and tree rings to the documentary sources described earlier—it is recognised that these are inherently incapable of generating a pure record of climate per se; they almost always reflect some element(s) of climatic variation at the expense of others, alongside unrelated physical or human variables (Jones and Mann, 2004). Nevertheless, methodological progress is enabling climatic signals in the documentary record to be isolated with increasing sophistication (Brázdil et al., 2010), while ever more nuanced analyses of the manifold physical and human parameters that may explain societal change are being presented (e.g. Endfield, 2008; Bulliet, 2009; White 2011). These considerations aside, it is clear that the empirical evidence gathered by historical climatologists holds considerable contemporary relevance.

As a sub-discipline of palaeoclimatology, historical climatology is of intrinsic value for developing scientific understanding of climate variability. The analysis of historical climate proxy data represents one of few means to address the shortcomings of standardised instrumental data series. Instrumental records cover insufficient time spans and geographic areas to assess the full range of climate variations that may be experienced over centuries and millennia, as well as the mechanisms responsible for them. As such, proxy-based reconstructions afford information crucial for calibrating models used to forecast future climate changes (Lowe and Walker, 1997; Bradley, 1999), the importance of which is manifest in the attention they have received in successive IPCC reports (Folland et al., 2001; Jansen et al., 2007; Masson-Delmotte et

al., 2013). The value of documentary sources in particular is the high-resolution, precisely-dated record of climate that they often provide, as well as their tendency to highlight discrete events like droughts and storms (see Section 4.2.). In the Caribbean—a region where few instrumental data series extend beyond the early twentieth century—this is all the more vital because climatic and geographical features limit the potential for using other high-resolution environmental proxies, such as tree rings and ice cores (Chenoweth, 2003).

A unique feature of historical documentation versus biophysical or geological proxies is that they allow for simultaneous investigation of climate and its societal ramifications. While direct analogues cannot be drawn from specific climate-related disasters or cultural shifts in the past, the study of these occurrences in diverse contexts can improve understanding of how and why certain populations, groups and economic systems are affected by weather perturbations (Caseldine and Turney, 2010; Carey, 2012). Again, the IPCC has highlighted the importance of such insights for devising appropriate disaster preparedness, mitigation and relief schemes and discerning especially vulnerable geographic areas and populations (McCarthy et al., 2001; Parry et al., 2007; Field et al., 2014). Much can also be learned about adaptation to climate change or, more crucially, influences over its success or failure. Exploring the ways in which past societies perceived and reacted to climatic stress enables the identification of structural and cultural influences over adaptability which have present-day parallels (Stehr and von Storch, 1995; Adger et al., 2005; Orlove, 2005; Endfield, 2008). Finally, in much the same way as historical data may serve as the basis for models of future climate scenarios, they can be employed to simulate the consequent effects on food and water resources. Despite the limited ability of computer simulations to account for social factors such as adaptation and market forces, they are recognised to be extremely effective at communicating large quantities of information to policy makers (Fraser, 2006).

As suggested in the previous chapter, arguments can also be made for the intellectual rather than practical merits of historical climate research. An approach which breaks from the academic tradition of explaining human history with reference to social, economic and political processes is more likely to bestow novel insights on past developments and a more comprehensive appreciation of the milieu from which they emerge (de Vries, 1985; McNeill, 2003, 2010). Evidence has, for instance, been presented that adverse climatic conditions contributed palpably to the outbreak of several well-documented conflicts, including the French Revolution (1789-1799) and the Mexican War of Independence (1810-1821), challenging conventional narratives of their causation (Grove, 2007; Endfield, 2008; see Section 7.2 for Caribbean examples). The study of disasters—climate-related or otherwise—is argued in particular to offer unique perspectives on the societies that they affect (Schenk, 2007). As noted by Eric Hobsbawm (1971: p.39), upheavals of this kind “dramatise crucial

aspects of social structure because they are here strained to breaking point." This is especially enlightening in the case of past societies which, of course, cannot be observed directly (Gasper, 1985).

2.4. Vulnerability to environmental shocks and stresses

2.4.1. Definitions, dynamics and drivers

In general terms, *vulnerability* can be regarded as the potential for loss from, or being adversely affected by, a given actor. It is a concept invoked in a range of academic disciplines from economics to medicine. Despite the existence of more specific and tailored definitions at this level, there is considerable variation in the uses and connotations of the term both within and across disciplinary divides (Cutter, 2006). With respect to environment and environmental change, recent IPCC Assessment Reports (Parry et al., 2007; Agard et al., 2014) and academic scholarship (Cutter 2006; Gallopín, 2006; Miller et al., 2010) suggest consistency as far as the term refers to *the propensity of an ecological or social entity to experience harm from a perturbation as a function of its exposure, sensitivity and capacity to adapt to said perturbation*. This, then, is the way in which the concept is understood in the present research project.

At this stage, it is worth explaining other terminology which is key to the study of vulnerability. For consistency, definitions are derived from the most recent IPCC Assessment Report, which are given specifically in relation to the phenomena of climate variability and hazards. Firstly, there are three terms with which vulnerability may mistakenly be confused: exposure—the presence of social or ecological entities (e.g. habitats, livelihoods or assets) "in places that could be adversely affected" (Agard et al., 2014: p.12); risk—"the potential for consequences where something of human value… is at stake and where the outcome is uncertain" (Agard et al., 2014: p.23); and sensitivity—"the degree to which a system… is affected, either adversely or beneficially, by climate variability or change" (Agard et al., 2014: p.24). An alternative approach to conceptualising social-environmental dynamics is through the study of resilience, which is the "the capacity of a social-ecological system to cope with a hazardous event or disturbance" through responses "that maintain its essential function, identity, and structure," as well as "capacity for adaptation, learning, and transformation" (Agard et al., 2014: p.23). Resilience has at times been treated as the antonym of vulnerability. However, this notion has been questioned on the grounds that the true "flip side" of vulnerability would account for the capability of a system to maintain structure against a perturbation, even if its resilience were overcome (Gallopín, 2006: pp.299-300). Despite these technicalities, integrative approaches to vulnerability and resilience have recently been proposed to offer more comprehensive

insights into disaster preparedness and coping strategies (Ibarran et al., 2010; Miller et al., 2010; Turner, 2010). Finally, there is the concept of adaptation, which can be seen as the "process of adjustment to actual or expected climate and its effects." More specifically, adaptation in human systems "seeks to moderate harm or exploit beneficial opportunities" (Agard et al., 2014: p.1). The ability of a system to adjust in this way is termed "adaptive capacity" (Agard et al., 2014: p.2).

Comprehensive research on vulnerability to environmental phenomena inherently involves interdisciplinarity. It is crucial to address interactions between biophysical parameters, such as exposure to and the characteristics of a given stressor, and cultural ones, including levels of technological, economic and political development as well as adaptive reactions (Cutter, 2006; Field et al., 2014). Earlier approaches were not as integrative, typically placing emphasis on one of these two major aspects. Studies focusing on biophysical factors tended to position vulnerability as implicit in the inhabitance of precarious environments, while those adopting the cultural perspective portrayed vulnerability as a primarily social construct (Endfield, 2008). Despite the recent incorporation of these distinct conceptualisations, it has been suggested that there remains a legacy of "fuzzy definitions and divergent themes" in the field (Cutter, 2006: p.69). Further complexity arises from the fact that vulnerability is a composite, dynamic concept that varies both spatially and temporally (Adger, 2006; Endfield, 2008).

In the context of contemporary environmental change, understanding and assessing vulnerability is of considerable relevance. Global warming will present challenges for human society, as it is likely to increase the frequency and/or intensity of extreme weather events in some areas (Stocker et al., 2013). Vulnerability research is important for determining the nature of these challenges, as well as the means of fostering remedial action through coping strategies and adaptation (Kelly and Adger, 2000; Adger 2006).

Of course, not all societies, groups and individuals feel the effects of climate change equally. This idea can be encapsulated by the term 'differential social vulnerability' (after Liverman, 1990). At the macro-scale, countries in the 'developing world' with natural resource-dependent economies are thought to be those impacted most deleteriously (Liverman, 1990; Adger et al., 2003). Nationally, institutional strength and market structures are key determinants of vulnerability levels, governing infrastructural sophistication, popular access to capital and material resources and, thus, social welfare at large (Adger and Kelly, 1999; Brooks et al., 2005). Reliance on rain-fed and non-diverse agriculture is a common source of vulnerability from the state down to community level (Liverman, 1990; Meyer et al., 1998). At the level of particular groups, those that are marginalised socially, politically, economically or environmentally are thought of as most threatened (Adger, 2003; Fraser et al., 2003; Cutter, 2006). As this would suggest, socio-economic class is central to an

individual's vulnerability to adverse climate phenomena, along with a diversity of other potential influences over resource entitlement like race, gender, education, age and physical (dis)ability (Meyer et al., 1998; Adger and Kelly, 1999; Endfield, 2008). It should be recognised, however, that the relationship between vulnerability and conventional western standards of development and privilege is not straightforward; economic growth invariably signifies more assets at risk, while some societies less exposed to globalisation and institutional control benefit from informal risk management networks (Adger, 2003) and indigenous land-use practices finely tuned with the local environment (Bankoff, 2007).

2.4.2. Historical approaches

The assessment of vulnerability to recent, current and future climate change(s) and hazards has been the subject of much scholarship, adopting various scales and methods of analysis (see Cutter et al., 2009). Although temporal context is acknowledged to be a fundamental influence over the extent to which social-ecological systems are affected by and respond to stresses of this type, there has been comparatively little work approaching vulnerability to them from an historical perspective or investigating changes in vulnerability over time (Parry, 2001; Cutter, 2006; Pfister, 2010). This may well owe to the fact that vulnerability is an intangible phenomenon that cannot be easily identified in historical sources. An additional difficulty is our imperfect knowledge of climate variability in the pre-instrumental period (Endfield, 2008). Select examples of studies which have been undertaken despite such restraints will now be discussed.

For present purposes, the literature on historical vulnerability to climate can be divided into two main categories. The first comprises that which focuses on the advancement of theoretical frameworks. Perhaps the earliest and most widely cited example of a study of this kind is that of Bowden et al. (1981). By drawing examples from the North African Sahel and US Great Plains from late 1800s through mid-1900s and the Tigris-Euphrates Valley in Iraq from the past 6,000 years, they presented evidence of two major hypotheses of climate-society dynamics. These are as follows:

1. the Lessening Hypothesis, which states that "societies are able, through their technology and/or social organisation, to *lessen* the impact of *minor climatic stresses*, defined as events with a return period of the order of less than 100 years";
2. the Catastrophe Hypothesis, which proposes that "success in insulating a livelihood system from minor climatic stress does little to reduce, and may increase, vulnerability to *major* climatic stress, defined as an event with a return period of more than 100 years" (Bowden et al., 1981: p.480, with original italicisations).

In another longue durée study, Messerli et al. (2000) proposed the notion of a 'trajectory of vulnerability' to climatic-environmental changes. This denotes a pathway through which all societies pass with economic, social and technological development over time and associated evolutions in adaptive mechanisms. The relative vulnerability of a given society is influenced by its position along the trajectory. Messerli and colleagues proposed three states of environment and society:

1. a 'nature dominated' environment of predominantly hunting and gathering societies in which human vulnerability is highest;
2. an environment altered by the establishment of fixed settlement and agriculture which buffer society from biophysical shocks;
3. a 'human-dominated' environment in which vulnerability once again increases as overpopulation results in over-exploitation of natural resources and over-reliance on buffer systems.

Each of these were illustrated with a different case study from the Holocene.

Bankoff (2007) also invokes the concept of trajectories of vulnerability, but with reference to environmental disasters and a focus on the most recent few centuries of human history. He contends that disasters have two historical trajectories: one natural, in that geophysical and climatic conditions vary temporally to determine the intensity and frequency of hazardous events, and one societal, which stems from the fact that people and cultures change over time. Bankoff outlines a range of major developments since the early-modern era which account for present-day vulnerability, such as deforestation, population explosion and mass migrations. He then discusses those of urbanisation, agricultural commercialisation and technological progress in detail. Implicit in Bankoff's and Messerli's conceptions of vulnerability is the widely-accepted notion that the net effect of natural forces upon a given human system is the product of complex, dynamic interaction between ever-changing cultural and environmental contexts, as well as shifting structures and contingencies of coping mechanisms (Butzer, 2012; Dugmore et al., 2012; Endfield et al., 2012).

The second major class of research considered here addresses the characteristics of vulnerability in time- and place-specific settings. A considerable number of climate histories can be loosely included in this category, as they have employed the concept of vulnerability, either explicitly or implicitly, in the study of nature-society dynamics without positioning it as a subject of central focus (e.g. Hurt, 1981; Davis, 2001; Myllyntaus, 2009; Prieto, 2009; Taithe, 2009; White, 2011). Significantly, these studies discuss the convergence of biophysical and social factors that rendered particular societies or groups susceptible to climate stresses. Often they do so by exploring the influence of such factors over human livelihoods and hazard responses.

Next, there are those investigations which focus expressly on vulnerability. Though a much less extensive literature, examples are available for many regions, including Europe (Pfister and Brázdil, 2006; Engler et al., 2013; Ogilvie, 2004), South Africa (Kelso, 2010), India (Adamson, 2012) and Latin America (Carey, 2005; Endfield, 2008; Gil-Guirado, 2013). This scholarship deals largely with the same subject matter as that described above, but gives overt attention to the interplay of variables modulating vulnerability. It typically incorporates insights and approaches from contemporary vulnerability studies (Section 2.4.1) and emphasises patterns of risk, exposure and resilience at a range of scales. Work by environmental historian Georgina Endfield (e.g. Endfield and Tejedo, 2006; Endfield et al., 2004, 2009; Endfield, 2008, 2012) on climate and vulnerability in colonial Mexico is of particular relevance to the present thesis, as this too focuses on a pre-industrial colonial society in the (sub)tropical Americas and utilises a similar selection of documentary sources (see Chapter 4). Predominantly, the research discussed in this paragraph adopts a qualitative and discursive empirical approach, though some recent studies also make use of semi-quantitative vulnerability indices (Engler et al., 2013; Gil-Guirado, 2013).

2.5. Chapter overview

This chapter has established the theoretical and disciplinary context of the present investigation. It considered the basic features of the two climatic hazards that will later take centre stage, the epistemology of the field of historical climatology and the concept and study of vulnerability. The first of these discussion points highlighted that droughts and tropical cyclones represent highly distinct hazards. While the former are slow-onset, enduring climatological anomalies that lack a universal definition and may have blurry start and end points, the latter are unmistakable, sudden and short-lived entities which, from a human perspective, may be regarded as dramatic or even spectacular. Such insights are relevant not least because they influence the representation of said weather events in the historical record. Subject matter of this kind is the domain of historical climatology—a well-established field fusing elements of palaeoclimatology and environmental history. The approach can be regarded as having two main investigative agendas: reconstruction of the physical characteristics of climate and exploration of climate-society inter-relations in times past. Both of these have considerable academic and practical merit.

The final focus of this chapter was vulnerability to climate, which is a complex and multi-faceted idea, constituted by dynamic interaction between humans and the natural environment. Despite conceptual and methodological difficulties associated with its study, historical investigations have afforded valuable insights into the parameters influencing temporal, spatial and socio-economic patterns of vulnerability to climatic vicissitudes. An especially relevant idea advanced in this area is that of a

‘historical trajectory of vulnerability.’ Though originally proposed as a fixed pathway of changing vulnerability to environmental stress associated with centennial-millennial scale cultural development (Messerli et al., 2000), the same notion can be employed more loosely for considering shifts in vulnerability and their drivers over a range of timescales (e.g. Bankoff, 2007). In this way, it will serve as an important conceptual framework later in the thesis (Chapter 11).

Chapter 3

Environmental and historical contexts

3.1. Introduction

Having established the theoretical basis of this thesis, an important next step is to outline the material research context. The present chapter tackles this by describing the contemporary environmental setting of Antigua and the human history of the island during and immediately prior to the study period. After introducing Antigua's basic geographical features, consideration is given to climatic conditions, major oceanic-atmospheric mechanisms affecting these and present-day human vulnerabilities to extreme weather events, both locally and regionally. In keeping with the thesis at large, the focus is on precipitation variability and tropical cyclone activity. The second half of the chapter discusses pertinent cultural, political, economic and demographic developments in Antigua's pre-twentieth century colonial past. Here, attention centres on the socio-economic order established by the rise of the sugar industry from the late 1600s to mid-1700s and the adjustments that this underwent over the following 150 years.

3.2. Environmental setting

Antigua (17°N, 61°W) is situated in the central-eastern Leeward Islands, which constitute the northern half of the Lesser Antilles archipelago (Figure 3.1). It is a small (~280km^2), predominantly low-lying limestone island (40-120 masl), which rises into a hilly volcanic zone in its south-western quarter (peaks above 300 masl). Unlike many of the other Lesser Antilles islands, Antigua is not mountainous and lacks both extensive tropical forest and permanent major water bodies such as rivers and streams. Numerous rain-fed ponds, small lakes, lagoons and springs are, however, present. Antigua is divided into six parishes and contains four major towns, St. John's, Parham, Falmouth and English Harbour (Figure 3.1), all of which were established in the seventeenth century. St. John's has been the capital and the largest settlement in the island since the late 1600s. Today, Antigua and Barbuda—a smaller (~160 km^2), flatter (<40 masl) island located some 50 km to the north—constitute a single dual-island nation (Harris, 1965; CCA, 1991).

In keeping with Antigua's tropical location, its climate is characterised by minimal variations in average temperatures throughout the year (25-28 °C), but a distinctive seasonal pattern of precipitation and storm activity. It is liable to two main types of meteorological hazard: precipitation extremes and tropical cyclones. The following

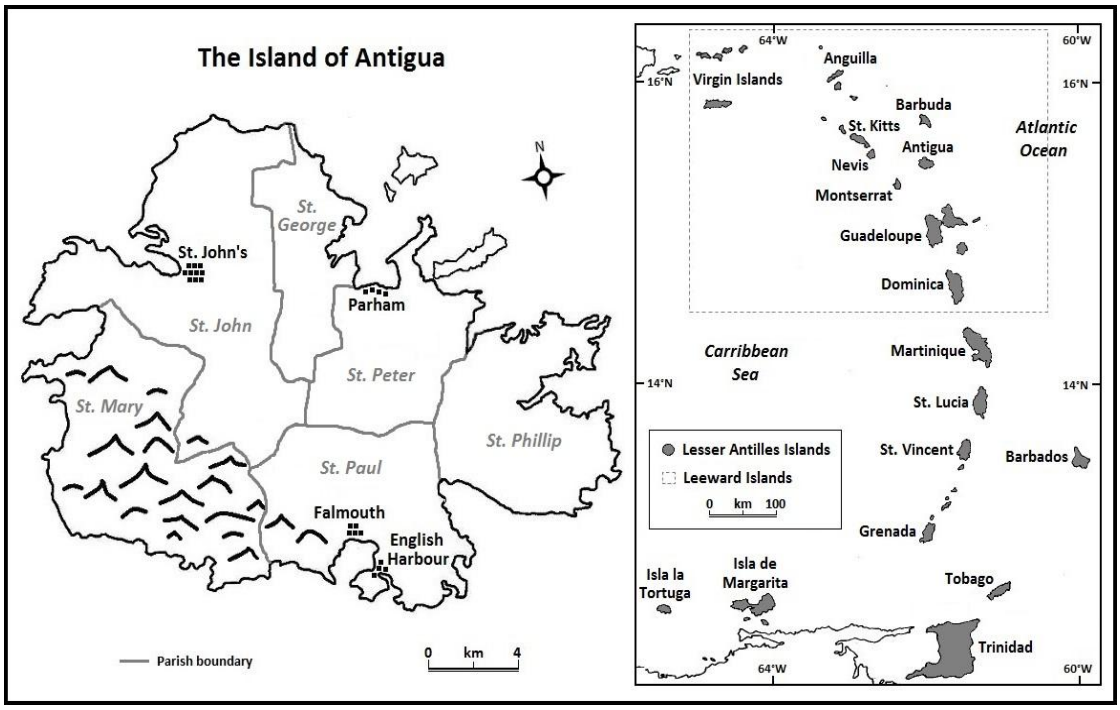

Figure 3.1. Maps of the major Lesser Antilles islands and locations mentioned in Antigua.

three subsections outline patterns of variability in the aforementioned meteorological elements at seasonal to multidecadal timescales, while the fourth identifies present-day vulnerabilities to climatic hazards in Antigua and beyond.

3.2.1. Seasonal variations in precipitation

According to the instrumental records of the Antigua and Barbuda Meteorological Service (available at www.antiguamet.com), which extend back to 1929, mean annual precipitation in the former island is 1181 mm. Some 70-80% of this is normally received during the wet season, which spans May to November. An early precipitation peak in May, a relative minimum in early summer and a maximum in October (Figure 3.2) are common to the wider region (Gamble and Curtis, 2008). Spatial variations correspond with the island's topography, the highest rainfall occurring in the southwest of Antigua (Figure 3.3).

Seasonal migrations of the Inter-Tropical Convergence Zone (ITCZ) and North Atlantic Subtropical High (NASH) drive rainfall seasonality. During the boreal winter, the former occupies an approximately equatorial latitude and the latter spreads from the Atlantic Ocean to the North American landmass. The results are strong Atlantic easterlies and relatively low SSTs in the Caribbean (e.g. Figure 3.4a), encouraging atmospheric subsidence and dry conditions. At this time, precipitation in the Greater Antilles arises from the intermittent incursion of cold fronts from higher latitudes. These seldom extend further southeast than Puerto Rico. Late spring until autumn is characterised by conditions favourable for convective rainfall; the NASH shifts

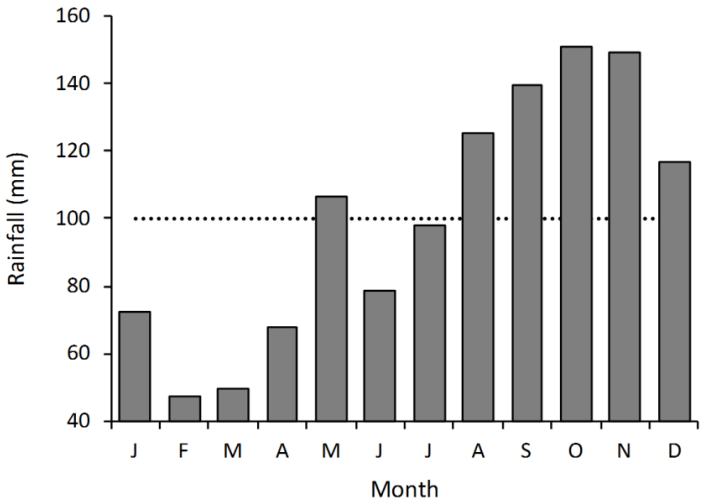

Figure 3.2. Mean monthly rainfall in Antigua, 1928-2012. Black dotted line represents average of monthly mean values. Data available at: www.antiguamet.com.

offshore and poleward, the ITCZ consequently moves north to 6-10 °N, SSTs increase (e.g. Figure 3.4b) and the Trade Winds converge over the Caribbean. Most wet-season precipitation is associated with easterly waves. These barometric troughs in the lower troposphere propagate across the tropical Atlantic from Africa's west coast between mid-June and October (Gianni et al., 2000, Taylor and Alfaro, 2005). The conventional explanation for the widely-experienced 'mid-summer drought' is the temporary intensification of the NASH in early summer and the resulting suppression of convection. Nonetheless, recent investigations have identified some variability in its onset—early June in the eastern Caribbean, but progressively later towards the west—which is yet to be fully explained (Curtis and Gamble, 2008).

3.2.2. Tropical cyclone activity

The general characteristics of tropical cyclones and conditions necessary for their formation were outlined in Section 2.2. In the North Atlantic there exists a well-defined zone, encompassed by the coasts of Africa and the Americas between latitudes of approximately 10 and 30 ^{o}N (Figure 2.1), where African easterly waves may trigger cyclogenesis. In this area, the official 'hurricane season' extends from June 1st to November 30th, though cyclones have occasionally been detected in May and December (Elsner and Kara, 1999). The climatological peak of cyclonic activity occurs from late August through to September, with the statistical maximum occurring around September 10th. This is when the risk of the most intense tropical cyclones is greatest (NHC, 2014b, 2014c). The storms typically follow a westerly track across the North Atlantic, curving poleward towards the American flank of the basin (e.g. Figure 2.1). The Lesser Antilles are, therefore, liable to cyclones formed locally and those originating to the east.

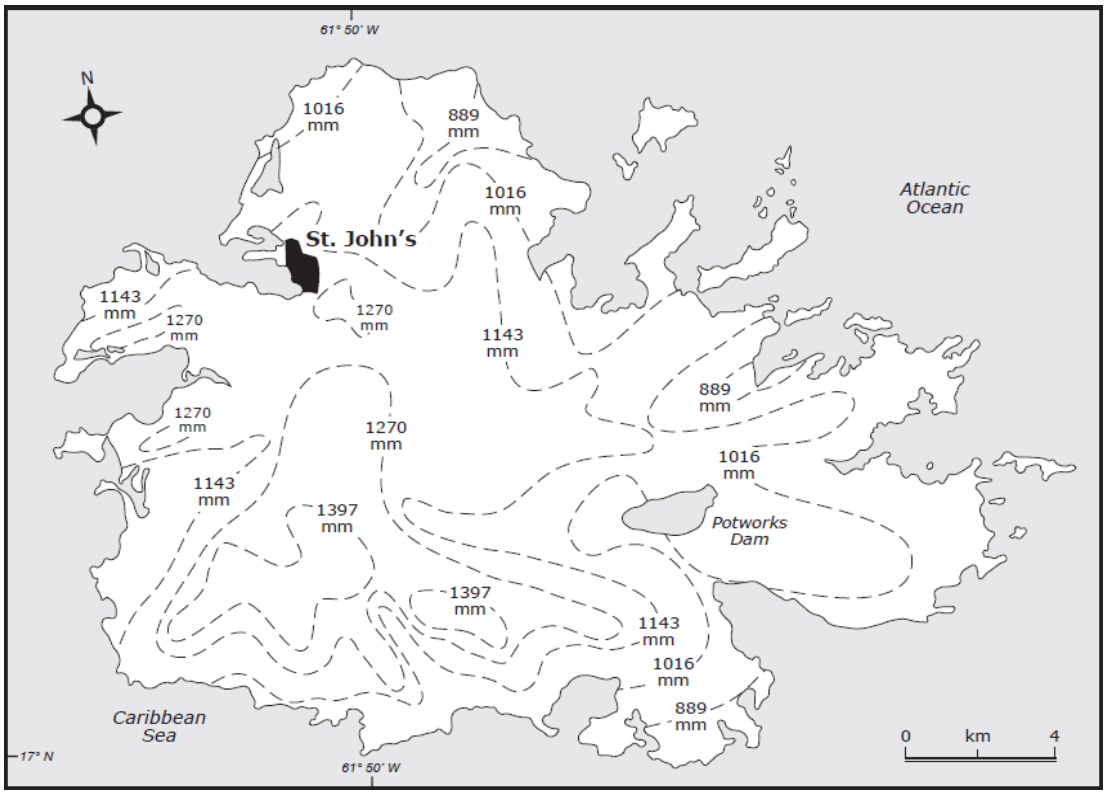

Figure 3.3. Mean annual rainfall distribution across Antigua. Adapted from CCA (1991: p.11).

The physical characteristics of North Atlantic tropical cyclones vary considerably. Storm diameter can range from 150 to 1,500 km, that of the eye from 16 to 70 km and total lifespan from 1 to 30 days. It is on the basis of central sea-level pressure and mean near-surface wind velocities that the cyclones are normally categorised. The NHC recognises four classes of tropical cyclone: depressions, storms, hurricanes and major hurricanes. There are also five intensity levels of major and non-major hurricanes, the distinctions between which are set out in Table 3.1. Beyond the eye of the storm, short-duration wind lulls and gusts occur, the latter typically exceeding sustained wind speeds by 25%. An important factor influencing the observed velocity of both gusts and winds is positioning relative to storm trajectory. Facing in the direction of movement, winds are strongest to the right of the eye and weakest to the left due to the effect of anti-clockwise circulation (Figure 3.5). As noted in the previous chapter, hurricanes represent powerful agents of environmental change, due not only to their winds, but also as a result of flooding. Pressure and wind induced storm surges generated on landfall may reach 5 m in height (Table 3.1). Cyclones also bring heavy rains, often amounting to 100-250 mm at an affected location. In this way, their occurrence can contribute substantially to annual rainfall variability. To gain an idea of spatial variations in the observed impacts of hurricanes of different intensities affecting the Lesser Antilles, readers are referred to Figures 3.6 and 3.7.

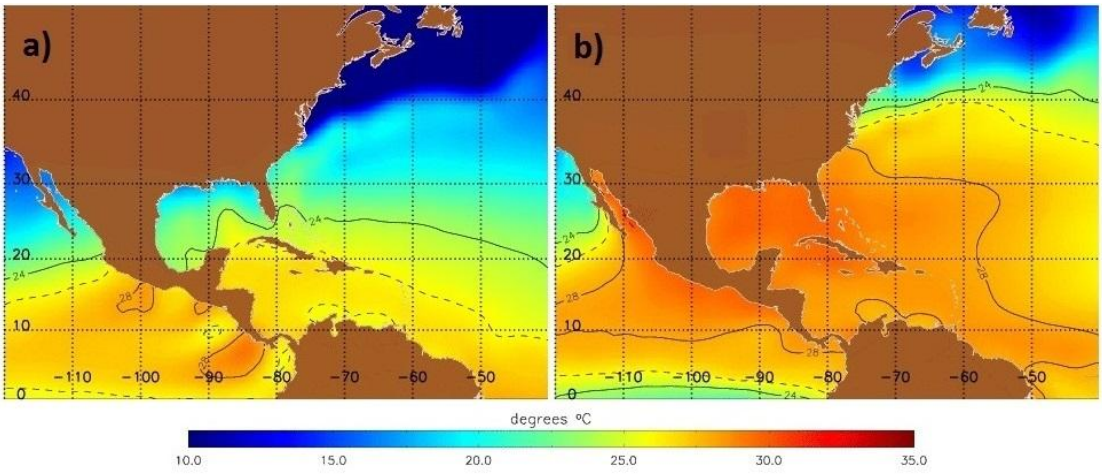

Figure 3.4. Mean SSTs in the North Atlantic in (a) February and (b) August, based on data from 1971-2000. Available at: www.nhc.noaa.gov/aboutsst.shtml.

3.2.3. Inter-annual precipitation and tropical cyclone variability

Year-to-year precipitation variations in Antigua can be substantial (Figure 3.8). In great part, this owes to the fact that the island generates fairly little dependable relief rainfall (GFDRR, 2010). The Antigua and Barbuda Meteorological Service offers the following magnitude classifications for instrumental precipitation data (Destin, 2014):

- well below normal—precipitation totals in the lowest 10% of the dataset;
- below normal—precipitation totals in the lowest 33.3% of the dataset;
- near normal—precipitation totals in the middle 33.3% of the dataset;
- above normal—precipitation totals in the highest 33.3% of the dataset;
- well above normal—precipitation totals in the highest 10% of the dataset.

These figures equate to the occurrence of one year of above or below normal rainfall every three years and one of well above or well below rainfall every ten years. The most complete modern database of North Atlantic tropical cyclones is kept by the NHC and dates back to 1944 (www.nhc.noaa.gov/data/). This record indicates that 52 tropical cyclones affected Antigua from 1944 to 2011, ten of which were hurricanes (Figure 3.9)[2]—equivalent to one tropical cyclone every 1.32 years and one hurricane every 6.9 years.

There are several major atmospheric-oceanic mechanisms known to influence climate variability in the Caribbean over annual to decadal timescales. The impacts of the El Niño-Southern Oscillation (ENSO) are especially well documented. This cycle

[2] All tropical storms and depressions documented within 160 km of Antigua and all hurricanes within 97 km were counted, which accounts for the typically larger diameters of the former (after Chenoweth, 2003; Mock, 2004, 2008).

Table 3.1. Basic classes and characteristics of tropical cyclones recognised by the NHC. Note that intensity classifications are defined by wind speeds and central pressure only.

Storm class	Hurricane intensity category	Maximum mean 1-minute wind speed (ms^{-1})	Central sea-level pressure (mb)	Typical storm surge height (m)
Tropical depression		<17		
Tropical storm		17-33		<1
Non-major hurricane	1	33-42	>979	1-1.7
	2	43-49	965-979	1.8-2.6
Major hurricane	3	50-58	945-964	2.7-3.8
	4	59-69	920-944	3.9-5.6
	5	>69	<920	≥5.6

of SSTs in the tropical Pacific affects early and late stages of the wet season differently. In the year of onset, the warm phase of ENSO—El Niño—is associated with an increase in sea level pressure in the North Atlantic, the divergence of moisture-laden winds away from the Caribbean and drier-than-normal conditions from July to October. Above average rainfall between April and June is typical the year after El Niño commencement, by which time warming in the eastern Pacific has spread to the western tropical Atlantic, encouraging convection (Gianni et al., 2001a, 2001b). Through the mechanisms outlined above and by increasing vertical wind shear over the region, El Niño events tend to stifle tropical cyclone formation during summer and autumn of the year of onset and promote it at the start of the following hurricane season (Chen and Taylor, 2002; Chu, 2004). La Niña, the cold phase of ENSO, has the opposite regional effects to El Niño. Inter-annual variability in rainfall and cyclone activity has also been attributed to regional barometric and wind shear anomalies connected with cyclic oscillations of stratospheric zonal circulation, the extent of seasonal ITCZ movement and the strength of the West African Monsoon (Grey et al., 1993, 1994; Landsea et al., 1999; Bell and Chelliah, 2006).

Over longer timescales, the two best documented drivers of North Atlantic climate variability are the Atlantic Multidecadal Oscillation (AMO) and North Atlantic Oscillation (NAO). The former is defined by SST patterns across the ocean basin, the latter by the magnitude of the sea-level barometric gradient between the pressure centres of the Icelandic Low and the NASH. The influence of the AMO over precipitation in the North Atlantic is most pronounced from March to August. Its warm (cold) phase is affiliated with a northward (southward) displacement in the climatological position of the ITCZ in these months and, thus, higher (lower) precipitation over the Tropical Atlantic (Figure 3.10; Knight et al., 2006). Caribbean rainfall is negatively correlated with the NAO, the effects of which are most notable from January to June. The positive NAO mode—implying a strengthened NASH in winter—equates to greater heat loss from the ocean at low latitudes due to stronger

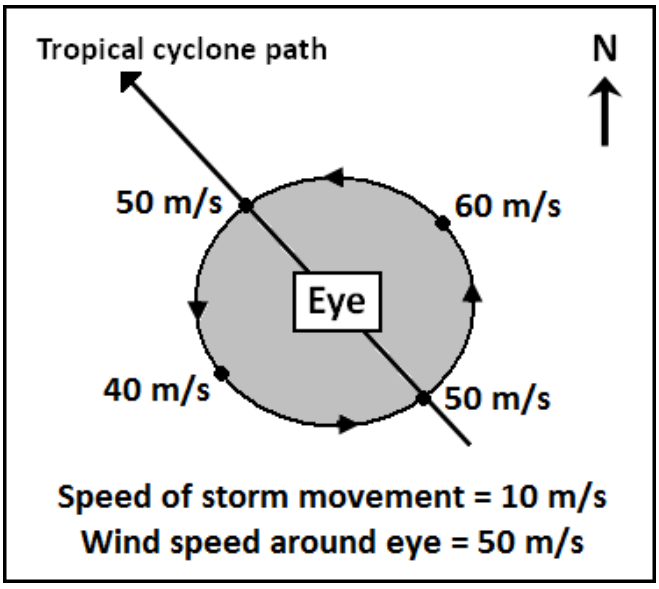

Figure 3.5. Conceptual sketch of observed wind speeds in the eye-wall of a hurricane moving northwest in the northern hemisphere. After Elsner and Kara (1999: p.9).

trade winds. This weakens convection until May-June when the resulting suppression of rainfall is most significant, after which its effects subside (Gianni et al., 2001a, 2001b). The relationship between tropical cyclone activity and both AMO and NAO is less well documented than for ENSO. Nevertheless, evidence suggests that AMO warming reduces wind shear, fostering cyclogenesis (Goldenberg et al, 2001; Knight et al., 2006). Meanwhile, it has been proposed that migrations of the mid-latitude jet stream connected with a strong (weak) NASH increase (reduce) the probability of tropical cyclones re-curving northwards earlier on their typical westward trajectory. As such, they are less (more) likely both to cross the Caribbean and reach higher intensities (Elsner, 2003). Another driver of inter-regional climate variability is the Pacific Decadal Oscillation (PDO), which is often described as a 20-40-year, ENSO-like mode of Pacific SST variability (Mantua and Hare, 2002).

Both long- and short-term mechanisms of climatic variability may act simultaneously to enhance or moderate one another's regional effects. For instance, the delayed warming and increased early wet-season precipitation expected the year after El Niño onset can be counteracted by the positive NAO phase, or augmented if concurrent with the NAO bearing the opposite sign (Gianni et al., 2001a). In the case of these particular oscillations, sub-regional analyses indicate that while ENSO effects dominate in the northwest Caribbean, their influence is smaller, and those of the NAO greater, in the Lesser Antilles (Gianni et al., 2001b, Jury et al., 2007). Detailed investigations of spatial variance in the relative importance of other major climate indices have yet to be undertaken.

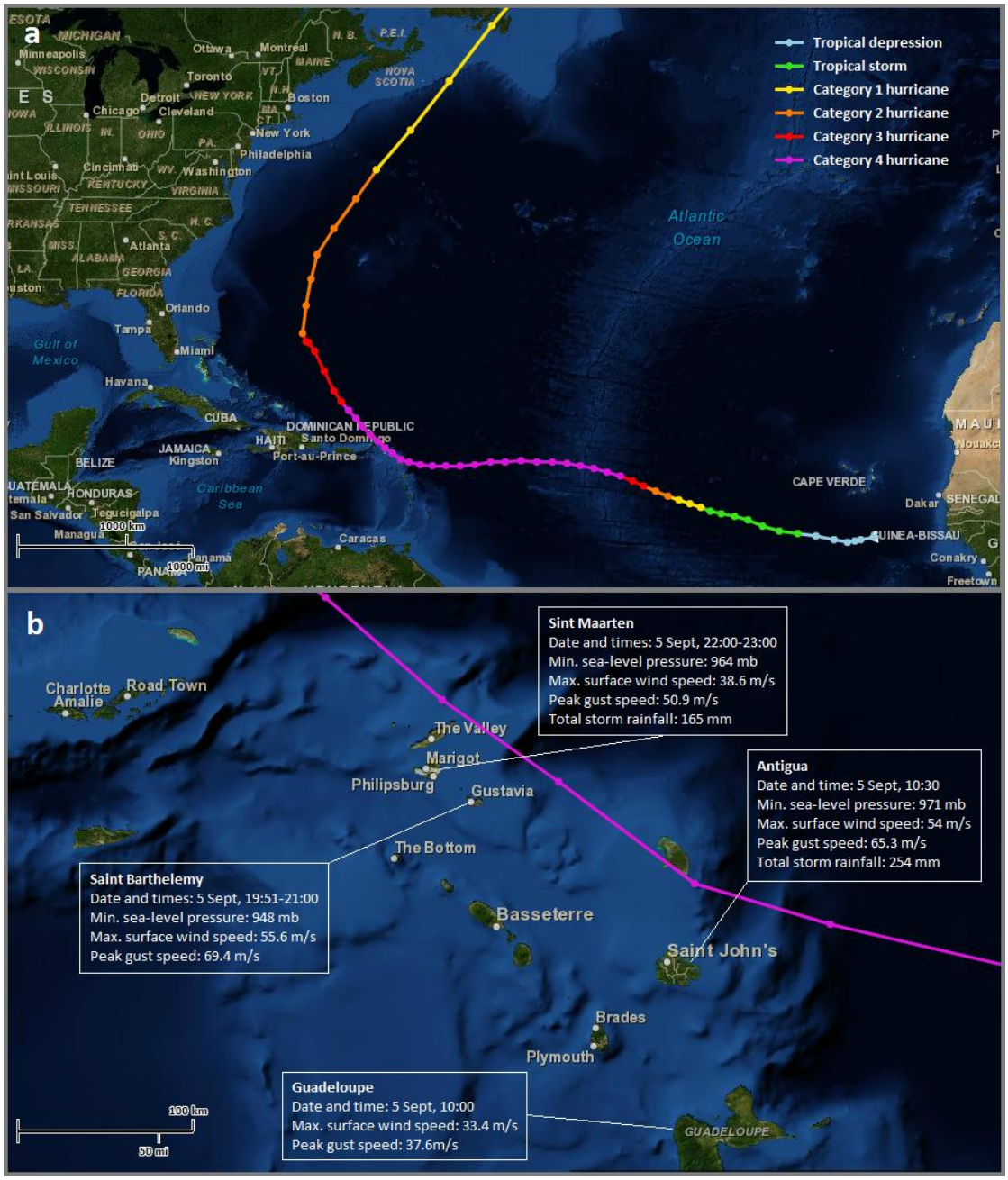

Figure 3.6. Track of hurricane Luis (1995) through (a) the North Atlantic Ocean and (b) the Leeward Islands, including available instrumental data. Plotted using NOAA 'Historical Hurricane Tracks' tool (http://csc.noaa.gov/hurricanes). Additional data from Lawrence (1996).

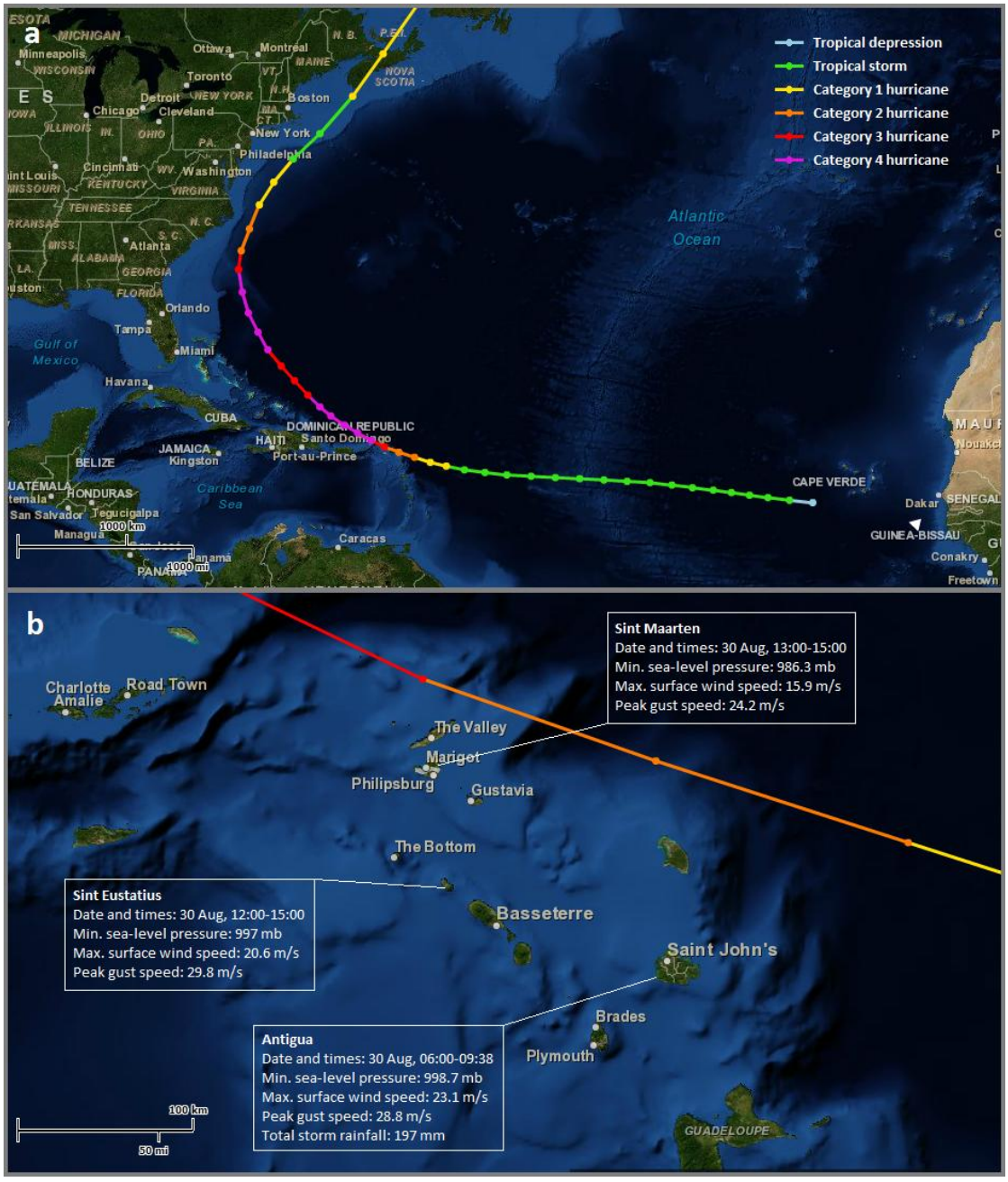

Figure 3.7. Track of hurricane Earl (2010) through (a) the North Atlantic Ocean and (b) the Leeward Islands including available instrumental data. Plotted using NOAA 'Historical Hurricane Tracks' tool (http://csc.noaa.gov/hurricanes). Additional data from Cangialosi (2011).

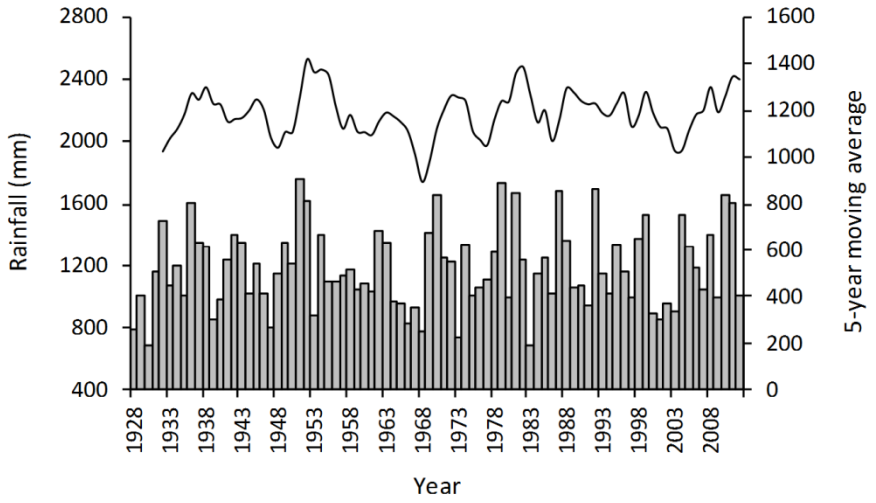

Figure 3.8. Annual rainfall in Antigua, 1929-2012. Data available at www.antiguamet.com.

3.2.4. Present-day vulnerability to climatic hazards

As 'Small Island Developing States', the Lesser Antilles share a number of structural features that enhance vulnerability to natural hazards. These features have been summarised by Pelling and Uitto (2001: p.53) as follows:

- *small geographical area*, which limits natural resource reserves, increases the intensity of land use and, therefore, heightens the immediacy of human-environment interdependence;
- *insularity and remoteness*, which impedes access to external resources and inhibits information flows;
- *limited mitigation capability* in the form of hazard forecasting, insurance and anticipatory action;
- *demographic factors*, including small populations, high-density settlement in coastal zones and single urban centres;
- *economic factors*, including small economies, dependence on external finance, small internal markets and highly specialised production and service sectors;
- *environmental factors*, including small exposed interiors and large coastal zones.

These are in addition to characteristics which render developing states vulnerable in general, such as reliance on primary exports, major socio-economic inequalities, limited infrastructure, improper land use and institutional weakness (Pelling and Uitto, 2001). Factors of this kind help to explain why, when ranked by the frequency of disaster events per unit area, SIDs account for 19 of the top 20 states at risk globally (Pulwarty et al., 2010). For its part, the Caribbean contains more SIDs than any other

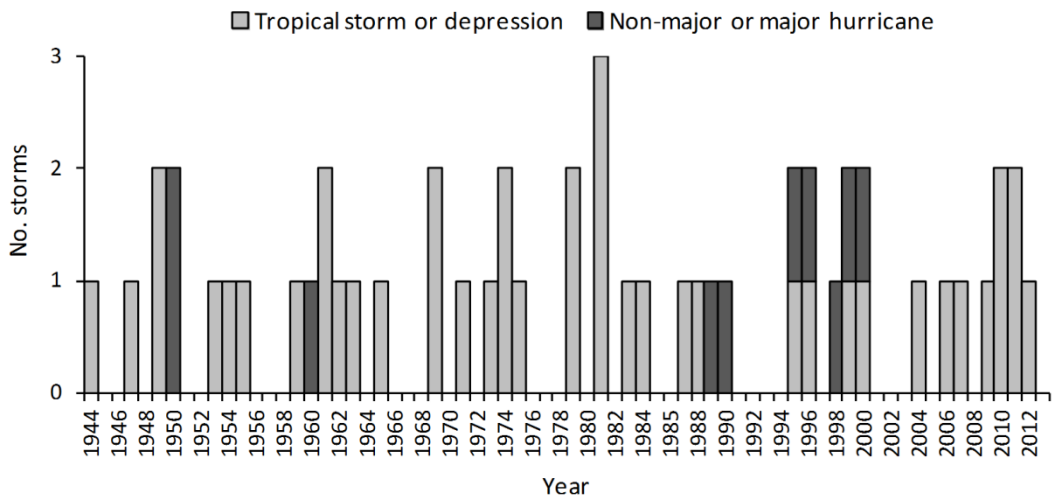

Figure 3.9. Annual frequency of tropical cyclones affecting Antigua, 1944-2011. Data available at www.nhc.noaa.gov/data/.

region. Here, vulnerability is associated with especially high levels of urbanisation and reliance on food imports, as well as economies based heavily on tourism and agriculture—sectors notoriously sensitive to meteorological extremes (Pelling and Uitto, 2001; Boruff and cutter, 2007; Pulwarty et al., 2010).

Antigua and Barbuda have themselves been ranked the sixth state in the world at greatest economic risk to multiple natural hazards—with an estimated 80.4% of GDP potentially threatened by these events—and sixteenth in terms of demographic exposure (Dilley et al., 2005). Aspects of the country's vulnerability to meteorological extremes have been assessed by the Global Faculty for Disaster Reduction and Recovery (GFDRR). As regards tropical cyclones, which often impact the entire population at once, it is highlighted that the lack of mountainous terrain minimises the risk of landslides, but increases exposure to winds. Low elevations coupled with an abundance of intrusive bays enhance the risk of coastal flooding. Despite the presence of some desalinisation systems, drought represents a major concern because of limited freshwater bodies (Section 3.2). Socio-economic vulnerability stems from reliance on the tourism sector, which contributes some 74% to GDP, and the concentration of critical infrastructure (e.g. power, water and healthcare provision) and international transport hubs in the vicinity of St. John's (GFDRR, 2010).

Another important dimension of contemporary vulnerability is climate change. In line with regional global warming models, Antigua and Barbuda are expected to experience a median decrease in precipitation of 6-16% and mean sea level rise of 13-56 cm over the present century (McSweeney et al., 2010). These changes are associated with more frequent and severe heat waves and droughts, as well as the expansion of areas threatened by storm surges (GFDRR, 2010).

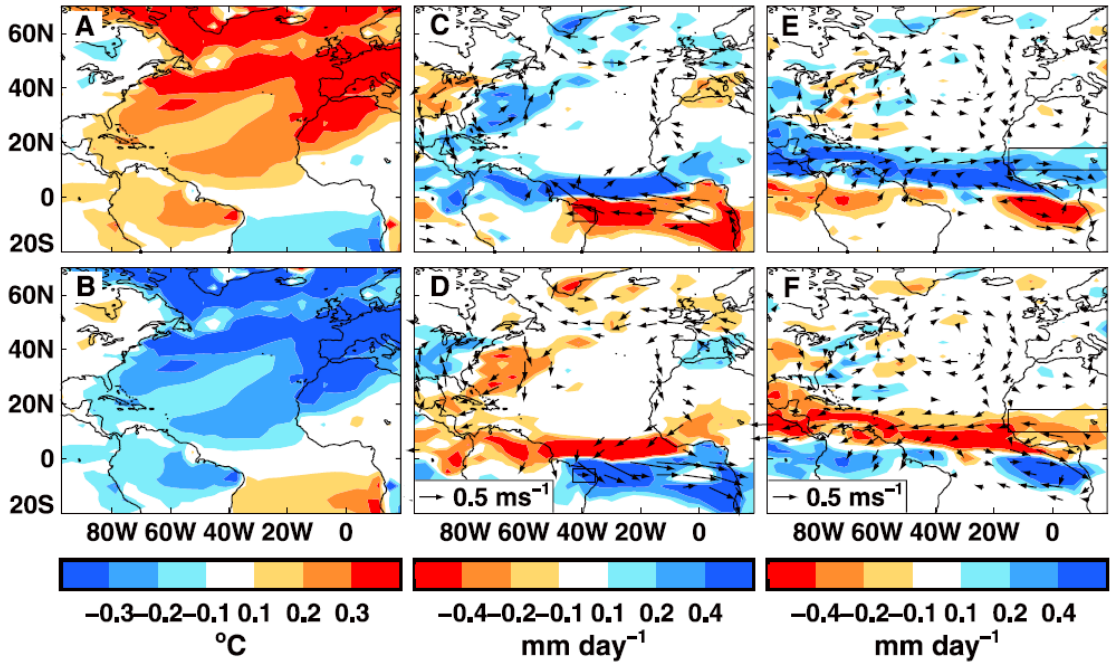

Figure 3.10. Decadal mean near-surface air temperature and precipitation in the North Atlantic based on computer modelling by Knight et al. (2006). Plots illustrate anomalies in the following: temperatures during extremely warm (a) and cold (b) scenarios, corresponding March-May precipitation levels (c, d) and corresponding June-August precipitation levels (e, f). Arrows display associated wind direction shifts.

3.3. Historical setting

Having established the contemporary environmental setting of this research project, consideration will now be given to the structure and development of human systems in the island during the period under study. The following subsections begin with a brief account of European activities in the island in the sixteenth and early-mid seventeenth centuries, followed by a more detailed summary of affairs from the late seventeenth through the first three quarters of the eighteenth centuries—an era that saw the establishment of the socio-economic order that prevailed throughout much of the colonial period. The adjustments that this order underwent between the late 1700s and late 1800s are then outlined. Themes of particular relevance introduced here will be discussed at greater length in later chapters.

3.3.1. The rise of a sugar colony

Early colonialism

Antigua, like the other Lesser Antilles islands, figured marginally in Spain's empire-building project in the sixteenth century. As a result, privateers, followed eventually by naval expeditionary forces, of other western European states managed to gain a

foothold in the region. Surviving documentation indicates that Antigua's first permanent settlement was established by the English in 1632—around the same time that they, as well as the Dutch and French annexed many of the neighbouring islands. Demographic and economic development was slow over the subsequent decades, owing not least to a series of debilitating invasions by the indigenous Carib Indians and the French. Finally, in the closing decades of the 1600s, Antiguan colonists shared in the commercial success already enjoyed elsewhere through the establishment of the sugar industry (Harris, 1965; Dyde, 2000). Following the example of Barbados in the 1640s, this 'sugar revolution' was predicated on the expansion of plantation agriculture and a captive West African workforce—processes propelled by burgeoning metropolitan demand for the 'sweet stuff' and the growth of European slave-trading companies (Watts, 1987). In time, the success of the industry elevated Antigua to a position of regional eminence; by the early 1700s, its population of 2,900 whites and 12,000 slaves was producing an average of 2,800 tonnes of sugar annually, making it the biggest producer in the Leeward Islands (Sheridan, 1974). This commercial importance bore geopolitical gains; Antigua was selected the seat of government for the sub-region and, with the construction of a naval dockyard at English Harbour in the 1720s, became its military bastion (Dyde, 2000).

The agro-economy and its place in empire

> There is little question that the economy of Antigua underwent a remarkable transformation during the first three-quarters of the eighteenth century. This was the period when the large sugar plantation became the dominant unit of production; when the race to acquire land, slaves and sugar works sometimes made for conditions approaching a Hobbesian state of nature. (Sheridan, 1961: p.343).

So it was that the environmental and socio-economic order that would prevail until the early twentieth century was established. The flowering of the Antiguan sugar industry is described in enormous detail in the literature (e.g. Sheridan, 1960, 1974; Harris, 1965; Watts, 1987; Dyde, 2000). Table 3.2 presents a selection of statistics demonstrating the escalation of plantation operations, slave imports and sugar production that attended this development, as well as the rise and fall of the white population—a trend reflecting the spread of new estates followed by their gradual amalgamation by successful planters. Deforestation is thought to have continued unabated until the early 1750s, when records suggest that practically all cultivable land in Antigua was accounted for (Sheridan, 1974).

Table 3.2. Select statistics reflecting the rise of the Antiguan sugar industry in the 1700s.

Statistic	**Year and number**		
White population	1708	1724	1774
	2,892	5,200	2,590
Slave population	1708	1745	1774
	12,943	27,892	37,808
White-black ratio	1708	1774	
	1:4½	1:14	
No. sugar estates	1700	1764	
	~150	>300	
No. sugar mills	1705	1748	
	170	239	
Approx. land area under cane (km^2)	1700	1751	~1768
	145	225	243
Average annual production (tonnes)	1700-09	1730-39	1760-69
	2,828	7,205	8,756

Sources: Sheridan (1960: p.132; 1961: p.343; 1974: pp.192-195), Gaspar (1985: p.95) and Watts (1987: p.286).

Thanks to a booming sugar industry, the Crown's Caribbean islands became one of its greatest sources of revenue. The British plantation economy of the region is commonly regarded as having reached its zenith during the third quarter of the eighteenth century, owing to high London sugar prices (Figure 3.11), British naval prowess and relatively low, stable running costs (Ragatz, 1963; Williams, 1970). By the late 1760s, Antigua was shipping an average of 10,690 tonnes every year, making it the third largest exporter in the entire Caribbean. At this time, the 37,000-strong slave population—over 65% of which was committed to estate labour—was valued at £1 million sterling, while all plantation works, equipment, livestock and privately-owned land in the colony was said to be worth almost twice that figure (Sheridan, 1974).

The process of sugar making comprised a fusion of husbandry and industry, which followed a continuous annual cycle timed meticulously to increase efficiency. Optimum conditions for the cane plant include average annual temperatures of 24^{o}C, precipitation of 1,500 mm, no frosts and nutrient-rich, quick-draining soils (Sheridan, 1974). Antigua largely satisfied these requirements, although modern data indicate average rainfall levels to be a not-insignificant 22% lower than the ideal figure. Without major setbacks, sown cane ripened in 14-18 months. It was planted throughout the wettest months of July to November and harvested under dry and hurricane-free conditions between January and May. Cut canes were carted to mills, which by the mid-1700s where predominantly wind-powered, to be crushed. The juice extracted was siphoned to a boiling-house where it was reduced in copper kettles.

Plate 3.1. Eman Bowen's 1752 map of sugar estates in Antigua. Image courtesy of Nicholas Nugent, British independent scholar descended from a leading Antiguan planter family (www.nugentsofantigua.net/).

Then, at the point of crystallisation, it was transferred into earthenware moulds and cured in a heated outhouse. The result was an accumulation of molasses, which could be distilled into rum; a dark crust, which required re-boiling; and a block of golden-brown muscovado sugar, which was shipped in casks known as hogsheads, each holding roughly 450 kg of the product (Sheridan, 1974; Ward, 1988; Dyde, 2000).

Meteorological conditions exerted a crucial influence over plantation operations. In broad terms, precipitation levels during the planting period and subsequent year were the chief determinant of the size of cane harvests. Too little rain reduced growth and

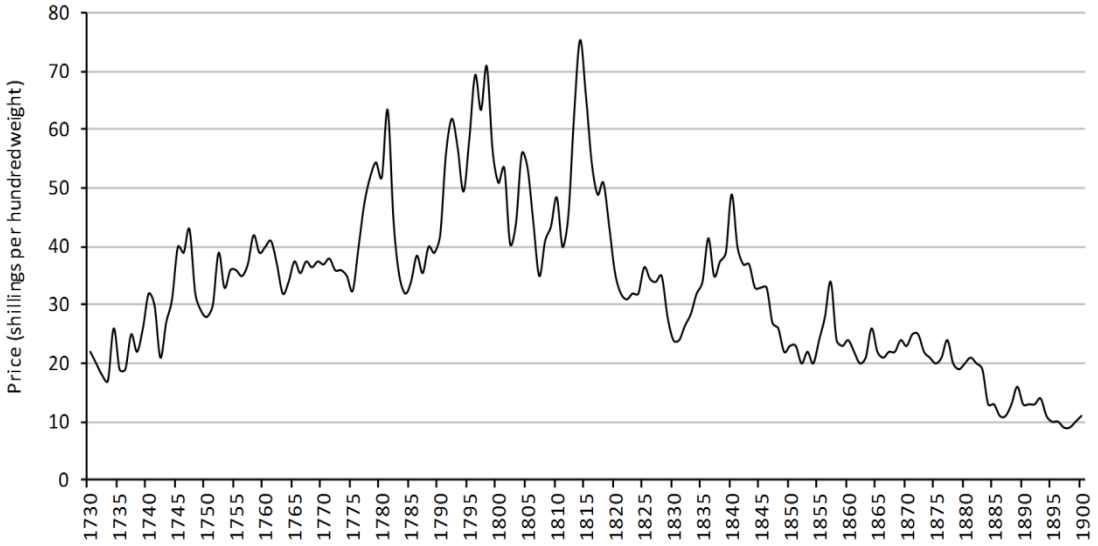

Figure 3.11. Annual average price of raw sugar in London, 1730-1900, in shillings per hundredweight. Source: Deerr (1950: pp.530-531).

yields, while too much could drown the plants. Short-term aberrations from seasonal norms could also incur setbacks. Downpours in the dry season, for example, inhibited reaping, grinding and carting. Hurricanes were among planters' greatest fears, being capable of laying to waste both canefields and plantation infrastructure (Gaspar, 1985; Chenoweth, 2003). Notably, particularities of the Antiguan climate offered a little more flexibility in the production cycle than was possible in most Caribbean colonies. Lower wet-season precipitation levels made it less crucial to process and ship the crop only in spring and, when extreme delays were experienced, these functions continued throughout summer (Ward, 1988).

Significantly, the basic regime of sugar production itself underwent little alteration over the eighteenth and nineteenth centuries. Once functioning profitably, few planters were inclined to disrupt the delicate balance struck between the agricultural, industrial and human components of the established model (Watts, 1987). Although some small-scale innovations were implemented intermittently—for instance, the use of new fertilisers and more efficient mill designs (Sheridan, 1960, 1974, Ward, 1988)—it is often commented that these could only palliate the mounting effects of soil exhaustion resulting from decades of intensive agriculture. In this way, the sugar industry was, perhaps, always destined to disappoint in the long-term, owing to its establishment in the atypically fertile soils of recently-deforested terrain and its structural inflexibility (Watts, 1987). These considerations are of significance not just as regards those individuals who owned and worked upon plantations, but Antiguan society at large; with the sugar industry as the motor of the political economy, all livelihoods, from high finance to petty retail, relied either directly or indirectly upon its profitability (Hall, 1971).

Plate 3.2. Engraving of a view of St. John's harbour from Fryers Hill in northwest Antigua by J. Johnson (1827). Available at www.bl.uk/onlinegallery/onlineex/carviews.

Government and people

Antigua, like the other British Leewards, had a bicameral government. A lower house, the Assembly, was composed of elected representatives of the island's six parishes, who themselves nominated members of the upper house or Council. The former was responsible principally for fiscal administration, devising local acts and implementing British rulings, while the latter passed judgment on such action. The only outsider in these affairs was a governor appointed by the British Colonial Office to represent the interests of parliament. As such, this was essentially a government of, by and for the sugar-planting elite, or 'plantocracy,' which dwarfed any other group possessing the franchise to vote for, or stand as, assembly members (Green, 1974).

It was as the plantation economy boomed that the plantocracy secured hegemonic control over island affairs. With British demand for sugar consistently outstripping supply and monopolisation of the market guaranteed by protectionist colonial import tariffs, financial success was virtually a given. Notably, this wealth did not foster a long-term growth of the elite, but rather gradually accrued to a shrinking circle of well-established planter families, who—through intermarriage and acquisition of less profitable estates—achieved ever-greater economies of scale. Thus, while plantations of over 300 acres (1.2 km^2) and stocked with several hundred slaves were rare in the early 1700s, by the 1770s they had become the norm and a few were four times as large (Dyde, 2000; Sheridan, 1961). Simultaneously, proprietor absenteeism rose, most planters retiring to Britain once accumulating sufficient riches. Their concerns

Plate 3.3. Aquatint image of the courthouse in St. John's by William Clark (1823). Available at www.bl.uk/onlinegallery/onlineex/carviews.

were then supervised by individuals who formed the other prominent strata of white society: high-earning 'attorneys,' who purchased supplies, organised sugar exports and directed lower-level estate administration; middle-income managers, responsible for superintending practical elements of planting; and, at the bottom of the hierarchy, overseers, who presided directly over slave labour. Another figure crucial to the industry was the merchant overseas. This professional acted as an impresario of the metropolitan end of commerce, receiving sugar on consignment, despatching shipments of plantations stores and arranging credit transfers (Green, 1976).

By far the most substantial human element of the plantation complex was the enslaved workforce. Over the early to mid-1700s, the introduction of West Africans into Antigua boomed from an average of 700 to 2,000 per annum (Sheridan, 1974). It is testament to the abysmal conditions to which these abductees became bound that one third died within their first three years on plantations. They would first be assigned to the most common slave occupation: field labour. This entailed a perpetual cycle of planting, manuring, weeding, reaping and carting, generally on a dawn-till-dusk, six-day-a-week basis. In the busy harvest period, night shifts were also common. Far preferable, in terms of both physical demands and status, was domestic service or work in essential trades, such as sugar-boiling, carpentry, pottery and cooperage.

These positions were, however, typically reserved for favoured Creole slaves (Dyde, 2000; Gasper, 1985).

No matter what their role or birthplace, all bondspeople operated within a sphere of institutionalised violence, where punishments ranging from whippings to mutilations were handed out for relatively minor or even suspected transgressions. The majority toiled in a continual state of malnutrition and resided in dirt-floored, wattle and daub 'cottages,' around 4 by 6 metres in basal dimensions. Average slave rations in the Leeward Islands consisted of some 3.85 litres of millet, maize or beans and 0.45 kg of salted fish every week, all imported (Green, 1976; Ward, 1988). These were supplemented through food cultivation, which became the principle source of sustenance when maritime trade ebbed in the hurricane season. Cassava, potatoes and eddoes (an East Asian root vegetable) were the principle produce of slaves' marginal allotments of estate land. Such crops could be cultivated reliably from the start of the rainy season to mature around September, resulting in a period of relative abundance in late autumn, after several months of minimal food imports and subsistence crop yields. The incidence of endemic nutrition-related disorders among bondspeople soared during these so-called 'hungry months,' during which death rates could as much as double. However, with affordable supplies of human cargo crossing the Atlantic, most slave-owners simply accepted death rates which exceeded fertility by an average of 20 per 1,000 of the population from the 1750s through 1770s (Gaspar, 1985; Ward, 1988).

Once in serfdom did not, however, necessarily mean always in serfdom. Occasionally, slaves gaining favour through decades of obedient service or, in the case of females, concubinage were granted or permitted to purchase their freedom. Sometimes the offspring of master-slave sexual relations were manumitted at birth. These occurrences in combination with natural increase forged a new segment of Antiguan society—that of 'free coloureds'—which, by the year 1800, comprised almost 3,000 individuals. This population, which was predominantly urban, contained its own stratifications ranging from vagabonds to hucksters, trades-people, clerks and even some small-time merchants. Nevertheless, like slaves, all free coloureds endured social and political inferiority to whites of virtually any standing (Green, 1976; Dyde, 2000).

An even smaller minority group worth mentioning are European missionaries. First to arrive, in 1756, were the Moravians and, within the next two decades, the Methodists, whose membership figures stood at approximately 5,000 and 2,000 respectively by the mid-1780s (Dyde, 2000). Although concerned chiefly with the conversion of non-whites to their particular brand of Protestantism, missionaries of both denominations also took it upon themselves to 'civilise' the enslaved by introducing European ideals of family and community. From this stemmed the

provision of religious education at Sunday Schools, a limited number of which were running by the turn of the 1800s (Green, 1974; Farquhar, 1999).

3.3.2. Plantership under threat and reformation, 1775-1834

After more than a century of rising affluence and political might, British West Indian planters witnessed unprecedented external challenges to their supremacy from the late 1700s. These, aggravated by chronic internal difficulties such as soil exhaustion, high rates of absenteeism and resistance to the established order, eventually set the stage for revolution of the very agro-economic model that underpinned it.

One major threat was the geopolitical climate. Wars between the major colonial powers in the Caribbean marked all but eight years in the period 1775-1815. First and most disastrous was the American War of Independence (1775-1783), which is often portrayed as marking the end of the quarter-century 'golden age' of the British sugar economy. Its colossal demographic and economic fallout in the British West Indies—highly dependent on imports of American provisions as they were—is discussed in detail in Chapter 8. The inter-war period of the 1780s and early 1790s brought more or less complete recovery for the plantation economy, thanks to ever-expanding European demand for sugar and the restoration of trade. However, between 1792 and 1815, Britain was again at war, first with revolutionary and from 1803 with Napoleonic France. As previously, Caribbean planters and slave populations endured enormous losses as a result of disruptions to commerce (Ragatz, 1963; Ward, 1988).

Concurrently, another threat to market stability materialised: the ascent of new sugar colonies. In the Seven Years' War of 1756-1763, Britain gained control of the islands of Dominica, Grenada, St. Vincent and Tobago and, following the Napoleonic Wars, had added Trinidad, St. Lucia, Demerara, Essequibo, Berbice and Mauritius to its tropical empire. At these locations, cultivation benefitted from soils that, if not virgin, were not as enfeebled as those of the old sugar colonies. While increased supply of sugar slowed the pace with which its retail value grew (Figure 3.11), elevated demand for estate managers and provisions drove up plantation expenditure on supplies and wages (Ward, 1988; Sheridan, 1974). Meanwhile, commercial reform in East India during the 1810s facilitated British imports from that region and two future giants of the sugar trade, Cuba and Brazil, had begun their rise (Ragatz, 1963). The repercussions were grave for the British Leewards;

> By 1820 markets were glutted, the price of sugar declined sharply to its lowest level since the middle of the eighteenth century, and the maintenance of import duties at their high wartime rates inhibited any compensating growth in consumption. (Ward, 1988: p.44).

Table 3.3. Slave population in Antigua, 1817-1832. From Higman (1984: p.413).

Year	No. slaves
1817	31,877
1821	30,574
1824	29,891
1828	29,372
1832	29,045

Such was the context in which the British plantocracy faced the final assaults of an anti-slavery lobby that had grown powerful on both sides of the Atlantic. Abolitionist ideology first entered significantly into imperial policy in 1792, when Parliament decreed that the slave trade should be gradually phased out of operation. Then, five years later, it was ruled that the conditions of bondage be improved with a view to stimulating natural increase among the workforce. The outcome were colonial 'Amelioration Acts,' which brought a diversity of major reforms, including the introduction of minimum rations and medical provisions, a fourteen-hour working day limit and restrictions on slave punishments (Dyde, 2000). The next abolitionist milestone came in 1807, when all trading of slaves was finally outlawed. Despite amelioration policy, Antiguan planters, like those elsewhere, failed to raise birth rates among their bondspeople above mortality (Ward, 1988). Invariably, the long-term result was demographic decline (Table 3.3).

Gradualism remained central to the abolitionist campaign in the 1820s. Another raft of amelioration measures was launched in 1823. One central new requirement was the restriction of slaves' activities on the Sabbath, which it was felt should be devoted to Christian instruction. Sunday markets—an accepted custom since the early 1700s—were forbidden by the Antiguan legislature in 1831, sparking riotous protest throughout the island (Dyde, 2000; Lightfoot, 2007). By this stage, conventional plantership was already on its last legs. Burgeoning competition, dwindling sugar prices and the costs of more humane slave treatment saw plantation profits plunge to a level at which overseas investment could no longer be attracted. Economic deceleration in the 1820s developed into widespread insolvency at the start of the 30s (Ward, 1988). Simultaneously, public outcry against slavery became increasingly vociferous. It was now evident that if not decreed from above, freedom may well be enforced from below. Thus, in 1832, parliament prepared for immediate emancipation. The following year, a bill was passed declaring that as of August 1834 the ties of bondage would be severed throughout the British Empire (Williams, 1970).

3.3.3. Free people and free markets, 1834-1890

The (not so) new social order

The form that emancipation took in Antigua, as well as its social and economic implications, is outlined in detail in Chapter 9. For now, it suffices to note that this was Britain's only major sugar-producing colony in which all slaves were granted 'full freedom' as of August 1st 1834, the others adopting a transitory scheme of unsalaried estate work. To limit the potential for labour shortages, the plantocracy did, however, unveil a suite of rulings which bound free workers to fixed-term plantation contracts, restricted access to alternative forms of employment and criminalised joblessness. Notwithstanding these obstacles, many ex-slaves succeeded in reducing the time and assiduity they dedicated to sugar labour over the following years. Accordingly, the free labour market became competitive one, some planters raising wages or offering non-monetary incentives to attract employees and improve performance (Hall, 1971; Green, 1976).

There was little compensation for new legislation stifling social mobility; political representation remained all but unobtainable for non-whites, while services such as petty courts, savings banks and poor relief were perpetually underfunded. The majority of freedpeople unable to work for reasons of age, infirmity or disability could only seek support from family members or independent charitable organisations known as 'friendly societies,' which started to emerge during the 1820s (Hall, 1971; Dyde, 2000). One exception to the general social neglect manifested by government officials was in the provision of education. Under the terms of Britain's emancipation act, the colonies were furnished annually with a £30,000 sterling 'Negro Education Grant' until 1839 and decreasing instalments thereafter (Green, 1976). Antigua's share was assigned principally to missionary societies. By 1837, there were approximately 100 day and Sunday schools in the island educating some 5,200 children—a figure which grew to 6,500 by 1847. This was also a time of surging religious activity; come the mid-1840s, almost 22,400 islanders had become members of the Moravian, Methodist or later-flourishing Anglican Church (Farquhar, 1999; Lightfoot, 2007).

Although tenancy was almost always attached to labour contracts, towards the end of the 1830s some ex-slaves had secured residential autonomy. The earliest attempts to establish independent communities were facilitated by the Moravians, who leased out small plots of their property to labourers in 1836. Upon such terrain were laid the foundations of Antigua's first 'free village,' Liberta, located just to the east of Falmouth town. At the start of the following decade, some planters began to cash in on their least fertile lands in a similar way. Between 1842 and 1846, the number of independent settlements more than doubled to reach 70, at which point they were home to some 9,000 people (Hall, 1971; Dyde, 2000).

Overall, the decade following emancipation undoubtedly brought marginalisation reminiscent of slavery for Afro-Creoles and the uncertainties of a free labour for planters. Nonetheless, it is recognised to have been an era of relative economic prosperity for the British West Indian populace at large. Following the near-collapse of the sugar economy in the early 1830s, the continuance of plantation operations and consequent restoration of investor confidence sparked a considerable recovery (Hall, 1971; Green, 1976; Watts, 1987).

The decline of a sugar colony

The middle of the nineteenth century marked a decisive end to socio-economic resurgence. An important watershed was parliament's Sugar Duties Act of 1846, which reduced duties on foreign sugar imported into Britain until, in 1854, matching those levied on shipments received from within the empire. The ultimate consequence was elimination of the colonial monopoly over metropolitan demand. Through economies of scale and the maintenance of slavery, Brazil and Cuba—the new powerhouses of cane cultivation—offered unbeatable prices for their produce. At the same time, production was spreading elsewhere in the tropics. Thus, 1846 precipitated another economic crisis for the British West Indies, featuring the failure of merchant houses, evaporation of credit and a precipitous drop in sugar prices (Figure 3.11). This was a situation from which there was no recovery over the remainder of the century; the industry only became more competitive and, accordingly, colonial producers' share of the home market gradually dwindled to around 10% by the 1890s (Williams, 1970; Green, 1976).

Although Antigua's sugar economy, unlike that of several neighbouring islands, managed to survive these commercial onslaughts, it did not go unscathed. After soaring in the late 1840s, turnover in land ownership remained high, 73 properties changing hands between the mid-fifties and nineties (Dyde, 2000). In response to falling profits, many planters restricted cultivation to the most productive terrain and hired fewer labourers. As early as 1852, government officials estimated that of 15,000 agricultural workers in the colony, less than half were still employed on estates (Lightfoot, 2007). Meanwhile, basic plantation wages, which tripled between 1839 and 1845, returned to their starting rate of six pence per day in 1848 and fluctuated negligibly thereafter (Hall, 1971). Other important adjustments were the implementation of more efficient plantation equipment, such as steam engines, and turning to the North American sugar market, which received three-quarters of Antiguan output by the 1880s. Notwithstanding these, domestic commerce, as well as religious and educational institutions, were hit hard by the shrinkage of disposable income. Church membership figures were at best stagnant from the fifties, while school enrolment slumped to 4,400 in 1863. Government tax revenues suffered too

Table 3.4. Antiguan census totals, 1844-1881. Source: CO152/146, Report on 1881 census, A. McHattie, 11 Jul 1881; CO152/179, Gov. Smith to Lord Knutsford, 3 Nov 1891.[3]

Year	Total
1844	36,178
1851	37,136
1856	35,408
1861	36,412
1871	34,344
1881	34,321
1891	36,119

and, with them, spending on already inadequate social services. The authorities did, though, establish a public hospital, lazaretto and poor house in central-western Antigua during the early 1850s (Hall, 1971; Dyde, 2000).

Austerity in the mid-late 1800s also spurred several major trends that had emerged after emancipation, namely the rise of unemployment, rural-urban migration and free villages. Though illustrative statistics are scarce, it is known that in 1864 the population of the island's villages exceeded 15,000, while that of St. John's—a town of some 2,500 inhabitants in the mid-1700s—increased by 917 between 1871 and 1881 to reach 9,636.[4] These developments were attended by a significant deterioration of sanitary conditions, owing to under-investment in basic amenities for Afro-Creole neighbourhoods, urban and rural alike. With blacks accounting for over 80% of the Antiguan populace and its white and 'coloured' elements having long been on the decline, the consequent rise in mortality rates arrested demographic growth (Table 3.4; Dyde, 2000).

Another significant development at the time was administrative reform. First, in 1860, the island's governor was empowered to elect an Executive Council to reduce his alienation from the rest of legislature. Seven years later, Antigua followed the example set by several other Caribbean colonies by replacing the Assembly and both Councils with a single chamber, composed of members elected publicly and by the governor. The final alteration came in 1871, when Antigua joined six other Leeward Islands to form a single presidency (Hall, 1971; Green, 1976).

3.4. Chapter overview and closing remarks

Salient features of the natural environment and human history of Antigua have now been reviewed, establishing the material context of this research project. The first half of the chapter focused on the precipitation and tropical cyclone climatology of the

[3] See Section 4.3 regarding the referencing of such archival evidence.

[4] Data from: CO152/146, Report on 1881 census, 11 Jul 1881.

island and wider Caribbean region. Variability in these meteorological elements associated with thermal, barometric and convective parameters were considered, alongside their various drivers, which range from seasonal migrations of the NASH and ITCZ to multi-annual oceanic-atmospheric cycles such as the ENSO, AMO and NAO. Diverse factors underpinning human vulnerability to natural hazards, both locally and regionally, were also identified.

The second half of the chapter described the basic characteristics of colonial Antiguan society and its development in the eighteenth and nineteenth centuries. In this potted history, a number of major social, economic and political transitions were documented during the study period of the thesis. Examples include the passing of war and peace, increasing state regulation and eventual abolition of slavery, growing autonomy of emancipated people from the land-owning elite and a shift from essentially mercantilist to laissez-faire imperial policy. It is worth emphasising, however, that one key trait outlasted all such changes: sugar production was the cornerstone of Antiguan livelihoods. With black enslavement and intensive plantation agriculture as fundamental components of the system from the outset, the colonial order was one of human and environmental exploitation. Certainly, emancipation eradicated the human degradation of slavery, but it could remove neither the profound inequalities within society, nor the drive for maximum cane yields.

Consideration of these themes is crucial for picturing the contours of human vulnerability to extreme weather events in colonial Antigua. Of particular note, this chapter has highlighted that geological features render the island especially liable to the effects of drought, while its small size and remoteness limit social capacity to cope with natural hazards in general. Moreover, eighteenth and nineteenth century livelihoods hinged almost entirely on a single rain-fed crop cultivated for export, while society was profoundly polarised, with racial delineations fixed by Europeans serving as the principal determinant of status and wealth. Finally, Antigua was a colony which, though favoured inasmuch as it represented a sub-regional political and economic hub, was of concern to the metropolitan government principally as an economic asset. The specific ways in which structural factors of this kind shaped the effects of climatic stress will be the subject of analysis in Chapters 8-11.

Chapter 4

Documentary sources and archival research

4.1. Introduction

This chapter introduces the sources of evidence employed in the present study. It outlines the nature of the documentary records and approaches to their assessment used in historical climatology generally, as well as the specifics of the archival research undertaken for this thesis. Detailed descriptions are provided of the document collections and published sources consulted, the forms of climate-related information encountered therein and the manner in which this information has been compiled for analysis. Discussion of the general strengths and weaknesses of documentary climate evidence and common methods of their evaluation will be concise, as these subjects have been reviewed comprehensively elsewhere (e.g. Wigley et al., 1985; Bradley, 1999; Pfister et al., 2009; Brázdil et al., 2005; Mock, 2012).

4.2. Documentary sources in historical climate research

Cultural evidence of past climate may take a variety of forms, ranging from visual art and landscape inscriptions to oral tradition. That which is by far best studied in historical climatology has been the documentary record. Scholars of this field have employed a diversity of documentation, such as personal papers, administrative material, academic writing and journalism, extracting from it both qualitative and quantitative climate evidence. This evidence is commonly grouped under two main classes:

(1) direct evidence, which takes the form of meteorological data based on instrumental measurement (e.g. using rain gauges or thermometers) or textual accounts of climate and weather;
(2) indirect (proxy) evidence, which refers to the effects of weather on elements of the hydrosphere, cryosphere or biosphere, for instance, river flow, the extent of glaciers or the growth of vegetation.

The second of these requires especially careful treatment as it may mark the influence of both climatic and non-climatic variables (Brázdil et al., 2005; Pfister et al., 2009). This point is all the more true when extending consideration to the possible effects of climate upon human affairs, as feedbacks of this type are a function of complex and

dynamic interactions between environmental factors and the cultural milieu (Wigley et al., 1985).

Relative to geological and biophysical proxies of past climate, documentary archives have the advantages of offering a high temporal resolution record—some sources recording meteorological patterns as often as hourly—which is typically dated precisely. Moreover, they are the only major source of historical evidence that provides explicit meteorological observations, enabling individual elements such as precipitation, temperature and wind to be distinguished. They are also unique in offering insights into human experience of climatic phenomena. The tendency of historical documents to focus on weather anomalies and events with significant implications for society makes them especially valuable for investigating climate-human dynamics (Brázdil et al., 2005). Their usefulness is, however, limited by the spatial and temporal availability of records, as well as problems related to reliability and interpretation, which will be considered in Section 4.5.

Section 2.3.1 noted three broad objectives of historical climatology, two of which—the reconstruction of climate variations and the investigation of its societal implications—are addressed in this thesis. The consensus among historical climatologists is that these investigative areas should comprise independent stages in the research process. This follows Le Roy Ladurie (1972), who advocated first studying the past climate for its own sake, in isolation from its effects. Then, as a possible second step, the results generated in this way can be used as a framework for exploring the consequences of climate and weather for society (Pfister and Brázdil, 2006). Crucially, the separation of climate evidence in this way helps to address the problem of circular argumentation—that is to say, using the same evidence to document past weather and, at once, its effects.

Methodologies of climate reconstruction and so-called 'historical climate impacts assessment' (Wigley et al., 1985) differ significantly. The former is approached as a physical science, founded on the principles of systematic observation and analysis, maximising data sample size, validating findings using established datasets and, where possible, testing for statistical significance. In most cases, researchers aim to produce chronologies of uniform climate data spanning decades to centuries. In the investigation of scalar meteorological variables, such as precipitation levels or temperature, a common approach is for qualitative climate information to be quantified on an ordinal scale to reflect departures from conditions perceived as normal. In its simplest form, this employs a three-point scale whereby '-1' denotes a negative departure from the norm (e.g. drier or cooler conditions), '1' signifies a positive departure (e.g. wetter or warmer) and '0' designates no significant divergence from the norm. If there is sufficient archival information, five- or seven-point scales (i.e. -2 to +2 or -3 to +3) may be used, allowing for more sophisticated analyses of relative climate variations (Brázdil et al., 2005; Pfister and Brázdil, 2006). For

reconstructing discrete climate events, the simplest approaches involve frequency counts (e.g. number of storms, floods, snow days). To gauge the relative magnitude of events, evidence of their environmental impacts (e.g. wind damages or flood extent) may serve as the basis for ordinal ranking systems (e.g. Barriendos and Rodrigo, 2006; Chenoweth, 2007; Brázdil et al., 2012). In the reconstruction of both scalar climatic parameters and specific events, a critical step to ensure reliability is to authenticate findings using available instrumental data (Brázdil et al., 2005).

Investigation of the repercussions of past climate and weather for human systems can be seen as a social science adopting the approach of historiography. The precise methods used tend to be far less formulaic than in the case of climate reconstruction, often being tailored in close accordance with the objectives of the researcher and the social-ecological context of the investigation. It is generally recognised that thorough understanding of the myriad social, environmental, political and economic variables that determine the fabric of a given society and influence human behaviour is vital (de Vries, 1985; Pfister and Brázdil, 2006; Endfield, 2008). In order to account for this complexity, the most popular approach adopted has been that of qualitative content analysis (see Mayring, 2000) and the presentation of evidence through 'thick description' (Geertz, 1973). Nevertheless, many studies have incorporated quantitative methods, based, for example, on the use of vulnerability indices or analysis of agricultural data (e.g. Engler et al., 2013; Gil-Guirado, 2013; Mohan and Strobl, 2013). Both qualitative and quantitative approaches often make use of case studies focused on events, periods or social groups of particular interest. Overall, Wigley et al. (1985: p.532) suggest that the most compelling studies are those which, establishing a strong empirical grounding, "consider the issue of climate only as one of many factors in the milieu of potential determinants of societal impact."

4.3. Sources used in this study

This thesis employs a variety of English-language archival sources pertaining to colonial Antigua, all of which are publicly available for consultation at document repositories in the United Kingdom. They can be divided into four main groups: government records, missionary papers, plantation correspondence and published scholarship. All of this dates from the eighteenth and nineteenth centuries and consists predominantly of material written in Antigua by residents of the island. Table 4.1 summarises the details of the major archival collections consulted, noting their locations, the specific document series comprising them, the shorthand codes assigned to each of these and their temporal coverage. Archival sources are cited in footnotes throughout the thesis, quoting the codes listed in Table 4.1 and—where available and

Table 4.1. Details of all major archival series consulted.

Category	Collection name	Archive location	Series consulted	Reference prefix	Relevant periods covered
Government Records	Colonial Office and Predecessors, Original Correspondence	National Archives, Kew, London	Leeward Islands Original Correspondence	CO152	1769-1816, 1872-1890
			Antigua and Montserrat Original Correspondence	CO7	1816-1872
	Colonial Office and Predecessors, Miscellanea	National Archives, Kew, London	Antigua and Montserrat Blue Books	CO10	1821-1887
			Leeward Islands Blue Books	CO157	1880-1890
Missionary Records	Trust Society for the Furtherance of the Gospel, Antigua Collection	Moravian Church House, Muswell Hill, London	Original letters	OL	1783-1818
			Periodical Accounts, first series	PA	1790-1889
			Periodical Accounts, second series	PAS	1889-1890
Plantation Records	Codrington Papers Microfilms	British Library, St. Pancras, London	Accounts	COD/A	1769-1861, 1872-1881
			Correspondence	COD/C	1769-1867, 1872-1890
	Tudway family Antiguan papers	Somerset Archive and Records Office, Taunton	Book of correspondence to Clement Tudway	DD/TD/15/6	1769-1784
			Transcripts of correspondence to various members of the Tudway family	T/PH/swd	1769-1858

appropriate—followed by the volume or series number, page numbers, item identifiers (i.e. author, addressee for correspondence or title for other documentation) and date. All quotations from the documentary sources presented are verbatim transcriptions with original misspellings, capitalisations and abbreviations left unaltered.

The following subsections describe the nature of the archival material consulted.

4.3.1. Government records

The governmental archives analysed in this study pertain to the British Colonial Office and other bodies responsible for the administration of the empire prior to its existence. Of all the document collections consulted, the ‘Original Correspondence’ (Table 4.1) was the most temporally continuous. It comprises two distinct series, one spanning 1816-1872, when Antigua and the neighbouring island of Montserrat were treated as a single administrative entity, and the other covering the remaining years of the study period, when all of the Leeward Islands were governed collectively. The content of both series is manuscript correspondence sent from the governor of these

administrative sub-regions to the 'Secretary of State for the Colonies,' based at Whitehall, London (Banton, 2008). Owing to the fact that Antigua was the location of the governor's residence and a major economic centre in the Lesser Antilles, much of these writings relate specifically to the island. Between 15 and 258 items of documentation are available for every year of the study period, save 1787, as the volume for that year is missing. Letters sent by the governor—or, in his absence, an acting-governor from the legislature—were often accompanied by enclosures of various types, such as letters sent between other local officials and public figures, transcripts of legislative minutes, government reports and petitions to British authorities. This material covered topics ranging from politics and the economy to public health and demographics. Of relevance here, it occasionally provided passing references to meteorological conditions and their implications. In the wake of major weather-related disasters, documentation discussing this subject matter at length was often present. Following each item of correspondence, there appeared the full or partial responses of officials at Whitehall, providing some insights into related metropolitan decision-making.

The second major governmental collection examined was that of the Blue Books. These are unpublished volumes of miscellaneous statistics relating to colonial affairs, primarily of a financial nature, compiled annually by Antiguan officials from 1821. Like the Original Correspondence, this collection is split into two series in accordance with changes to the administrative organisation of the Leeward Islands. The Blue Books were of great value for investigating the economic implications of extreme weather, as they consistently contained export, import and fiscal data. Some also included instrumental meteorological measurements (see Section 5.2.3). Reports on each Blue Book, which were available for most years from the 1850s in the Original Correspondence series, provided valuable reflections on such statistics. As these reports were missing in the period 1873-1887, copies of them which are available online in the digitised 'House of Commons: Parliamentary Papers' collection (http://parlipapers.chadwyck.com/marketing/index.jsp) were referred to. A special Parliamentary Paper on the slave trade dated 1790 was also examined as a previous study (Sheridan, 1976) indicated that this would contain details of particular relevance. All Parliamentary Papers are cited using the original system in the online database.

4.3.2. Plantation records

This research utilises extensive archival collections relating to the Antiguan sugar estates of two mercantile families originating from southwest England. To begin, we have the Codringtons of Dodington, Gloucestershire, who acquired their first estate in the colony in 1668 (Sheridan, 1961). By the mid-1700s, the Codringtons were among the largest landholders in the island. Their most valuable concerns were four

neighbouring plantations located in central-eastern Antigua (Figure 4.1)—thus referred to as the 'Windward Estates'—which they retained until twentieth century. These properties collectively accounted for some 1,300 acres (~5.3 km^2) and 800 slaves at that time (Dyde, 2000). The Codrington family owned five plantations elsewhere in the island by the 1770s (see Figure 4.1), though these were discussed far less frequently in their papers (Lowe, 1951). From 1685 to 1870 the family also held a royal lease over the whole of Barbuda. That island was essentially run as an adjunct of their Antiguan estates, but dedicated principally to livestock breeding, provision cultivation and staging shipwreck salvage operations (Dyde, 2000). The 'Codrington Correspondence' collection held at the British Library concerns the properties described above. Two series of these unpublished, microfilmed manuscripts were studied: correspondence (consisting almost entirely of letters) and account documents (Table 4.1). Of the former, only documentation sent from Antigua and Barbuda to England was examined for time efficiency. Letters from superintendents of the latter island were checked as these often described affairs in the former, which they either frequently visited or made their home.

The second planter family whose records were studied were the Tudways of Wells, Somerset. They too became proprietors of an Antiguan estate in the late 1600s. By 1800, they possessed two plantations neighbouring those of the Codrington family (Figure 4.1), which encompassed roughly 800 acres (~3.2 km^2) and a slave population of 500. In 1829, their holdings were divided to create three individual estates in central-eastern Antigua (Ward, 1988). Time restraints allowed for only two of over a dozen document series pertaining to these properties to be studied. The first was a manuscript volume of letters dated 1759-1784 sent to Clement Tudway—then the owner of the plantations—from various Antiguan contacts. The second comprised three volumes of type-written transcripts of similar correspondence received by Clement and his successors from the 1760s through 1850s (Table 4.1). Unfortunately, the compiler of these transcripts is unknown. Efforts have, however, been taken to verify their contents (see Section 4.4). The two aforementioned series were selected because they covered the late 1700s and early 1800s, which would otherwise have been poorly documented.

With few exceptions, the analysed estate papers were written by Antiguans connected professionally with the sugar industry, such as overseers, merchants and other planters. The vast majority was specifically from plantation managers and attorneys, who served the absentee estate-owners for as many as nineteen consecutive years. Collectively, the papers spanned almost the entire study period, but coverage was much more inconsistent and fragmentary than in the case of government sources, with fewer than five letters available for several consecutive years. The plantation records also largely provided shorter accounts of major weather events. However, general commentary on the state of the weather and its consequences was included far

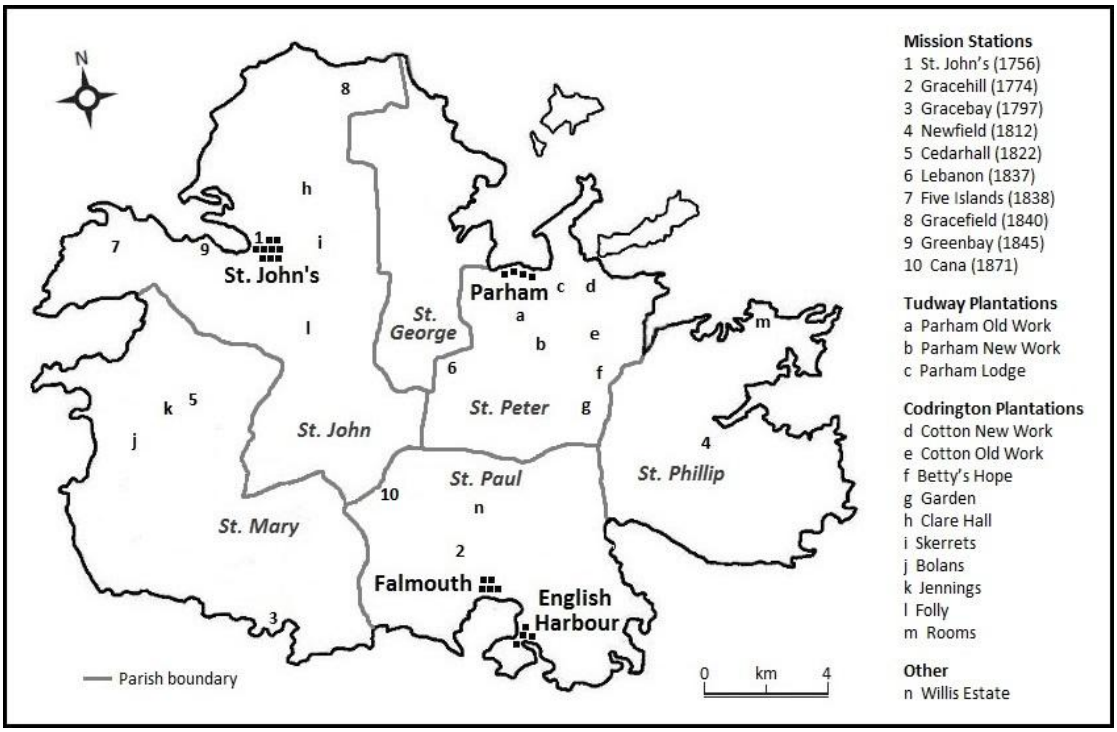

Figure 4.1. Locations of sugar estates and Moravian mission stations referred to in the documentary sources. Dates of mission station establishment shown in brackets.

more regularly. Indeed, the letters of estate administrators seldom failed to discuss these topics.

4.3.3. Missionary records

The missionary papers consulted are those of the Trust Society for the Furtherance of the Gospel, founded by the protestant Moravian Church of Bavaria in 1741. The society began its evangelical work in Antigua at St. John's in 1756. Over the next century, Moravian became the most popular religious denomination among the Afro-Creole population (Farquhar, 1999), leading to the establishment of another nine mission stations throughout the island (Figure 4.1). Letters, mission diaries and reports were regularly sent from the field to Moravian headquarters in London and Herrnhut, Germany.

This study makes use of two major series of such material that are held in Britain. The first is a collection of 36 original letters from missionaries in Antigua to the secretary of their society dating from the late 1700s and early 1800s (Table 4.1). The second are the Periodical Accounts—extensive published volumes which reported on the spiritual and physical welfare of missionaries and their congregations across the globe by presenting syntheses, extracts and full transcripts of the correspondence

received from the former.[5] Between 2 and 14 individual items relating to Antigua were available in each volume from 1790, when the Periodical Accounts began. Like the correspondence of the governors of Antigua, the Moravians' Original Letters and Periodical Accounts intermittently gave passing mention to weather conditions in general and offered detailed, lengthy accounts of extreme events and their effects. They differ from all of the other collections examined in having been produced by individuals regularly in close contact with the non-white population who were not members of the plantocratic elite.

An early history of the Moravians' Antiguan operations (TSFG, 1856) was also consulted. This contained additional information on major episodes of adverse weather, some of which predated the Original Letters and Periodical Accounts.

4.3.4. Colonial-period scholarship

Eleven scholarly publications from the 1700s and 1800s were accessed, either at the British Library, St. Pancras, or the Foyle Special Collections Library, King's College London. Three main classes of literature can be distinguished, the first of which are general histories of colonial Antigua. The most detailed was the three-volume genealogical study of Dr. Vere Langford Oliver (1894, 1896, 1899), the English-born descendent of a prominent Antiguan planter family. This opens with a 150-page chronology of major events in the island—including climatic disasters—from European settlement through the late nineteenth century. Oliver compiled his history using local parish registers, some Colonial Office records and tens of other publications, the latter of which were cited, enabling the originals to be checked. The other long-term Antiguan history examined was that of Lanaghan (1844), whose full name is unknown, but was a British planter's wife and resident of the island for a time in the 1830s and 1840s. Unlike Oliver, Lanaghan (1844) did not cite any other sources that may have contributed to her monograph.

The second type of early literature consisted of travel writings. Six publications of this variety were consulted: Luffman (1789), Collins (1792), Young (1801), Sturge and Harvey (1838) and Hart (1866). All were the work of British professionals visiting Antigua for personal business or recreation, except that of Sturge and Harvey—two anti-slavery campaigners who set out to document the results of emancipation in several British colonies.

Finally, two items of specialist scholarship were examined: Joshua Peterkin's (1790) treatise on sugar production, dedicated to his fellow planters of St. Kitts and the other Leeward Islands, and an essay on outbreaks of yellow fever in Antigua during the early-mid 1800s by British physician Thomas Nicholson (1856).

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[5] With respect to referencing, it is worth noting that correspondence included in the Periodical Accounts rarely recorded the addressee's name.

While weather phenomena and their societal effects were the central focus of none of the aforementioned publications, all contained information on these subjects, much of which was unique and/or considerably detailed.

4.3.5. Miscellaneous manuscript sources

Further to the major archival collections listed in Table 4.1, two small series of unpublished correspondence were consulted during a visit to Senate House Library, University of London. The first contained twelve letters sent from Samuel Quincy, a Harvard-educated lawyer born in Massachusetts, to his family in Boston between 1771 and 1781.[6] Of greatest relevance were those dating from 1779-1781, when Quincy worked as Antigua's 'Controller of Customs.' Secondly, there were three letters received in 1840, 1842 and 1845 by the Sutton family of East Bilney in Norfolk, Britain, from David Cranstoun.[7] They concerned an Antiguan plantation known as 'Willis' (Figure 4.1) which Cranstoun managed for the Suttons. These two letter series were included as a preliminary survey revealed that they contained several novel accounts regarding weather phenomena in Antigua.

4.4. Archival research

Archival research took place between August 2011 and October 2012. All documents, volumes and other texts pertaining to the period 1769-1891 were read, working from the oldest through newest items wherever possible. Accounts relating to climate, weather and their (possible) effects were recorded verbatim. Alongside these, the author, location, date of writing, intended recipient and any other citation details were noted to produce a comprehensively-referenced, chronologically-ordered transcript for each archival collection and publication. Three main classes of information of relevance to this study can be distinguished:

(1) that which notes the physical characteristics of climate and weather, such as the timing, intensity and spatial extent of specific events (e.g. storms, droughts, downpours) or prolonged phases of particular meteorological conditions (e.g. wetter/drier, cooler/warmer, windier/calmer periods spanning weeks to years);
(2) that which offers evidence of the effects of climate and weather on the natural and human environment, including both direct impacts (e.g. on vegetation, human-made structures, water supplies, transport) and possible indirect consequences (e.g. for the economy, administration of institutions, health of humans and animals);

[6] Archive code: AL321

[7] Archive code: AL367

(3) that which related to human responses to climatic phenomena and their apparent impacts.

In addition to the above, information considered to be of value for contextualising and interpreting climate-related findings was recorded. This included observations on non-meteorological factors that might be implicated in the effects of and responses to climate and weather (e.g. technological changes associated with harvest failures or booms, epidemiological conditions affecting public welfare, fiscal considerations influencing disaster management), as well as generally noteworthy developments of a economic, environmental, political or cultural nature. Series of potentially relevant quantitative data, such as agricultural, financial, demographic and administrative statistics, were copied into individual spreadsheets.

The vast majority (>95%) of the documents consulted specified the dates of the climate-related phenomena to which they referred. Where dates were unspecific or omitted, comparison with other sources often enabled their timing to be constrained. Records for which it remained impossible to assign even approximate dates were excluded from the analyses presented in this thesis unless otherwise stated. Particular care was taken when interpreting accounts derived from published sources, as it was occasionally unclear whether their authors were direct witnesses of events described. Information of this nature was treated as auxiliary to definite firsthand observations. If any accounts conflicted, those provided by individuals who had resided in Antigua longer or whose background was considered to make them more reliable reporters were given priority. To gauge the validity of the consulted transcripts of the Tudway correspondence and the contents of the Moravians' Periodical Accounts, over fifty entries in both of these series were compared with the original documents used to compile those records.[8] This revealed no significant discrepancies.

In total, 13,946 items of archival documentation (i.e. individual letters, reports, statistical volumes, entries in Periodical Accounts and other miscellaneous documents) relating to Antigua or, in the case of the Codrington materials, Barbuda were consulted. Table 4.2 records the total number of items examined in each major document series and the proportion deemed to contain 'relevant information'—that is, evidence pertaining to one of the three information categories listed at the start of this section. It is acknowledged that deciding whether or not a given document contained evidence of the indirect effects of climate and human responses is problematic and subjective, as such phenomena may have multiple non-climatic drivers. Nevertheless, quantifying how many items were judged to contain such information at least gives an

[8] This required consulting several document series not described earlier, including miscellaneous letter bundles in the Tudways' Antigua papers and the Moravians' Original Letters from other West Indian Islands.

Table 4.2. Summary of items and climate evidence (classes 1-3 listed above) contained in each major archival grouping.

Series groupings (and codes)	No. items consulted	No. items containing relevant info	% items containing relevant info
Codrington Antigua correspondence (COD/C)	581	353	61
Tudway Antigua correspondence (DD/TD/15/6; T/PH/swd)	884	646	73
Moravian Missionary Original Letters (OL)	38	10	36
Moravian Missionary Periodical Accounts (PA; PAS)	571[a]	206	26
Colonial Office Original Correspondence (CO152; CO7)	11585	650	6
Other miscellaneous correspondence (AL321; AL367)	15	6	40
Codrington Antigua Accounts (COD/A)[b]	203	-	-
Colonial Office Blue Books (CO10; CO157)[b]	69	-	-

[a] Total number of separate entries in all PA volumes relating to Antigua.
[b] The number of items containing 'relevant items' was not recorded for these collections.

impression of the relative usefulness of the consulted sources for the present investigation.

As can be seen from Table 4.2, the correspondence pertaining to the Colonial Office and its predecessors was by far the most abundant source type (>80% of documents consulted). It contained a higher number of 'relevant' items than any other series grouping listed, but proportionally the lowest. The Tudway and Codrington Correspondence were the groupings containing the next highest number of total documents and relevant documents. They also offered the highest proportion of relevant items, which was more than tenfold higher than for the governmental correspondence. However, the latter were valuable in offering accounts of weather-related phenomena at an island-wide rather than local scale, whereas the former mainly reported on affairs in central-eastern Antigua. Missionary papers offered a middle ground inasmuch as they contained a moderate proportion of relevant evidence (Table 4.2) and location-specific accounts for many sites across the island.

Temporal variability in the abundance of sources and climate evidence, as well as the specific methodologies used to analyse the latter, will be discussed at pertinent points in the empirical chapters of this thesis.

4.5. Methodological caveats

It should be acknowledged that the use of documentary sources in historical climatology is not without its drawbacks. Many of these stem from an issue common in historiography generally: record incompleteness. Researchers are reliant on the survival and accessibility of sources which themselves are incapable of offering all-encompassing, eye-witness testimony of all past events and processes. Although pooling evidence from multiple sources can help to address this problem, it cannot be eliminated entirely (Brázdil et al., 2005).

Where records of interest are available, uncertainty in their content is, to a considerable extent, associated with human subjectivity. All documentation has been produced by observers with unique positionalities, influencing their perceptions, attitudes and biases (Baker, 1997), as well as their environmental awareness. The latter in turn determines impressions of the scale, impact and severity of a given climate event and also that which constitutes average climatic conditions (Endfield, 2007). Because normal conditions may vary over timescales which make them unperceivable to humans, it is useful to think of the observer as a filter registering "short-term fluctuations about an ever-changing norm" (Bradley, 1999: p.442). Individuals' positionality means, however, that 'filtered' observations of the same climatic fluctuation or event are rarely uniform.

While the propensity of documentary sources to emphasise weather events with major societal impacts can be useful (Section 4.2), the downside is that those events which happened to have limited effects may receive limited or no commentary (Pfister et al., 2009). Furthermore, not all forms of disruptive weather or hardship are necessarily equally well-documented. For instance, it was noted in Section 2.2, that sudden and dramatic hazards disturbing quotidian routines extensively tend to attract much attention. In contrast, gradually building stresses with socially-selective effects, like droughts or famines, can simply invoke a 'business as usual' approach among elites (Dirks, 1980), who were the principal authors of documentation in historical times (Duncan, 1999).

Information is included and excluded from a given document reflecting factors of the kind discussed above, as well as its intended purpose and readership. This can result in certain occurrences being subject to unwarranted attention or even sensationalism. Observers might, for instance, mis-represent the severity of a climate-related disaster in the pursuit of a particular political or economic agenda, such as securing financial aid (Endfield, 2008; Pfister et al., 2009). The historical record also contains intentional or unintentional 'silences.' More often than not, colonial archives are dominated by material created by government officials and other privileged colonists whose local interests were primarily economic (Duncan, 1999). In the case of this study, such individuals were members of the plantocracy. As will become apparent in the following chapters, reliance on their writings has resulted in a notable

skew towards reporting of the agro-economic effects of adverse meteorological events and institutional action taken in response. It also invariably results in a biased narration of the experiences of other sectors of the populace. In particular, Lambert (2009: p.48) emphasises that the voice of slaves is all but absent in the West Indian archives, making researchers heavily reliant on accounts about them provided by white "hostile observers". The same point could be made in relation to the African-descended majority more broadly, both before and after the abolition of slavery.

4.6. Closing remarks

This chapter has introduced the documentary evidence used in the present investigation of climate and climate-society dynamics in colonial Antigua. Documentary sources have an established value for historical climate research, owing to the high resolution, precisely-dated information they typically contain, their ability to distinguish individual meteorological elements and the fact that they can provide insights into both the physical features of past weather and its implications for human society. Nevertheless, it should be borne in mind that the archival record presents researchers with some significant challenges, not least its fragmentary nature and the inherent subjectivity of its contents. To account for such difficulties, as large and varied a selection of documentation is used in this thesis as time and logistical restraints have permitted. Four principal source types have been studied: plantation, governmental and missionary papers and published scholarship. In sum, 13,946 individual items of archival documentation and twelve publications pertaining to Antigua in the period 1769-1891 have been consulted. The particulars of each source type, as well as the systematic approach adopted to assess their contents and extract relevant evidence, have been detailed at length in Sections 4.3 and 4.4. This archival research serves as the basis for two distinct investigative areas in the remainder of the thesis: firstly, in the following two chapters, the reconstruction of precipitation variability and tropical cyclone activity in colonial Antigua and, secondly, in Chapters 7-10, exploration of the societal repercussions of extreme weather events.

Chapter 5

Reconstructing precipitation variability

5.1. Introduction

The Caribbean has by no means been neglected in the study of historical climate variability. In recent years, numerous high-resolution reconstructions of SSTs (e.g. Winter et al., 2000; Haase-Schramm et al., 2003; Kilbourne et al., 2008; Vásquez-Bedoya et al., 2012) and tropical cyclone activity (e.g. Boose et al., 2004; Chenoweth, 2006; García-Herrera et al., 2005; Nyberg et al., 2007) during the last half-millennium have been undertaken for the region. There is, though, a notable paucity of research into pre-instrumental fluctuations in precipitation. Investigations of this type have been conducted by Chenoweth (2003), who interrogated qualitative and quantitative rainfall data contained in a Jamaican weather journal spanning 1752-1786, and Mendoza et al. (2007), who created a sixteenth-nineteenth century drought index for the Yucatan Peninsula using published compendia of agricultural disasters in Mexico (García-Acosta et al., 2003; Escobar-Ohmstede, 2004). Meanwhile, reconstructions of precipitation at annual to sub-annual resolutions have been produced through isotopic analysis of speleothems from Puerto Rico (Winter et al., 2011) and Belize (Kennet et al., 2012).

It is clear from work by Chenoweth (2003) and Mendoza et al. (2007) that documentary archives from the Caribbean represent a valuable source of historical rainfall data. In order to assess qualitative climate evidence in this form, researchers focusing on southern Africa (Vogel, 1989; Nash and Endfield, 2002; Kelso and Vogel, 2007; Nash and Grab, 2010) have used an ordinal classification system of relative annual wetness and dryness of the kind described in Section 4.2. The approach has enabled decades' worth of comparable results to be generated for various areas of the continent, leading to detailed analyses of the possible drivers of widespread hydrological extremes (Lindesay and Vogel, 1990; Nash and Endfield, 2008). The present thesis chapter develops the first extensive rainfall reconstruction in the Caribbean employing this classification system. Archival material described in the previous chapter is used to construct separate chronologies of annual and seasonal precipitation variability in Antigua covering the years 1770-1890 and 1770-1854 respectively. Evidence for major wet and dry episodes is reviewed and the reconstruction evaluated critically. First, however, the methods used to generate findings are outlined.

It is worth noting that the work presented in this chapter has been published in summary by Berland et al. (2013).

5.2. Data isolation and analysis

The archival research described in the previous chapter produced a series of transcripts of evidence from the period 1769-1890 regarding the following: (1) weather events and climatic conditions, (2) the direct and possible indirect effects of these upon society, (3) human responses to both of the above. It is the first of these groupings of information that serves as the basis of the climate reconstructions developed in this chapter. Such evidence, which was isolated from the other groupings for analysis here, itself can be split between two main types. The first and most common were descriptions of specific weather events such as droughts, storms and falls of rain, while the second consisted of anecdotal observations of short- or long-term meteorological variations, including remarks about the timing of rainy season onset and prolonged wetter or drier periods.

Archival data were used to produce two separate chronologies of Antiguan precipitation variability, which are detailed in the following subsections. The precise analytical approach implemented is based on that of Nash and Endfield (2002). This involves assigning one of a small number of relative climatic classifications to regular units of time comprising the study period. One important difference in its implementation in this research is that classifications are assigned solely on the basis of direct references to meteorological conditions and weather events. By contrast, Nash and Endfield (2002) and others applying their methodology (Kelso and Vogel, 2007; Nash and Grab, 2010) assigned classifications to reflect this type of material as well as indirect evidence of climate variability, such as reports of harvest success or failure and changes in river regimes. Indirect evidence of this kind is subject to detailed assessment in Chapters 7-10, which explore the societal implications of extreme weather events. It is not used for present purposes in order to avoid circular argumentation (see Section 4.2). Notably, Berland et al. (2013) did present some archival information regarding the socio-economic consequences of rainfall variability alongside their Antiguan rainfall reconstructions. These findings were, however, provided only to contextualise evidence of extreme events. As is the case here, they were not involved in the development of the precipitation chronologies themselves.

5.2.1. Island-wide precipitation reconstruction

All extracts mentioning meteorological phenomena experienced in Antigua were compiled in chronological order in a single database. Descriptions of weather patterns or events affecting the island generally or at several disparate locations in a given timeframe were included, while one-off references to conditions at a single location or multiple locations within a small geographical area were excluded. All entries in the database were ordered in accordance with the Antiguan ‘rain-year’ (December-November) and examined carefully for evidence of rainfall levels, which was

highlighted. Any information in the original sources suggesting bias in observers' recording of the weather was also reviewed.

Analysis revealed considerable variability in the abundance and detail of references to climatic conditions over the 121-year study period. In some cases, weather patterns were well-documented throughout all twelve months of the rain-year, whereas in others, they received no mention at all. All rain-years between 1769-1770 and 1889-1890 for which sufficient information was available were assigned one of five classifications to reflect the predominant balance of climatic conditions reported. These classifications were: very wet, wet, 'normal' (i.e. seasonable rains), dry or very dry. Throughout this process, careful consideration was given to what would be expected to constitute 'normal' weather at different times of year. Examples of extracts and terminology typical of the five categories are shown in Table 5.1.

As a means of gauging the confidence with which classifications of wetness and dryness were assigned, the results of this process were compared with the total number of documents and data points (i.e. references to rainfall or a lack thereof) available for each rain-year. In total, 34 rain-years could not be categorised due to a lack of conclusive information. For all but one of these rain-years, between 40 and 187 documents written by a variety of observers were available. Given the regularity and abundance of this documentation, it seems reasonable to suppose that if any major deviations from 'normal' weather conditions had been experienced, they would have been reported. Such rain-years have been tentatively labelled as 'assumed normal' to indicate that it is unlikely that they featured any significant precipitation extremes, but that a classification of 'normal' lacks explicit confirmation. Only five documents were available for the rain-year 1786-87, so this has not been classified.

5.2.2. Central-eastern Antiguan precipitation reconstruction

The consulted plantation papers related primarily to estates situated nearby one another in central-eastern Antigua, immediately to the south and east of Parham town (Figure 4.1). These sources reported regularly on meteorological conditions, often enabling local inter-seasonal rainfall variability to be identified. All direct references to weather phenomena experienced within this area were collated and analysed according to the dry season (December-April) and wet season (May-November) of each rain-year. The fivefold classification system described in the preceding section was applied to reflect the predominant conditions reported seasonally, with careful reflection on meteorological norms in different months. Due to the lack of relevant records available after the mid-1850s, the coverage of the resulting chronology is restricted to the rain-years 1769-1770 to 1853-1854. Even within this period, a shortage of data points made it impossible to classify multiple individual seasons. In such cases, no classification was given rather than assuming normal conditions, as total numbers of sources relative to data points for each season were much lower than

Table 5.1. Examples of statements and key descriptors characteristic of the five classifications assigned to each rain year.

Category	Key descriptors	Illustrative quote
Very wet	Torrential, superabundant, excessive, unremitting rains; continual heavy/abundant rains	"The quantity of rain which fell during the year was very remarkable, being much greater than anyone could remember in former years…"[a]
Wet	Very fine, very favourable, plentiful, abundant rains; squally or wet weather	"We have had much rain during the last five months in Antigua, which has been a great blessing to the island."[b]
'Normal'	Sufficient, seasonable, favourable, satisfactory, fine rains; fair weather	"This Island remains perfectly healthy, the weather seasonable and the Crop in the best possible State."[c]
Dry	Little, lacking, insufficient, scanty rain; dry weather; drought (referring to short time periods, e.g. weeks to one month)	"The island throughout its extent requires abundant and heavy rains. Fortunately showers have been frequent… but as yet the crop is by no means safe. The weather has been for many months hot and dry..."[d]
Very Dry	Severe, unprecedented, extreme, long-continued drought or period of dry weather	"Ye weather still continues severely dry, & ye Prospect for next year is very bad…a severer Drought I do not recollect…"[e]

(a) PA Vol.15 p.79, Gracehill station diary 1838; (b) PA Vol.20 p.422, Letter from G. Westerby, 29 Dec 1852; (c) CO7/7, Gov. D'Urban to Earl Bathurst, 15 Jan 1821; (d) CO7/68, W. Walker to Gov. Macphail, 24 Jul 1841; (e) DD/TD/15/6, F. Farley to C. Tudway, 11 Jun 1777.

in the case of the island-wide chronology. The availability of documents and data points pertaining to each wet and dry season was, as before, used as a measure of classification confidence.

5.2.3. Comparison with instrumental rainfall data

Calibration with standardised instrumental data is an essential step for ensuring the validity of any proxy-based reconstruction of climate variability (Brázdil et al., 2005). The potential for doing so in this study is considerably limited by the absence of such data for Antigua prior to 1928. Nevertheless, several short series of unstandardised rainfall measurements are available, which at least enable reconstructed trends to be assessed against an independent record. Oliver (1894: pp.vii-viii) provides a continuous sequence of monthly rainfall figures recorded at a public library in St. John's from 1870 to 1887 and a more fragmentary record for 'The Ridge'—a fort located in the outskirts of Falmouth town—covering 1846-1852. Monthly totals for the St. John's library are also available in the colonial Blue Books of 1887, 1888 and 1889, while that of 1890 includes equivalent figures for a 'government laboratory' in the capital. Auchinleck (1956) presents another rainfall series, consisting of annual rainfall totals for 1874-1949 averaged from measurements taken at between 40 and 70 'stations' throughout Antigua. The island-wide chronology was compared to the following sequences of instrumental data: (1) annual precipitation totals recorded at

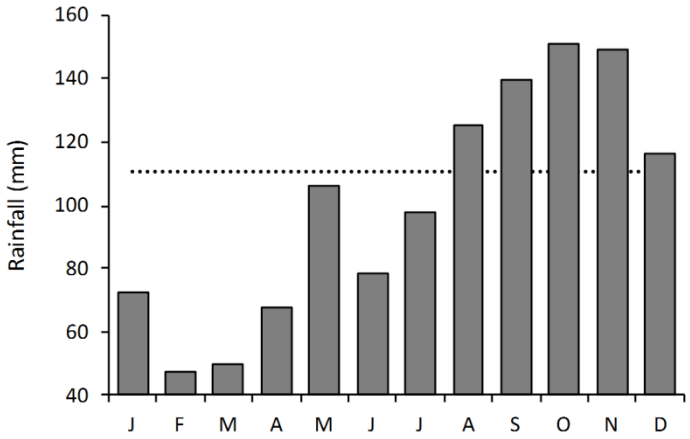

Figure 5.1. Mean monthly rainfall derived from St. John's rainfall data, 1870-1890. Solid grey line represents average of monthly means. Data from Oliver (1894: p.viii) and Leeward Islands Blue Books for 1888-1890 (CO157/2-4).

St. John's for the rain-years 1870-71 to 1889-90 and (2) totals for the calendar years 1874 to 1890 provided by Auchinleck.

Of course, these instrumental data are not without their limitations. Despite thorough examination of archival sources, very little information indicative of the reliability of rainfall measurements and their comparability with modern figures has been uncovered. Specifically, nothing is known of the recording instruments and procedures used, other than that a rain gauge of unspecified design was suspended at a height of twelve feet (~3.66 m) above ground-level at the St. John's library.[9] Who exactly was responsible for taking measurements is a mystery. Drawbacks of this kind, as well as others associated with the use of the instrumental data in question receive further consideration in the following subsection. Notwithstanding these, it is a positive indication of the validity of the St. John's data that the twelve-month precipitation cycle exhibited by its monthly means (Figure 5.1) matches the broad seasonal shifts evident in modern data (Figure 3.2).

5.2.4. Methodological caveats

General limitations associated with the use of documentary archives in historical climatology were outlined in Section 4.5. This subsection will focus on those associated with the precise methods implemented here. First, it should be acknowledged that the categorisation of rain-years and seasons into discrete classes is inevitably a subjective and generalised representation of climate variability. Often, classifications were assigned to reflect drier conditions in certain months counterbalancing wet weather in others. Several examples of such cases are presented in Sections 5.3.1 and 5.3.2. When determining yearly classifications, greater

[9] CO157/2, Blue Book for 1888.

weighting was attached to conditions in the wet season, which spans a greater number of months than the dry season and typically accounts for 70-80% of rainfall. Importantly, only rain-years and seasons in which meteorological extremes were consistently reported by several observers were classed 'very wet' or 'very dry.'

Spatial limitations should also be considered. Most of the source material was produced by correspondents based either in St. John's or at a limited number of plantations and mission stations throughout Antigua (Figure 4.1). Although missionaries were writing regularly from nine locations across the island by the mid-1800s, news of weather conditions in isolated or sparsely populated areas would have been spread chiefly by word of mouth. A degree of inaccuracy may be expected as such. With respect to the central-eastern Antiguan chronology, small-scale variations in rainfall distribution may introduce error. On 23rd November 1836, for example, Thomas Foote, manager of the Tudway family's 'Old Work' estate, wrote:

> Within the last ten days some heavy rains have fallen to the West and South of us but so partial that the South side of the New Work had more than any other part of it, and not one drop on this [estate] or the Lodge, nor had the New Work anything worth mentioning.[10]

While this passage identifies local differences in precipitation levels, others reporting conditions at a particular plantation may not.

As noted in Section 5.2.3, a lack of background information about the rainfall measurements with which findings are compared makes their reliability and precision uncertain. An additional complication associated specifically with the series of Auchinleck (1956) is that the number of rainfall records from different sites used to calculate annual totals was variable. These values are, therefore, not strictly comparable. However, uncertainties of this kind over trustworthiness and homogeneity are often inevitable with early instrumental data (Chenoweth, 2003). The series employed here are the only comparable records of Antiguan rainfall variability in the period 1769-1891 known to the author.

5.3. Results

The analysis discussed above produced a semi-continuous record of climate data for Antigua spanning the rain-years 1769-70 to 1889-90. Chronologies of average rainfall conditions throughout the island and at the Tudway and Codrington estates in central-eastern Antigua are shown in Figures 5.2a and 5.3a respectively. It is important that

[10] T/PH/swd/2, T. Foote to R. Tudway, 23 Nov 1836.

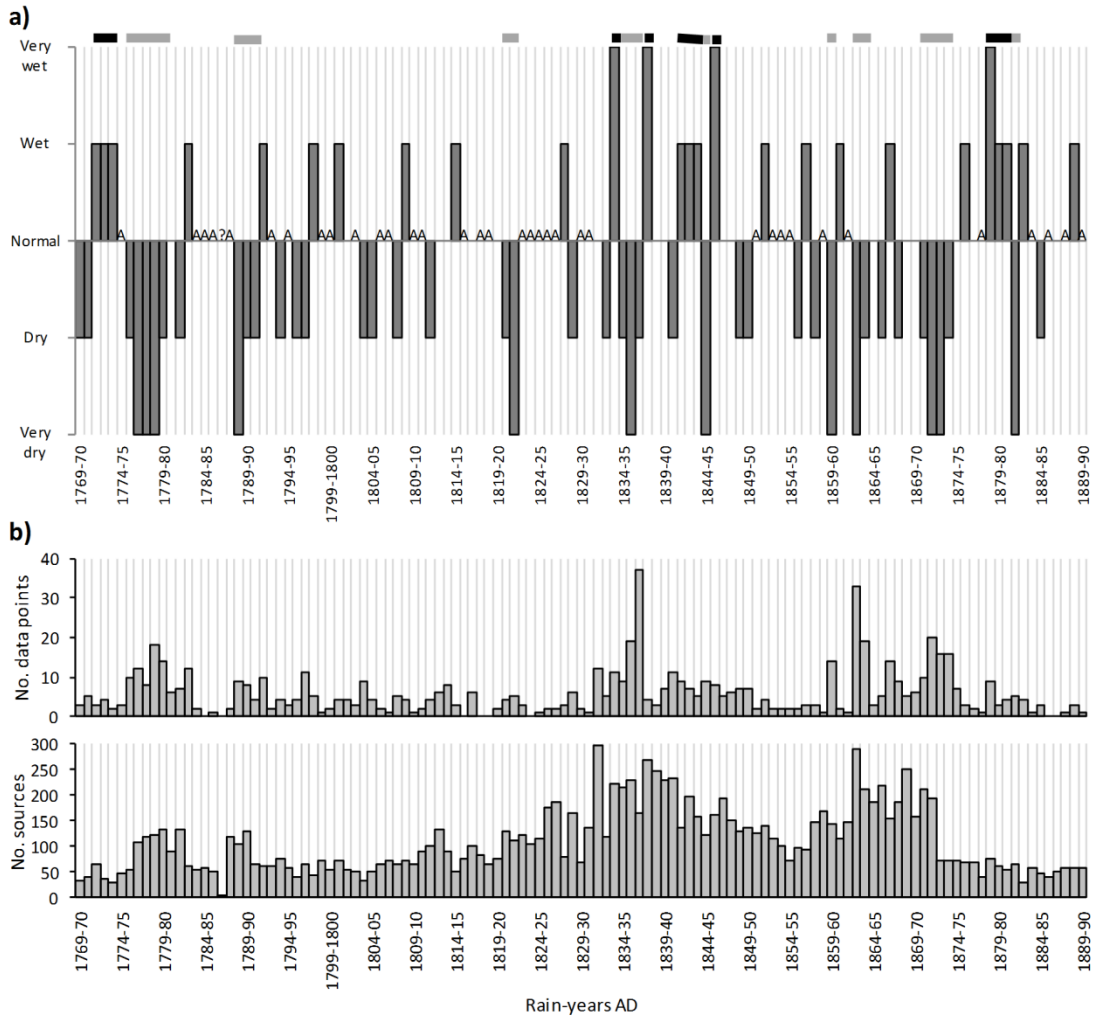

Figure 5.2. (a) Document-derived chronology of predominant rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. *A* and *?* denote 'assumed normal' and unclassified rain-years respectively. Major dry (wet) phases highlighted in grey (black) at top of chart. (b) Number of documents and data points available for each rain-year.

the trends displayed therein are interpreted with consideration of the availability of documentation and weather references (Figures 5.2b, 5.3b), which serves as an indication of classification confidence.[11] Table 5.2 displays total classification

[11] Kelso and Vogel (2007) have developed an alternative means of conveying the confidence of annual classifications, assigning each a "confidence rating" (CR) of 1, 2 or 3 (1 representing the lowest and 3 representing the highest level of confidence). In the island-wide Antiguan chronology, 73 of the 85 rain-years assigned definitive classes (i.e. very wet, wet, normal, dry or very dry) would receive a CR of 3 under the system described by those scholars. Twelve rain-years (1771-72, 1773-74, 1780-81, 1804-05, 1808-09, 1814-15, 1819-20, 1827-28, 1838-39, 1855-56, 1860-61 and 1876-77) would be awarded CRs of 2. Categorisation of rain-years as "assumed normal" or "unclassified" where evidence was inconclusive eliminates the need for any CRs of 1. With respect to the central-eastern Antiguan reconstruction, Kelso and Vogel's system is not strictly applicable, as most classifications here were

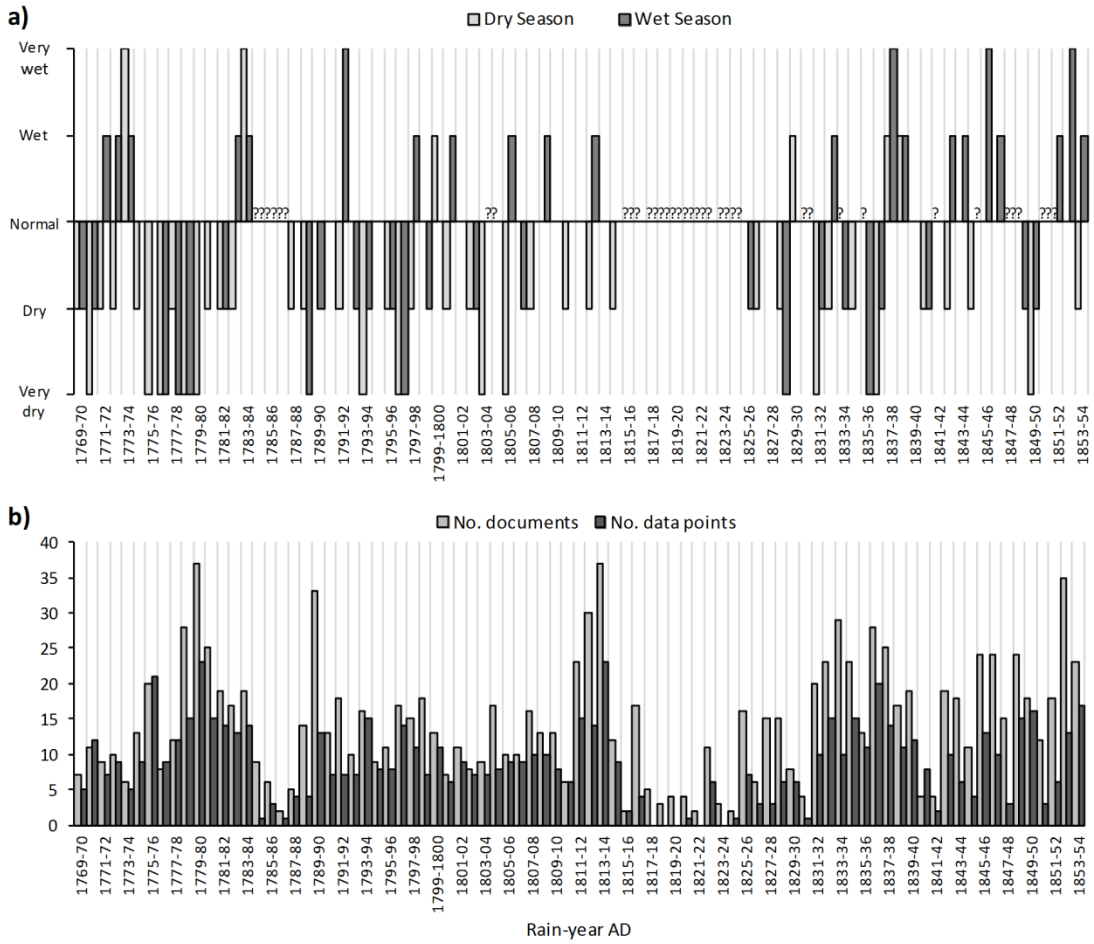

Figure 5.3. (a) Document-derived chronology of predominant rainfall conditions experienced at Tudway and Codrington estates in central-eastern Antigua. *?* denotes unclassified rain-years. (b) Number of documents and data points available for each rain-year.

frequencies for both chronologies. A comparison of classifications for rain-years 1870-71 to 1889-90 with available instrumental data can be seen in Figure 5.4.

Results indicate that major droughts were experienced throughout Antigua in the rain-years spanning 1775-80, 1788-91, 1820-22, 1834-37, 1844-45, 1859-60, 1862-64, 1870-74 and 1881-82. Consecutive rain-years of wetter-than-normal conditions were documented in 1771-74, 1841-44, 1878-81, while 1833-34, 1837-38 and 1845-46 were isolated rain-years of particularly high rainfall levels. Examples of evidence for the duration, severity and, where possible, spatial variability of these major dry and wet episodes will now be discussed.

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assigned on the basis of descriptions of the progression weather conditions or climate events over intervals of weeks to months, rather than annual/seasonal summaries.

Table 5.2. Classification frequencies for island-wide and central-eastern rainfall chronologies.

Classification	Island-wide data	Central-eastern data		
		Dry season	Wet season	Totals
Very wet	4	2	4	6
Wet	22	4	17	21
Normal	53*	18	23	41
Dry	30	27	17	44
Very dry	12	12	7	19
Unclassified	1	22	17	39
Assumed normal	35			

* Includes documented and assumed classifications.

5.3.1. Major dry periods

The consulted archives indicate that the late 1770s witnessed the most severe and protracted drought episode throughout the 121 years under study. Conditions in this period were particularly well-documented. A total of 62 direct references to weather conditions throughout the island and 80 pertaining specifically to central-eastern Antiguan estates were available for the rain-years 1775-80—considerably more than in any other comparable timeframe prior to the 1830s. The data indicate that after commencing in October 1775, severe drought predominated across the island for five successive rain-years. The only major breaks appear to have been in September 1776 and October 1777, when moderate-heavy rains were reported widely. Some localised variations in drought severity are also evident, with showery spells reported in the neighbourhood of the Tudway plantations in January and June 1776, March-April 1778 and early-August 1779.[12] Conversely, the occurrence of precipitation in early-mid 1780 was observed to have been limited to the southwest of the island.[13] Notwithstanding this, one planter suggested in March 1780 that Antigua was passing through "the most unfortunate duration of the severest dry weather that ever providence inflicted upon an individual Island."[14] Questionable use of superlatives aside, several contemporaries made similar assertions and, when dry weather returned in 1782 (after mixed conditions in 1781), Antiguan politicians recorded that the colony had suffered intense drought "for more than seven years."[15]

Firsthand observations of climatic conditions throughout Antigua are relatively sparse for the rain-years 1788-91. Nonetheless, various retrospective accounts noted

[12] DD/TD/15/6, M. Walrond to C. Tudway, 28 Mar, 23 Jun 1776, 10, 28 Apr 1778, 19 Aug 1779.

[13] DD/TD/15/6, M. Walrond to C. Tudway, 29 Jul 1780.

[14] COD/C10, R. Clarke to W. Codrington, 14 Mar 1780.

[15] CO152/63, Legislative petition, 28 May 1783.

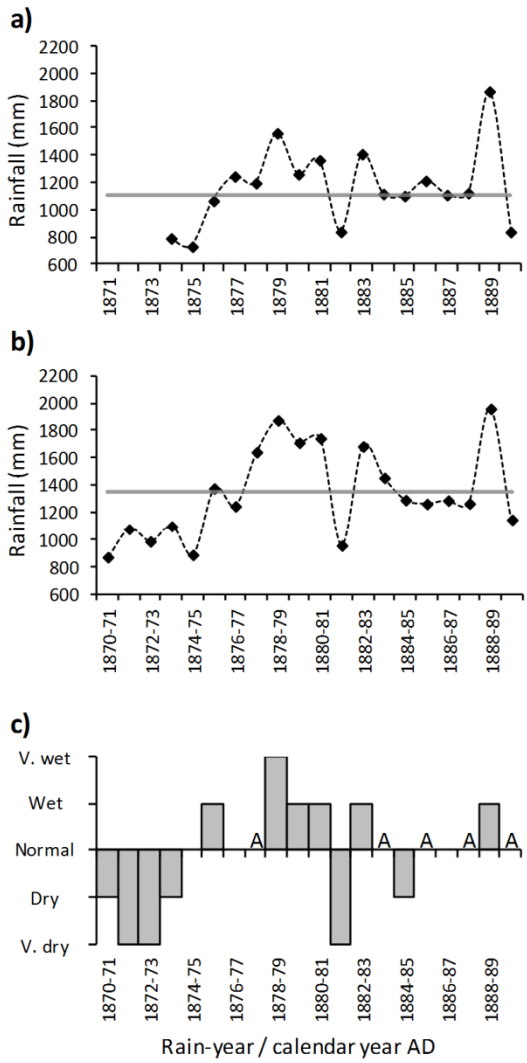

Figure 5.4. (a) Instrumental rainfall data for Antigua, 1874-1890, averaged from multiple measurements from Auchinleck (1956). Black diamonds display annual totals for calendar years; grey line displays annual mean for the full dataset (1874-1949). (b) Instrumental rainfall data for St. John's, 1870–71 to 1889-90, from Oliver (1894), CO157/2, CO157/3 and CO157/4. Black diamonds indicate totals for each rain-year; grey line represents annual mean (1870-71 to 1889-90). (c) Documentary-derived chronology of average rainfall conditions throughout Antigua, rain-years 1870-71 to 1889-90. *A* denotes assumed "normal" classification.

major precipitation scarcities in this period. For instance, an overview of past droughts in Antigua appearing in an 1830s mission diary recalled that "in 1789 there was no rain for seven months"[16]—a statistic also quoted by Oliver (1894: p.cxxxviii). A report on the same subject produced by government officials in 1877 identified both 1789 and 1790 as years of "prolonged drought."[17] Travel writings also provided useful

[16] PA, Vol.14, p.444, St. John's diary, 21 Jan 1837.

[17] CO152/129, Report of E. Baynes, 14 May 1877.

insights into the characteristics of the dry episode. For example, British Physician William Young (1801: p.282) recorded the non-arrival of the wet season in 1790 and 1791, as well as the prevalence of "partial rains" in the interim. Notably, while correspondence from the Tudway and Codrington plantations also suggested extremely deficient precipitation in central-eastern Antigua in 1788-89 and the 1790 wet season, it reported largely seasonable rainfall levels during early 1790 and 1791. Widespread heavy rains in spring 1792 brought an end to this episode of drought.

It is not until the early 1820s that there is further evidence of successive years of major rainfall deficiency across Antigua. In part, this may reflect the general paucity of references to island-wide meteorological phenomena uncovered for the first three decades of the 1800s, when relatively few precipitation extremes were recorded (Figure 5.2). Even a severe episode of dry weather in the rain-years 1820-21 and 1821-22 received little mention in sources other than governmental correspondence. In a despatch to Whitehall dated October 3rd 1822, Antigua's governor conveyed the news that a fortnight of seasonable rains had brought an end to "a most severe drought during the last and the present year, such as has not been known for more than thirty years past."[18] The testimony of various colonial officials in the accompanying documentation contained several comparable references to rainfall scarcity.[19] When precisely the drought started is unclear, but reports suggest that although 1821 opened with seasonable weather,[20] "deplorably dry" weather had come to predominate by the end of the year.[21]

While there is no evidence of especially severe drought events from the mid-1820s through the early 1830s, certain records suggest that this period may have been characterised by somewhat drier-than-normal weather conditions at large. In a statement on agricultural affairs from August 1835, legislature-member Nicholas Gilbert noted:

> The seven years, from 1826 to 1832, both inclusive, were very unfavourable to the cultivation of the cane, the amount of rain for those years averaging only 40.81 inches [1037 mm]; whereas, that of the three preceding years was equal to 49.83 inches [1266 mm], or nearly one-fourth more, and the rain of last year was 60.83 inches [1545 mm]…[22]

[18] CO7/7, Legislative address to Gov. D'Urban, 26 Sept 1822.

[19] CO7/7, Gov. D'Urban to Earl Bathurst, 3 Oct 1822 and all enclosures.

[20] CO7/7, Gov. D'Urban to Earl Bathurst, 15 Jan 1821.

[21] COD/C26, G. Ick to C.B. Codrington, 21 Dec 1821.

[22] CO7/42, Report of N. Nugent, Jul 1835 [precise date unspecified], with letter from Gov. MacGregor to Lord Glenelg, 1 Aug 1835.

The absence of information about the origin of these instrumental data makes their reliability questionable. Nonetheless, earlier that year another colonial official also commented on the relative dryness of the same timeframe, observing: "for the last six or seven years the average [sugar production] may have somewhat declined, from a greater prevalence of dry weather."[23]

The next phase of intense drought, which spans 1834-35 to 1836-37, is among the best documented in this study. In total, 111 references to climatic conditions pertaining to a wide range of observers were encountered in these rain-years, of which 77 mentioned precipitation scarcity. The records denote relatively dry weather throughout Antigua during much of 1834-35, save August, when a tropical cyclone on the 12th was followed by several weeks of moderate rains. They then indicate that extremely dry conditions predominated from autumn 1835 through late spring 1837, including several reports of up to "13 months without any rain."[24] A small number of sources suggest that dry conditions were alleviated briefly in the south-western 'highlands' by showers in June, November and December 1836 as well as spring 1837. Eventually, plentiful rains in late May and early June 1837 ended this drought of allegedly "unexampled duration."[25] A consistent sequence of events is described at the Codrington and Tudway estates during the mid-thirties, with the exception that precipitation levels were seemingly seasonable throughout autumn 1835.

The subsequent two and a half decades seem to have been free from major precipitation scarcities of comparable duration. Nonetheless, 1844-45 and 1859-60 were isolated rain-years of 'very dry' conditions in the island. Both were commented to have witnessed periods of extreme drought lasting over six months throughout much of the rainy season[26]—observations supported by frequent references to short-term weather patterns throughout the year. Spells of moderate precipitation in October 1845 and June 1860 appear to have punctuated the dry weather. Although evidence for central-eastern Antigua was largely unavailable for both rain-years, drought was registered here in early-mid 1845.

The final multi-year droughts in this study were during the rain-years 1862-63 to 1863-64 and 1870-71 to 1873-74. Both were documented in considerable detail, with 52 and 62 weather references available for these periods respectively. Following accounts of abundant rains late in 1862, the first weather observation for 1863, dated 12th June, noted that soils in the environs of St. John's had been "baked by long drought nearly as hard as bricks" and that dry weather was becoming a widespread

[23] CO7/42, Report of N. Nugent, 26 Jan 1835.

[24] PA, Vol.14, p.444, St. John's diary, 21 Jan 1837.

[25] PA, Vol.14, p.193, Letter from F. Thraen, 26 Jun 1837.

[26] E.g. CO7/82, R. Horseford to Gov. Fitzroy, 30 Jun 1845; PA, Vol.23, p.525, Letter from J. Hasting, 25 Jun 1860.

concern.[27] Thereafter, reports of extremely arid conditions persisting until the arrival of rains in the final months of 1864 are abundant. In the summer of 1865, Antigua's Registrar General recalled this as a time of "unprecedented Drought extending over twenty months."[28] As in the year 1863, the precise timing of drought onset in the early 1870s is unclear. Missionary papers note dry weather to have predominated both in 1870 and early 1871 in the far north and east of the island. It is then recorded extensively that, between downpours in late summer 1871 and autumn 1874, Antigua was affected by three years of intense and almost-unbroken rainfall deficiency. This "succession of severe droughts"[29] seems to have been interrupted by short spates of rainfall in autumn 1872 and at the start of that and the following calendar year, which were largely restricted to western areas. In the case of the dry phase of the early-mid sixties, no significant interludes of rainfall were identified.

One last "very dry" rain-year was identified in 1881-82 on the basis of multiple references in missionary and government documentation. The following excerpt from one of the Moravians' annual reports for 1882 offers especially comprehensive insights into its timing and magnitude:

> A severe drought prevailed during a considerable portion of the year, the rainfall at Gracehill, for instance, in December 1881, to September 1882, being only 26.52 inches [674 mm], as compared with 50.71 inches [1288 mm] in the corresponding months of 1880 and 1881. … In some places heavy rains… fell towards the end of the year.[30]

Once again, a lack of additional information precludes the verification of the included instrumental data. Nonetheless, relatively low rainfall throughout much of 1881-82 and a high equivalent value for the preceding rain-year is in keeping with textual accounts.

5.3.2. Major wet periods

Overall, prolonged and/or intense phases of above-average precipitation were identified less frequently than those of major rainfall deficiency (Table 5.2). As can be seen from Figure 5.2b, they were also documented comparatively poorly, with fewer than twenty island-wide weather references available for rain-years comprising such episodes. Nevertheless, as will now be illustrated, the available archival evidence often provided considerable insights into the progression and intensity of wet periods.

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[27] COD/C52, G. Holborow to C. Codrington, 12 Jun 1863.

[28] CO7/126, O. Eldridge to Gov. Hill, 21 August 1865.

[29] CO152/129, Report of E. Baynes, 14 May 1877.

[30] PA, Vol.32, pp.468-469, 'Eastern Province' report for 1882.

The first major wet phase in the climate reconstruction extends from 1771-72 to 1773-74. The rain-year 1771-72 opened with three months of dry weather, but the arrival of abundant general rains was reported in late July. In mid-December the governor of Antigua remarked that "uncommonly propitious Weather" had prevailed since a powerful rain-bearing cyclone on August 21st.[31] Another dry winter-spring was experienced in 1773, after which various sources register persistently wet weather until the autumn of 1775. For instance, early in the latter year, the Tudway Family's Antiguan attorney commented that the island had received "great falls of rains… for sixteen months from ye middle of June 1773 to ye latter end of September 1774."[32] Estate papers record the same sequence of weather patterns in central-eastern Antigua during the early-mid 1770s, but suggest that rainfall was especially abundant there in spring 1774.

From the 1780s through 1820s, above-average rainfall characterised seven rain-years, none of which were consecutive or presented conclusive evidence of 'very wet' conditions. As mentioned in the previous section, this apparent absence of major extremes may reflect the relatively low number of accounts to meteorological conditions at this time. Those records which are present suggest that wetter-than-normal weather may have prevailed throughout 1783-84—which was classified as 'assumed normal'—as well as the 'wet' rain-year preceding it. Deficient precipitation marked the opening months of 1783, after which accounts of universally wet weather in mid-summer and autumn are abundant, with one plantation correspondent describing precipitation in October and November as "too heavy."[33] A handful of plantation letters then record untypically abundant rains to have fallen across the island throughout spring and early summer in 1784. Although the archives are otherwise silent on the weather experienced generally in that year, they provide ample details of circumstances in the neighbourhood of several central-eastern Antiguan landholdings. Here, conditions were reported to have been remarkably wet from February to May and largely wetter than usual from June to November. While it is possible that these high rainfall levels were experienced only in this relatively small locality, it seems more probable that they would have extended to other parts of the island.

Extremely wet conditions are exhibited clearly during the rain-years on either side of a major drought in the mid-1830s. Rainfall excess was first reported in early February 1834, when, according to the Moravians, the island "had so much storm and rain, that the oldest inhabitants never remembered the like at this season."[34] Missionary and plantation sources registered abundant precipitation for most of the

[31] CO152/32, Gov. Payne to Earl Dartmouth, 19 Dec 1772.

[32] DD/TD/15/6, S. Blizard to C. Tudway, 15 Mar 1775.

[33] DD/TD/15/6, M. Walrond to C. Tudway, 29 Apr 1784.

[34] PA, Vol.13, p. 233, Gracehill diary 1834.

remainder of the year and more rainstorms in June, while assembly member William Byam distinguished the months of August-December for the occurrence of "heavy torrents of rain, washes, &c. [etc.]."[35] As noted in Section 5.3.1, another civil servant claimed that 60.83 inches (1545 mm) of rain had fallen during 1834.[36] If comparable with the national data of the Antigua and Barbuda Meteorological Service, this would rank among the eleven highest annual rainfall totals between 1928 and 2012. Interestingly, the neighbourhood of the Tudway and Codrington properties appear not to have shared in the weather experienced elsewhere in 1833-34, estate supervisors reporting predominantly drier-than-normal conditions throughout the rain-year. In contrast, unusually high precipitation levels were recorded universally throughout 1837-38. While reports from the aforementioned properties told of an especially wet rainy season that year, those referring to wider conditions described rainfall as being copious generally. For example, one mission diary for 1838 noted: "the quantity of rain which fell during the year was very remarkable, being much greater than anyone could remember in former years."[37] Unlike the rest of the island, central-eastern Antigua appears to have experienced wetter conditions than normal in 1838-39 also, though precipitation in that rain-year was largely described as plentiful, rather than excessive.

The rain-years 1841-46 comprise a largely wet period, interrupted by severe drought in 1844-45. Weather patterns in both 1841-42 and 1842-43—which are documented almost exclusively in government correspondence—appear to have followed a similar course; drought was registered from late winter through spring, followed by abundant rains throughout the remainder of the year. The former was distinguished for having witnessed profuse downpours in late August, which were described by one colonial official as "the heaviest falls of rain ever remembered."[38] Precipitation variations in 1843-44 are less clear, but five separate plantation and government sources described the weather as having been unusually 'propitious' from April through November. At the plantations to the south-east of Parham, wetter-than-normal conditions were observed only during the rainy seasons of 1843 and 1844. After a drought in 1845, which persisted until the following spring, very wet weather was reportedly widespread during 1846. This was the best-documented rain-year of above-average precipitation, with 22 individual weather references, 19 of which mentioned rainfall occurrence. The evidence indicates that rainfall was extremely abundant from May through November. In early August, for instance, one Moravian noted: "This season has been and still is most propitious…[;] we never experienced

[35] CO7/42, Report of N. Nugent, Jul 1835 [precise date unspecified], with letter from Gov. MacGregor to Lord Glenelg, 1 Aug 1835.

[36] Ibid.

[37] PA, Vol.15, p.79, Gracehill station diary 1838.

[38] CO7/74, Report of R. Horsford, 30 Sept 1842.

such constant rains as have fallen during the last three months."[39] Weeks later Antigua was simply said to be "deluged,"[40] while the following May, it was recalled that autumn 1846 had been characterised by "heavy and continuous rains."[41] The same patterns were chronicled in central-eastern Antigua.

Another sustained period of above-average rainfall is evident in 1878-81, with especially wet conditions in 1878-79. Antigua's chief medical officers recorded 1879 to have been a year "of unusual severity as regards the quantity of rain which fell"[42]—an observation echoed by numerous missionaries and other civil servants. There are signs that conditions were consistently wet, with Moravian correspondence noting that the island received an "abundance of rain… pretty evenly throughout the year," without "a single dry month."[43] The majority of climate references available for the subsequent 'wet' rain-years were contained in annual reports. Government returns for 1880, for example, enumerated the infrastructural damage occasioned by powerful downpours that year. For their part, the Moravians wrote of "fruitful seasons" throughout Antigua from July 1880 to mid-1881, with "heavy rains" in the far west of the island.[44]

5.4. Reconstructions evaluation

Summaries of annual and seasonal classification frequencies (Table 5.2) suggest that considerably more evidence of drier- rather than wetter-than-normal rain-years was available overall. In the island-wide chronology—which was the most continuous and corresponded with available instrumental data (Figure 5.4)—'dry' or 'very dry' classifications were assigned every 2.88 rain-years on average. 'Very dry' classifications alone were assigned every 10.1 rain-years. The equivalent figures for 'wet' or 'very wet' and just 'very wet' assignations are 4.65 and 30.3 respectively. By comparison, the Antigua and Barbuda Meteorological Service defines 'above/below normal' years of rainfall as the highest/lowest 33.3% of annual totals on record and 'well above/below' totals as the highest/lowest 10% (i.e. occurring once every three and once every ten years respectively; see Section 3.3.3). While this would suggest substantial under-recording of wet episodes in the historical chronology, it is a positive indication of the reliability of the reconstruction of dry rain-years. Significantly, 3-5 successive years of drought or precipitation excess, such as those discussed in the previous sections, are also discernible in modern Antiguan instrumental data (Figure 3.8).

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[39] PA, Vol.18, p.40, Letter from A. Hamilton, 11 Aug 1846.

[40] COD/C30, J. Winter to C. Codrington, 27 Aug 1846.

[41] CO7/86, Gov. Higginson to Earl Grey, 26 May 1847.

[42] CO152/138, Report of W. Edwards and A. Edwards, 9 April 1880.

[43] PA, Vol.31, p.365, Gracehill report for 1879.

[44] PA, Vol.32, p.98, Annual Report for Jul 1880-Jul 1881.

It is important that results are evaluated with consideration of the socio-economic context in which the examined documentation was produced. As noted in Chapter 3, the prosperity of all sectors of colonial Antiguan society was bound tightly with the success of the sugar industry. Sugarcane husbandry followed a continuous annual cycle timed carefully to enable planting during the rainy season and harvesting in drier months (Section 3.3.1). While this meant that climatic conditions in general—being crucial for livelihoods—were commented upon frequently in contemporary writings, it is probable that meteorological phenomena causing notable disruptions to plantation regimes were best documented. Heavy rains in early summer, for example, could delay harvesting, attracting particular attention. Conversely, above-average precipitation in autumn, if not consistently torrential, is unlikely to have resulted in serious setbacks to planting. These factors may help to explain why substantially more relatively dry episodes were documented than wet ones; rainy weather, unless extreme or coinciding with harvest, would largely have allowed plantation agriculture to proceed in a normal manner, providing little stimulus for discussion. Moreover, Antigua's predominantly limestone geology and lack of permanent surface water features reduces the potential for major floods with profound societal impacts. Conversely, droughts tend to have readily perceptible effects for agro-economic productivity and supplies of drinking water (Kelso and Vogel, 2007).

There is largely good correspondence between the trends displayed in the island-wide and central-eastern rainfall chronologies (Figures 5.2a, 5.3a). As would be expected, the relationship is especially clear when comparing annual classifications in the former with wet season classifications in the latter (Kendall Tau-b correlation coefficient of 0.72, significant at the 0.01 level). Classification frequencies (Table 5.2) suggest that the central-eastern Antiguan sources were especially biased towards recording drier-than-normal conditions. This may be accounted to some extent by the factors noted above. The location of the studied estates in a part of the island characterised by lower average precipitation than elsewhere (see Figure 3.3) may be another contributor. Occasionally, correspondents based at these properties described local meteorological conditions with reference to those experienced in other areas of Antigua. It is possible that their writings may often have expressed the state of the weather relative to what was perceived as normal across the island generally, without explicitly stating so.

Another potential caveat is the potential for observers to overstate the severity of, or give undue attention to, adverse weather during times of socio-economic hardship. Such potential inaccuracies are inherent in historical climate research. Here, they have been accounted for as far as possible through assessment of multiple observations and reference to contextual information in the archives and historical scholarship. The dry episode of 1776-80 merits particular attention, however, for it is the longest reconstructed drought period and coincides with the American War of Independence

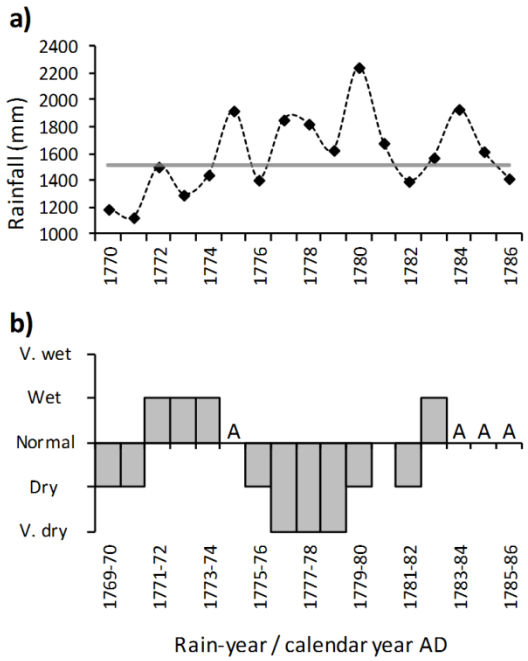

Figure 5.5. (a) Annual rainfall totals calculated from daily measurements taken at Savanna-la-Mar, western Jamaica, calendar years 1770-1786 (after Chenoweth, 2003). Grey line represents mean of annual totals. (b) Documentary-derived chronology of average rainfall conditions in Antigua, rain-years 1769–70 to 1785–86. *A* denotes 'assumed normal.'

(1775-1783). This conflict was attended by unprecedented subsistence and economic crises regionally (Section 3.3.2), potentially aggravating the effects of episodes of rainfall scarcity that would otherwise have received little or no mention. It can only be emphasised that contemporary testimony of weather conditions reveals almost entirely consistent trends over diverse timescales ranging from weeks to years. Furthermore, this testimony was provided by a variety of islanders, many of whom, including the governor and estate attorneys, were specifically tasked with providing unbiased accounts of local affairs to their British paymasters. As will be seen in Chapter 8, the archives were also replete with indirect evidence, such as descriptions of water availability and the condition of vegetation, which is indicative of recurrent and severe drought at the time.

It is difficult to assess the regional significance of the findings reported here due to the shortage of high-resolution reconstructions of precipitation variability in the Caribbean. Literature reviews have identified just four published investigations of this type that coincide with the study period. No relationship is evident between the Antiguan chronology and a document-derived time series for the Yucatan Peninsula (Mendoza et al., 2007)—which exhibits phases of low drought incidence in 1774-1799 and 1855-1880 and frequent droughts in the interim. The same is true when comparing findings with an instrumental rainfall series from western Jamaica spanning 1760-1786 (Figure 3.5; Chenoweth, 2003) and precipitation records based

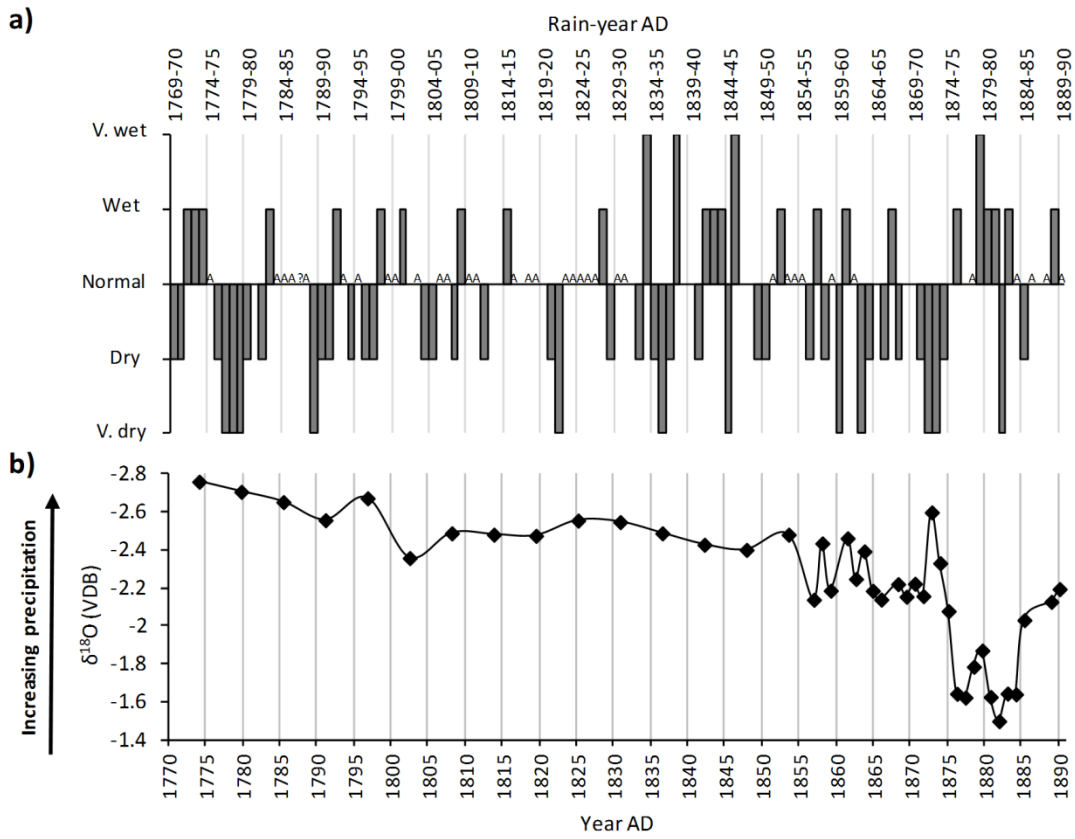

Figure 5.6. (a) Document-derived chronology of average rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. (b) Variations in $\delta^{18}O$ recorded in Speleothem PDR-1 from Perdida Cave, near Utuado, Puerto Rico (after Winter et al., 2011).

on $\delta^{18}O$ analysis of speleothems from Puerto Rico (Figure 5.6; Winter et al., 2011) and southern Belize (Kennet et al., 2012; not shown). This lack of coherency is, perhaps, unsurprising, given the considerable distances between the locations studied and differences in the approaches used to produce each record. Furthermore, certain major drivers of inter-annual precipitation variability (e.g. ENSO, NAO) are known to affect these parts of the Caribbean slightly differently (Gianni, et al., 2000, 2001a; Taylor and Alfaro, 2005; Jury et al., 2007). Possible linkages between the Antiguan chronologies and such mechanisms, as well as other climate reconstructions for the region will be explored in Chapter 11.

5.5. Chapter overview

This chapter has presented the first long-term reconstruction of pre-instrumental precipitation variability in the Lesser Antilles, and one of few in the Caribbean at large. Based on direct references to weather phenomena in the archival sources described in Chapter 4, two chronologies of relative precipitation fluctuations were developed. The first documented predominant conditions across the island between the rain-years 1769-70 and 1889-90, while the second focused on those reported at a

number of neighbouring sugar plantations in central-eastern Antigua and spanned 1769-70 to 1853-54. From these time series, nine periods of particularly severe and/or prolonged drought and six of precipitation abundance were identified, the timing of which is highlighted in Figure 5.2a. An overview of the evidence available for these episodes of rainfall extremes was provided in Sections 5.3.1 and 5.3.2. Notwithstanding methodological and interpretive difficulties associated with the reconstructions, which were considered in Section 5.2.4, the island-wide climate chronology has been shown to correspond well with two series of unstandardised instrumental data covering 16-21 years in the late 1800s. There is also much coherence between the separate Antiguan chronologies themselves, which is noteworthy as each was derived from independent documentary climate evidence. At present, there exist few Caribbean rainfall reconstructions with which these records could be compared. No relationships are apparent with those that are available for the Yucatan Peninsula, Belize, Jamaica and Puerto Rico. However, such comparisons will receive further consideration later in the thesis. Meanwhile, several of the major wet and dry phases identified here will be the focus of detailed investigations of the societal implications of extreme weather events in Chapters 8-10.

Chapter 6

Reconstructing tropical cyclone activity

6.1. Introduction

Palaeotempestology—the investigation of tropical cyclone activity prior to the period of instrumental observation—is a relatively young but expanding branch of palaeoclimatology. The North Atlantic has been particularly well studied in this field. Sediment cores from coastal lakes and lagoons have, for example, been used to reconstruct hurricane strikes over several millennia at sites in Puerto Rico (Donnelly and Woodruff, 2007), St. Martin (Malaizé et al., 2011), Belize (McCloskey and Keller, 2009) and along the US Gulf Coast (Liu and Fearn, 2000; Liu, 2004; Liu et al., 2008). Meanwhile, historical documents from former British, Spanish and French colonies in the region have enabled the frequency and intensity of cyclones during the past five centuries to be documented (e.g. Chenoweth, 2006; Mock, 2008; Chenoweth and Divine, 2012). The present chapter contributes to palaeotempestology research by reconstructing the timing and intensity of tropical cyclones affecting Antigua between the years 1770 and 1890. To this end, a proven methodology for assessing documentary storm evidence is employed. This uses descriptions of wind force and damage to estimate the severity of storm events (Chenoweth, 2007). Findings are evaluated through comparison with eighteenth to twenty-first century cyclone records. Prior to these analyses, the chapter reviews the existing research on historical tropical cyclone activity in the North Atlantic.

6.2. Historical records of North Atlantic tropical cyclones

One of the most valuable resources available for researchers of past tropical cyclone activity is the official Hurricane Database (HURDAT) of the NHC. This contains track records for over 650 tropical cyclones in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico from 1851 to the present, in the form of six-hourly position and intensity data. These data are collated from a variety of terrestrial, marine and aerial monitoring networks and are subject to continual updating and reanalysis. Though representing the most comprehensive record of direct tropical cyclone observations available globally, HURDAT suffers from inconsistencies in data completeness associated with improvements in monitoring technology over time (Figure 6.1). Event capture rates are recognised to be highest from the mid-1940s, with the advent of aircraft reconnaissance (Neumann et al., 1993).

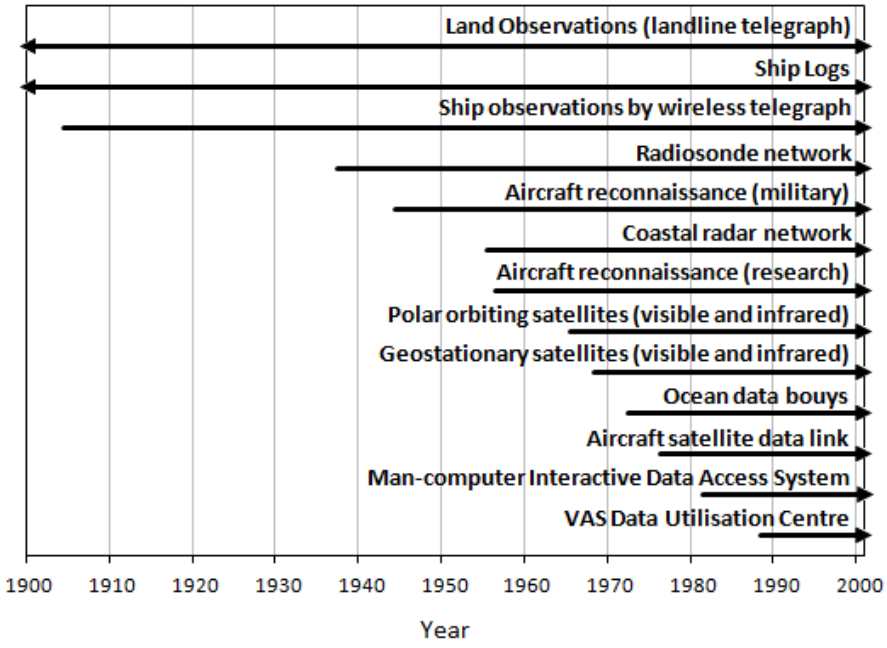

Figure 6.1. Twentieth century technical advances in systems for monitoring tropical cyclones. After Landsea et al. (1999).

For observations of cyclones prior to the coverage of HURDAT, researchers must turn to historical documentary sources. Efforts to catalogue North Atlantic tropical cyclones systematically using these records are thought to have begun in the 1820s. The earliest known compilation is that of French government official Alexandre Moreau de Jonnès (1822, cited in Chenoweth, 2006), who consulted Caribbean almanacs and colonial histories to create a list of hurricanes since 1495. Over the following decades, a number of similar compilations emerged, synthesising findings from newspapers, diaries, naval logbooks, previous storm lists and contemporary scientific scholarship (e.g. Southey, 1827, Evans, 1848, Johnston, 1856). Of particular note is that of Poey (1855), which cited dozens of primary and secondary sources and contained 401 individual storm entries for the period 1493-1855. This milestone publication has itself been repeatedly revised, refined and re-assessed, forming the basis of new tropical cyclone lists collated from the mid-1900s (Tannehill, 1952, Ludlum, 1963, Millás, 1968). More recent chronologies (e.g. Fernández-Partagás and Diaz, 1995, 1996, 1997) have placed renewed emphasis on evidence from unpublished sources, rather than extant scholarship. The latest example—a basin-wide compilation spanning 1700-1855—was presented by historical climatologist Michael Chenoweth in 2006. Combining meticulous primary research of newspapers, weather diaries and ships' logbooks with the findings of recent primary research (Mock, 2004, García-Herrera et al., 2005), Chenoweth reassessed critically the major existing lists of Atlantic storms (Figure 6.2). Findings comprise a catalogue of 383 tropical storms and

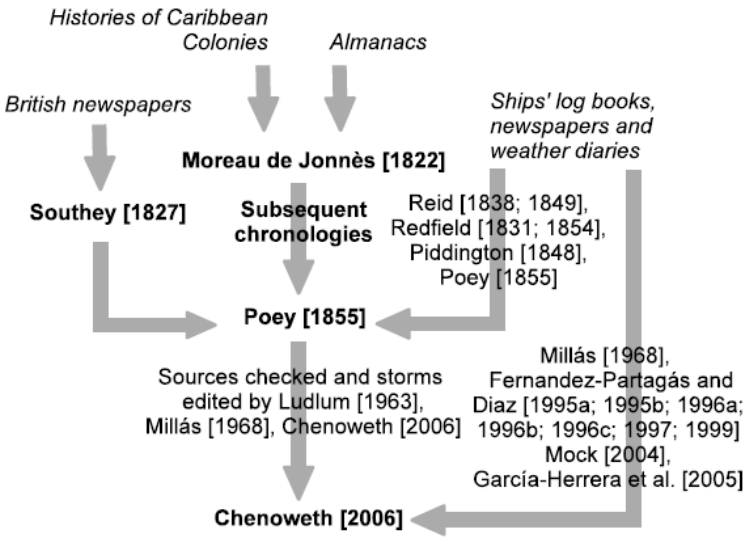

Figure 6.2. Schematic of publications contributing to the tropical cyclone chronology of Chenoweth (2006). Italicised words represent primary sources; bold names denote published storm compilations. Figure from Scheitlin et al. (2010).

hurricanes, which, at the time of its publication, represented the most complete dataset of tropical cyclone occurrences prior to the mid-nineteenth century.

Documentary archives have also been used to investigate historical tropical cyclone activity at sub-regional and local scales. Chenoweth and Divine (2008) employed the HURDAT database and various British and Danish sources—primarily newspapers, ships' logs and meteorological journals—to produce a time series of tropical cyclone frequencies for the Lesser Antilles from 1690 to 2007. Subsequently, descriptive statistics were applied to this record to investigate variability in storm seasonality and accumulated energy over time (Chenoweth and Divine, 2012). Document-based studies of tropical cyclone frequencies with a more refined spatial focus have been undertaken for Jamaica (Chenoweth, 2003), Guadeloupe (Zahibo et al., 2007), South Carolina (Mock, 2004) and Louisiana (Mock, 2008). Historical ecologist Emery Boose and colleagues have adopted an alternative approach, reconstructing spatial variability in the landscape impacts of hurricanes in Puerto Rico (Boose et al., 2004) and New England (Boose et al., 2001). Archival sources have also been exploited to produce highly detailed case studies of individual storm events (e.g. Chenoweth and Landsea, 2004, Mock et al., 2010).

Developing robust methods for assessing documentary cyclone data has been an important focus of research. For example, Boose et al. (2004) devised a modified version of the Fujita Scale (Fujita, 1972, 1987)—a system for classifying the strength of tornado and hurricane winds in accordance with levels of damage to common cultural and biological structures—for analysis of Puerto Rican records from the last five centuries. A detailed discussion of this methodology and the use of computer models for examining spatial and temporal patterns of storm damage was provided by

Boose (2004). Chenoweth (2007) also built upon the adapted Fujita scale, using newspaper reports relating to fifty tropical cyclones experienced in Jamaica and the Lesser Antilles between 1795 and 1879. Wind speed estimates derived from damage assessments were shown to agree with those calculated from barometric data. Chenoweth also identified wind force terms used in the original sources which were associated with different wind speed ranges. These findings served to formulate basic criteria for distinguishing between cyclones of tropical depression, tropical storm, hurricane and major hurricane intensity in the absence of instrumental data.

6.3. Methods of analysis

6.3.1. Tropical storm identification

As noted in Section 4.4, direct references to weather patterns and events in the consulted documentation were recorded verbatim, along with extracts of potential value for contextualising findings. Contextual information of particular relevance here comprises descriptions of the design, size and state of repair of elements of the built environment, which could be used to inform assessments of storm damage. All accounts of storms or instances of strong winds experienced in Antigua were compiled chronologically. The available evidence was assessed critically to ascertain, as far as possible, whether each discrete event exhibited characteristics indicative of tropical cyclone occurrence. A final list of instances of tropical cyclone force winds was compiled, including only events satisfying one or more of the following criteria:

1. sustained winds described as ‘gale’ force or greater;
2. gradual shifts in wind direction consistent with the passing of a closed centre of circulation;
3. recurrent powerful gusts interspersed with periods of lighter winds;
4. quantitative or qualitative descriptions of barometric pressure measurements indicative of the passage of a low pressure centre;
5. evidence of the movement of damaging storms through the wider region (i.e. references to impacts in other islands).

Criteria 1-4 above follow those proposed by Chenoweth (2006). Criterion 5 has been adopted to distinguish between severe localised thunderstorms and tropical cyclones in the absence of other evidence of the latter.

6.3.2. Classification of tropical cyclone wind intensity

Guidelines established by Chenoweth (2007) were used to classify the intensity of tropical cyclone winds. All available references to damage on land or at sea,

descriptions of wind strength and instrumental data associated with each identified instance of tropical cyclone winds were analysed. Evidence that the eye of a storm passed nearby Antigua was flagged, as well as possible indicators of storm surges. It should be acknowledged that the use of Antiguan sources alone does not permit the radial dimensions and forward velocity of each tropical cyclone to be calculated, from which maximum intensity could be inferred. Nonetheless, a homogenous local record of cyclonic wind magnitudes can be constructed for comparison with modern data.

Descriptions of wind-induced damage in Antigua were rated according to the modified Fujita scale of Boose et al. (2004). This contains four categories (F0-F3) defined by specific wind speed ranges and levels of injury to natural and man-made structures (Table 6.1). The category assigned to each documented instance of tropical cyclone winds was determined by the highest damage level for which evidence was available. Isolated damage uncharacteristic of that experienced widely was discounted if recorded as such, while accounts of damage to unspecified structure types were assigned an F0 rating. Care was taken to exclude damage caused by storm surges, inland flooding or landslides. Examples of extracts describing different damage levels can be seen in Table 6.2. The number of individual sources, rateable damage reports and rateable damage types available for each instance of tropical cyclone winds was used as a measure of categorisation reliability.

Based on the analysis of both damage reports and descriptions of wind force, instances of cyclonic winds were assigned one of the following intensity classes: tropical depression, tropical storm, hurricane or major hurricane. According to Chenoweth (2007), tropical storms can be distinguished from depressions by simple damage/no damage and gale/no gale criteria. Differentiation of higher intensity tropical cyclones requires more detailed appraisal of the severity and extent of damage alongside wind force terminology, as observers were less able to describe associated wind magnitudes effectively. The distinctions which can be made using this information are displayed in Tables 6.3 and 6.4. When discrepancies arose between damage data and wind force terms, final intensity classifications were decided on a case-by-case basis with reference to all archival evidence.

Barometric data were encountered in documentary sources for five tropical cyclones. This was used to calculate approximate wind speeds for comparison with storm intensity classifications derived as described above. All of the uncovered barometric data were quoted as deviations from an unstated ‘normal level,’ which was assumed to be 30.00 inches (1015.9 millibars). This follows Chenoweth (2007), who assessed 95 barometer readings and corresponding metadata, concluding that most observers in his study calculated departures from that level when not otherwise stated. As no information was available about the instruments and procedures used to obtain barometric pressure values, corrections cannot be made for temperature and elevation.

Table 6.1. The Fujita scale of wind damage, modified by Boose et al. (2004) for application in Puerto Rico. Includes only property types and other wind force measures mentioned in Antiguan documents.

	F0 damage	**F1 damage**	**F2 damage**	**F3 damage**
Sustained wind speed (ms^{-1}) [a]	18-25	26-35	36-47	48-62
Trees	Leaves/fruit off, branches broken, trees damaged	trees blown down	extensive blowdowns	most trees down
Crops	damaged or blown down			
Masonry buildings	minor damage	roof peeled, windows broken, chimneys down	unroofed	blown down or destroyed
Wood-zinc houses[b]	minor damage	unroofed or damaged	blown down or destroyed	50% or more blown down or destroyed[c]
Wood houses,[d] municipal buildings	minor damage	roof peeled, windows broken, chimneys down	unroofed or destroyed	3+ blown down or destroyed in same settlement
Cabins, outbuildings, warehouses	minor damage	unroofed, blown down or destroyed		
Huts[e]	damaged	blown down or destroyed		
Furniture, bedding, cloths	not moved	blown out of building		
Masonry walls, radio towers, traffic lights	no damage	blown down		
Signs, fences	damaged	blown down		
Small boats	no damage	sunk		
Missiles	none	none	light objects, metal roofs	

[a] Derived from Fujita's equations (1971), assuming a wind gust factor of 1.5 over land.
[b] Also barns, town halls, wood churches, schools, sugar mills, commercial or military buildings.
[c] F2 assigned if buildings described as rural or poor.
[d] Wood-frame houses described as well-constructed or owned by a wealthy person.
[e] Constructed of palm leaves or similar materials.

An estimated sustained wind speed was calculated for each reading using the following wind-pressure relationship given by Landsea et al. (2004):

$$W = 12.016 \times (1013\text{-}P)^{0.5337}$$

This applies to tropical cyclones at latitudes south of 25ºN, where *P* is the pressure reading in millibars and *W* is the wind speed in knots. An adjustment to the resulting values of -7.5% has also been made to reflect lower average wind speeds over land.

Table 6.2. Select extracts from Antiguan documents describing different damage levels outlined by the adapted Fujita scale.

Damage category	Illustrative quote
F0	"…this little *puff* (so it was called here) had done no other damage than scattering a few shingles and driving a sloop or two out to sea."[a]
	"We had on the first of this month a very severe gale of wind, which has damaged the canes on Bolans, & Jennings considerably, but little or no damage done to the Buildings."[b]
F1	"The east end of the roof of Brother Reichel's house was lifted up, and other damage done both to that and our other houses. All our out-houses… and fences were thrown down…"[c]
	"The stock-house, and another out-house, was entirely blown down; the roof of another uncovered: many spouts were torn off and blown away…"[d]
F2	"Your Majesty's Barracks in the Town of Saint John, which was lately Erected by your faithful Subjects here at a very heavy Expence [sic], and the Hospital belonging to it have been almost totally destroyed."[e]
	"Several large Buildings in Saint John's were either partially damaged or entirely ruined; and the poorest class of inhabitants have suffered the most, from the total demolition of their humble dwellings, with all their furniture…"[f]
F3	"Strong stone walls, and stone buildings, were levelled to the ground, some of which were quite thrown over in the mass."[g]
	"[At] Saint Marks Village 27 substantially built houses [were] destroyed [and] 26 injured."[h]

(a) Luffman (1788: p.64); (b) COD/C28, J. Osborne to C. Codrington, 11 Oct 1812; (c) PA, Vol.1, p.342-345, Letter from H. Tschirpe, 20 Aug 1795; (d) OL, J. Newby to Br. Latrobe, 5 Oct 1812; (e) CO152/32, Legislative Petition, 18 Sept 1772; (f) CO7/42, Gov McGregor to Lord Glenelg, 13 Aug 1835; (g) CO152/116, Report of Hurricane Committee, 15 Nov 1872; (h) CO7/91, Return of hurricane damage by parish, Aug 1848.

Error in estimated wind speeds arising from the use of unstandardised barometric data and the wind-pressure relationship itself is in the order of ±7 knots (~3.6 ms^{-1}) (Chenoweth, 2007).

Results were compared with tropical cyclone frequencies complied from HURDAT for the period 1851-2011, counting all tropical depressions and storms centred within 160 km of Antigua and major and non-major hurricanes within 97 km. This is consistent with the limits adopted in other local-scale reconstructions to reflect the typical extent of maximum winds produced by storms of different intensities (Mock, 2004, 2008).

6.3.3. Limitations

Further to the issues of data reliability and completeness discussed in Section 4.5, caveats associated specifically with the application of the modified Fujita scale require acknowledgement. Damage levels may be overestimated if a given structure or object was defective or weak before a cyclone struck or if historical records fail to

Table 6.3. Distinctions between tropical storm, hurricane and major hurricane damage described by the modified Fujita scale (after Chenoweth, 2007).

Object damaged	Tropical storm	Non-major hurricane	Major hurricane
Trees	F0, branches broken and fruit stripped; old trees felled F1, damaged or blown down	extensive blowdowns	most down
Crops	F0, damaged or blown down		
Fences	F0, weaker fences down F1, most fences down		
Huts, unmaintained buildings	F0, weakest buildings down F1, most damaged or blown down	entirely swept away	
Small houses or unspecified buildings	F0, minor damage F1, unroofed or damaged	blown down or destroyed	>50% blown down or destroyed
Maintained wood frame houses	F0, little, if any, damage F1, minor damage such as roof shingles peeled off	unroofed or damaged	blown down or destroyed
Public buildings	F0, no damage F1, no significant damage if any	some unroofed or damaged	most damaged or destroyed
Wind mills and other estate buildings	F0, scattered light damage F1, widespread light damage and localised heaver damage	damaged or destroyed widely	most damaged or destroyed
General descriptions of overall damage	F0, light damage of no consequence to property F1, no major damage done to property on land	widespread damage on land, but most homes inhabitable	almost complete damage on land; most homes uninhabitable

differentiate the impact of winds from that of storm surges, inland flooding or landslides. Isolated severe damage resulting from spatial variability inherent in tropical cyclone winds or the spawning of tornadoes in the eye wall, may also lead to the assignation of a Fujita class higher than that of actual sustained wind speeds. Conversely, the underestimation of damage levels could occur if observers comment only on injury sustained by weak or small structures, without providing examples of higher level damage. A cyclone may have a limited impact on the built environment if occurring soon after another event causing widespread destruction. The susceptibility of individual buildings to wind damage is not uniform, but the result of a complex interaction of factors, including design, construction quality, exposure and wind direction (Boose, 2004, Boose et al., 2004). Where possible, contextual information presented in archival sources has been considered to account for such variables, although this was possible in fairly few cases.

The methods of Chenoweth (2007) were developed primarily on the basis of his work on nineteenth century newspapers pertaining to the Lesser Antilles. They are, therefore, the most appropriate existing analytical framework for use in this study. Chenoweth's findings indicate that building standards in Puerto Rico—where the

Table 6.4. Common wind force terms and their associated tropical cyclone category identified by Chenoweth (2007) using newspapers from Jamaica and the Lesser Antilles.

Tropical depression	Tropical storm	Hurricane
Blew pretty fresh	blew severely, fierce gusts	blew with great and destructive fury
Blew rather heavily	fearful gale, frequent gusts	blew with indescribable violence
Blew heavy (hard)	furious gale, hard squalls	fierce roaring
Blowing half a gale	gale, heavy gusts	hurricane
Brisk wind	heavy gale, severe blasts	indescribable force
Inclining to a gale	heavy storm, severe gusts	mere hurricane
Nearly a gale	not a hurricane, severe squalls	roared and howled most terribly
Stiff breeze	regular gale, strong blasts	terrific hurricane
Strong breeze (wind)	severe gale, strong puffs	violent hurricane
Very fresh and variable	smart gale, strong squalls	
Wind whistled loudly	stormy, tremendous gusts	
Wind unsteady	strong gale, violent gusts	
(Very) high wind	violent gale, wind raged	

adapted Fujita scale was first applied by Emery Boose and co-workers—and the wider region were largely comparable. Nonetheless, gradual changes in construction practises over time may generate systemic errors in damage assessments. Chenoweth did, in fact, test for temporal bias in his results associated with such changes. Identifying no discernible differences in his appraisal of data by date, he concluded that bias of this nature is too small for detection within in the broad wind-intensity classification ranges used.

Certain limitations related to the wind-pressure relationship of Landsea et al. (2004) are acknowledged by its developers. The translational speed of a tropical cyclone influences residual wind velocities independently of their central pressure and represents an additive or subtractive factor in different places within the storm (e.g. Figure 3.5). This study cannot account for these factors due to the absence of synoptic-scale data from which to ascertain storm trajectories and forward velocities. Furthermore, individual tropical cyclones can exhibit great variability in the relationship between central pressure, radius of maximum winds and sustained wind speeds. Values resulting from the application of the wind-pressure relationship should therefore be recognised as approximations. It should also be noted that they are unlikely to represent maximum tropical cyclone wind speeds, as none of the barometer readings were specified to have been taken in the eye of the storm. The reduction of barometer-inferred wind speeds by 7.5% suggested by Chenoweth (2007) to reflect the effects of near-surface circulation over variable terrain may result in systematic underestimation of velocities. While this adjustment may be appropriate

for large islands, such as Jamaica, it may be less representative of observed wind magnitudes in Antigua, which is small relative to the average diameter of tropical cyclones.

6.4. Results

Archival research yielded evidence of 42 instances of tropical cyclone winds affecting Antigua between 1770 and 1890. Table 6.5 provides a chronological summary of information relating to each of these, including wind force descriptors, damage assessments, source availability and final wind intensity classifications. On several occasions, observations of the passing of the eye of the storm were encountered. For example, a letter from Moravian missionary Joseph Newby reported that midway through "a perfect hurricane" in October 1812, "it suddenly sunk into a dead calm" for twenty minutes and then "recommenced… more furiously than ever."[45] Similarly, Lanaghan (1844: p.201) described the occurrence of a "deep solemn silence" during the storm of 1835, after which "the wind returned with redoubled fury." References of this nature indicate the direct passage of the tropical cyclone centre over Antigua which would, therefore, have experienced the maximum wind velocities generated at that stage of the cyclone's development. Where such evidence was available it is also noted in Table 6.5. The assignment of intensity classifications for 30 of the 42 events identified was relatively straightforward, as wind force terms were consistent with the levels of damage reported. For the remainder, discrepancies arose between these two indicators, requiring careful, case-by-case assessments of available evidence. Justifications for the intensity classifications finally assigned in such instances—which should be recognised as tentative—are displayed in Table 6.6.

Accounts of storm damage related primarily to the largest settlements in Antigua, as well as a small number of missionary stations and estates scattered throughout the island. For the hurricanes of 1848 and 1871, however, detailed damage reports were available for over 100 plantations, churches, villages, missionary premises and military outposts. These findings are mapped in Figures 6.3 and 6.4.

From the 1830s, documentary materials frequently mentioned that instrumental measurements had been taken during storms. However, on only six occasions were quantifiable barometric data encountered. These are displayed in Table 6.7, which also contains estimated sustained wind speeds calculated from the wind-pressure relationship developed by Landsea et al. (2004) and an 'adjusted' wind speed to reflect reduced wind speeds over land (see Section 6.3.2). Two of the adjusted and unadjusted values fall within the wind speed ranges characteristic of the intensity classifications that were assigned (see Table 6.7). All of the remaining values did not meet the minimum associated wind speed thresholds, except one which exceeded

[45] OL, J. Newby to B. Latrobe, 5 Oct 1812.

Table 6.5. Identified instances of tropical cyclone winds in Antigua, 1770-1890, with a summary of documentation availability, wind descriptors, damage assessments, evidence of the passage of storm centre and final storm intensity classifications. *ND* indicates that sources specified no damage; *NR* indicates the absence of references to damage.

Date(s)	No. sources	Wind force descriptors		Damage assessments				Assigned storm class	Passage of storm centre?
		Winds	Gusts	No. rateable sources	No. rateable damage types	Max. damage category	Associated wind speeds (ms^{-1})		
27 Aug 1772	2	"most violent gale of wind"; "exceeding hard gale of Wind"		2	3	F1	26-35	TS	
31 Aug 1772	24	"most dreadful hurricane"; "severe hurricane"; "a hurricane… which baffles all the powers of description"		8	9	F3	48-62	MH	
6 Sept 1776	3	"violent gale of wind"; "gale of wind"; "hurricane"		2	2	F1	26-35	TS	
10-12 Oct 1780	11	"hard blowing weather"		1	1	ND	<18	TD	
24-25 Aug 1785	2	"gale of wind"; "very severe gale of wind, almost a hurricane"		0	0	NR		TS	
Sept 1787 [day unspecified]	1	"blew hard"		1	2	ND	<18	TD	
1 Aug 1792	4	"smart gale of wind"; "severe gale of wind"; "hurricane"; "violent gale of wind"		3	3	F2	36-47	TS	
18-19 Aug 1795	4	"hurricane"; "most severe hurricane; "complete hurricane"		3	7	F2	36-47	H	
3-5 Sept 1804	2	"Gale of wind"		1	3	F0	18-25	TS	

Date(s)	No. sources	Wind force descriptors		Damage assessments				Assigned storm class	Passage of storm centre?
		Winds	Gusts	No. rateable sources	No. rateable damage types	Max. damage category	Associated wind speeds (ms^{-1})		
7-8 Jul 1811	4	"Gale"; "Hurricane"		3	4	F1	26-35	TS	
30 Sept -1 Oct 1812	11	"Very heavy gale"; "dreadful gale"; "very severe gale"; "hurricane" "serious hurricane"; "perfect hurricane"		6	6	F1	26-35	H	Yes
23 Jul 1813	2	"Gale of wind"; "very smart gale of wind"		1	1	F0	18-25	TS	
30 Jul 1813	1	"smart gale of wind"		0	0	NR		TS	
20 Aug 1813	1	"severe gale"		1	1	F0	18-25	TS	
24 Jul 1814	1	"narrowly escaped a hurricane… very high wind"		1	1	F0	18-25	TS	
21-23 Sept 1818	1	"Gale"; "hurricane"		1	3	F0	18-25	TS	
21-22 Sept 1819	1	"most violent gale… a perfect gale"	"resembling in violence a tornado"	1	5	F2	36-47	H	
9-10 Sept 1821	16	"blew most furiously"; "gale"; "very severe gale"; "extremely violent gale"; "hurricane"; "perfect hurricane"		11	7	F2	36-47	H	Yes
7-8 Sept 1824	1	"blew very strong"		1	1	F1	26-35	TS	
26 Jul 1825	1	"a smart blow"		1	2	F1	26-35	TS	
17 Aug 1827	4	"Severe gale"; "severe hurricane"; "very severe hurricane"; "tremendous hurricane"	"strong"; "tremendous blasts"	3	9	F2	36-47	H	

Date(s)	No. sources	Wind force descriptors		Damage assessments				Assigned storm class	Passage of storm centre?
		Winds	Gusts	No. rateable sources	No. rateable damage types	Max. damage category	Associated wind speeds (ms^{-1})		
21 Aug 1827	1	"Gale"		0	0	NR		TS	
27 Aug 1827	4	"Gale"; "Severe hurricane"; "blew with violence"		1	1	F0	18-25	H	
12 Aug 1830	2	"Gale… not a severe one"		2	2	F0	18-25	TS	
19 Aug 1830	1	"Strong gale"; "Blew violently all night"		1	2	F1	26-35	TS	
24 Aug 1832	1	"Wind… not Sufficient to do the least possible injury"		1	1	ND	<18	TD	
20-21 Sept 1834	1	"Blew hard"		1	1	ND	<18	TD	
12 Aug 1835	37	"Hurricane"; "severe hurricane"; "awful hurricane"; "violent hurricane" ; "disastrous hurricane"; "desolating hurricane"; "furious hurricane"	"Sudden gusts… characteristic of a hurricane"	15	12	F3	48-62	MH	Yes
26-27 Jul 1837	1	"Heavy gale"		0	0	NR		TS	
1 Aug 1837	2	"Severe gale"		1	2	F0	18-25	TS	
25 Aug 1842	1	"Blew with great fury"		1	1	F0	18-25	TS	
12 Sept 1846	1	"Severe gale"		1	2	F0	18-25	TS	
21-22 Aug 1848	21	"Severe gale"; "hurricane"; "fearful hurricane"; "dreadful hurricane"; "appalling hurricane"; "severe hurricane"		12	11	F3	48-62	H	

Date(s)	No. sources	Wind force descriptors		Damage assessments				Assigned storm class	Passage of storm centre?
		Winds	Gusts	No. rateable sources	No. rateable damage types	Max. damage category	Associated wind speeds (ms^{-1})		
11 Jul 1850	6	"Gale"; "hurricane"		3	4	F1	26-35	TS	Yes
17 Aug 1851	3	"Gale"; "hurricane"; "severe hurricane"		1	1	F0	18-25	H	
22 Sept 1852	3	"Gale"; "severe gale"; "hurricane"		2	2	F0	18-25	TS	
25 Aug 1855	2	"Small gale"; "gale… not of long duration nor very violent";"		2	1	ND	<18	TD	
6 Jul 1861	1	"Small hurricane"		1	3	F1	26-35	TS	
21 Aug 1871	43	"raged with great fury"; "hurricane"; "severe hurricane"; "disastrous hurricane"; "destructive hurricane"; "furious hurricane"; "terrible hurricane"; "calamitous hurricane"	"Violent; "frequent and powerful"; "terrific"; "heavy squalls"	12	11	F3	48-62	MH	Yes
26 Sept 1871	1	"Gale"		1	1	ND	<18	TD	
11 Sept 1875	2	"Gale"	"rough and squally"	0	0	NR		TS	
12 Sept 1876	1	"Severe gale, approaching at times in force to a hurricane"		1	3	F1	26-35	TS	

Table 6.6. Justifications for the final intensity classifications assigned to tropical cyclone events for which available evidence conflicted.

Date(s)	Final intensity classification	Justification
6 Sept 1776	TS	Described as a "hurricane" by one observer and a "gale" by two. One account specified that little damage was sustained throughout Antigua, while another two reported only F1 damage.
1 Aug 1792	TS	Two retrospective histories published over 50 years after the event contained the wind force term "hurricane" and one also described the occurrence of F2 damage. However, three contemporary observers recorded this as a powerful "gale", two of whom stated explicitly that no serious damage was sustained in the island.
7-8 Jul 1811	TS	Described as a "gale" twice and a "hurricane" twice. The available evidence is of only F1 and F0 damage, two sources specifying that this was general in extent.
30 Sept – 1 Oct 1812	H	Described by three observers as a "gale", but by four as a "hurricane", including references to a "serious" or "perfect hurricane." The available damage reports indicate just F1 or F0 damage, but relate only to weak structures (e.g. outbuildings and sugarcane crops) at individual locations.
21-23 Sept 1818	TS	Described as both a "gale" and "hurricane" by the same observer. Damage reports state explicitly that no substantial injury was sustained by major buildings or plantation works.
21-22 Sept 1819	H	Wind and gust descriptors (a "most violent" or "perfect gale" with gusts "resembling in violence a tornado") suggest greater than tropical storm intensity. Three separate instances of F2 damage described.
27 Aug 1827	H	There were two references to the occurrence of a "hurricane", one to a gale and one to "violent" winds. There was only one damage reference available, describing F0 injury. However, the lack of details of more severe damage may well owe to the injury already produced by two other cyclones during the preceding ten days (see Table 6.5).
11 Jul 1850	TS	Described as a "gale" by one observer and as a "hurricane" by three. There are four references to F1 damage at both local and island-wide scales. Nonetheless, accounts of the storm explicitly stated that the destructive winds expected of a hurricane were not experienced onshore. Use of the term "hurricane" probably reflects observers' knowledge that the storm passed relatively far from the island and caused more damage elsewhere.
17 Aug 1851	H	Described once as a "severe hurricane" and once as a "hurricane" in contemporary accounts. Described as a "gale" six months after the event. One instance of F0 damage is reported, but this relates only to the Tudway

Date(s)	Final intensity classification	Justification
		plantations.
22 Sept 1852	TS	Described once as a "severe gale", once as a "gale" and once as a "hurricane." There are two references to F0 damage generally. One account stated explicitly that the storm centre passed far from Antigua and little damage was sustained throughout the island.
6 Jul 1861	TS	Described by one observer as a "small hurricane"—a term sometimes used historically to denote an incipient system, rather than a true hurricane of small diameter (Chenoweth, personal communication, 26 Feb 2013). One case of F0 and two of F1 damage were documented. The latter was reportedly of general extent.
26 Sept 1871	TD	Described as a "gale" by one observer, who also notes that no damage was caused in the island. The aforementioned wind force term appeared in the phrase "in September we had a second Gale" after a lengthy discussion of a major hurricane that occurred one month earlier. This wording may have been used to highlight the fact that both storms were of a cyclonic nature, rather than as reflection of wind intensity.

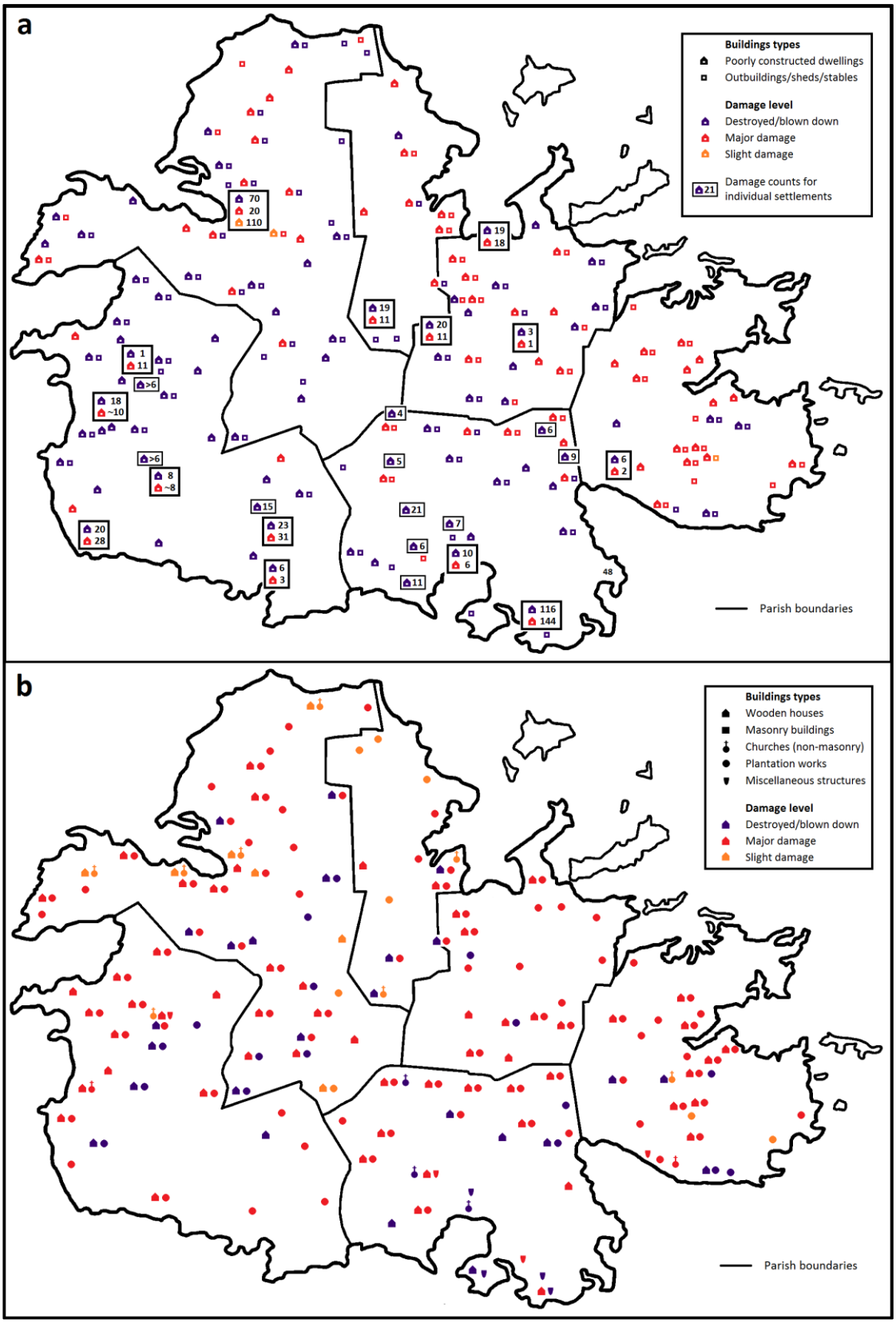

Figure 6.3. Spatial distribution of damage caused by the hurricane of 21st-22nd August 1848 to (a) weak or poorly constructed buildings, such as dwellings of the working class and small outbuildings, and to (b) well-constructed buildings of wood and/or masonry.

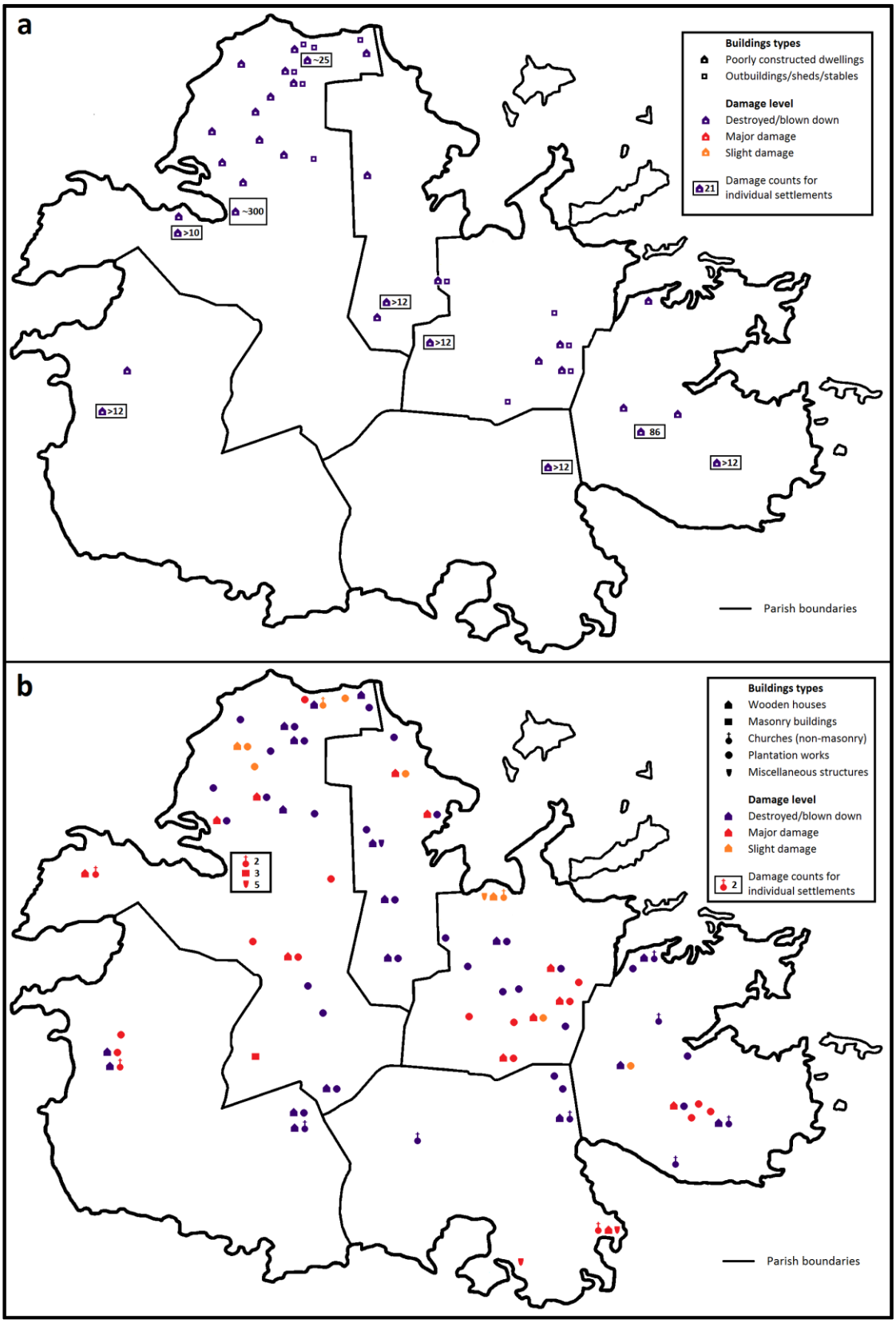

Figure 6.4. Spatial distribution of damage caused by the hurricane of 21st August 1871 to (a) weak or poorly constructed buildings and to (b) well-constructed buildings of wood and/or masonry.

Table 6.7. Barometric measurements available for identified tropical cyclones and estimates of sustained wind speeds.

Storm date(s)	Min. pressure (inches)	Min. pressure (millibars)	Wind speed (ms^{-1})	Adjusted wind speed (ms^{-1})
12 Sept 1846	29.8	1009.1472	12.6977	11.5138
21-22 Aug 1848	29.22	989.5061	33.3253	30.4611
25 Aug 1855	29.7	1005.7608	17.7791	16.4457
21 Aug 1871	29.30	992.2152	31.2159	28.8747
	28.5	965.1239	48.7275	45.0729
12 Sept 1876	29.30	992.2152	31.2159	28.8747

them. Errors inherent in pressure-derived estimates and the fact that measurements were likely peripheral to the storm centre may account for these discrepancies. On several occasions, observations of sea swells during storms were encountered. Nonetheless, no such information was sufficiently detailed to approximate event magnitudes.

In addition to the events listed in Table 6.5, twelve documented storms or instances of strong winds have not been associated with tropical cyclone occurrence. Four of these were described explicitly as localised thunderstorms, one as a "tornado" lasting five minutes[46] and another as a "heavy flood of rain for 24 hours… but not a hurricane."[47] The remainder were of an unspecified nature otherwise failing to meet the criteria stipulated in Section 6.3.1.

6.5. Comparison with other tropical cyclone records

HURDAT represents the most complete record of modern tropical cyclones against which the findings of this study can be assessed. Figure 6.5a displays the annual frequencies of all tropical cyclones experienced in Antigua from 1770-2011 based on the combined findings of this study and HURDAT. Annual frequencies of major and non-major hurricanes only are shown in Figure 6.5b. Table 6.8 lists average recurrence intervals of tropical cyclones and hurricanes in this study, the entire HURDAT database and in HURDAT before and after 1944—considered to be the period of most reliable tropical cyclone monitoring. The average frequency of tropical cyclones identified in this study for 1770-1890 is slightly lower than in the full HURDAT dataset (1851-2011), while that of hurricanes was substantially lower. A comparison of tropical cyclone frequencies by month for the two data sets can be seen in Figure 6.6. Results for this study deviate somewhat, though not remarkably, from the established climatology of the region, the greatest proportion occurring in August

[46] COD/C29, R. Jarritt to C. Codrington, 30 Jun 1829.

[47] T/PH/swd/2, J. Freeland to J. Tudway, 30 Aug 1833.

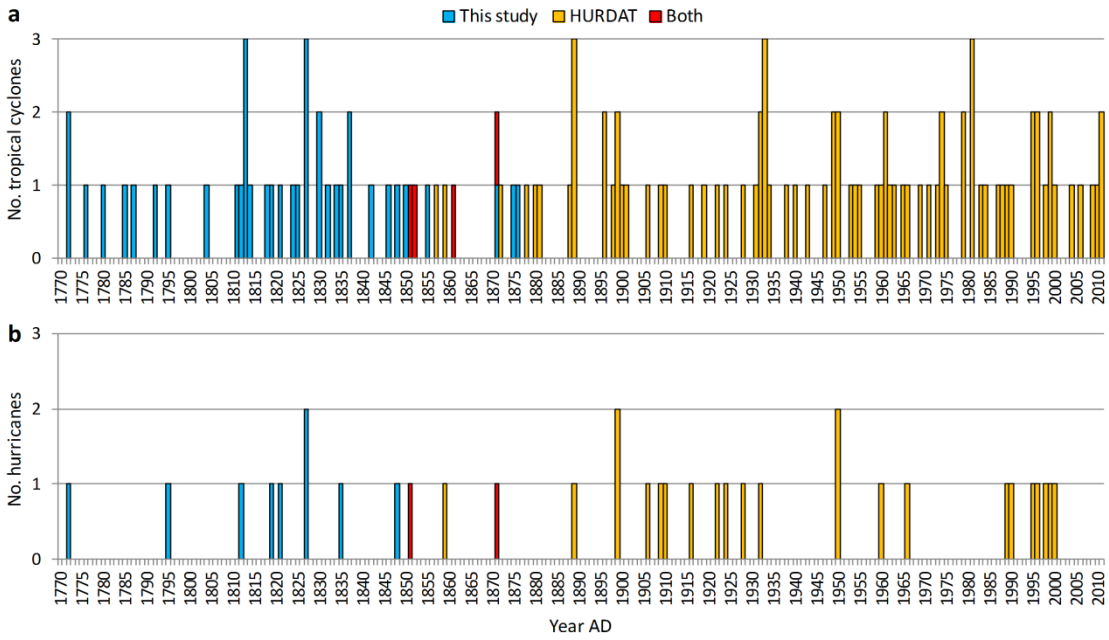

Figure 6.5. Annual frequencies of (a) tropical cyclones and (b) major and non-major hurricanes experienced in Antigua, as documented in this study (1770-1890) and HURDAT (1851-2013).

and a relatively high number in July. This may, however, represent an artefact of the sample size, rather than an earlier peak in tropical cyclone activity.

Several previous studies have employed documentary sources to extend records of circum-Caribbean tropical cyclone activity beyond the time span covered by HURDAT. As can be seen in Figure 6.7, which shows reconstructions undertaken for the whole North Atlantic basin, the Lesser Antilles, western Jamaica and the south-eastern United States, findings reveal a degree of correspondence in temporal variability. All but one exhibit a phase of increased tropical cyclone numbers centred on the 1830s, while those that include the final decades of the eighteenth century show another peak in the 1770s and/or 1780s. A period of relative quiescence is discernible across records around the turn of the nineteenth century. Chronologies for the Lesser Antilles and Jamaica (Figures 6.7b, 6.7c) also indicate high storm frequencies in the 1810s. These findings coincide with a preliminary investigation of basin-wide storm occurrences using Spanish-language sources (García-Herrera et al., 2005), which suggests particularly high activity from 1766-1780 and a slight rise in the 1810s (not shown). Records of pre-twentieth cyclones are scarce in a documentary-derived chronology for Guadeloupe (Zahibo et al., 2007). Nevertheless, fairly frequent storm incidence is also registered from the mid-1760s to mid-1780s (not shown). Although the absolute numbers of cyclones recorded in this research (Figure 6.7f) are low relative to many of the aforementioned studies, perceptible increases correspond with those identified in the 1810s and 1830s. Slightly higher storm numbers in Antigua

Table 6.8. Recurrence intervals of instances of tropical cyclone (TC), hurricane (H) and major hurricane (MH) winds calculated from the findings of this study and HURDAT.

Database and time span	No. TC events	No. H and MH events	TC recurrence interval	H and MH recurrence interval
This study, 1770-1890	42	11	1 every 2.88 years	1 every 11 years
HURDAT, 1851-2011	92	24	1 every 1.76 years	1 every 6.75 years
HURDAT, 1851-1943	40	14	1 every 2.3 years	1 every 6.57 years
HURDAT, 1944-2013	52	10	1 every 1.32 years	1 every 6.9 years

during the late 1820s and early 1850s were also observed at Savanna-la-Mar in Jamaica and throughout the Lesser Antilles respectively.

Based on maximum wind speed estimates for each tropical cyclone documented in their chronology for the Lesser Antilles (Figure 6.7b), Chenoweth and Divine (2012) produced an annual index of total cyclone energy in the region, known as LACE (Lesser Antilles Accumulated Cyclone Energy). Persistently high LACE values in the 1810s, 20s and 30s were recorded in their most reliably sampled transect (10-18^{o}N, 61.5^{o}W). Significantly, this coincides with the period of highest storm frequencies and instances of hurricane-intensity winds in this research (see Figure 6.5b).

6.6. Evaluation of dataset

While the comparisons made above indicate that the Antiguan record reflects some major variations in tropical cyclone activity documented regionally, the reconstructed trends are also likely connected with the sensitivity of the archival evidence. Average recurrence intervals for Antigua calculated from the present reconstruction and from HURDAT indicate slight under-recording of storms in the former (Table 6.8). The magnitude of the discrepancy is, however, such as could be explained by the derivation of the HURDAT record from direct observation networks (Figure 6.1). This would suggest that the archival sources examined and analytical methods applied here are largely appropriate for the reconstruction of past tropical cyclone occurrences. There is, however, greater divergence between the datasets in the average frequencies of major and non-major hurricanes, suggesting much lower capture rates of these intense storms in the archive-based compilation. Partly, this may be accounted for by the reliance on descriptions of wind damage—which varied greatly in detail and number—to inform classifications of tropical cyclone intensity. As noted in Section 6.3.3, a simple failure to uncover reports of higher level damage can lead to underestimation of wind speeds. Errors of this kind may be persistent in cases for which conclusive evidence is scarce. The appraisal of both damage and wind force descriptions addresses this limitation as far as possible from the consulted materials. It

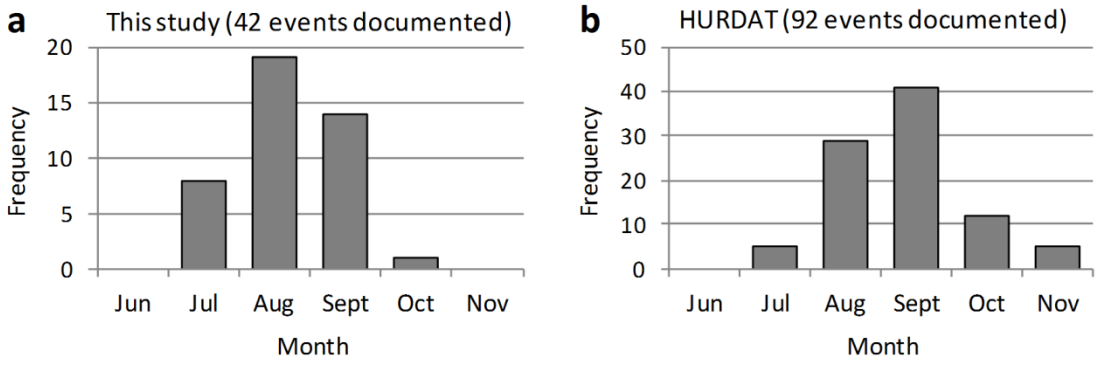

Figure 6.6. Instances of tropical cyclone winds experienced in Antigua by month based on (a) the documentary sources consulted in this study and (b) HURDAT.

is advised, however, that the availability of sources and rateable damage types (Table 6.5) is borne in mind when considering intensity classifications.

The previous chapter discussed an important factor which may be implicated in the under-recording of past weather events—the potential for episodes of socio-economic or administrative breakdown to reduce the sensitivity of the documentary climate record. It is noteworthy that instances of cyclone winds were documented rather infrequently throughout the first four decades of the study period. This coincides with an era of recurrent conflict in the Caribbean involving Britain and other major colonial powers (see Section 3.3.2). Naturally, issues of defence, commercial disruption and fiscal instability may have taken priority in contemporary writings above meteorological phenomena. During the final decades under study, rather different factors may have diminished the attention given to particular weather events in historical records. From the mid-1860s, government correspondence became increasingly concerned with a series of local administrative reforms (see Section 3.3.3). These culminated with the union of the British Leeward Islands as a single presidency in 1871, which made the governor of Antigua responsible for reporting on this and all of the other colonies in the sub-region. Such a task would inevitably have required some synthesis of detail, potentially obscuring locally-specific information. The mid-late 1800s also represents the zenith of Moravian missionary expansion globally, possibly reducing the space devoted to reports from Antigua in their Periodical Accounts. It was also a period for which plantation papers were scarce.

Many of the developments mentioned above may have been more detrimental to the reconstruction of storms than precipitation extremes, the latter of which appear to have been better documented prior to 1800 and from the 1860s (Figure 5.2). This might stem from the fact that storms, unlike phases of deficient or abundant rain, are discrete and short-lived events. The failure of the archives to register a long-duration weather extreme at a given moment is likely to have been compensated for by subsequent records. By comparison, tropical cyclones—which would normally have

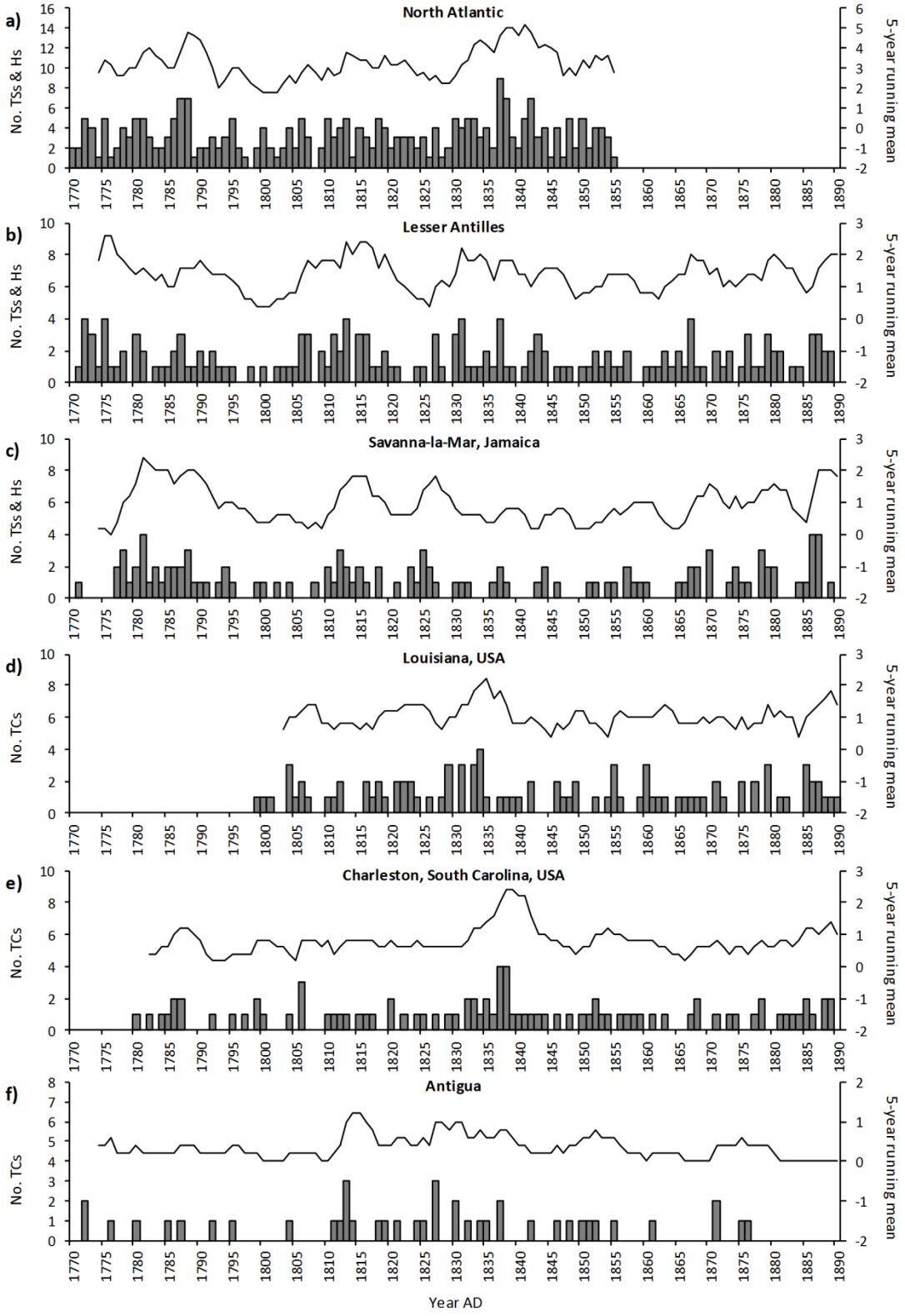

Figure 6.7. Documentary-derived reconstructions of tropical cyclones for (a) the North Atlantic basin (after Chenoweth, 2006), (b) the Lesser Antilles (after Chenoweth and Divine, 2008), (c) Savanna-la-Mar, Jamaica (after Chenoweth, 2003), (d) Louisiana (after Mock, 2008), (e) Charleston (after Mock, 2004) and (f) Antigua (this study). Reconstructions b to e include storms documented in HURDAT. *TC* denotes tropical cyclone, *TS* tropical storm and *H* hurricane.

passed a small island in a few hours—tended to be reported during a short timeframe following their occurrence. Thus, the absence of a few temporally-clustered storm records may have been enough for such an event to go completely un-noted in the research process. While this may have been the case following weak tropical storms and depressions, it is improbable that hurricanes producing major socio-economic disruption and, therefore, a longer paper trail, would have been omitted so easily. Interestingly, during what seems to be the best sampled period, 1810-1864, tropical cyclones and hurricanes were documented once every 1.9 and 6.89 years respectively. This differs minimally from the equivalent figures calculated from HURDAT (Table 6.8).

Despite the application of an established methodology (Chenoweth, 2007), the classification of storm intensity on the basis of archival records was not always straightforward. As demonstrated by Table 6.6, the available evidence was inconclusive or contradictory in several instances. Aside from the potential failure to uncover accounts of the most severe storm damage, this may arise from variability in the terminology used in historical accounts to describe the wind force of a single event (e.g. Table 6.5). Findings were derived from the writings of a broad cross-section of Antiguan society, including government officials, missionaries and agriculturalists. Some of these individuals would have had limited knowledge of the appropriate usage of official meteorological terms. By contrast, the accounts informing Chenoweth's (2007) guidelines for the analysis of wind force descriptors were likely more consistent in language usage, being derived only from newspapers. To account for subjectivity as far as possible, the frequency, as well as magnitude, of different wind force terms was considered when assigning storm intensity classes in this study.

Limitations and uncertainties aside, this research has yielded new primary evidence relating to 42 tropical cyclones affecting Antigua in the eighteenth and nineteenth centuries. As can be seen from Figure 6.6, four storms identified in the period 1851-1890 are not currently included in the HURDAT database. Another six cyclones for which information has been presented (those of 27 Aug 1772, Sept 1787, 7-8 Jul 1811, 30 Sept-1 Oct 1812, 23 Jul 1813 and 22 Sept 1852) are not documented at any of the Leeward Islands in the most complete historical compilation of Atlantic tropical cyclones published to date (Chenoweth, 2006). Records of all cyclones documented in this study have, however, been uncovered by Michael Chenoweth through ongoing research using newspapers and ships' logbooks from the region, much of which is yet to be published (M. Chenoweth, personal communication, 26 Feb 2013). Significantly, every storm indicated by Chenoweth's personal database to have struck Antigua at hurricane intensity has been represented in this study (M. Chenoweth, personal communication, 26 Feb 2013). The discovery of new evidence pertaining to known tropical cyclones is itself crucial for refining the timing of storm landfall and intensity estimates. A case in point is the Antiguan hurricane of 30th September-1st

October 1812. Chenoweth currently has this storm rated as a tropical storm with estimated sustained winds of around 45 knots (~23.2 ms^{-1}) when passing near Antigua at a longitude of 61.5^{o}N. However, the primary sources analysed here indicate significantly higher sustained wind speeds (Table 6.5). These firsthand accounts have been shared with Chenoweth, who has acknowledged that the intensification of this storm to a weak hurricane with 65-knot (~33.4 ms^{-1}) sustained winds on approach of the island is supported by the evidence uncovered in this research (M. Chenoweth, Personal Communications, 18 Mar 2012, 26 Feb 2013).

6.7. Chapter overview

This chapter has presented a novel investigation in palaeotempestology based on the assessment of documentary evidence of tropical cyclones affecting Antigua from 1770 to 1890. By employing proven methods for the analysis of textual accounts of wind force and storm damage (Boose, 2004; Chenoweth, 2007), a total of 42 cyclones have been identified and their local intensity estimated. As was the case in the previous chapter, the availability and climatic sensitivity of the documentation examined appear, to some extent, to have shaped the results generated. Nonetheless, existing storm records for the Caribbean indicate that the reconstruction has captured meaningful trends in the frequency and intensity of cyclones experienced widely, including peaks in the 1810s and 1830s and a trough around the turn of the 1800s. Notably, average event frequencies recorded during the seemingly best-sampled part of the study period diverge very little from those calculated from the official modern record (HURDAT). Findings also include unique evidence of tropical cyclone activity; ten storms that are undocumented in published records as well as new information about the intensity of known storms has been uncovered. The possible connections between the Antiguan storm record, other proxy-based climate reconstructions and mechanisms of regional oceanic-atmospheric variability will be considered in Chapter 11. First, however, the precipitation and tropical cyclone chronologies developed so far will serve as a framework for assessing the societal ramifications of extreme climate events in the following four chapters.

Chapter 7

Climate and people: variability, vulnerability and times of crisis

7.1. Introduction

Chapters 5 and 6 dealt with the reconstruction of two important features of the Antiguan climate: precipitation variability and tropical cyclone activity. Having thus addressed the first objective of this study, we shall now turn to the second and third—namely, to investigate the societal implications of extreme climate events and patterns of vulnerability to them (Section 1.2). The present chapter introduces these elements of the research by reviewing the existing literature on historical climate-society interactions in the Caribbean and adjacent mainland, describing the methodological approach adopted in this thesis and providing an overview of select findings. The bulk of the empirical evidence uncovered through archival research is presented in the subsequent chapters, which focus on three short case study periods. As such, this chapter also serves as a bridge between the longue durée perspective of climate reconstruction and the fine-grained case studies to which attention turns next.

7.2. Climate and society in circum-Caribbean history

7.2.1. A review of the literature

With its particularities of human development and physical geography, the Caribbean has long allured historians of environment and, more specifically, climate. Hurricanes in particular have taken centre stage, becoming the subject of an extensive literature with its origins in the nineteenth century. Early scholarly endeavours consisted primarily of the chronologies discussed in Chapter 5, which collated evidence of past storm occurrences at regional or sub-regional scales (e.g. Southey, 1827; Evans; 1848; Poey, 1855). These, like many of their subsequent re-analyses (e.g. Tannehill, 1952; Ludlum, 1963; Millás, 1968), were almost exclusively of a descriptive nature, presenting evidence of the meteorological characteristics of individual events as well as the damage they produced.

It was not until the middle of the twentieth century that there emerged any major analytical scholarship on the dynamic relationship between cyclones and human society. Foremost is social historian Fernando Ortiz's *El huracán: su mitología y sus símbolos* (1947), an acclaimed monograph exploring the linkages of hurricanes to the

art, myth and religion of pre-Hispanic cultures in the tropical Americas. Over the subsequent few decades, several general surveys of human encounters with hurricanes throughout history were undertaken, Douglas (1958) and Hughes (1987) offering a regional perspective and Boytel Jambú (1978) concentrating on Cuba. From Columbus' first ventures in the Americas to events such as the devastation of Galveston, Texas, in 1900, these works document the experience of prominent historical figures with the storms, recount myriad disasters and posit numerous instances in which they seem to have shaped the trajectory of military and political campaigns. In contrast, Konrad (1985), a contemporary of these investigators, returned attention to the pre-Columbian era, considering the ramifications of tropical cyclones for patterns of settlement, trade and conflict among the Maya of the Mexican Yucatan.

The last fifteen to twenty years have witnessed a surge in the historiography of the interplay between hurricanes and people. Of particular note is *Hurricanes and Society in the British Greater Caribbean, 1624-1783* by environmental historian Matthew Mulcahy (2006). Establishing the storms as windows upon the places that they affected, he offers a wide-ranging exploration of the ways in which the events were experienced and processed by inhabitants of the Crown's plantation-zone territories. Its seven empirical chapters encompass themes including popular conceptualisations of the hazards, architectural practises engendered by storm risk and institutional- to community-scale responses to their impacts. Schwartz (2005) presents another overview of the cultural legacy of the fearsome cyclones. In particular, his essay emphasises the role of cyclones in defining a unique trans-national West Indian identity. Several climatologists and social scientists have opted for a wholly different long-term approach, quantifying the losses occasioned by hurricanes. Researchers of the US National Oceanic and Atmospheric Administration have produced a series of investigations into the costliest and deadliest North Atlantic hurricanes, which enumerate the causes, magnitude and spatial distribution of casualties and property damage over the last five centuries (e.g. Rapaport and Fernández-Partagás, 1997; Blake et al., 2007; Pielke et al., 2008). In an unrelated research programme, Mohan and Strobl (2013) employ sugar export data for 21 nations in conjunction with existing tropical cyclone reconstructions (Chenoweth, 2006; HURDAT) to analyse the agricultural impact of the storms from 1700 to 1960.

Other investigations cast the spotlight on shorter timeframes. In *Winds of Change*, Louis Pérez (2001) inspects the ramifications of three severe cyclones that struck Cuba in the 1840s. He contends that these were pivotal to a subsequent shift from coffee to sugar in the island's agriculture sector, as well as burgeoning nationalist sentiment. Similarly, Johnson (2002) examines the disaster policy adopted by Cuban and Floridian administrators after successive destructive storms in the 1760s through 1790s. This was noteworthy, among other reasons, for defying Spain's mercantilist

imperial doctrine. Case studies focusing on individual hurricanes are numerous. Those drawing examples from the eighteenth, nineteenth and twentieth centuries broach themes as diverse as the storms' physical characteristics, their implications for agro-economic and political stability and the crisis management measures that they spurred (e.g. Hughes, 1990; Schwartz, 1992; Larson, 1999; Mercantini, 2002; Johnson, 2005; Mock et al., 2010; Neely, 2011, 2012; Smith, 2012). The approach of Campos Goenaga (2008) differs markedly, considering the ways in which the imposition of Christianity heightened the perceived vulnerability of the Yucatecan Maya to a hurricane in 1561.

In comparison with the body of scholarship on Caribbean cyclones, there has been a conspicuous lack of histories directing attention to other elements of climate. One study of the latter variety, prominent for its empirical rigour, is *Climate and Catastrophe in Cuba and the Atlantic World in the Age of Revolution* (2011) by colonial-cum-climate historian Sherry Johnson. Concentrating predominantly on the Hispanic Caribbean, but occasionally extending focus to French and British domains, she re-narrates several of the major social, political and economic developments of the second half of the eighteenth century, emphasising their connection with the recurrent climate-related crises that marked the period. In the unfolding of events ranging from the British capture of Havana in 1762 to the Spanish adoption of free trade over subsequent decades, sequences of drought, hurricanes and torrential rains are positioned as causal agents in the historical process through the environmental stress and the administrative reactions they produced. In a similar vein, a paper by Tuten (2009) contends that a variety of inclement weather phenomena played a central part in the collapse of rice agriculture in South Carolina between 1893 and 1920. Paar (2009), turning an eye to the sixteenth century history of that region, pieces together fragmentary documentary, archaeological and tree-ring evidence to contemplate the influence of atmospheric parameters—primarily precipitation—on Spanish settlement of Santa Elena (present-day Parris Island). References to the societal impacts of miscellaneous climatic hazards in south-eastern Mexico can be found in the extensive catalogues of agricultural disaster over the past millennium that exist for that country (García-Acosta et al., 2003; Escobar Ohmstede, 2004).

The ways in which past society understood and conceptualised circum-Caribbean environments has attracted modest scholarly interest, though it has been discussed at some length within the wider context of New World colonialism (e.g. Kupperman, 1982, 1984; Fleming, 1998). In a study focusing on the British West Indies, Carey (2011) tracks international attitudes towards the region's climate, which was seen as noxious and disease-inducing in eighteenth and early nineteenth centuries, but gradually came to be portrayed as paradisiacal, salubrious and even curative by the mid-1900s. Connections between weather conditions and human health also receive treatment in a cluster of epidemiological investigations. A landmark example is John

McNeill's *Mosquito Empires* (2010). The monograph, which covers the years 1620-1914, assesses the geopolitical sequels of yellow fever and malaria throughout the Greater Caribbean, demonstrating their powerful sway over the outcome of various empire-building projects, imperial rivalries and revolutions. Underpinning this central narrative is the argument that the climatic characteristics of the region in combination with colonial land use created conditions ideal for sustaining the mosquito vectors of the diseases. Additionally, certain short-term meteorological fluctuations are observed to have stimulated booms in mosquito populations. The relation between a strong El Niño episode in 1877-1878 and a yellow fever epidemic across the southern United States is evaluated by Diaz and McCabe (1999). Meanwhile, the potential for climate change or events to have triggered nineteenth-century outbreaks of cholera in Puerto Rico has been considered by Christenson (2008).

A noteworthy trend that emerges from this review of pan-Caribbean literature is the shortage of analytical climate histories targeting the Lesser Antilles. One such study which is highly pertinent to this thesis is James Lewis' *A multi-hazard history of Antigua* (1984). Drawing on select published and firsthand sources pertaining to the Wesleyan Missionaries and Colonial Office, the paper discusses the material consequences of a sample of hurricanes, droughts and earthquakes in the nineteenth and twentieth centuries. Discussion also extends to the governmental responses generated. Notably, in introducing the topic of drought, attention is drawn to the dependence of the colonial economy on the sugar industry. Following from this, a positive relationship is established between annual rainfall totals for 1930-1954 and the size of the subsequent year's sugar harvest.[48]

Despite Lewis' survey, there remain a number of temporal and theoretical openings that merit further inquiry. A comprehensive long-term history of climate-society inter-relations in Antigua, or indeed any of the Lesser Antilles, remains wanting, as does an in-depth examination of specific weather-related disasters that extends focus beyond agro-economic impacts and administrative reactions. Before outlining the methodology employed here to address some of these gaps, the

[48] Curiously, Lewis (p.194) notes: "Before 1898[,] cane disease was the prevailing factor influencing [sugar] production. It took many years of experience to distinguish the effects of disease and drought but successful experimentation with resistant cane brought disease under control by 1898." However, the grounds for such a statement seem questionable for two reasons. Firstly, it is accompanied by no supporting citations and, secondly, no mention has been encountered in the archives or other literature of the importance of cane disease prior to 1898 or its impacts being mistaken with those of drought. Even if it were assumed that this had been the case, any links posited in this thesis between precipitation variability and agricultural productivity are not necessarily invalid; although production data inherently reflect a range of environmental and social influences, here they are compared with reconstructions derived from explicit references to meteorological conditions.

following subsection outlines themes of major relevance emerging from the literature reviewed above.

7.2.2. Salient themes

To begin, it is worth discussing several key ideas that underpin both disaster historiography at large and that which relates to connections between climate and people in the Caribbean. As highlighted in Section 2.3.2, a moment of emergency can afford a valuable lens through which to picture a society which can no longer be observed directly. Pérez (2001: p.11), for instance, affirms that hurricane-related calamities in 1840s Cuba serve to expose

> new realities and larger truths about the colonial condition; about the roles of the state, the nature of class structures, the character of slavery and race relations; about kinship and community; and, in the end, about the people that Cubans were becoming. …[they] illuminate the colonial landscape during a brief but revelatory moment, when complex relationships—between the moral and the material, between production systems and political structures, between national character and historical context—suddenly appeared with clarity…

Moreover, by dramatising the interruption of everyday routines, episodes of adversity may render visible "practises and behaviours so ordinary that they cease to be apprehended at all" (Pérez, 2001: p.12). Work by Pérez (2001) as well as Johnson (2002, 2011), Tuten (2009) and McNeill (2010) also illustrates the potential for an environmental perspective to challenge conventional explanations of well-documented historical events and processes. A second fundamental premise of the literature is that environmental disasters are by no means wholly natural events. To become a disaster, a hazard must take place within a social context, which determines the scale of its physical repercussions, as well as its longer-term political and economic imprint (Bankoff, 2007). An important corollary is that no two disasters are identical; all differ in accordance with the continuously morphing milieu in which they occur (Howe, 2011). Finally, it is recognised that researchers should avoid examining discrete hazards in isolation; account should be taken of the synergistic effects of different environmental trends in addition to "factors outside the natural disaster spectrum" (Lewis, 1984: p.190).

While humans shape and give meaning to the impacts of natural hazards, the latter may, in turn, leave its mark on the character of places and populations. Schwartz (2005), for example, frames hurricanes as one of multiple meta-narratives, such as sugar, slavery and colonialism, defining the region's past. Meanwhile, Mulcahy (2006) contends that the ever-present threat they posed to livelihoods contributed to the development of a distinct mentality among colonists informed by a sense of

communal vulnerability. Despite the overarching attention hurricanes receive in the literature, we should not lose sight of the potentially critical influence of other meteorological hazards. Johnson (2011: p.5) emphasises that while tropical cyclones are events discernible for their spectacular nature, the West Indies are and were "equally vulnerable to the quietly debilitating consequences of severe prolonged drought." Case studies presented by the same scholar illustrate that it was a succession of varied climatic stresses, among which precipitation scarcity featured recurrently, that gave several crisis periods particular resonance.

With respect to broad temporal trajectories of human vulnerability to climate, existing scholarship on the Caribbean, again, speaks only of hurricanes. Pérez (2001), Schwartz (2005), Mulcahy (2006) and Johnson (2011) all comment that progressive deforestation and physical development accompanying colonialism heightened the potential for costly cyclone damage, while demographic growth placed ever greater numbers of people at risk. Patterns of differential social vulnerability to climate—that is, heterogeneity in levels of susceptibility and resilience between different social groups—are more apparent from the literature. Vulnerability often follows delineations of affluence and class, the socially and economically disadvantaged suffering disproportionately when calamity strikes (Section 2.4.1). In the colonial West Indies, African slavery and its legacy had the implication that stratification on these terms was bound tightly with race. Smith (2012: p.117), summarising the findings of countless other regional histories, asserts:

> slave communities possessed a number of systematic risk factors that weakened their ability to endure and recover from disasters, including malnutrition, poor health status, restricted education and limited physical assets.

For the reasons highlighted in Sections 3.3 and 3.4, these characteristics prevailed widely among black and mixed-race populations long after emancipation.

Owing to its material wealth, white colonial society was to some extent spared from physical harm in the wake of climatic shocks. Nonetheless, it appears to have been far from impervious to any economic fallout. The ruin of harvests and estate infrastructure by powerful hurricanes is documented to have unleashed waves of bankruptcy among agriculturalists already struggling in the face of competition and operational costs (Pérez, 2001; Mercantini, 2002; Neely, 2012; Smith, 2012). This is contended to have hastened the ongoing process by which small planters were driven from husbandry, enabling land engrossment by the wealthy and well-established. Consecutive devastating tempests could also have transatlantic reverberations, affecting sugar prices, supply and even credit markets in Europe (Schwartz, 2005). Such observations have, heretofore, been made only with respect to hurricanes. It

seems plausible, however, that other climatic forces disrupting agriculture would have affected groups and branches of commerce dependent on it similarly.

Another important way in which atmospheric conditions impacted upon human affairs was through their influence on the disease environment. Malnutrition resulting from weather-induced food scarcity often appears to have exacerbated human susceptibility to infectious diseases, particularly among the already vulnerable, such as slaves, soldiers and free agricultural labourers (Mulcahy, 2006; Paar, 2009; Johnson, 2011; Smith, 2012). At other times, the state of the weather seemingly established ideal preconditions for outbreaks of vector-borne illnesses (Diaz and McCabe, 1999; McNeill, 2010). These narratives suggest a connection between extreme climate events and epidemic sickness. Nonetheless, it is one recognised to be imbued with particular complexity; a multiplicity of environmental factors are implicated in human health, while certain meteorological patterns may simultaneously have increased the incidence of certain diseases and reduced that of others (Endfield, 2008).

Much recent scholarship has emphasised the way in which climatic shocks, by virtue of their short-medium term ramifications for human livelihoods, may operate as catalysts of lasting change. Many studies have made a case for their having precipitated the widespread abandonment of agro-economic activities already threatened by commercial or social conditions (Pérez, 2001; Tuten, 2009; Neely, 2011, 2012). Weather-related disasters may have had comparable implications in the realm of politics, by tipping the balance in favour of a given cause in warfare or policymaking (Douglas, 1958; Hughes, 1987; Johnson, 2002, 2005, 2011). Cautious and critical reflection is, however, imperative when considering the explanatory power of hazards such as droughts and storms, given the relative frequency with which they strike throughout the extensive circum-Caribbean region. As Schwartz (2005: p.388) comments:

> [a]lmost every regional event, battle, revolt, revolution, or election has been preceded by one or several hurricanes. To find the balance between explaining too much or too little in the history of the hurricanes, or in any environmental history, is a tricky business at best.

The specific approach used in the remainder of the thesis to conduct the "tricky business" of environmental history will now be discussed.

7.3. The methodology

7.3.1. Analysis and presentation of findings

The archival research outlined in Chapter 4 yielded various transcripts of material regarding (1) the characteristics of climatic conditions in Antigua in the period 1769-1890, (2) the direct and possible indirect implications of these, (3) human reactions to the above and (4) any phenomena of potential relevance for contextualising such findings. The first type of information mentioned was subject to detailed analysis in Chapter 5 and 6. This and subsequent chapters are concerned with the repercussions of climate variability for society, with a particular focus on vulnerability to extreme events. Therefore, to avoid overlap in the usage of evidence as much as possible, the second and third types of information listed above were isolated for examination and the fourth re-assessed. The result was an abridged transcript of extracts from and notes on each archival collection and major published source consulted. In addition to textual material, this part of the thesis also analyses several series of numerical data compiled from the archives. These include statistics relating to agricultural production, demography, human health and the economy. An annual record of sugar production contained in a modern secondary source (Deerr, 1949) is also incorporated.

All textual and statistical material excerpted from the documentary sources was reviewed and re-reviewed for familiarisation. On the basis of the objectives of this research and preliminary examinations of the archival material, qualitative evidence was divided between three major categories. These were:

(1) the direct impacts of climate variability or events upon the natural and built environment, as well as human activities;
(2) the wider implications of such impacts for economic stability, standards of living, the administration of public and private institutions and the health of human and animal populations;
(3) human responses to climate variability and events, their direct impacts and secondary implications for society;

During the categorisation process, it emerged that a great wealth of information was available for certain themes falling under these broad groupings. This warranted the formulation of the sub-categories relating to the implications of climate phenomena for the following:

(a) agricultural productivity;
(b) water availability;
(c) food security;
(d) human and animal health.

Similarly, material concerning (possible) human responses to climatic stimuli was considered for inclusion in three sub-divisions:

(e) governmental crisis management measures;
(f) coping strategies at the level of civil society;
(g) social unrest and unlawful behaviour.

Any material deemed fitting of more than one classification was included under all relevant groupings, rather than being assigned to one at the expense of another.

Having generated a series of thematic compilations of chronologically-ordered documentary information, it remained to devise a means of further analysis and presentation of findings. Historical research often entails some level of compromise between a general, longue durée approach versus one constrained temporally, but precise in detail. The subsequent three chapters adopt the latter. Each focuses on a separate case study of climate-related disaster, the first centring on the end of the 1770s and early 1780s, the second on the mid-late 1830s and the third on the 1860s and 1870s. While attention centres predominantly on those timeframes, parallels are also drawn with other moments in Antigua's eighteenth and nineteenth century past. Long-term assessments of climate impacts and vulnerability are incorporated later in this chapter and in Chapter 11, which respectively provide an introductory overview and a final discussion of findings from the archives. Chapter 11 also presents some new evidence from various episodes between 1770 and 1890 to enhance the assessment of certain subthemes, such as the possible connection between climate and outbreaks of disease and rebellious behaviour. As these are especially complex topics, it has been decided that a long-term, multi-case outlook is needed to supplement case studies.

There are several theoretical justifications for the case study approach adopted in Chapters 8 to 10. Invariably, levels of detail in accounts of the repercussions of climatic conditions, as well as contemporary social, economic and political developments, were changeable over time. Thus, there were episodes in which the nature of climate-society interactions emerged relatively clearly from the archives, while in others they could only be speculated at. Honing in on the former allows themes of interest to be considered in depth, rather than providing a generalised and potentially superficial assessment spanning the entire study period. The short-term case study approach also facilitates the contextualisation of findings with reference to broader societal conditions. Developing thorough understanding of the cultural circumstances in which environmental processes unfold is vital in the assessment of climate impacts (Section 4.2.4). Within the remit of a PhD research project, targeting relatively brief timeframes offers an attractive means of accounting for this human

milieu as comprehensively as possible; it can be woven into the central narrative of weather-related disaster in a case-specific manner, rather than separated for synthesis as important, yet inevitably tangential 'background.' Finally, a focus on particular periods instead of fixed groupings of subject matter allows for greater investigative and hermeneutic freedom, as well as simultaneous consideration of the interplay between different themes. Such an approach is especially advantageous in the study of vulnerability, being a highly complex and multifaceted concept.

The importance of the periods examined in the case studies is considered in subsequent chapters and will, therefore, be outlined only briefly here. One reason for their selection was to afford insights into disparate moments in the colonial past distributed throughout the full research period. Additionally, the case studies coincide with major developments in the British Atlantic which have already received detailed treatment in social, political and economic histories: the American Independence War, the abolition of slavery and the decline of the colonial plantation economy. As noted in Section 7.2.2, an analysis that positions climate at the fore can offer novel understanding of well-studied occurrences of this kind. All three cases are also exceptionally well-documented in terms of the availability of references to climate-related phenomena (e.g. see Figure 5.2).

In preparation for the examination of each case study, archival material pertaining to the relevant timeframes was surveyed once more. Any crucial details which may have been sidelined by the earlier emphasis on broad thematic categories was highlighted. Compilations of information about the physical characteristics of climatic conditions, which was separated for analysis in Chapters 5 and 6, were revised in order to chart the progression of key weather events. Further exploration of case studies took the form of critical reflection and narration by way of 'thick description.' All three case studies share a common structure. They first introduce the broad socio-economic context in which climate extremes unfolded; they then examine the effects of adverse meteorological events on material conditions—that is to say, agro-industrial activity, financial stability and human health; next they explore human responses to these; and, finally, they reflect on the patterns of vulnerability discernible from these findings. Monetary figures are quoted in £ Sterling unless otherwise stated. For readers' benefit, the value that these sums would have in modern terms has been calculated in several cases using the conversion tool available at http://apps.nationalarchives.gov.uk/currency/.

7.3.2. Caveats and complications

General limitations to the use of documentary sources for historical climate research were discussed in Chapter 4. These were kept mind throughout the process of analysis. In this subsection, three pitfalls associated specifically with the assessment of historical climate-society inter-relations are considered.

The potential for circular argumentation (explained in Section 4.2) is a difficulty confronted in all investigations of the characteristics and implications of past climate variability. To address this, archival material was separated for different stages of analysis as noted above. The precipitation chronology developed in Chapter 5 was based exclusively on accounts of meteorological conditions, rather than their effects. Some quotations containing references to environmental and economic impacts were included therein, but solely for the purpose of contextualising the pre-existing reconstruction. In Chapter 6, tropical cyclones were identified primarily from descriptions of the characteristics of storm winds. However, damage reports served as a crucial foundation for storm intensity estimates. Throughout the archives there were various passages that alluded simultaneously to climate phenomena and their ramifications. The splitting of quotes for use in the appropriate stages of analysis helps to address this problem to some extent. Nevertheless, a small number were too convoluted for this to be undertaken without compromising their comprehension. Those extracts were not split, but instead flagged for careful treatment.

Case studies represent useful analytical units, but also have drawbacks. At the most basic level, they are limited in time and space. While specific stories may bring to light environmental processes, human behaviours and patterns of vulnerability which would, conceivably, have played out in other similar situations, one cannot extrapolate directly to these (Ford et al., 2010). There is also potential for a focus on disasters to be somewhat misleading. Phases of acute hardship, which lend themselves well to discrete investigation, are often documented in detail unmatched in times of relative stability (Endfield, 2008). Concentrating on crises episodes of this nature may give an unrealistic impression of the significance of climate for human affairs (Wigley, 1985). For both of these reasons, it should be recognised that some bias is inherent in the resulting portrayals of society and climate-society interaction.

Evidence of long-term human adaptation can be difficult to identify from documentary sources, often taking place over timescales that render them unperceivable by human observers (Endfield et al., 2004). Naturally, centring attention on short timeframes renders this is yet more problematic. It should be noted, however, that several critical surveys of the archival material revealed little information of prospective value for investigating this subject matter, relative to that connected with other themes. Despite their limitations, case studies offer a manageable and flexible means of exploring the societal dimension of climate variability, which, through context-specificity, enables issues of long-term data heterogeneity to be overcome (Wigley, 1985; de Vries, 1980; Endfield, 2008).

Finally, certain features of the analysed sugar data are worth noting. Deerr (1949) presents an almost continuous series of yearly sugar production in Antigua spanning 1696-1946, which was derived from the records of Britain's Colonial Customs Service. Unfortunately for this study, there is a significant hiatus in the dataset

between 1781 and 1814. All pre-twentieth sugar data may be subject to an uncertain degree of imprecision due to the fact that they were recorded in hogsheads. This approximate unit of volume was generally equivalent to between 900 and 1,100 lbs (roughly 410-500 kg) of sugar, but more substantial variation was not uncommon.[49] Such potential error is masked in Deerr's data, which were converted from hogsheads to imperial tons, but still applies.

7.4. From climatic events to cases of crisis: an introduction to findings

As demonstrated by Chapters 5 and 6, the consulted archives afforded ample evidence of droughts, tropical cyclones and major periods of rainfall excess in colonial Antigua. They also abounded with references to thunderstorms, spells of strong winds or calms, short-lived hydrological extremes and the onset or otherwise of wet and dry seasons. Although the very state of the weather occasionally received extensive commentary, what attracted attention most consistently was the bearing it had upon human activities. Littered throughout the historical record are observations of the manifestation of meteorological patterns and events in agricultural production, food and water availability and the health of people and livestock, as well as remarks about the interplay between all of these. Occasionally, contemporaries also made a connection between atmospheric conditions and phenomena further removed from the physical environment, such as economic stability, military strength and human behaviour. Holistic evaluation of this type of evidence over multiple decades enables the identification of various apparent instances of climate-related crisis. These represent critical junctures in environment-society interaction as moments when collective human capacity to absorb, adapt to or adequately mitigate the effects of a meteorological shock or series of shocks may have been surpassed. The study of any such rupture in societal resilience is worthwhile for the various academic and practical reasons outlined in Sections 2.3.2 and 5.2.2. Before delving into specific cases of emergency related to adverse weather episodes in the following chapters, it is useful to identify some of the unifying features of similar periods documented throughout the study period. To this end, the remainder of this section establishes a chronology of major climate trends and events, from which phases of stress may be inferred. This is then built upon with select findings arising from the analysis described in Section 7.3.1 as a means of illustrating some of the recurrent environmental effects that extreme weather events had in colonial Antigua. As such, it does not seek to provide a comprehensive overview of the repercussions of meteorological shocks, but rather to flag up possible themes and periods of interest for further examination.

Chapters 5 and 6 developed the first extensive reconstructions of tropical cyclone activity and precipitation variability in Antigua for the pre-instrumental period. The

[49] CO7/138, Legislative memorial, 14 Nov 1869.

principal results of this work are summarised by Figure 7.1a, which displays an annually-resolved time series of relative rainfall levels and instances of hurricane and tropical storm winds recorded in the period 1769-1890. For present purposes, cyclones of tropical depression intensity have been excluded from the chronology, as they are not typically associated with terrestrial damage (Chenoweth, 2007) and are, therefore, unlikely to have had major consequences for socio-economic wellbeing. Though inherently limited in temporal resolution, this approach offers a convenient starting point to consider the cumulative effects of distinct, successive climate events.

One of principal means by which climatic conditions impinge upon human well-being in pre-industrial society is their influence over agriculture. In eighteenth and nineteenth century Antigua, economic activities revolved around the cultivation and processing of sugarcane (Section 3.3). Homogenous series of harvest or harvest-related data can be valuable for assessing the agro-economic impacts of climate variability at inter-annual or inter-decadal resolutions, though it should be remembered that they reflect social, commercial and other environmental factors also (Brázdil, et al., 2005). The longest and most continuous record of this type available for this study takes the form of yearly totals of Antiguan sugar production chronicled by Deerr (1949; described in Section 7.3.1). Primary research has uncovered separate compilations of annual sugar exports spanning 1779-1788 and 1822-1877 in Oliver (1984) and Antigua's Blue Books. It is noteworthy that these datasets, which are displayed in Figures 7.1b and 7.1c, are independent of the evidence used to reconstruct precipitation variations and tropical cyclone winds.[50] Comparison of the combined climate chronology with the sugar data—that is to say, the juxtaposition of climate phenomena documented in specific rain-years against export and production data in the subsequent calendar year (when harvesting and shipping took place)—reveals reasonable correspondence (Figure 7.1). As would be expected, relative annual rainfall levels are the reconstructed component that appears to be best reflected by the sugar data. Without wishing to overstate the significance of meteorological parameters, there are also several instances in which rain-years of powerful and/or multiple tropical cyclones, sometimes in combination with precipitation extremes, were followed by notably low export values (e.g. calendar years 1773, 1814, 1820, 1822, 1836 and 1872).

Certain recurrent environmental problems appear to have been associated with drought in particular. The most consistently reported of these were water shortages, to

[50] Similar series of agricultural data have been used widely as a proxy for climate reconstruction (e.g. Garcia-Herrera et al., 2003; Wetter and Pfister, 2011; Pribyl et al., 2012). Such an approach has not been adopted in this thesis for two reasons: (1) statistical correlations between available instrumental rainfall data (described in Chapter 5) and the sugar data were comparatively low (coefficients of 0.26-0.66) and (2) analysis of fluctuations in sugar production was deemed to be integral to a detailed history of Antiguan climate-society interactions, but could not at once be used for climate reconstruction due to the possibility of circular argumentation.

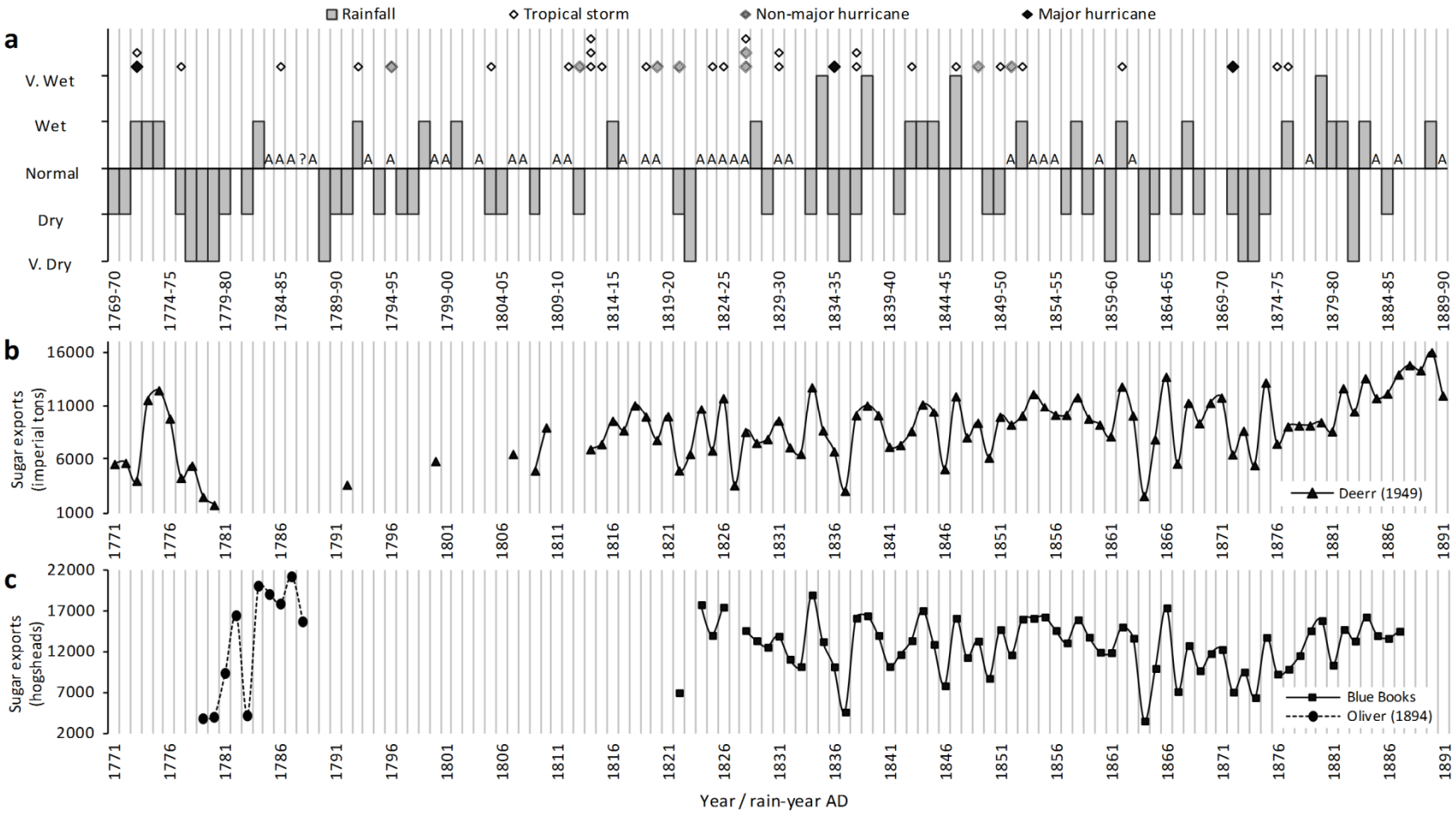

Figure 7.1. Comparison of (a) a combined chronology of relative annual precipitation levels and instances of tropical storm, non-major hurricane and major hurricane intensity winds in Antigua, rain-years 1769-70 to 1889-90 (from Chapters 4, 5), with (b) Antiguan sugar production (after Deerr, 1949: p.195) and (c) Antiguan sugar exports (after Oliver, 1894: p.cxxxviii; CO10/6-71, Blue Books for 1822-1887).

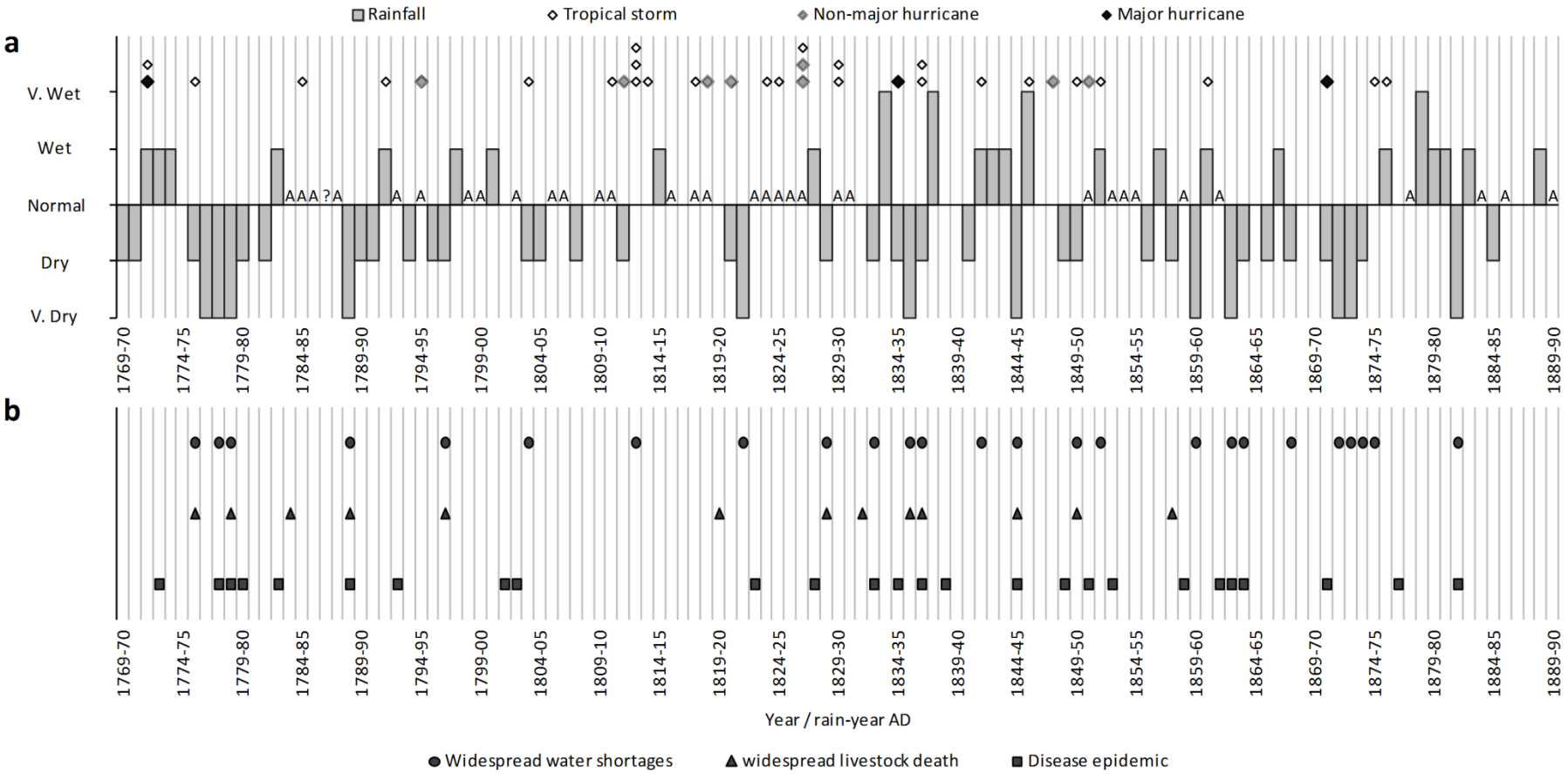

Figure 7.2. Comparison of (a) a combined chronology of relative annual precipitation levels and instances of tropical storm, non-major hurricane and major hurricane intensity winds in Antigua, rain-years 1769-70 to 1889-90 (from Chapters 4, 5), with (b) a plot of the incidence of widespread water shortages, livestock mortality and disease epidemics as recorded in documentary sources, rain-years 1769-70 to 1889-90.

which Antigua is especially susceptible because of its physical geography (Section 3.2.4). Rain-fed ponds, small lakes and springs represented the only natural source of potable water available in the island. Cisterns and, eventually, reservoirs constructed during the colonial period shared their limitation of reliance upon precipitation (Lanaghan, 1844; Dyde, 2000). Hence, especially dry climatic conditions frequently occasioned island-wide scarcities of potable water. Arising from this as well as the wilting of pasture, drought could take a great physical toll on livestock, occasionally culminating in considerable mortality. This had wider economic significance because cattle and mule carriage was crucial for the transportation of plantation produce. As illustrated by Figure 7.2, recorded instances of both widespread water shortages and mortality among livestock in the nineteenth and late eighteenth centuries coincided consistently with reconstructed phases of precipitation deficiency.

Evidence of the effects of episodes of rainfall excess was, by contrast, slightly elusive and inconsistent. Abnormally wet weather was reported to have produced localised crop damage in seven years—1773, 1774, 1833, 1834, 1842, 1880 and 1881[51]—and to have otherwise interrupted agricultural operations on three occasions—in 1833, 1846 and 1879.[52] Major flooding events were reported categorically in 1838 and 1842—cases which are examined in Chapter 8. It is noteworthy, however, that in three of the aforementioned years, 1838, 1842 and 1846, contemporaries emphasised the positive net consequences that precipitation abundance had for husbandry.[53] Moreover, none of the listed years corresponded with the substantive drops in sugar output that characterised episodes of severe drought and/or tropical cyclone activity (Figure 7.1), while many rain-years of wetter-than-normal conditions actually coincided with discernible peaks in production and/or exports (calendar years 1774, 1775, 1834, 1839, 1844-1845, 1847, 1858, 1861, 1882, 1884 and 1890 in Figures 7.1b, 7.1c). These findings suggest that, in the long term, agricultural success may have been a more consistent implication of above-average rainfall than decline.

Climate variations and weather events often seem to have directly or indirectly influenced the incidence of sickness among the human population. Several Caribbean environmental histories have highlighted connections between extreme climate events and outbreaks of infectious and vector-borne diseases (Section 7.2.2). As we shall see in later chapters, several cases in eighteenth- and nineteenth-century Antigua lend

[51] DD/TD/15/6, S. Bilzard to C. Tudway, 15 Mar 1775; T/PH/swd/2, J. Freeland to J. Tudway, 29 Sept 1833; PA, Vol.13, p.233, Gracehill diary 1834; CO7/74, Report of R. Horsford, 30 Sept 1842; PA, Vol.32, p.98, Annual Report Jul 1880-Jul 1881.

[52] T/PH/swd/2, J. Freeland to J. Tudway, 30 Aug 1833; CO7/86, Gov. Higginson to Earl Grey, 26 May 1847; PA, Vol.31, p.366, Lebanon report 1879.

[53] PA, Vol.15, p.79, Gracehill station diary 1838; CO7/74, Report of R. Horsford, 30 Sept 1842; PA, Vol.18, p.40, Letter from A. Hamilton, 11 Aug 1846.

support to these correlations and indicate that certain meteorological patterns may have been associated with other forms of illness too. Consideration of disease types aside, the archives suggest a degree of consistency between bouts of inclement weather and the emergence of island-wide disease epidemics, as demonstrated by Figure 7.2. This possible relationship will receive more detailed scrutiny in Chapter 8-11.

Taken as a whole, what emerges from the present overview of findings is a picture of a common set of hardships attending diverse episodes of unfavourable meteorological conditions. Figures 7.1 and 7.2 exhibit a series of prominent event clusters—synchronous phases of extreme events, agricultural decline, resource scarcity and, at times, human morbidity or livestock mortality—which can be viewed as potential cases of climate-related crisis (e.g. 1776-1780, 1827-1829, 1834-1837, 1848-1853, 1860-1864 and 1871-1874). "A crisis only becomes so, however, when a significant proportion of the population is at risk or significant life and economic losses are incurred" (Endfield, 2008: p.70). The historical record necessarily emphasises occurrences with notable implications for society, but not all such occurrences unleashed upheaval or stimulated major human responses. Ultimately, the societal effects of individual or successive environmental shocks are mediated by the time- and place-specific context in which they unfolded (Bankoff, 2007). It is to the interplay between precise contexts, climate and human vulnerability that attention turns in the following three chapters. The first examines a period of recurrent drought between 1775 and 1783, marked also by an armed conflict with disastrous ramifications for food supplies and economic activities. Next, focus shifts to a time of profound social and commercial transition in the wake of emancipation and, more particularly, a string of extreme events experienced from 1834 to 1838, including a powerful hurricane and precipitation abundance as well as scarcity. The final case study chapter centres on a phase of frequent drought from 1860-1874 marked also by a devastating cyclone, which falls within a half-century of pronounced and persisting socio-economic decline.

7.5. Chapter overview

This chapter has set the scene for the components of the thesis that examine the societal implications of climate variability in eighteenth and nineteenth century Antigua. As illustrated in Section 7.2, the existing body of scholarship concerned with climate-society inter-relations in the Caribbean is dynamic and growing. It broaches multifarious themes, ranging from past conceptualisations of climate and extreme events to their socio-economic, cultural, epidemiological and political repercussions. The powerful cyclones peculiar to tropical waters have thus far been especially well studied, while geographical focus has centred overwhelmingly upon the Greater Antilles and south-eastern United States. In small part, this thesis addresses the

resulting spatial and theoretical openings for novel inquiry. To do so, its methodology involves isolating archival evidence of the direct and possible indirect effects of climate-related phenomena for thematic analysis. As an introduction to findings, some of the common features of apparent phases of inclement weather were considered in the previous section. By using the climate chronologies developed in Chapters 5 and 6 as a framework upon which to plot agricultural data and the incidence of select eco-environmental problems, potential episodes of climate-related crisis have been highlighted. Despite the image of uniformity that such an approach creates, it should be noted that each of these episodes took place over a fluid, ever-changing backdrop of socio-economic prosperity and political stability, not to mention human behaviours and interactions. The following three chapters cast a spotlight upon such idiosyncrasies; concentrating on the precise nature of the effects that extreme weather had upon society, they explore the dynamic ways in which human vulnerability to climate played out in distinct moments of Antigua's colonial past.

Chapter 8

Drought, distress and disease in a revolutionary age: 1776-1783

8.1. Introduction

Things were not going well for the second battalion of King George III's 60th Regiment. It was June 1777 and food prices in Antigua, the British colony where they were stationed, were extraordinarily high. So high, in fact, that after making the outlay on clothing essential to uphold "a Clean and Soldierlike manner," the infantrymen could barely afford to feed themselves. Had they not been issued with advances on their wages, opined their commanding officer, "many must inevitably have died thro' want."[54] This was no state for the troops to be in. Great Britain was losing an armed struggle to retain control of its North American territory, while the threat of interstate warfare in the Caribbean loomed large. On the receipt of a plea for succour from the garrison, Antigua's legislature took decisive action. By August, the men had been granted a wage increase and a special allowance of £165 for purchasing supplies. This measure was highly commended by the governor, Sir William Matthew Burt, in light of the "distressful Situation" in which the colony found itself at the time.[55] Laudable it may have been, but the response soon proved insufficient. Within two months, the battalion had exhausted its funds and lodged another request for support. This time, though, the authorities were unable to assist, for the public treasury was empty. Knowing that without swift intervention the troops would starve, Governor Burt supplied £100 worth of food at his own expense.[56]

Over a year later, the state of affairs had scarcely improved. With the meagre tax revenues then being collected, local government eventually managed to reimburse Burt and resume footing the bill for the regiment's sustenance—a bill which, by February 1779, totalled £800.[57] That April, another £165 was expended in like manner, by which point the soldiery was in a "piteous Condition."[58] This now owed not only to caloric deprivation, but also a lack of drinking water. The only tenable solution was to acquire that vital liquid from a private contractor at the exorbitant rate

[54] CO 152/56, Petition of the 60th Regiment, June 1777.

[55] CO 152/56, Gov. Burt to Commissioners of Trade and Plantations, 25 Jul 1777, Legislative proclamation, 29 Aug 1777.

[56] CO152/57, Gov. Burt to Lord Germain, 1 Nov 1777.

[57] CO152/59, undated legislative petition, with letter from Gov. Burt to Lord Germain, 22 Feb 1779.

[58] CO152/59, T. Jarvis and R. Burton to Gov. Burt, 30 Apr 1779.

of £4 a day.[59] However, it soon transpired that these, alongside the colony's countless other expenses, were more than its coffers could bear. Within a matter of weeks, bankruptcy was declared once more.

How did the 60th Regiment, Antigua's first line of internal defence, come to be exposed to such acute and persistent privations? Why was a colony which four years previously boasted a thriving economy, founded upon the multimillion-pound sugar industry, now so plagued by fiscal malaise? The conventional answer is geopolitics. From the mid-1770s, the severance of commercial ties with the rebelling North American colonies, exacerbated by conflict with other imperial powers, precipitated profound subsistence and economic emergencies throughout the British West Indies (Section 3.3.2). Yet there was another potent force at play in the Antiguan case: an intense drought lasting for over half a decade. The present chapter scrutinises the effects of this extreme event upon human wellbeing in the island to improve understanding of the well-studied episode of war-induced dearth within which it unfolded. To begin, however, it is pertinent to outline the socio-political origins of such hardship and its regional ramifications.

8.2. The West Indies at war

The antecedents of the North American War of Independence are numerous and varied. For now, it suffices to note that chronic frustration with British rule in the Crown's thirteen long-standing continental colonies—which stretched from Massachusetts to Georgia on the east coast (Figure 8.1)—had reached fever pitch by autumn 1774. Of greater importance as regards circumstances in Antigua, is the trade embargo imposed by the administrators of those colonies in manifestation of their grievances. Late in October that year, delegates of the first 'Continental Congress' resolved that all imports from Britain, Ireland and the West Indies would be banned as of December. Then, if no concessions were forthcoming from the mother country by the following September, shipments of all American goods back to those territories would be suspended. Britain's response was to commence an extensive military campaign against the rebelling provinces in spring 1775 (Bonwick, 1991).

The commercial blockade, which was upheld until the thirteen colonies were recognised as independent in September 1783, spelt calamity for the British Caribbean. It eliminated the principal supply of hardware, raw materials and livestock that was fundamental to the plantation economy of the region, as well as the foodstuffs sustaining the human population. In no region was the rupture felt more keenly than the Leeward Islands, where sugarcane monoculture was most pervasive and, consequently, dependence upon imports greatest. To make things worse, British transports throughout the tropical Atlantic now fell prey to American privateers

[59] Ibid.

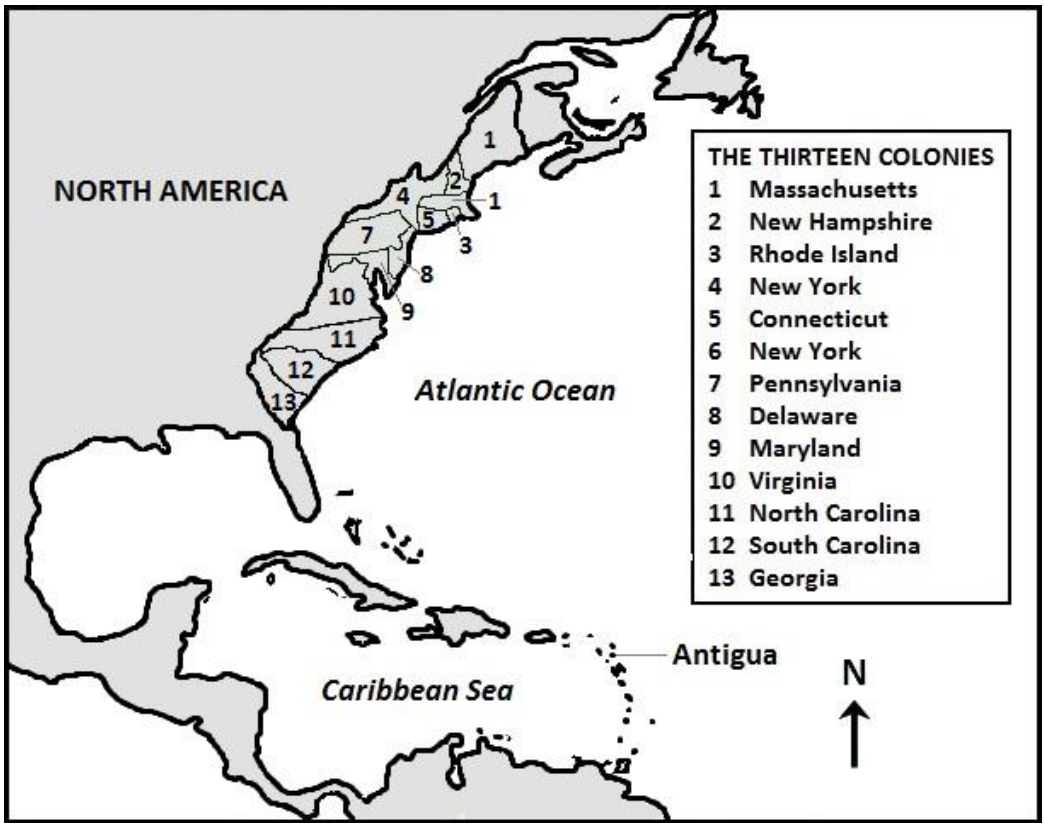

Figure 8.1. Britain's original thirteen colonies in North America.

(Sheridan, 1974, 1976). Concerns assumed a new gravity from the late 1770s, when hostilities broke out with other major players in New World geopolitics. Tiring of France's open support for the rebel cause, Great Britain declared war in March 1778. A year later, Spain entered the conflict in alliance with her Bourbon allies. Holland followed suit in 1780. In the theatre of combat that the Antilles became, the eastern islands once again bore the greatest excesses. This multinational archipelago of small colonies witnessed a maelstrom of territorial gains, losses and re-acquisitions, featuring some of the war's most ambitious and costly naval campaigns. When, in early 1782, Britain's military capacity was at its lowest ebb, all of the Leewards save Antigua were in enemy hands. With the return of peace the following year, however, those possessions not already retaken by force were restored to King George III (Ragatz, 1963; Watts, 1987).

Throughout the years of military engagement, procuring provisions from new sources was critical to British West Indian livelihoods. This took two main forms, the first of which was to restructure trading networks. From within the empire, the islands were supplied by the motherland, Ireland and loyal North American holdings in Canada and Florida. From without, imports were permitted periodically from non-hostile foreign dominions. By the final years of the 1770s, indirect commerce with the enemy had also become well established, with the neutral Dutch and Danish Leewards serving as entrepôts for cargoes of any origin—even the embattled mainland. The

second major alteration to provisioning systems was to reduce reliance on food imports altogether. British planters throughout the Antilles expanded cultivation of common subsistence crops and experimented with various new varieties. While these practises were employed most widely in the abundant fallow lands of Jamaica, smaller islands saw substantial tracts of caneland set aside for ground provisions (Ragatz, 1963; Sheridan, 1976).

Scholars of British West Indian history agree unanimously that, despite such measures to protect colonial interests, the conflict of 1775-1783 ushered in a phase of unprecedented crisis in the region (e.g. Williams, 1970; Sheridan, 1976; Watts, 1987). Food shortages culminated in famine on numerous occasions, which, in combination with the lack of other crucial supplies, saw plantation production fall just as running costs rose. Prices of many staples more than doubled in the Leewards, while sugar exports from the British Caribbean plummeted by 40% between 1774 and 1777. The plantation economy also endured a series of secondary stresses, including the loss of the American market for rum and molasses, increased taxation to cover war expenses and increasingly inefficient and costly shipping (Ragatz, 1963). It was in these ways that the international political atmosphere from the mid-1770s through early 80s rendered his Majesty's Caribbean colonies peculiarly vulnerable to further potential dislocations of socio-economic wellbeing.

8.3. Resource availability, morbidity and mortality in embattled Antigua

8.3.1. "Ye horrors of a Famine every day stare us more & more in ye face"

Immediately prior to the turbulent war period, successive years of relative domestic tranquillity and agro-economic success had been enjoyed throughout the British Leeward Islands. Writing in mid-January 1775, the governor of the region, Sir Ralph Payne, enthused:

> The Trade of every Island… is uncommonly flourishing; Provisions of all Kinds from the Continent of America are cheaper and more plentiful than they have been in the Memory of Man; and the Crops for the present Year, promise to be much superior even to those of the last, in Quality as well as in Quantity.[60]

Circumstances in Antigua had been exceptionally auspicious. After a hurricane in August 1772, wet weather prevailed until October 1774 (Section 5.3.2). A bumper sugar crop in 1774 was followed by the largest of the eighteenth century in 1775, with the colony producing 11,672 and 12,580 imperial tons in those years respectively (Figure 8.2a). For their part, the plantations of Sir William Codrington—one of the

[60] CO152/55, Gov. Payne to Earl of Dartmouth, 12 Jan 1775.

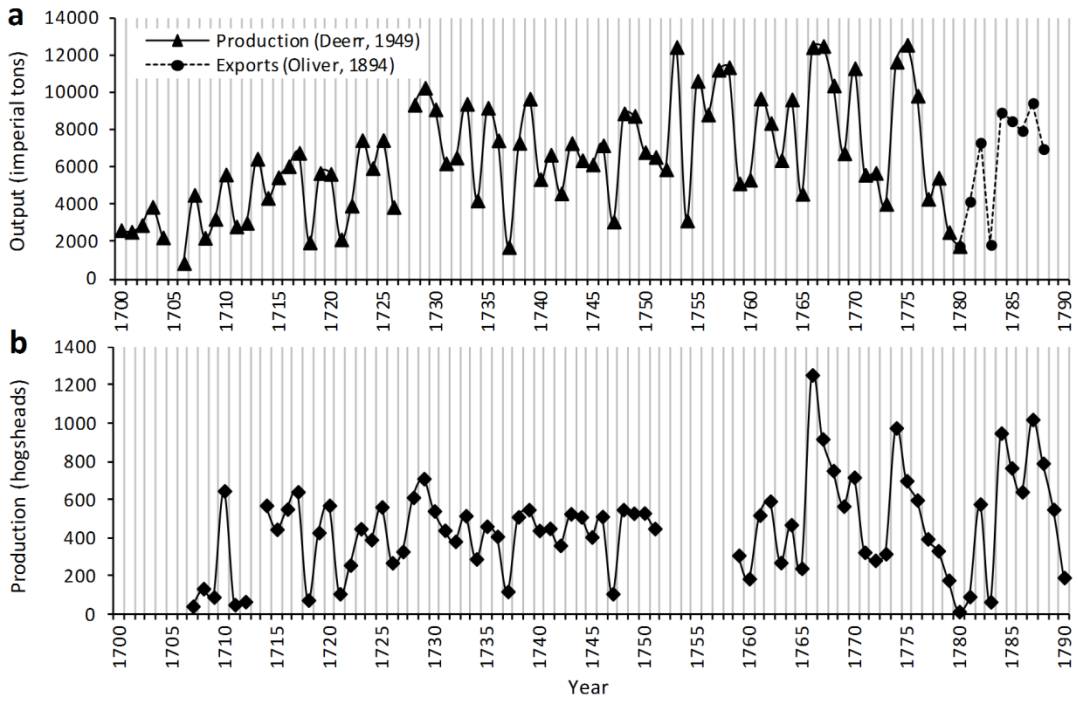

Figure 8.2. Annual Antiguan sugar output, 1700-1790. (a) Total production (after Deer, 1949: p.195) and exports (after Oliver, 1894: p.cxxxviii; data converted from hogsheads to imperial tons). (b) Combined production (hogsheads) of the Codrington family's principal estates (COD/A62, 'Sugar made on the Codrington Plantations from 1707', undated). Data from Oliver (1894) converted from hogsheads to imperial tons.

largest landholders in the island—generated three of their eight highest yields then on record in the years 1774-1776 (Figure 8.2b). Anxious to protect their industry, planters responded to the news of deteriorating Anglo-American relations with firm action. While imports from the continent continued, purchases were increased to build up reserves. The head manager of the Tudway family's estates, Francis Farley, noted in late October 1775 that in this way the colony's inhabitants would be able to process the ensuing harvest and subsist for three months.[61] At the same time, cultivation procedures were adapted in a move towards greater self-sufficiency. Stephen Blizard, an attorney for several estates, reported that agriculturalists had begun to plant "every sort of Provisions."[62] Blizard was, however, alive to the ramifications if cut-backs to inbound shipping became severe. Should this be the case, he prophesised, "we shall be reduced to great distress, especially if we should have any long spells of dry weather, as we sometimes do."[63]

Unhappily for Antiguans, it was not long before these preconditions were met. The regional subsistence difficulties occasioned by the American Independence War have

[61] DD.TD.15.6, F. Farley to C. Tudway, 23 Oct 1775.

[62] DD.TD.15.6, S. Blizard to C. Tudway, 21 Jul 1775.

[63] Ibid.

already been discussed (Section 5.2). Meanwhile, Chapter 5 has documented contemporary meteorological conditions based on the systematic analysis of Antigua's colonial archives (see also Berland et al., 2013). Findings indicate that intense drought predominated across the island for the best part of seven years, from late 1775 to the summer of 1783. In this period, widespread abundant precipitation is recorded during just three short spells—in September 1776, October 1777 and October 1780—while alternating wet and dry weather were registered throughout 1781.

Dearth took hold from the close of 1775. Revising his optimistic earlier words on the matter, in late December Francis Farley wrote to his employer, Sir Clement Tudway, that the colony's stockpiles of imported goods were running low. "People… would gladly appropriate [a] good part of their caneland to raising provisions," he asserted, "had we rain to plant with."[64] Complaints became increasingly strident over the subsequent months as the concomitant pressures of dry weather and dwindling supplies mounted.[65] Come April 1776, Mainswete Walrond, another of Sir Tudway's estate managers, simply lamented: "ye horrors of a Famine every day stare us more & more in ye face."[66] That July, he was also obliged to report that island-wide water shortages had claimed the lives of "a great number of cattle."[67] Fortunately for Walrond and his fellow Antiguans, the following twelve months saw the pressure on food supplies assuaged; showers in May and September enabled subsistence crops to be sown,[68] the temporary prohibition of exports of plantation stores slowed the depletion of local reserves and the capture of American craft by British privateers provided the Leewards "Plenty of Provisions."[69]

However, when overseas trade took its seasonal dip in the hurricane season of 1777, acute scarcities returned, drought having reigned since October the preceding year. As early as July, Farley wrote that there remained "not a bushel of corn or beans for sale in ye island," while domestic sources of food and water also faced extinction.[70] Famine set in that autumn. In his next letter, dated October 27th, the estate manager exclaimed: "I believe from 1000 to 1500 Negroes will be lost in consequence of this scarcity; many are already dead."[71] Soon after this, it even became necessary to sacrifice one of Sir Tudway's least emaciated cattle to feed his

[64] DD.TD.15.6, F. Farley to C. Tudway, 29 Dec 1775.

[65] E.g. DD/TD/15/6, M. Walrond to C. Tudway, 20 Jan 1776; 28 Mar 1776; 18 Mar 1776.

[66] DD/TD/15/6, M. Walrond to C. Tudway, 20 Apr 1776.

[67] DD/TD/15/6, M. Walrond to C. Tudway, 20 Jul 1776.

[68] Ibid.; DD/TD/15/6, F. Farley to C. Tudway, 13 Sept 1776, 25 Sept 1776, R. Martin to C. Tudway, 25 Sept 1776.

[69] CO152/55, C. Greathead to Lord Germain, 5 Jun 1776; CO152/56, Gov. Burt to Lord Germain, 4 May 1777.

[70] DD/TD/15/6, F. Farley to C. Tudway, 27 Jul 1777.

[71] DD/TD/15/6, F. Farley to C. Tudway, 27 Oct 1777.

estate overseers.[72] Hunger persisted through the opening months of 1778, proving Falrey's fears for the enslaved populace alarmingly accurate. In a closed letter to the Colonial Office sent from St. Kitts in mid-March, the governor of the Leewards confessed:

> I would not mention in my Public Dispatch the great losses this Government has sustained from the Want of Provisions: …from the best informations I have been able to collect, The Island of Antigua has lost above a thousand Negroes, Montserrat near twelve hundred, & some Whites; Nevis three or four hundred, & this Island as many from the want of Provisions…[73]

8.3.2. "Its face the deserts of Arabia"

Over the next two years, the state of emergency climaxed. France's entrance into the war left Antigua wholly reliant upon intermittent maritime captures and perilous trade with the Empire and a handful of neutral islands.[74] Accounts speak comprehensively of these exigencies and the confounding affects of meteorological conditions. Francis Farley, for example, penned the following on September 27th 1778:

> It has been long extremely dry & more so at present than I ever before knew it, both Water & provisions are scarcer than they ever were in the Memory of Man and this without a prospect of relief as to provisions for a considerable time, [as] it is unlikely that the fleet from London will be here before Christmas and should we be blessed with plentiful rains immediately we can't raise any Provisions in less than four months.[75]

Even the arrival of emergency supplies the following March could not avert disaster. At the start of May, Governor Burt, again visiting St. Kitts, wrote of the Antiguan populace:

> [they have] most severely felt the heavy hand of want: Their present Crops are Distroyed by a long[,] very long severe Drought; nor have they now any prospect of a succeeding Crop: they have not had a thorough Season of Rain since October was a Twelve Month: Their Cysterns are and hav been some time Emptied; their large Ponds are in the same State; they are compelled to carry Water for their Families' use many Miles, for which they pay eighteen Pence a

[72] DD/TD/15/6, M. Walrond to C. Tudway, 10 Jun 1778.

[73] CO152/57, Gov. Burt to Lord Germain, 17 Mar 1778.

[74] CO152/58, Gov. Burt to Lord Germain, 15 Aug 1778; CO152/59, Gov. Burt to Lord Germain, 2 Nov 1778.

[75] DD/TD/15/6, F. Farley to C. Tudway, 27 Sept 1778.

> Gallon. Heavan has denied them not only Seasons but even refreshing Showers from whence they might raise Pulse and Vegetables or some Provisions for their Negroes… My letters from that Island paint nothing but ruin and its face the deserts of Arabia. [sic].[76]

On witnessing firsthand the state of affairs in September, Burt could only add that "many hundreds of Negroes" had starved to death.[77] Despite failing to enumerate its magnitude, contemporaries also reported unprecedented mortality among the island's cattle.[78]

There was one final contributor to death and despair in late 1770s Antigua: disease. In June 1777, a correspondent of Sir Tudway expressed his misgivings that the absentee's slaves would remain healthy if drought continued obliging them "to drink bad water."[79] Eleven months on, amid further commentary of the unwholesome quality of remaining water supplies, the first fatality from a widespread dysentery outbreak was registered on the Tudway estates.[80] Another year after that, it was observed that "all the Negroes in the Island" were "very sickly, chiefly with ye flux," while "Dropsical Complaints" were causing additional mischief.[81] Account documents reviewed by Ward (1988) indicate that, overall, one tenth of Tudway's black serfs perished from the summer of 1779 through autumn the next year, due primarily to the flux. Similarly, between autumn 1778 and the end of 1779, the death toll on two of Sir Codrington's plantations, Betty's Hope and The Garden, was calculated at 15%.[82] Yet, the Antiguan physician Samuel Athill placed the island-wide death rate far higher. When interviewed by parliament years later, he estimated on the basis of his own examinations that dysentery had claimed the lives of between one fourth and one fifth of Antiguan slaves (i.e. some 7,500-9,000) in the years 1778-1780.[83] Though substantial, the discrepancy in the above figures may well be explained by the considerable resources available to large and well-established planters like William Codrington and Clement Tudway, which could be invested in the care of the workforce. Indeed, in a letter to the former, Dr. Athill asserted the proprietor's loss had been "less in proportion than any other Estate in the Island."[84] Notably, it was not

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[76] CO152/59, Gov. Burt to Lord Germain, 3 May 1779.

[77] CO 152/34, Gov. Burt to Board of trade and Plantations, 26 Sept 1779.

[78] DD/TD/15/6, M. Walrond to C. Tudway, 19 Aug 1779, 29 Mar 1780.

[79] DD/TD/15/6, R. Martin to C. Tudway, 1 Jun 1777.

[80] DD/TD/15/6, M. Walrond to C. Tudway, 19 Jul 1778.

[81] DD/TD/15/6, M. Walrond to C. Tudway, 19 Aug 1779.

[82] COD/C10, R. Clarke to W. Codringon, Jan 1780 [precise date unspecified].

[83] Parliamentary Papers, XXVI [I789] 'Report on the Slave Trade,' Report 646a, Pt.3, Antigua, A. No. i5.

[84] COD/C16, S. Athill to W. Codrington, 1 Mar 1780.

exclusively bondspeople who suffered; Francis Farley was, for instance, among a minority of whites who had lost their lives to the affliction by the autumn of 1779.[85]

Circumstances again improved temporarily from the spring of 1780, with British food aid arriving (Section 8.5.1), the dysentery epidemic abating[86] and spells of wet weather that October and throughout the following year then gradually restoring livestock, water supplies and subsistence agriculture.[87] Antigua was also singularly fortunate in emerging unscathed from a devastating hurricane year that tore through the Lesser Antilles in mid-October 1780.[88] Subsistence problems did not, however, disappear completely; food prices remained high and scarcities were again registered in the 1781 hurricane season.[89] And, when drought returned at the start of 1782, so too did all of the evils of the late 1770s. By mid-summer, these included water shortages, famished livestock and a floundering slave subsistence sector.[90] The final years of the war period were also disease-ridden. "Intermitting fevers" in the winter of 1781-82,[91] pleurisy during an unspecified portion of 1782,[92] and measles from spring to summer in 1783 were rife and claimed the lives of blacks and whites alike.[93]

At long last, the drought and international military campaigns that had dominated island affairs for over seven years came to their end in the summer of 1783. The wet weather that continued through spring the following year was attended by a pronounced improvement in the colony's commercial prospects.[94] "We now have plenty of good water, & a tolerable quantity of grass, & I hope to get the cattle & mules in good order for taking off the crop" acclaimed Mainswete Walrond in late September.[95] By this time, "great supplies of provisions & lumber" had already been imported, trade with the now-independent thirteen colonies having been re-established at the start of the month.[96]

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[85] DD/TD/15/6, M. Walrond to C. Tudway, 29 Sept 1779.

[86] COD/C10, R. Clarke to W. Codrington, 19 May 1780; DD/TD/15/6, M. Walrond to C. Tudway, 26 Sept 1780.

[87] COD/C10, R. Clarke to W. Codrington, 15 Oct 1780, 26 Apr, 29 Jun 1781; COD/C11, J. Lindsay to W. Codrington, 18 Oct 1780; DD/TD/15/6, M. Walrond to C. Tudway, 7 Oct 1780, 10 Nov 1780, 28 Nov 1781.

[88] CO152/60, Gov. Burt to Lord Germain, 1 Nov 1780.

[89] CO152/61, T. Jarvis & R. Burton to A. Johnson, 6 Apr 1781, Gov. Shirley to Lord Germain, 30 Aug 1781; DD/TD/15/6, J. Grey to C. Tudway, 29 Nov 1781.

[90] CO7/1, R. Oliver to anonymous, 4 Jun 1782; CO152/62, Gov. Shirley to Lord Townsend, 8 Nov 1782; DD/TD/15/6, M. Walrond to C. Tudway, 12, 31 Aug 1782.

[91] DD/TD/15/6, M. Walrond to C. Tudway 28 Nov 1781, 19 Jan 1782.

[92] Parliamentary Papers, XXVI [I789] 'Report on the Slave Trade,' Report 646a, Pt. 3, Antigua, A. No. i5.

[93] DD/TD/15/6, M. Walrond to C. Tudway, 15 Apr, 24 Jul 1783.

[94] DD/TD/15/6, M. Walrond to C. Tudway, 17 Mar 1784.

[95] DD/TD/15/6, M. Walrond to C. Tudway, 26 Sept 1783.

[96] DD/TD/15/6, S. Elliot to C. Tudway, 27 Sept 1783.

8.4. "To destroy the hope of the planter": the political economy under threat

8.4.1. Agricultural and financial instability

Indisputably, the resource scarcities, morbidity and mortality that accompanied drought and warfare were remarkable of themselves. Nonetheless, for most planters and government officials—who, despite inflated prices, could secure themselves the necessaries of life—these hardships were of concern foremost because of their ramifications for the sugar industry. Annual sugar harvest and export data (Figure 8.2) offer a broad but useful framework for assessing agro-economic trends. Bearing in mind that yearly totals reflect conditions throughout the period of crop growth and processing, notable coherence is evident between these statistics and the narrative of fluctuating material circumstances presented in the previous section; exports and production fall after 1775 to reach their nadir in 1780, rise moderately from 1781 to 1782 and then plummet once more in 1783.

Through its effects on plant life, drought may well have been the most direct driver of decline at the time. The archives contained tens, if not hundreds, of references to its consequences for sugarcane husbandry, over timescales ranging from weeks to years. The earliest examples date from spring 1776, when Mainswete Walrond observed:

> ye weather continues very dry & ye Canes are burning fast thro all ye Country which will soon alter ye quality of ye sugar much & lessen ye quantity.[97]

Over the subsequent years, accounts of this nature became increasingly frequent,[98] until, in 1780, sugar yields dropped to some of their lowest levels in the eighteenth century (Figure 8.2). The predicament then faced by planters is summarised neatly in the writings of Sir Codrington's chief Antiguan attorney:

> we are now as dry as 'tis possible [to be] and the Canes are perishing daily, whilst the Season is but already too far advanced to replant with hopes of success or to form any great dependence [sic] upon Canes that have been so materially injured in their infant State.[99]

Conversely, a resurgence of cane husbandry in 1781 (Figure 8.2) was attributed to the prevalence of "very favourable" weather during the first half of that year.[100] Two years of agricultural ruin were, nevertheless, still to follow. By the middle of April

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[97] DD/TD/15/6, M. Walrond to C. Tudway, 18 Apr 1776.

[98] E.g. DD/TD/15/6, Letters to C. Tudway from F. Farley, 11 Jun 1777; J. Grey, 27 Sept 1778; S. Elliot, 29 Apr 1779; J. Grey, 11 Jun 1779.

[99] COD/C8, L. Lovell to W. Codrington, 10 Jun 1780.

[100] COD/C10, R. Clarke to W. Codrington, 29 Jun 1781.

1783, "the Calamity of excessive Dry Weather" was such "as totally to destroy the hope of the Planter."[101] As was the case throughout the Leeward Islands, manufacture of sugar was simultaneously undermined by shortages of vital wares and the diversion of land and labour to subsistence agriculture.[102] Once famine and disease set in, however, the enfeeblement of the workforce appears to have become planters' principal challenge. So many slaves had died by June 1780, claimed Richard Clarke, that even if that year's crop had been large, "there would have been almost unsumountable [sic] difficulties in taking it off."[103] Another planter made the same point following the measles epidemic of 1783.[104]

With the sugar industry as the lifeblood of the colonial economy, it was only a matter of time before recurrent harvest failure precipitated financial ruin. This emerged first at the plantation level. As one anonymous visitor to the island explained in November 1781:

> Where there is so great a failure of yearly revenue, the expense of maintaining such a number of negroes as is necessary for cultivating these Estates, must be prodigious. The plantation unable to yield its accustomed quantity of vegetables is insufficient for the support of the negroes settled on it, and the owner must supply the deficiency by purchasing, which he is unhappily necessitated to do, at a time when he can least afford it. (Oliver, 1894: p.cxxv).

Pecuniary difficulties were also aggravated by escalating costs of plantation stores and mortality among bondspeople and livestock.[105] The loss of the labour of eighty Codrington slaves that perished in 1777 and 1778, for instance, was estimated to have cost the proprietor no less than £4,000.[106] Once fighting between England and France rendered already inauspicious commercial conditions untenable, securing credit from merchants became all but impossible.[107] Thus, many plantations became locked in a relentless cycle of decline; as climatic and geopolitical threats to plantation agriculture diminished investor confidence, the flow of overseas resources needed to sustain production evaporated, reducing operational efficiency and output further. The circle was broken only when intractable levels of debt drove proprietors out of the sugar industry altogether. So widespread was bankruptcy by the end of 1779, that local

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[101] CO152/63, Gov. Shirley to Lord Townsend, 15 Apr 1783.

[102] DD/TD/15/6, F. Farley to C. Tudway, 19 Jun 1776, M. Walrond to C. Tudway, 26 Jun 1782; CO152/58, Gov. Burt to Lord Germain, 15 Aug 1778.

[103] COD/C10, R. Clarke to W. Codrington, 8 Jun 1780.

[104] DD/TD/15/6, M. Walrond to C. Tudway, 15 Apr 1783.

[105] E.g. DD/TD/15/6, F. Farley to C. Tudway, 29 Dec 1775, M. Walrond to C. Tudway, 10 Jun 1778, 11 Feb 1779, 29 Mar 1780; COD/C10, R. Clarke to W. Codrington, 12 Jun 1779, 18 Jul 1781.

[106] COD/C12, R. Oliver to W. Codrington, 14 Jul 1783.

[107] CO152/59, Gov. Burt to Lord Germain, 3 May 1779.

Plate 7.1. Oil on canvas depiction of the Battle of the Saints (approx. 5 km south of Guadaloupe, Leeward Islands), 12 April 1782, by Thomas Whitcombe (1782). Courtesy of Royal Museums Greenwich.

government found it prudent to renew seldom-enforced legislation for "preventing the Escape of Debtors from this Island."[108]

Connected as they were through local taxes and shipping duties, private insolvency soon precipitated public insolvency. As we learnt at the start of this chapter, the colonial treasury was already depleted by autumn 1777. Military expenditure only mounted thereafter. Government accounts indicate that £140,000 colonial currency (roughly £80,000 sterling at the time and £5 million in modern terms) was invested in defence between 1777 and 1783—approximatley 80% of the total spent from 1776 to 1790.[109] After teetering at the precipice of insolvency for two years, the colony finally received British financial aid in 1780 (see Section 8.5.1). Nevertheless, fiscal instability lingered; come 1783, the legislature had again "run amazingly into debt."[110]

It is significant that, while repeatedly drawing links between Antigua's financial woes, the American trade embargo and international hostilities, government officials also frequently underscored the role played by precipitation scarcity.[111] Especially emphatic were the words of the Assembly in a three-page testimonial on the matter:

[108] CO152/34, Report of R. Jackson, 28 Dec 1779.

[109] CO152/67, Legislative minutes, 29 Jun 1789; CO7/1, Report of W. Hutchinson, 21 Jan 1791.

[110] CO152/63, Gov. Shirley to Lord North, 27 Jul 1783.

[111] E.g. CO152/59, Gov. Burt to Lord Germain, 3 May 1779; CO7/1, R. Oliver to anonymous, 4 Jun 1782; CO152/62, Gov. Shirley to Lord Townsend, 8 Nov 1782; CO152/67, Legislative minutes, 29 Jun 1789.

> For more than seven years… has this unhappy Colony been visited with a Drought, the severity of which cannot be more justly described than by a detail of the disappointments & Misery it has produced. Our Crops have been destroyed—our Labours and Industry frustrated—Our debts accumulated by a deprivation of the only means to reduce them. Families falling from Ease & Affluence into Penury and Want, have been obliged to abandon the Estates of their Ancestors. Our Lands… [have] become sterile, and debarred thereby of our Usual resources, our Expenses in the Cultivation of our Plantations have continually increased—Such has been and such is still the Situation.[112]

The brief revival of plantation operations in the drought-free year of 1781, despite the persistence of geopolitical and commercial stresses, serves as another demonstration of the pivotal influence of meteorological factors.

8.4.2. Physical (in)security

Military expenditure may have been vast during the war period, but there is much evidence that, in the case of attack, Antigua's vulnerability would have been amplified by the difficulties attending drought and commercial stagnation. In addition to the case of the royal 60th Regiment recounted earlier, the archives offer numerous anecdotal illustrations of this point. The bankruptcy of state and citizenry was blamed for sluggish progress in fortifying the island in 1780,[113] as well as the legislature's refusal to provide for "a considerable Body of Troops" due to arrive in the Leewards late in 1782.[114] Meanwhile, in September 1778, one plantation manager pronounced:

> if the French have the command of the Seas… they could at the most plentiful time starve us out, but at this time it could soon be done as we already have the greatest scarcity I ever knew…[115]

Shortages of supplies also seemingly augmented threats to physical security from within Antigua's shores. This was highlighted by Mr. Farley as early as December 1775:

> Famine (the worst of all Evils) approaches fast, which may, & probably will bring on a rebellion of our slaves, & as there are about 35,000 of them in this Island, [but] not above 4,000 whites, we shall stand a bad chance.[116]

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[112] CO152/63, Legislative petition, 28 May 1783.

[113] CO152/60, Gov. Burt to Lord Germain, 4 May 1780.

[114] CO152/62, Gov. Shirley to Lord Townsend, 8 Nov 1782.

[115] DD/TD/15/6, F. Farley to C. Tudway, 27 sept 1778.

The same fear was reiterated both by Farley and Mainswete Walrond in subsequent years.[117] Meanwhile, Governor Burt was convinced that by sanctioning foreign provision imports in 1778 (Section 8.5.1.), he had "prevented Insurrections among the slaves."[118]

Ultimately, Antigua was fortunate; foreign belligerents made no serious attempt to invade the island and the enslaved masses mounted no substantial uprising during the American revolutionary period. The colony did, however, witness violent slave dissent on a smaller scale at least twice. Late in March 1780, Richard Clarke had the duty of acquainting William Codrington that three of the proprietor's slaves—two from Tuites estate and one from Cotton—had been condemned to summary execution for trying to poison several of his plantation superintendents. Interestingly, Clarke also revealed that one of the intended victims, the manager of Tuites, had been the target of a similar attempt eighteen months earlier.[119] The scanty details afforded by related correspondence make it difficult to establish conclusively the factors driving these attacks. The fact that the same plantation manager was targeted twice within a relatively short timeframe suggests that his behaviour towards slaves may have been particularly antagonistic. Nonetheless, as noted earlier, contemporaries were certain that the exceptional hunger which then afflicted blacks enhanced the threat that they would turn against their masters. Such argumentation, as well as consideration of the role of climate as potential contributor, will now be put to one side for more detailed discussion in Chapter 11.

8.5. Combating crisis

8.5.1. Government interventions

By the late eighteenth century, administrators throughout the Caribbean had established a well-defined set of emergency procedures to tackle local resource scarcities. In the light of heavy dependence upon imported supplies, many of these involved amending the terms of overseas commerce (Mulcahy, 2006; Johnson, 2011). Action of this kind was taken by the Antiguan legislature just months after the American conflict began. Late in 1775, an appeal was made to the acting-governor of the Leeward Islands for provision exports from the island to be prohibited for thirty

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[116] DD/TD/15/6, F. Farley to C. Tudway, 27 sept 1778.

[117] DD/TD/15/6, M. Walrond to C. Tudway, 18 Apr 1776; DD/TD/15/6, F. Farley to C. Tudway, 10 Jun 1778.

[118] CO152/58, Gov. Burt to Lord Germain, 15 Aug 1778; see also CO152/57, Gov. Burt to Lord Germain, 1 Dec 1777.

[119] COD/C10, R. Clarke to W. Codrington, 30 Mar 1780.

days. After receiving approval from the Colonial Office, the proposal was sanctioned the following June.[120] One year later, British endorsement was obtained for a rather different amendment to maritime regulations: the legalisation of anti-American piracy.[121] As noted in Section 8.3.1, these early measures, in combination with favourable weather in autumn 1776, were seemingly successful in staving off serious shortages for a time. However, with the former serving only while some provision stocks remained, and the latter affording a limited and irregular supply, more cogent action was soon required. Earlier in 1776, the governors of the Crown's Caribbean colonies had been vested with the power to authorise temporary imports from non-hostile foreign provinces in the case of emergency, provided it be realised by British shipping.[122] Learning of the famine that threatened Antigua and several of its neighbours in the summer of 1777, Governor Burt called for commerce in the Leewards to be liberalised on these terms for six months. The subsequent commendation of the step by the British monarch[123] appears to have set somewhat of a precedent; it was taken when famine returned in autumn 1778 and after supplies elsewhere in the region were decimated by the hurricane of October 1780.[124] Such was the perceived danger on these occasions that trade was permitted in any non-enemy vessel.

Come the final years of the 1770s, local government had to legislate not only for provision shortages, but also fiscal decline. "The Annual Expense of this Island is… so large that it requires every Aid," wrote Burt in January 1778, before reporting the introduction of a new tax on alcohol retail in Antigua.[125] The following summer, acts were passed to stimulate commerce by expediting the collection of export customs and granting additional naval protection to shipping.[126] Yet, by the time the latter, relatively nominal, expedients came into effect, Antigua's interconnected subsistence and credit crisis had climaxed, rousing calls for British intercession. The Council and Assembly petitioned the King on three occasions in 1779 to solicit, firstly, that the local contingent of the 60th Regiment be supported at the Crown's expense; secondly, that emergency supplies of flour and beans be sent out; and, finally, that £30,000 of

[120] CO152/55, C. Greathead to Lord Germain, 5 Jun 1776.

[121] CO152/56, undated Legislative Petition, in letter from T. Warner to C. Greathead, 13 Feb 1777, Lord Germain to Gov. Burt, 26 Jun 1777.

[122] CO152/55, C. Greathead to Lord Germain, 5 Jun 1776.

[123] CO152/58, R. Burton to Gov. Burt, 6 Jun 1778, Lord Germain to Gov. Burt, 9 Jun 1778.

[124] CO152/59, Gov. Burt to Lord Germian, 2 Nov 1778; CO152/60, Gov. Burt to Lord Germain, 1 Nov 1780.

[125] CO152/34, Gov. Burt to Board of Trade and Plantations, 6 Jan 1778.

[126] CO152/34, Gov. Burt to Board of Trade and Plantations, 26 Sept 1779.

paper money be allowed to circulate in the colony for two years.[127] At great length, British officials acquiesced to all three of these requests, but not without imposing substantive adjustments to the second and third. Late in 1779, arrangements were made for bills of exchange totalling £20,000—which, accounting for inflation, would today amount to roughly £1,257,000—to be drawn on the royal treasury to enable the legislature to purchase provisions. These were then to be dispensed to slave-owners, who would subsequently pay an unspecified capitation tax on their serfs as a means of reimbursing the Crown.[128] Meanwhile, £17,000 worth of food—which finally arrived in March 1780—was despatched for subsidised sale rather than free distribution.[129] Notwithstanding the vast slave death toll of 1779 and 1780, Antigua's politicians praised the efficiency with which the aid was administered.[130]

This was not, however, the last that was to be heard of the relief package. By May 1783, the colony had managed to repay a meagre £600 of its £37,000 debt to Britain and, now bankrupt once more, was forced to suspend further repayments.[131] When exactly the balance was finally settled is unclear, but in 1801 officials reported for the first time in three decades that the treasury was in a "respectable State of Credit."[132] Neither was 1779 the last year local administrators sought to remedy provision supply problems. To protect the modest reserves that had accumulated in 1780, the exportation of all foodstuffs and wares was again banned for a limited time the following summer.[133] In 1783, the legislature also petitioned for St. John's and Parham to be given permanent free port status, though the appeal was snubbed by British officials.[134]

Whilst not offering comprehensive insights, contemporary material regarding institutional crisis management sheds some light upon such intangibles as community spirit in the face of adversity and religious conceptualisations of extreme weather. The former manifested itself first in late 1776, when a group of sixteen Antiguans armed a privately-owned sloop—the aptly-named 'Reprisal'—and began to maraud American shipping in the region. Public outcry against their indictment for this action eventually led parliament to condone the practise, prompting many others to embark on their own

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[127] CO152/59, undated legislative petition, in letter from Gov. Burt to Germain, 22 Feb 1779, legislative resolutions, 8 Apr 1779; undated legislative petition, in letter from T. Jarvis to Gov. Burt, 30 Apr 1779, undated legislative petition, in letter from Gov. Burt to Germain, 24 May 1779.

[128] CO152/59, undated legislative resolutions, in letter from Gov. Burt to Lord Germain, 10 Jun 1779; Lord Germain to Gov. Burt, 8 Oct 1779, copy of a minute of the Board of Treasury, 14 Dec 1779.

[129] CO152/34, Gov. Burt to Commission of Trade and Plantations, 13 Jun 1780; CO152/87, Gov. Lavington to Earl Camden, 30 Jul 1805.

[130] CO152/60, Gov. Burt to Lord Germain, 17 Mar 1780.

[131] CO152/63, Gov. Shirley to Lord North, 27 Jul 1783.

[132] CO152/80, Gov. Lavington to Duke of Portland, 23 Feb 1801.

[133] CO152/61, Gov. Shirley to Lord Germain, 30 Aug 1781.

[134] CO152/63, undated legislative petition, in letter from Gov. Shirley to Lord Townsend, 15 Apr 1783.

quests of plunder against the enemy.[135] On at least two occasions the authorities also extended aid to nearby colonies despite domestic exigencies. In March 1778, Governor Burt ordered 150 barrels of flour to be sent from Antigua to Montserrat's capital town, where several hundred destitute migrants had gathered.[136] Then, after the Great Hurricane of October 1780 devastated the Windward Islands, 1,300 barrels were shipped to St. Lucia and Barbados.[137] The authorities' next response to that storm was to declare the observance throughout the Leewards of a day of "Gratulation [sic] and thanksgiving to the divine Governor of the Universe," for having spared the islands of major destruction.[138]

8.5.2. Plantation-level responses

Aided intermittently by state intervention, Antiguan planters waged local campaigns to protect their livelihoods. At the most basic level, there appear to have been three ways in which estate administrators sought to cope with the disruption to established provisioning systems: the reduction of reliance on food imports, acquisition of emergency supplies from Britain and regulation of the workload and rations of bondspeople.

As noted in Section 8.2, the American embargo compelled planters in the British Lesser Antilles to dedicate significant resources to subsistence agriculture. In Antigua, it was the yam that became the domestic staple of slave diets, proving to be best suited to the island's soils and more resilient to precipitation shortages than other food crops.[139] This had become the principle produce of Clement Tudway's provision grounds by autumn 1775.[140] Come the early 1780s, thirty three acres were being planted with the vegetable yearly—an allowance which supported his slaves for four months in 1781 when overseas supplies failed to arrive.[141] Having had a similar experience in 1780, the Codringtons' Windward Estates doubled their yam allotment to cover ten canefields in subsequent years.[142] Nevertheless, recurrent drought appears to have meant that successful cultivation was the exception rather than the norm

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[135] CO152/56, petition of owners of the Reprisal, January 1777; T. Warner to C. Greathead, 14 Jan 1777; undated legislative petition, in letter from T. Warner to C. Greathead, 13 Feb 1777; Governor Burt to Lord Germain, 4 May 1777.

[136] CO15257, Gov. Burt to Lord Germian, 17 Mar 1778.

[137] CO152/60, Gov Burt to Lord Germain, Nov 1780 [precise date unspecified].

[138] SQL, S. Qunicy to H. Hill, 15 Nov 1780.

[139] 'Minutes, &c. Reported To The House, Veneris, 19^{o} die Martii 1790,' House of Commons Sessional Papers of the Eighteenth Century, Minutes of Evidence on the Slave Trade 1790, Part 2, Vol.72, pp.41-42; DD/TD/15/6, J. Grey to C. Tudway, 29 Nov 1781.

[140] DD/TD/15/6, M. Walrond to C. Tudway, 19 Oct 1775, F. Farley to C. Tudway, 29 Dec 1775.

[141] DD/TD/15/6, M. Walrond to C. Tudway, 26 Jun 1782; Ward, 1988.

[142] COD/C10, R. Clark to W. Codrington, 19 May 1780.

during the war years (Section 8.3), rendering the practise a largely unworkable solution.

In such a context, overseas supplies were vital. Late in December 1775, plantation manager Farley reported to Tudway:

> Some prudent people that have money or credit in England have ordered out Beans, but the greatest part were [sic] not able, & others that were able neglected to do it…. You, I & perhaps one third of the people that have plantations here have & expect a good many.[143]

It seems, though, that this minority only shrunk over the next half-decade as confidence in the colonial sugar industry and, thus, the possibility of obtaining provision advances from British merchants faded.[144] Market volatility did not, however, break the resolve of Sirs Codrington and Tudway to provide for their Antiguan slaves, as evinced by the numerous acknowledgements they received for having shipped dried goods during the war period. They also maintained a constant flow of capital to meet the expenses of exorbitant local supply costs, high taxes and the death of slaves and stock.[145]

Ultimately, when food reserves became depleted despite the aforementioned practises, slave-owners had little choice but to get by as best they could by reducing the workload and allowances of their chattels. Though normally better stocked than most, the plantations of Clement Tudway were not always exempt from such desperate measures. So it was in July 1777, when Farley wrote the absentee proprietor:

> I am sorry you did not send some Beans by ye fleet just arrived [as] this obliges me to stint yr negroes more yn I wish to do, they do not get more yn two thirds of ye allowance I give my own… . Yr Negroes shall be lightly worked, & everything done to keep them up until a proper Supply of Provisions arrive…[146]

The slaves' workload was also eased in October 1781, when many of their number were observed to be "thin for want of sufficient food."[147] Even at the harshest of times, however, Sir Tudway's labour force does not appear to have faced total starvation. While famine raged in the hurricane season of 1778, each of his adult

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[143] DD/TD/15/6, F. Farley to C. Tudway, 29 Dec 1775.

[144] CO152/59, Gov. Burt to Lord Germain, 3 May 1779; DD/TD/15/6, F. Farley to C. Tudway, 10 Jun 1778.

[145] See document series DD/TD/15/6 & COD/C8-12.

[146] DD/TD/15/6, F. Farley to C. Tudway, 27 Jul 1777.

[147] DD/TD/15/6, M. Walrdond to C. Tudway, 9 Oct 1781.

bondspeople received ten pints (5.5 litres) of beans weekly,[148] whereas the typical ration in the Leeward Islands throughout the mid-1700s is believed to have been seven pints (Ward, 1988). Nonetheless, it should be acknowledged that the latter was usually supplemented by an allowance of imported fish or meat and the produce of provision grounds, both of which were scarce in an embattled and arid Antigua. There is also some evidence that planters made labour-saving alterations to estate functions in response to harvest failure. For instance, in March 1780, such a trifling crop was expected that Sir Codrington's head manager arranged for the harvest of Betty's Hope to be processed on his other estates to enable an early start on caneland preparation and building repairs.[149]

Overall, it is apparent from the sources that plantations backed by wealthy and committed overseas investors, well established in the sugar trade, were best positioned to withstand the climatic and geopolitical strains of the late 1770s and early 80s. These individuals were not only most likely to meet the vast costs arising from such strains, but also to possess vital commercial ties and local resources that facilitated adaptation of individual elements of sugar manufacture. It may not be coincidence that the largest Antiguan planter families—the likes of the Codringtons and Tudways, the Martins, Byams and Nugents—retained their holdings from the early 1700s through much of the following century (Oliver, 1894; 1896, 1899).

8.6. Crisis in context: the local and regional, the revolutionary period and beyond

In Antigua, the period of the American Independence War was one of prolific, protracted and multifaceted resource scarcities and agro-economic downturn. At the root of said difficulties were the pressures of warfare and the attendant dislocation of regional trade, in coincidence with successive years of severe precipitation deficiency. But what of conditions after the war? Under imperial Navigation Acts, which were strictly enforced from the end of 1783, American produce could again be received in the British Caribbean colonies if conveyed in colonial shipping. Nevertheless, Ward (1988: p.42) asserts that by the late 1780s—thanks to the expansion of legal as well as illegal trade—North American supplies were reaching British plantations "in roughly the same quantities as before the war, at prices which had risen by no more than that of sugar over the intervening period." It is difficult to ascertain the precise degree of recovery that Antigua experienced due to the relative shortage of documentation available for this period and the absence of homogenous fiscal and agricultural statistics. Available sugar production and exports data do, however, suggest a substantial resurgence of plantation operations in the colony (Figure 8.2). Meteorological conditions are also poorly documented at the time, but no instances of

[148] DD/TD/15/6, M. Walrond to C. Tudway, 27 Sept 1778.

[149] COD/C10, R. Clarke to W. Codrington, 14 Mar 1780.

major climatic stress are recorded in the archives. This and the comment of Christopher Bethell Codrington—then residing in the island—that "Antigua perhaps never knew successive Years better" than the mid-1780s[150] is suggestive at least.

After this phase of ostensibly improved commercial and environmental conditions, came another two and a half decades marked by island-wide misery resulting from international conflict and bouts of extreme weather. Initially, however, these evils did not coincide, offering insights into their individual influence over human livelihoods. Antigua was again gripped by a powerful drought while peace prevailed between 1789 and 1791 (Section 5.3). The first of these years is recorded in multiple retrospective accounts to have witnessed an absence of rain culminating in the death of some 5,000 cattle (Lanaghan, 1844: p.189; Oliver, 1894: p.cxxxviii).[151] Meanwhile, visitors to the island noted that dry weather throughout 1789-1791 caused sugar yields to decline "near two-thirds" throughout the Leewards (Collins, 1792: p.36) and Antiguan ground provisions to fail completely (Young, 1801: p.282). Despite these difficulties, there were not the unanimous calls of public and private insolvency that had been so common a decade earlier. They did, however, emerge in 1795, when the accumulation of expenses associated with the outbreak of the French Revolutionary Wars (1792-1802), drought in 1794 and a hurricane the following August prompted local officials to petition the Crown—ultimately unsuccessfully—for a £10,000 rescue loan.[152] A similar combination of climatic and geopolitical stresses is documented ten years later. Scanty precipitation, a tropical storm in September 1804 and the proclamation of martial law—which suspended agricultural operations for six weeks—resulted in a ruinously small harvest in the summer of 1805. With the third of these developments also costing the colonial treasury over £20,000 and a fleet carrying "almost the whole Pittance of the miserable Crop" captured by the enemy, bankruptcy became universal in early July.[153] Administrators were once more obliged to solicit a £10,000 loan from the Crown[154]—a request successful on this occasion.[155] Records from subsequent periods of environmental and geopolitical stress are scarce. Nonetheless, a handful of missionaries' letters from 1812, when Britain was embroiled in conflict with both Napoleonic France and the United States, are eerily reminiscent of the situation at the turn of the 1780s. In early October, for example, just days after a hurricane had wrought destruction throughout the colony, Joseph Newby of Gracehill church wrote:

[150] COD/C20, Memorandum of C.B. Codrington, 1790-1792, p.30.

[151] See also PA, Vol.14, p.444, St. John's diary extract, 21 Jan 1837.

[152] CO152/77, Petition of W. Hutchinson, 26 Dec 1795.

[153] CO152/87, Gov. Lavington to Earl Camden, 30 Jul 1805.

[154] CO152/87, Legislative address to Gov. Lavington, 19, 28 June 1805.

[155] CO152/87, Earl Camden to Gov. Lavington, 2 Oct 1805.

> This year has been a remarkable dry one in this Island[;] this with the American war, makes provisions very scarce & dear. Both Black & White [people] feel it severely. Indian corn, the principal food for Negroes & Stock, is very high in price & indeed scarcely to be got for money.[156]

Notwithstanding commonalities between the late 1700s and early 1800s, records indicate that the government responses enacted in the American Revolution period, like the hardships stimulating them, were extraordinary. Especially noteworthy is the £37,000 of aid received by Antigua in 1779. Earlier in the eighteenth century, intervention of this nature was seemingly rare in the British Caribbean. According to Mulcahy (2006), on just one occasion did Parliament allocate significant funds to disaster relief in the region, pledging £20,000 to the victims of a fire in Charleston, South Carolina, in 1740. The only comparable example in Antigua appears to have been the decision to exonerate the colony of paying £2,500 of royal duties after a hurricane in 1772.[157] Notably, Britain's vast investment in relief in 1779 may not have stemmed purely from humanitarian concern. In his analysis of the even-more-exceptional £120,000 grant afforded to Barbados and Jamaica after suffering tremendous hurricane damage in 1780, Mulcahy (2006) highlights that the move had political benefits; by demonstrating the advantages of subject-hood, it offered a means to unify Britain and her West Indian possessions and ease criticism of wartime policy at a time of revolutionary sentiment. Such considerations could hardly have escaped Members of Parliament when Antiguan disaster relief was negotiated one year previously. To what extent this earlier action influenced the decision-making process behind the Jamaican-Barbadian grant is unclear, but the former was unquestionably an important precursor.

The temporary liberalisation of colonial trade restrictions was another institutional reaction to climate-related dearth that became common during the tumultuous late eighteenth and early nineteenth centuries. Again, there is no evidence—either in the consulted archives or histories extending back to colonisation (Lanaghan, 1844, Oliver, 1894, Dyde, 2000)—of this measure having been implemented prior to the American war. Subsequently, however, it appears to have been viewed as a standard emergency procedure. The colony was again opened to foreign imports in response to weather-related shortages at a time of peace in 1789 and on four occasions during the years of war that followed—twice in 1793 and once in 1794 and 1813.[158] When the

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[156] OL, Br. J. Newby to Br. Latrobe, 5 Oct 1812.

[157] CO152/32, Gov. Payne to Earl of Hillsborough, 18 Sept 1772, Earl of Hillsborough to Gov. Payne, 9 Dec 1772.

[158] CO152/67, J. Nugent to Lord Sydney, 13 Jul 1789, Gov. Shirley to W. Grenville, 8 Dec 1789; CO152/73, Gov. Woodley to H. Dundas, 7 Jan 1793, H. Dundas to gov. Woodley, 24 Feb 1793; CO152/75, Gov. Stanley to H. Dundas, 11 Jan 1794, Gov. Stanley to Antiguan Legislature, 11 Jan 1794; CO152/102, Gov. Elliot to Earl of Bathurst, 15 Aug 1813, 1 Oct 1813.

legislature requested the procedure to be implemented in late 1793, Governor Burt's admittance of cargoes from foreign territories in the late 1770s was explicitly cited as a justification.[159] The measures of temporarily prohibiting provision exports and legalising acts of piracy against the enemy were also brought into effect in later decades following tropical cyclone strikes in 1785, 1812 and 1813.[160]

Similarly, a number of plantation-level crisis mitigation measures adopted in the years around 1780 were commonplace during later episodes of environmental deterioration and geopolitical instability. The correspondence of the Tudways and Codringtons contains countless references to customary estate regimes being altered in accordance with weather patterns and the availability of provisions from the 1780s through 1810s.[161] Of the regional expansion of subsistence agriculture at the time, much has been written elsewhere (e.g. Ragatz, 1963; Sheridan, 1974; Ward, 1988). In the case of Antigua, it is possible that dry weather in the 1770s played a part in the selection of the yam, which, as noted earlier, was known for its resilience to precipitation scarcity, as the 'staple of choice.' This seems to have represented a lasting adaptation, for documentation from the late 1700s and early-mid 1800s reveals that it remained one of the most important subsistence crops on the Codrington and Tudway estates.[162] Similarly, droughts in the late eighteenth century may have played some part in the popularity of a new strain of sugarcane known as the 'Otaheite'. Many planters are thought to have phased out other cane varieties, which were less able to withstand dry conditions, during the 1790s and early 1800s (Ward, 1988). More evidence, would, of course, be required to substantiate this claim.

Notably, there is an almost total absence of evidence of reactions to climate-related dearth enacted by the slave community itself during the decades spanning 1775-1815. The inevitability of certain silences in the archive has already been considered in Section 4.5. A few sources indicate, nevertheless, that petty thievery was a popular coping strategy among the enslaved. For instance, in 1808, a year of low rainfall during the Napoleonic Wars, one Antiguan missionary asserted that a great rise in theft, particularly of livestock, owed to slaves' "poverty and hunger" at the time.[163] Interestingly, the stealing of plantation produce by bondspeople was also observed to be rife in the summer of 1780 and in 1812-1813 following drought and a series of cyclones.[164]

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[159] CO152/75, Gov. Stanley to H. Dundas, 31 Dec 1793, Legislative minutes, 21 Nov 1793.

[160] CO152/64, Gov. Shirley to Lord Sydney, 1 Oct 1785; CO152/100, Gov. Elliot to Earl of Bathurst, 12 Oct 1812; CO152/102, Gov. Elliot to Earl of Bathurst, 15 Aug 1812.

[161] See document series T/PH/swd/1-2 and COD/C20, C23.

[162] See document series T/PH/swd/2-3 and COD/C15-16, 24, 28-29, 33.

[163] PA, Vol.4, p.301, Extract of letter from Br. C. Richter, 19 Sept 1808.

[164] CO152/34, Gov. Burt to Board of Trade and Plantations, 28 Jul 1780; COD/C28, J. Osborn to C.B. Codrington, 27 Oct 1813.

It is noteworthy that Antigua was not the only British Caribbean colony where the troubles attending the American Revolution were intensified to the point of disaster by nature's onslaughts. In Barbados, Sheridan (1976) documents a familiar succession of precipitation scarcity, subsistence crop failure and famine in 1777 and 1778, prompting parliament to despatch food aid to the island. Several colonial historians (Sheridan, 1974, 1976; Schwartz, 2005; Mulcahy, 2006) have also identified remarkably frequent and destructive tropical cyclones in 1780 and 1781 as the source of considerable regional adversity. The wider significance of such environmental shocks has been postulated by Schwartz (2005). In late eighteenth-century parliamentary debates over the amelioration of slavery, he notes, some conclusions about the conditions of bondage appear to have been founded upon the abysmal situation observed at the beginning of the 1780s. Antigua may have been spared major storm damage at this time, but, in the context of unremitting rainfall scarcity, circumstances there were likely just as bad as elsewhere. In a similar way, Johnson (2002, 2011) contends that a succession of climate-related crises in the second half of the 1700s was pivotal to political developments in the Spanish Caribbean, including the adoption of free trade. Critically, Johnson also draws attention to the concurrence of recurrent meteorological extremes with an approximately fifty-year global warm anomaly beginning around 1750, which punctuated the cooler-than-normal temperatures of the Little Ice Age (c. 1400-1850). Following this, she notes that a recent ENSO reconstruction (Gergis and Fowler, 2009) exhibits an exceptional number of El Niño and La Niña cycles in the period 1748-1804—eighteen of the former and thirty-one of the latter—which may have been associated with more frequent extreme weather events in the tropical Atlantic (Johnson, 2011). These observations have important implications for contextualising human vulnerability in the late eighteenth-century British Caribbean. It is clear that recurrent warfare at the time rendered this commerce-reliant region peculiarly susceptible to additional strains upon food reserves and finances. If one follows Johnson's line of argumentation, it may be that macro-scale atmospheric forces at once made the occurrence of meteorological strains more probable. While not allowing for a comprehensive evaluation of such a suggestion, it would certainly not be refuted by the evidence presented in this chapter.

8.7. Closing remarks

It was June 1779 and prospects were still grim for the second battalion of the Royal Sixtieth Regiment. Food and drinking water in Antigua remained dangerously scarce, the threat of a French invasion was now imminent and the island's legislature—the only body capable of furnishing aid in these treacherous times—was sinking in debt. What ultimately became of the infantrymen is open to conjecture; surviving documentation remains silent on their fate during the years that followed. They were

not to die in battle, for foreign forces never mounted a direct attack on the island during the American war. What is clear is that the trials faced by the battalion were by no means isolated. From 1776 to 1783, the colony was gripped by intractable resource scarcities and economic downturn, which, in one way or another, touched all strata of society. It could be that the receipt of a vast relief package from Britain late in 1779 afforded local government the wherewithal to end the troops' sufferings permanently. Far more likely, however, is that among their ranks were some of the thousands of islanders whose lives were lost subsequently to famine and disease.

The findings presented here illustrate that the state of emergency that prevailed in late 1770s and early 1780s Antigua cannot be explained solely by the international hostilities and breakdown in trade for which that period is best known. Regional geopolitical and commercial pressures interacted with local nutritional, epidemiological, social and agro-economic circumstances, which were aggravated severely by climatic deterioration. Although massive loss of life in other Caribbean islands indicates that famine was perhaps inevitable during this age of war-induced dearth, the firsthand observations of Antiguans leave little doubt that the destruction of subsistence crops by drought contributed considerably to its human cost. Similarly, it is evident that the recurrent failure of sugar harvests, which rendered public and private finances increasingly unstable, owed both to the non-arrival of plantation stores and dry weather. Climate-related calamities of this nature were by no means unique in either time or space; the historical literature tells of various other West Indian colonies in which environmental shocks compounded existing subsistence difficulties catastrophically in the years around 1780. Meanwhile, there are clear parallels between the situation in Antigua during this timeframe and subsequent phases of warfare and extreme weather in the island's late eighteenth and early nineteenth century records. It also appears that the steps taken to manage resource depletion and financial ruin may have created somewhat of a precedent for future institutional action in the face of natural disasters, both locally and regionally. Homogeneities aside, the Antiguan crisis of the American Revolution period was singular in many ways, most notably, in the persistence and severity of adverse weather, human mortality and agricultural ruin experienced. By exploring Antigua's climate history during this time, the present case study has illustrated the critical role of natural forces which have hitherto received only passing commentary (e.g. Ragatz, 1963, Sheridan, 1974, 1976; Ward 1988), offering a novel perspective on what is otherwise a well-studied chapter of British West Indian history.

Chapter 9

Crisis among the free: storms, droughts and deluges at the dawn of emancipation, 1834-1838

9.1. Introduction

August 1st 1834 marks one of the great landmarks of British colonialism: the date on which slaves throughout the Empire were formally emancipated. In the West Indies—where the subjugation of an African-descended majority had underpinned socio-economic development for nearly two centuries—liberation catalysed a profound reconstitution of relations of land, labour, community and commerce. Evaluation of the nature and implications of such transformation has been the domain of many social, cultural and economic histories (e.g. Williams, 1970; Hall, 1971; Green, 1976; Olwig, 1994). A common point of emphasis in these writings is that processes of change played out over many years and were shaped critically by local factors. In Antigua, one notable particularity was the adoption of so-called 'immediate freedom' rather than the transitional programme of officially-regulated, but unwaged, plantation labour that was implemented in the other principal sugar colonies. Another, which has received much less attention, is the succession of varied meteorological extremes that impinged upon local livelihoods immediately after emancipation. The present case study explores the ways in which these environmental perturbations were experienced by Antiguan society within the context of the major transformation that it was undergoing. After sketching out the terms of emancipation policy and the modifications to popular livelihoods that it produced, the chapter examines the socio-economic effects of the meteorological shocks experienced from 1834-1838 and then discusses the governmental and civilian coping mechanisms implemented in response to them. By drawing on this evidence and referring to other phases of weather-related hardship in the early-mid nineteenth century, the chapter finally considers how abolition altered Antiguans' susceptibility to climate extremes, building upon the concept of 'differential social vulnerability' (see Section 2.4.1).

9.2. Liberation, legislation and livelihoods in the early-mid 1830s

Despite the rhetoric of immediate liberation that accompanied the British Emancipation Bill of 1833, it only, in fact, mandated instant and unqualified freedom for enslaved people under the age of six. For all others, the bill provided for a four- to six-year apprenticeship scheme—"a mitigated form of slavery" whereby freedpeople were required to labour for a maximum of 40½ hours a week for their former masters

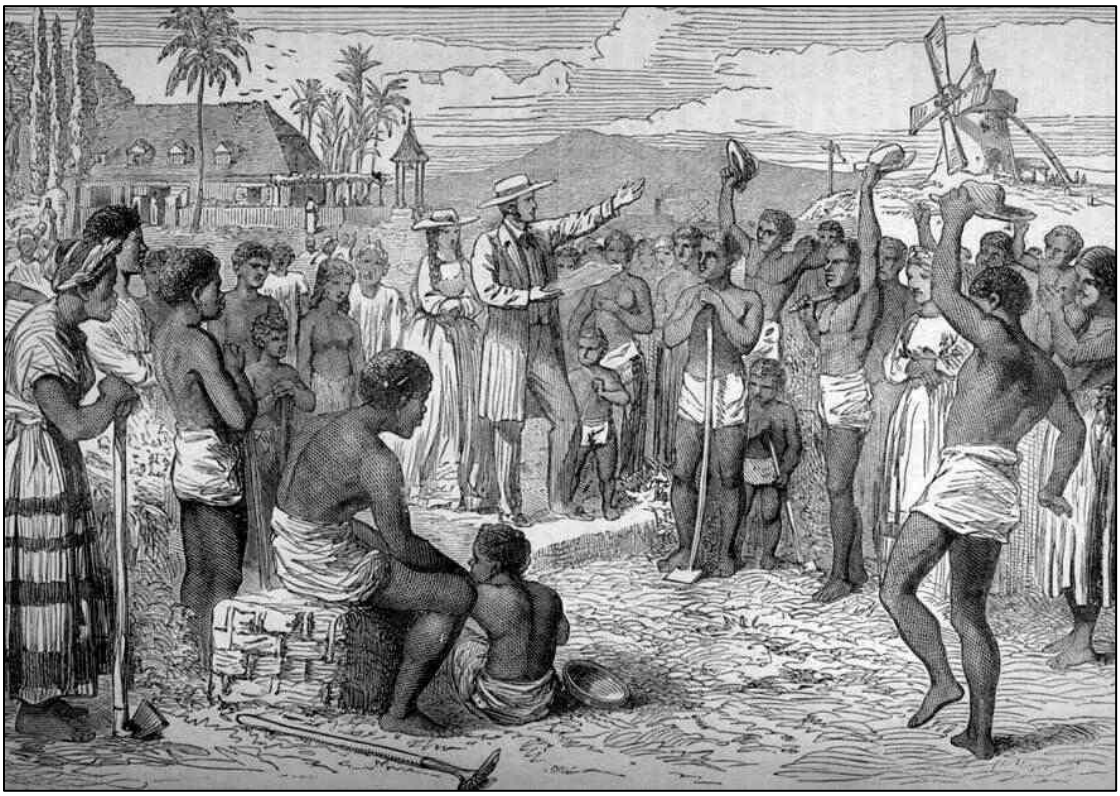

Plate 9.1. An engraving depicting a fictitious scene of West Indian slaves receiving news of the passage of the British Emancipation Bill of 1833 (anon.). From Cassell (1863: p.234).

in return for sustenance and lodging (Green, 1976: p.151). To reimburse slave-owners for the release of their chattels, parliament set aside £20,000,000—equivalent to a staggering £990,000,000 in modern terms. Before any compensation could be claimed, however, each colony had to acquire parliamentary approval of domestic emancipation laws. It was at this stage that the Antiguan plantocracy appears to have spotted the potential for their sugar estates to be operated more cheaply with free rather than apprenticed labour. The rationale was straightforward. Planters would be spared the expense of providing food, clothing, board and medical care for all bondspeople—many of whom were unable to work effectively due to age or disability anyway—and could instead offer wages for labour in accordance with their seasonally-variable demands. Whereas many Caribbean colonies faced the possibility that emancipation would precipitate a mass exodus from the plantations, this threat was minimal in Antigua; with virtually all cultivable land in this tiny island already devoted to the sugar industry, peasant livelihoods would be nigh on impossible (Hall, 1971; Dyde, 2000). Climatic considerations also figured decisively in lawmakers' calculations. In a letter to the governor outlining several reasons why apprenticeship would be redundant, members of the Assembly highlighted:

> the all-important and paramount one of an utter dependence, from peculiarity of climate and the absence of unoccupied lands, except those of absolute sterility, of the labourer to proprietor and capitalist for the means of procuring food; and that a large proportion of the population, whether bond or free, could not hope for the means of subsistence except by some laborious occupation in one of those frequent periods of long drought especially to which we are almost annually subject.[165]

In short, climate was another factor that would help to keep the elite in power. With this ostensibly in mind, the legislature drafted an emancipation act that went on to confer immediate and putatively full freedom upon all of the colony's 29,131 slaves as of August 1834 (Dyde, 2000).

The plantocracy's concern for economic efficiency at this time is comprehensible considering the bleak economic environment that they inhabited. As noted in Section 3.3.2, the co-action of a range of factors, including soil exhaustion, 'amelioration' measures and increasing overseas production, saw plantation profits slashed during the 1820s throughout the Leeward Islands. By the beginning of the 1830s, the regional economy was in paralysis; London sugar prices had fallen to their lowest values in a century (Figure 3.11), the prospect of emancipation had all but exterminated investor confidence and indebtedness had become epidemic among planters and merchants (Hall, 1971; Ward, 1988). Rather than ushering in an age of ruin, emancipation was actually succeeded by modest economic revitalisation, stemming partly from a boom in regional commerce stimulated by wage-earning and spending among the masses (Green, 1976). A rise in sugar's retail value also contributed, as did the capital injection Antigua received from the returns of a bumper crop in 1834[166] and emancipation compensation payments totalling £425,549 (Dyde, 2000). Commercial conditions were not entirely idyllic, however; competition in the sugar market was still growing, while planters faced the new difficulty of inducing emancipated people to work with the rigour they had under duress (Ward, 1988).

In 1833, Antigua contained over 200 km^2 of cultivated land, at least two thirds of which was dedicated to cane.[167] It was then standard for slaves to toil throughout the daylight hours, five to six days a week (Dyde, 2000; Lightfoot, 2007). Notwithstanding local geographical factors limiting the potential for pursuits other than sugar labour, emancipation witnessed major disruptions to this regime. Estimates suggest that during the first few months after August 1st 1834, the turnout of estate labourers fell to between a third and one half of its previous level. It became common for adult ex-slaves to supplement earnings from a few days of plantation work with

[165] CO7/37, N. Nugent and S. Warner to Gov. McGregor, 2 Nov 1833.
[166] CO10/18, 1834 Blue Book.
[167] CO10/17, 1833 Blue Book.

the proceeds from huckstering, whilst devoting more time to their provision grounds. Meanwhile, several hundred freed persons were observed to have opted for complete occupational change, dedicating themselves to urban or maritime trades, and children to have withdrawn from the canefields altogether.[168] Those who did report for estate labour pushed fervently for greater control over their schedules. Some, for example, refused to dedicate as much time to menial tasks, laboured during breaks in order to shorten the working day or simply retired from their duties whenever they saw fit.[169] Commitment to employers was further undermined by the fact that considerable variation in pay emerged between plantations.[170]

Naturally, the plantocracy did not sit idly by as its free labour experiment began to backfire. Within months of emancipation, a Vagrancy Act requiring all persons to possess a legally recognised occupation was introduced, along with licensing fees limiting entrance into popular forms of self-employment. More controversial was the Contract Act, which came into operation towards the end of 1834. This provided for year-long contracts, terminable at a month's notice, which bound plantation workers to a particular employer in return for a fixed wage and tenancy. Often, the very residence of a potential signatory on an estate was treated as contract confirmation. The act also introduced penalties ranging from immediate loss of pay to imprisonment for 'negligent' working practises. Any breach of contract by the employer, by contrast, resulted in a relatively small fine (Hall, 1971; Dyde, 2000; Lightfoot, 2007). To some extent, these draconian labour policies appear to have achieved their intended outcome; by July 1835 the consensus was that the availability of labour had recovered to two-thirds of what it had been during slavery.[171] Even so, complaints of low work rates and inconsistent attendance among labourers continued.[172]

On the whole, there were few positives that black Antiguans could take from the 'free' system. While planters remained responsible for supporting ex-slaves already too old to labour before August 1834, they had no obligations to those subsequently incapacitated by age or illness. Demand for poor relief now far surpassed the scope of the funds allocated by local government, which—just as had been the case prior to emancipation—consisted of nothing more than 2.5% of domestic custom duties and any unspent parish tax revenues. Furthermore, public institutions such as a hospital, poor house or orphanage had yet to be established (Hall, 1971; Dyde, 2000). Another grievance for the poor was increasing dependence upon costly imported foodstuffs—a

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[168] CO7/39, H. Loving to Gov. MacGregor, 27 Aug 1834.

[169] T/PH/swd/2, G. Ottley to J.P. Tudway, 22 Aug 1834; CO7/39, H. Loving to Gov. MacGregor, 27 Aug 1834; COD/C29, R. Jarrit to C.B. Codrington, 4 Sept.

[170] CO7/39, H. Loving to Gov. MacGregor, 31 Jan 1835.

[171] CO7/42, Responses to questionnaire issued by Gov. MacGregor, July 1835 [precise date unspecified].

[172] Ibid.; CO7/41, H. Loving to Gov. MacGregor, 28 Feb 1835; COD/C29, R. Jarrit to C.B. Codrington, 16 Mar 1835.

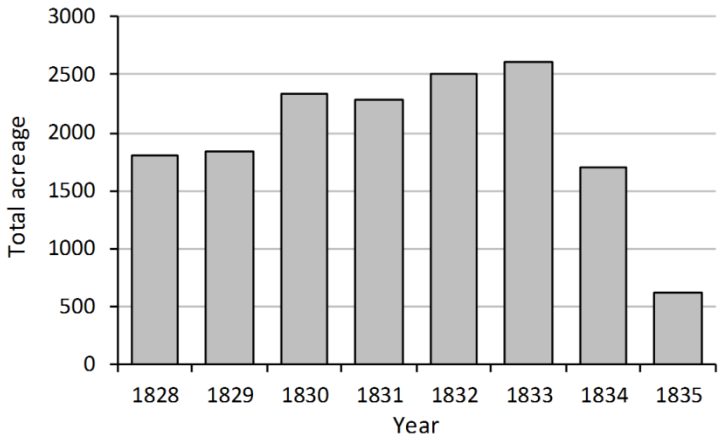

Figure 9.1. Total acreage of provision grounds on fifty Antiguan estates, 1828-1835. Source: CO7/42, undated statistical returns, enclosed with letter from Gov. MacGregor to Lord Glenelg, 1 Aug 1835.

trend brought about by the widespread abandonment of subsistence agriculture by planters (Figure 9.1). That this would further disadvantage the masses at times of climatic stress was identified by Henry Loving, Antigua's mixed-race chief of police, as early as July 1835; "the result will be deplorable indeed," he warned, "should we be overtaken with one of those visitations of Divine Providence, so much to be apprehended at this season of the year."[173]

9.3. Severe weather and socio-economic well-being, 1834-1838

9.3.1. Come rain, come storm…

Antigua embarked on its free labour venture in the midst of notable agricultural success. Following a succession of copious rains starting in autumn 1833, planters reaped one of the colony's largest sugar crops of the nineteenth century the following summer (Figure 9.2).[174] Despite the vicissitudes of the labour market emerging from August 1834, prospects largely remained pleasing. Addressing his house in late October, the speaker of the Assembly remarked that thanks to "the succession of fruitful seasons, the avoidance of the hurricane… [and] the respectful demeanour of the lower classes," commercial activity was "absolutely on the advance."[175] In fact, detailed analyses of archival weather descriptions (Chapter 5; Berland et al., 2013) indicate that the rain-year spanning December 1833 to November 1834 was quite remarkable as regards rainfall levels. Precipitation is documented to have been

[173] CO7/42, H. Loving to Gov. MacGregor, 31 Jul 1835.

[174] T/PH/swd/2, J. Freeland to J.P. Tudway, 7 Jul 1834.

[175] Antiguan legislative minutes of October 30th 1834, quoted in PA, Vol.13, p.238, Letter from B. Harvey, 2 Dec 1834.

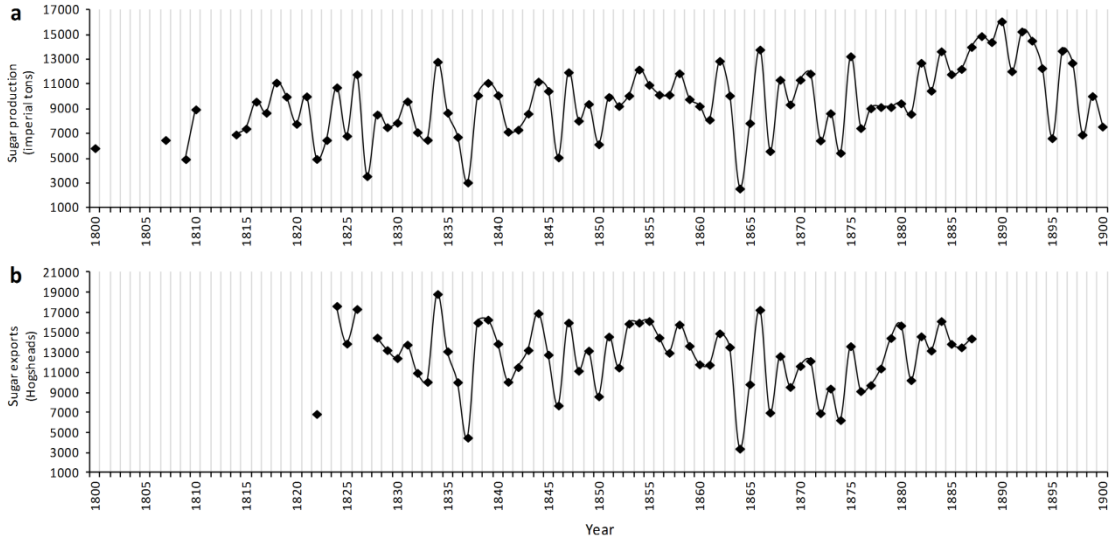

Figure 9.2. Annual Antigua sugar output, 1800-1900. (a) Sugar production (after Deerr, 1949: p.195) and (b) exports (CO10/6-71, Blue Books for 1822-1887).

abundant throughout those twelve months, but abnormally so in the dry season (December-April). According to the Moravian missionaries, thunder storms in February and March wrecked several vessels on the island's coast, while the downpours attending them damaged canefields and washed away dirt roads.[176] Such disruptions to human activities are unlikely to have been persistent or severe, however, given that they received no mention in the consulted government and plantation records, and also considering the large harvest that was reaped in 1834. Come December, even a member of the Moravian clan acknowledged that things were "the more promising for the prevalence of wet weather, and every kind of crop… [looked] remarkably fine."[177]

Certain localities did not share in the wet weather, instead experiencing the conditions that were soon to plague the island at large. In central-eastern Antigua, summer and autumn rains were deficient and complaints of water shortages commenced in early 1835.[178] It appears that dry conditions had come to prevail more extensively by July that year, several government correspondents reporting that a combination of drought and recalcitrance among the workforce were inhibiting sugar production.[179]

The manner in which wet weather finally returned could scarcely have been more grievous. At four pm on August 12th, Sister Elizabeth Morrish watched sky and sea from the Moravian premises in St. John's with mounting trepidation. A darkening

[176] PA, Vol.13, pp.233, 234, 474, Gracehill diary extract, February and March 1834.

[177] PA, Vol.13, p.239, Extract of letter from Br. C. Zellner, 13 Dec 1834.

[178] T/PH/swd/2, G. Ottley to J. Tudway, 3 Feb 1835.

[179] CO7/42, Responses to governmental questionnaire, July 1835 [precise date unspecified].

horizon, ragged clouds chasing one another at speed and waves swelling above their usual level: the well-known portents of an approaching cyclone. When a gust toppled a garden fence along with the brick pillars supporting it, Morrish's brethren sprung into action securing the buildings of their mission.[180] These were the outer bands of what military engineer William Reid (1838) christened the 'Antiguan Hurricane' in his landmark monograph on the storms. First sighted at sea some 500 km east of the Leewards, the whirlwind tracked westward across the Antilles to make its final landfall near the mouth of the Rio Grande, Texas, on August 18th (Ludlum, 1963; Chenoweth, 2006). In the island of its namesake, the winds raged with growing intensity until around midnight on the 12th, interrupted only by the passing of the eye of the hurricane some four hours earlier.[181] Daylight on the 13th bore a "scene of ruin" that left Sister Morrish lost for words to describe.[182] Attempting to articulate that which the clergywoman could not, Henry Loving, who was now the Governor's private secretary, and Richard Wickham, the new police superintendent, penned the following:

> Several large Buildings in Saint John's were either partially damaged or entirely ruined; and the poorest class of inhabitants have suffered the most, from the total demolition of their humble dwellings, with all their furniture, &c. [etc]. Many of these persons are left without a shelter or food; … we learn, generally, that the effects have been of a most serious character on the Sugar Plantations where, in some instances, the Proprietors' Dwellings have been much injured, the Managers or Overseers' Houses demolished or rendered uninhabitable, as well as the Negroes' Cottages; and Mills, Boiling Houses, and their Appurtenances shattered in various respects.[183]

Other accounts tell of "many small vessels" sunk in the island's waters (Lanaghan, 1844: p.202), twenty-two craft cast ashore, trees left branchless or prostrate, and "almost every species of Property" either "totally destroyed" or "ruinously injured."[184] Damage descriptions reviewed in Chapter 6 indicate that the storm struck at major hurricane intensity and was among the three most destructive cyclones in Antigua between 1770 and 1890.

Naturally, the devastation was extremely costly. A special legislative committee estimated the total loss to private individuals at £168,477 colonial currency—

[180] PA, Vol.13, pp.380-382, Letter from Sr. E. Morrish, 18 Aug 1835.

[181] CO7/42, H. Loving and R. Wickham to Gov. MacGregor, 13 Aug 1835; PA, Vol.13, pp.382-383, Letter from Br. B. Harvey, 25 Aug 1835.

[182] PA, Vol.13, pp.380-382, Letter from Sr. E. Morrish, 18 Aug 1835.

[183] CO7/42, H. Loving and R. Wickham to Gov. MacGregor, 13 Aug 1835.

[184] PA, Vol.13, pp.382-383, Letter from B. Harvey, 25 Aug 1835, pp.383-385, Letter from C. Zellner, 8 Sept 1835; quotations from CO7/42, Proclamation of Gov. MacGregor, 15 Aug 1835.

approximately £74,800 sterling, which would be equivalent to some £3,300,000 today—accounting for all agricultural, animal and structural assets. An additional £3,339 currency worth of damage was sustained by public property.[185] Evidence of consequent fiscal instability emerged in mid-September, when members of the legislature grumbled that their resources were "well nigh exhausted," due to "derangements in… productive industry" occasioned by the hurricane, outlays on repairs and the expenses of administering emancipation.[186] The cyclone also had longer-term fiscal consequences; in June 1836, it was recognised that the relief measure of removing import duties for six months (see Section 9.4.1) had denied the treasury one of its principal incomes.[187] The human cost of the storm is much less clear. Though twelve hurricane-related fatalities were officially logged, it was believed that "many others" had gone unreported.[188] Evidence of the number of persons injured or left homeless, as well as the exigencies to which they were exposed, have not been encountered. Nevertheless, it may be suggestive of the trauma experienced by some that Sister Morrish noted:

> [On] the Sunday following [the hurricane], we had a larger congregation than the church could contain. … The negroes were so deeply affected, that when we knelt down in prayer… [the pastor's] voice could scarcely be heard for their convulsive sobs and weeping.[189]

Unhappily for Antiguans, the gradual restoration of amenities and few weeks of seasonable showers that followed the storm did not mark the end of this phase of nature-induced hardship. By late September, epidemic yellow fever had descended upon St. John's. It is possible that the sudden transition from dry to wet weather which began with the hurricane acted as a catalyst, for such conditions are known to be conducive to the explosion of populations of mosquito vectors (McNeill, 2010). Causation aside, the epidemic raged in the capital for two months, committing its trademark ravages among Europeans, who lacked inherited immunity to the virus. During this period, one resident physician attended 220 cases, of which 140 were in whites and fourteen resulted in death (Nicholson, 1856).

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[185] CO7/43, Hurricane loss estimates, enclosed with letter from Gov. MacGregor to Lord Glenelg, 4 Mar 1836.

[186] CO7/42, Legislative memorial to the Crown, 10 Sept 1835.

[187] CO7/43, Legislative minutes, Address of President to Council and Assembly, 2 Jun 1836.

[188] CO7/42, P. Horseford to H. Loving, 17 Aug 1835.

[189] PA, Vol.13, pp.380-382, Letter from Sr. E. Morrish, 18 Aug 1835.

9.3.2. ...Come drought, come deluge

While yellow fever wrought havoc in St. John's, nature's next assault on Antiguan livelihoods was already underway. From September 1835 through May 1837, Antigua was gripped by a drought which—like the cyclone preceding it—was of rare severity (Section 5.3.1; Berland et al. 2013). Evidence of its effects began to emerge in May 1836, when—just as in 1835—low sugar yields were blamed on emancipated people's "idleness" and "unpropitious weather."[190] One month later, however, police chief Richard Wickham suggested that the latter had become the greater difficulty, noting: "the manufacture of sugar has advanced as far as the long and continued want of rain will admit."[191] This was certainly the case on the Old Work estate—then belonging to Sir Robert Charles Tudway—where unsown lands were said to lie in readiness for planting, wanting only "a drop of rain."[192] Come September, Wickham simply described prospects as "most gloomy and unfavourable," the twelve previous months having been "the driest known in this island for several years, and the crop produced the shortest."[193]

With the near total failure of the 1836 rainy season, the colony was propelled from a state of acute peril to one of acute hardship. Writing on the penultimate day of the year, Thomas Foote, the man in charge of the Tudway estates, described the situation as follows:

> no part of the country will make anything worth calling a Crop, for the late canes will now do nothing, and the forward canes are so stunted and nowhere near ripe, as to leave us but little to expect of them. Such a form of dry weather I never knew... the Cattle are in great distress for food & Water, & are dying all over the Island… The labourers feel the dry weather as much as the Proprietors, for their gardens do nothing and provisions are so extremely high [in price]…"[194]

Widespread livestock mortality, owing to the decimation of pastures and water supplies, continued to be a prominent theme in the archives through the middle of 1837.[195] In June that year, Foote relayed the news that ten head of his patron's cattle had died in May alone, while some planters had "lost their all."[196] Shortages of vital

[190] CO7/43, letter from R. Wickham, 20 May 1836.

[191] CO7/43, letter from R. Wickham, 16 Jun 1836.

[192] T/PH/swd/2, T. Foote to R.C. Tudway, Jun 1836 [precise date unspecified].

[193] CO7/44, response of R. Wickham to Lord Glenelg's survey, 12 Sept 1836.

[194] T/PH/swd/2, T. Foote to R. Tudway, 30 Dec 1836.

[195] E.g. T/PH/swd/2, T. Foote to R. Tudway, 4 Mar, 4 Apr 1837; COD/C32, S. Auchinleck to C.B. Codrington, 1 May, 10 Jun 1837; PA, Vol.15, p.180, Gracebay diary, 5 Mar 1837; CO7/49, A. Browne to Lord Glenelg, 3 Jul 1837.

[196] T/PH/swd/2, T. Foote to R. Tudway, 15 Jun 1837.

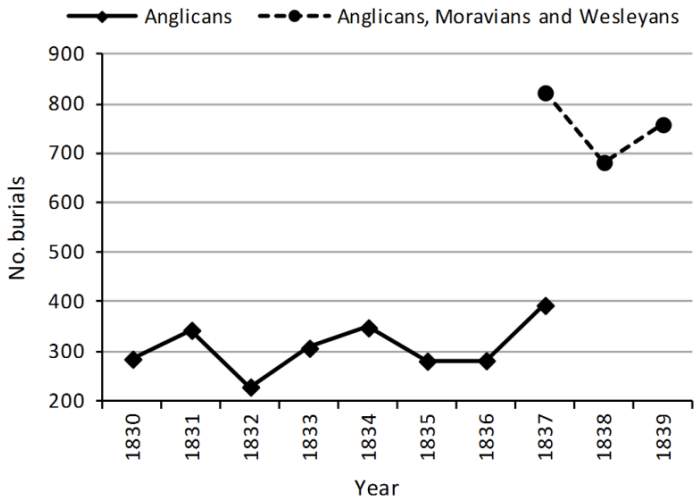


Figure 9.3. Number of burials registered annually in the Antigua, 1830-1839. Data from colonial Blue Books (CO10/14-23).

resources also plagued the human population, especially in Antigua's ever-growing capital. One Moravian from St. John's commented in late June that during the preceding eight months water had grown "so scarce, as to produce great alarm and a general depression of spirit." The distress, it was observed, had been utmost among the poor, "as there was, at the same time, a great dearth of provisions."[197] Nevertheless, Mr. Foote, who had to purchase imported water for his family at Parham Lodge, asserted that none in the island were unaffected by thirst.[198] Subsistence problems stemming from the ruin of domestic food crops—which multiple accounts attest was absolute[199]—were all the more severe for the failure of grain harvests in the United States in 1836. This accelerated already-escalating prices[200]—a problem naturally weighing heaviest on islanders of modest means and especially those unable to work. Though the particulars of their plight were not noted, the fact that aged and disabled individuals not supported by former slave-owners now faced utter destitution was highlighted repeatedly by missionaries and state officials.[201]

While unquestionably representing a phase of extraordinary privation, the years 1835-1837 did not ultimately witness the mass human death toll that some had feared. Available burial registers from the 1830s, though not of a uniform nature, suggest a

[197] PA, Vol.14, p.193, Letter from F. Thraen, 26 Jun 1837.

[198] T/PH/swd/2, T. Foote to R. Tudway, 28 May 1837.

[199] E.g. PA, Vol.14, p.444, St. John's diary, 21 Jan 1837; CO7/47, undated legislative memorial, enclosed with letter from Gov. Colebrooke to Lord Glenelg, 26 Jun 1837; CO7/49, A. Browne to Lord Glenelg, 1 Jul 1837.

[200] CO7/47, undated report on 1836 Blue Book, enclosed with letter from Gov. Colebrook to Lord Glenelg, 13 Jun 1837.

[201] CO7/44, Gov. Light to Lord Glenelg, 22 Nov 1836; CO7/58, Governor Colebrooke to Marquess Normanby, 8 Aug 1839 [see enclosures]; Sturge and Harvey, 1838.

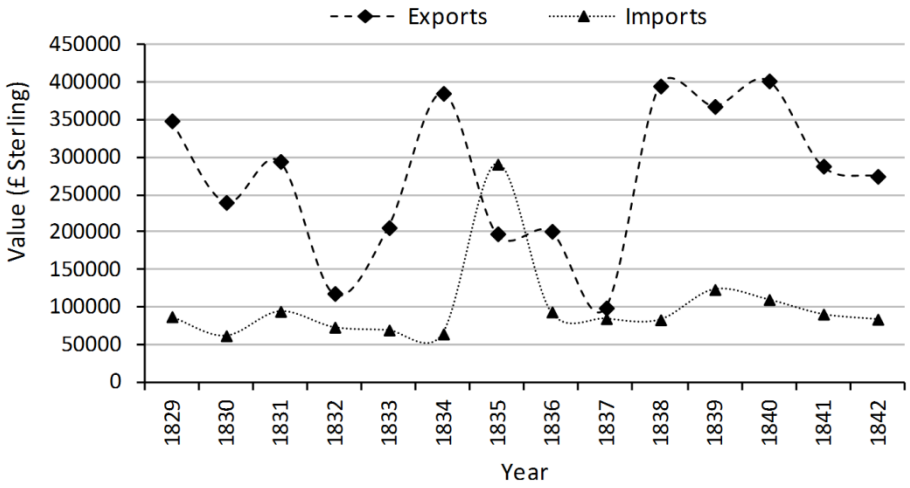


Figure 9.4. Annual value of Antiguan imports and exports, 1829-1842. Data from colonial Blue Books (CO10/13-26).

rise in mortality in 1837, when food and water scarcities climaxed (Figure 9.3). The spread of fevers in the second half of the year, which will be discussed shortly, likely contributed to the increase. However, the number of interments then recorded was far from orders of magnitude greater than in the surrounding years. Overall, relatively high survival rates during this phase of environmental stress likely owe to the fact that sustenance continued to be received from overseas. Indeed, with the exception of 1835, when customs duties were temporarily suspended, the value of imports to the colony remained stable throughout the thirties (Figure 9.4).

The mid-thirties drought may not have been attended by demographic crisis, but it did precipitate agro-economic upheaval. After bemoaning the disappointing returns of the 1836 harvest, estate managers became increasingly despondent in their correspondence as all hope for the next crop evaporated; canefields across much of the island remained too dry to plant and, where showers did fall, the shoots they brought forth either wilted away or were severely stunted.[202] As Thomas Foote had foretold, the 1837 harvest was a complete failure; only in one other year in the 1800s did the island's sugar output plummet so low (Figure 9.2). Having expended the majority of their emancipation compensation funds on hurricane repairs, many planters—amongst whom indebtedness had been widespread in the early 1830s—lacked the wherewithal to cover expenses in the unfortunate year of 1836.[203] As such, trifling returns in 1837 were disastrous. Even those plantations benefitting from economies of scale and fertile terrain suffered considerably. On the Tudway estates, for instance, production collapsed that year (Figure 9.5), while the Codrington plantations registered their only

[202] See document series T/PH/swd/2 and COD/C32.

[203] CO7/47, undated legislative memorial, enclosed with letter from Gov. Colebrooke to Lord Glenelg, 26 Jun 1837.

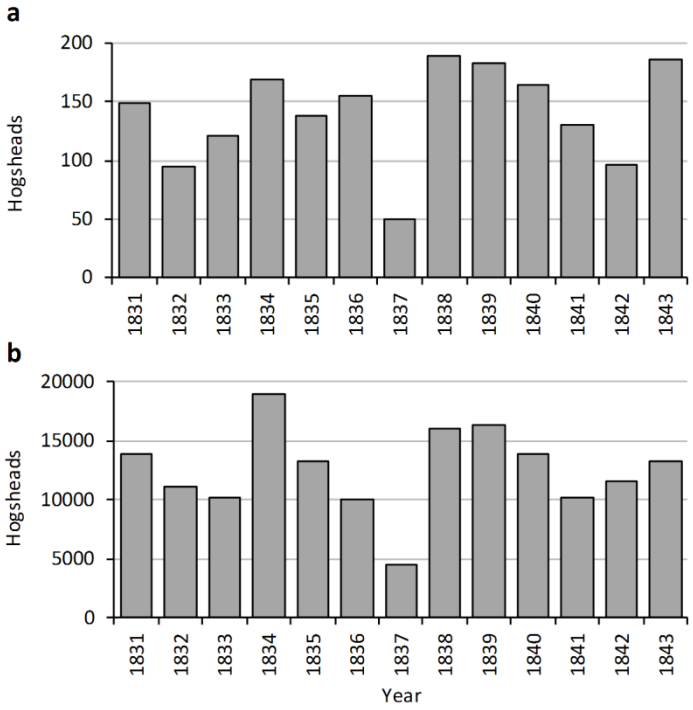


Figure 9.5. (a) Annual sugar production on the Tudway Family's New Work estate and (b) total annual sugar exports from Antigua, 1831-1843. Data from: T/PH/swd/2, J. Freeland to R.C. Tudway, 24 Jul 1835, 27 Feb 1836; T/PH/swd/3, T. Foote to Mrs. Tudway & H. Tudway, 28 Jul 1858; CO10/15-27, Blue Books for 1831-1843.

departure from profit-making in the fourteen years 1828-1841 (Figure 9.6). A similar pattern characterised government finances, as export duties dropped and tax defaults mounted; after trailing narrowly behind in 1836, the following year expenditure exceeded revenue for the first time in over a decade (Figure 9.7). By July 1837, the treasury was empty.[204]

Before government insolvency set in, however, the drought came to its end; the final week of May brought island-wide downpours.[205] Records then indicate the prevalence of seasonable conditions throughout the remainder of the year, with a pair of tropical storms in summer contributing their share of the wet weather without producing any major disruptions. Various sources tell of considerable soil erosion in the environs of St. John's with the arrival of the rains, followed by the gradual restoration of water supplies and subsistence agriculture across the island.[206] Food prices seem to have recovered more slowly, Thomas Foote commenting in November

[204] CO7/47, R. Horseford to Gov. Colebrooke, 21 Jul 1837; CO7/49, A. Browne to Lord Glenelg, 1 Jul 1837.

[205] PA, Vol.14, p.446, St. John's station diary, 29 and 30 May 1837.

[206] CO7/47, Gov. Colebrooke to Lord Glenelg, 19 May 1837 [undated postscript], R. Wickham to Gov. Colebrooke, 7 Sept, 10 Oct 1837; T/PH/swd/2, T. Foote to R.C. Tudway, 28 May 1837; COD/C32, S. Auchinleck to C.B. Codrington, 10 Jun 1837; see also Lanaghan, 1844: pp.195-196.

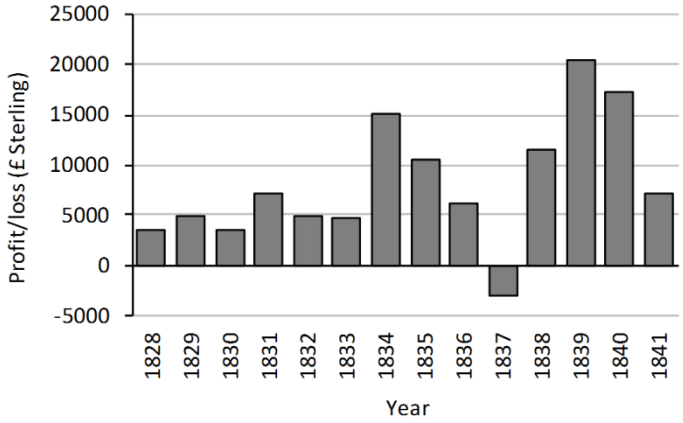


Figure 9.6. Annual profitability of the Codrington Family's 'Windward Estates,' 1828-1841. Data from COD/C46, undated plantation return, circa 1842.

that these continued to provoke "great distress amongst the Labouring Classes."[207] Nevertheless, four months later, Antigua's newest police chief, Martin Nanton, affirmed: "the state of the markets, for cheapness and quantity, will show the abundance of the provision crop."[208]

Wet weather persisted throughout 1838 (Section 5.3.2), at the end of which the diary of the Moravians' Gracehill mission recorded:

> fields and provision-grounds brought forth abundant crops, and the whole island presented a fresh and luxuriant appearance. Even our surrounding hills, on whose sunburnt brows dryness and barrenness generally reign, exhibited the same fruitful aspect. The attendance at church and school was, however, often thinned by the floods which poured down in such abundance. It happened several times on a Communion-Sunday, that in some places it would have been quite dangerous for our people to try to cross the torrents, swollen as they were.[209]

These inundations had a deleterious effect on economic activity too. In the height of the wet season, Sir Tudway's head manager observed that some of his canefields were "absolutely chilled & yellow from too much water,"[210] while "the roads throughout the Island" had become "nearly impassable &… most destructive to Carts and laborious to the [live]stock."[211] Contemporary accounts also associate some sickness with the wetter-than-normal conditions following the drought. As early as June 26th,

[207] T/PH/swd/2, T. Foote to R.C. Tudway, 15 Nov 1837.
[208] CO7/51, M. Nanton to Gov. Colebrooke, 5 Apr 1838.
[209] PA, Vol.15, p.79, Gracehill station diary 1838.
[210] T/PH/swd/2, T. Foote to R. Tudway, 25 Sept 1838.
[211] T/PH/swd/2, T. Foote to R. Tudway, 10 Nov 1838.

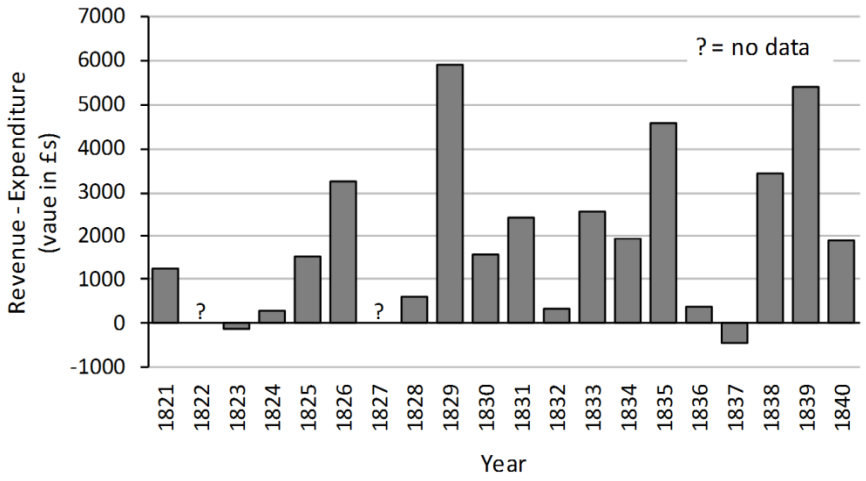


Figure 9.7. Difference between revenue and expenditure of the Antiguan government, 1821-1840. Data from Blue Books (CO10/5-24).

Brother Thraen of the Moravians claimed that "the sudden change of the weather… brought on, as usual, some sickness."[212] Analogously, Foote reported that "a continuance of good showers" in the winter of 1837-38 had produced "much fever," claiming an unspecified number of lives.[213] Nevertheless, no set-backs of this kind appear to have had repercussions of an appreciable magnitude for the wider agro-economy. Planters and colonial officials alike celebrated the large sugar crop that was processed in 1838, despite the prevalence of drought at the start of the growing season.[214] This was then exceeded in 1839 (Figure 9.2, 9.5b). Meanwhile, the Codrington plantations saw a decisive return to profitability (Figure 9.6) and government revenue surpassed expenditure comfortably once more (Figure 9.7).

9.4. Coping with catastrophe

9.4.1. Government measures "to avert… the evils of Famine and Despair"[215]

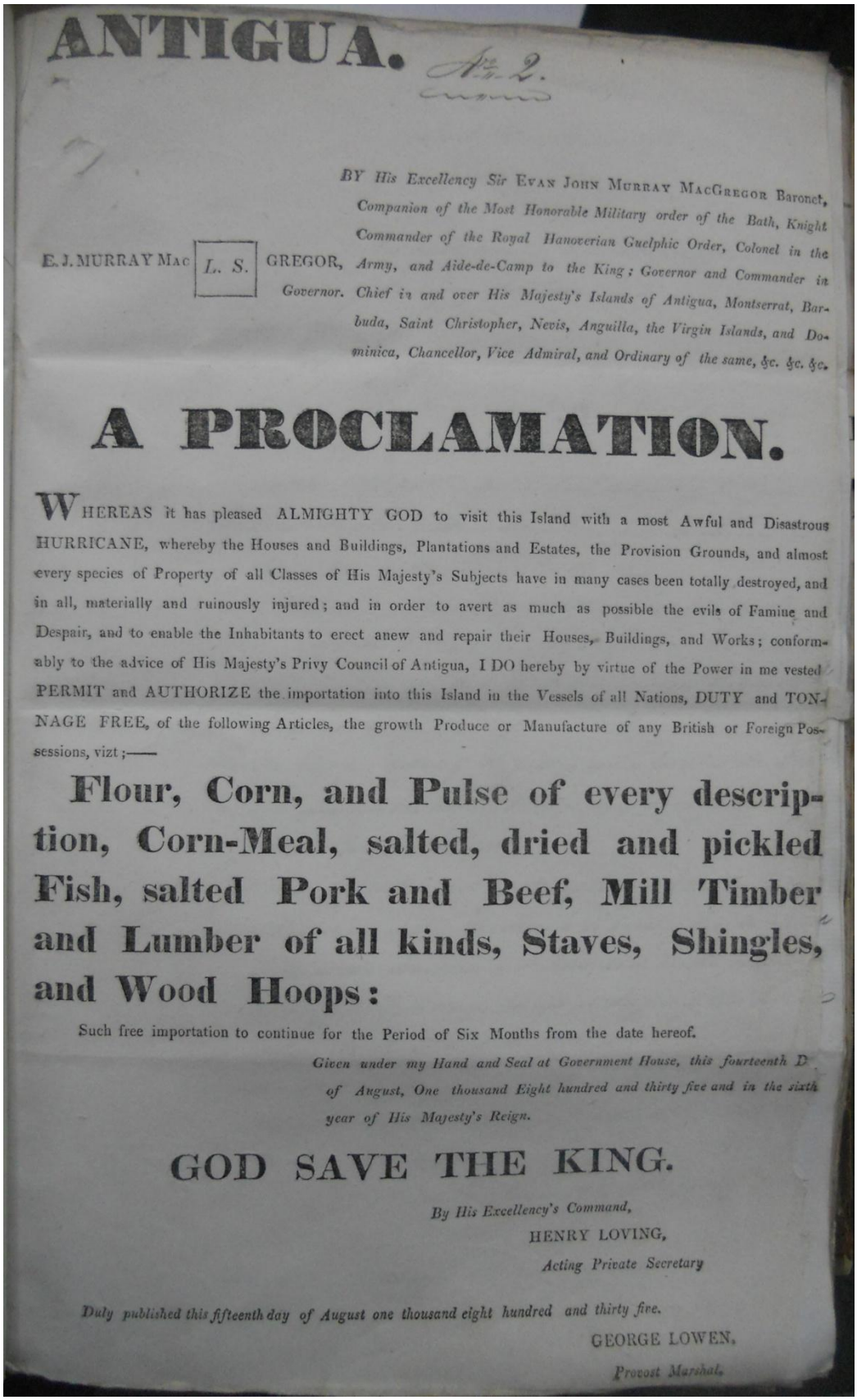
As noted in the previous chapter, colonial government in the British Caribbean often turned to a uniform selection of emergency procedures in the face of disaster, predicated upon procuring the resources needed to sustain vulnerable populations and economic activities. Such steps were first documented three days after the hurricane, when the governor, Evan John MacGregor, called for all import tariffs to be

[212] PA, Vol.14, p.193, Letter from Br. F. Thraen, 26 Jun 1837.

[213] T/PH/swd/2, T. Foote to R. Tudway, 16 Jan 1838.

[214] COD/C32, S. Auchinleck to C.B. Codrington, 10 Sept 1838; CO7/51, Gov. Colebrooke to Lord Glenelg, 1 Jun 1838.

[215] Quotation from CO7/42, Proclamation of Gov. MacGregor, 15 Aug 1835 (Plate 7).



ANTIGUA.

No. 2.

BY His Excellency Sir EVAN JOHN MURRAY MACGREGOR Baronet, Companion of the Most Honorable Military order of the Bath, Knight Commander of the Royal Hanoverian Guelphic Order, Colonel in the Army, and Aide-de-Camp to the King; Governor and Commander in Chief in and over His Majesty's Islands of Antigua, Montserrat, Barbuda, Saint Christopher, Nevis, Anguilla, the Virgin Islands, and Dominica, Chancellor, Vice Admiral, and Ordinary of the same, &c. &c. &c.

E. J. MURRAY MAC GREGOR, Governor. L. S.

A PROCLAMATION.

WHEREAS it has pleased ALMIGHTY GOD to visit this Island with a most Awful and Disastrous HURRICANE, whereby the Houses and Buildings, Plantations and Estates, the Provision Grounds, and almost every species of Property of all Classes of His Majesty's Subjects have in many cases been totally destroyed, and in all, materially and ruinously injured; and in order to avert as much as possible the evils of Famine and Despair, and to enable the Inhabitants to erect anew and repair their Houses, Buildings, and Works; conformably to the advice of His Majesty's Privy Council of Antigua, I DO hereby by virtue of the Power in me vested PERMIT and AUTHORIZE the importation into this Island in the Vessels of all Nations, DUTY and TONNAGE FREE, of the following Articles, the growth Produce or Manufacture of any British or Foreign Possessions, vizt;——

Flour, Corn, and Pulse of every description, Corn-Meal, salted, dried and pickled Fish, salted Pork and Beef, Mill Timber and Lumber of all kinds, Staves, Shingles, and Wood Hoops:

Such free importation to continue for the Period of Six Months from the date hereof.

Given under my Hand and Seal at Government House, this fourteenth D of August, One thousand Eight hundred and thirty five and in the sixth year of His Majesty's Reign.

GOD SAVE THE KING.

By His Excellency's Command,
HENRY LOVING,
Acting Private Secretary

Duly published this fifteenth day of August one thousand eight hundred and thirty five.
GEORGE LOWEN,
Provost Marshal.

Plate 9.1. Proclamation of Governor Evan MacGregor permitting unrestricted duty free imports of various provisions (CO7/42, photographed by the author, June 2012).

suspended on a range of foodstuffs, plantation stores and construction materials for the next six months (Plate 9.1). That local and overseas merchants took full advantage of this boon, which was extended to foreign as well as British shipping, is illustrated by the more than threefold increase in the value of imports into the island between 1834 and 1835 (Figure 9.4). Yet, in the context of emancipation, this measure alone could not guarantee the receipt of incoming supplies by the African-creole underclass—a responsibility previously borne by planters. The legislature's solution, enacted on August 22nd, was to spend £1,500 on basic food and buildings supplies for the "indigent sufferers by the late hurricane". To the same end, another £100 was donated to the Daily Meal Society—a charity based in St. John's providing the needy with that which its name suggests.[216]

Similar action was taken in response to water shortages. In April 1837, the legislature appointed a special committee with £500 at its disposal to establish a supply for the colony's thirsty inhabitants.[217] Over the course of a month, several springs were cleared of debris in the outskirts of the capital to lessen the pressure on diminished urban reserves. The committee then turned to overseas resources. Two local merchant houses were engaged to obtain 130 casks of an unspecified volume, followed by another 100 puncheons of water (roughly 31,800 litres), from Montserrat. Some thirty casks were also shipped from an isolated spring in the southwest Antigua. By mid-May, the landed supply was being retailed in St. John's at 4½ pence colonial currency per four gallons (approx. 18.2 litres).[218] The success of this intervention is not clear from the extant documentation. Notably, no direct provision appears to have been afforded outside the capital, presumably leaving much of the population dependent on spring, pond and cistern water of decreasing quantity and quality.[219]

Tackling fiscal decline formed another important strand of disaster management. Attempts to do so commenced during the hurricane recovery effort of 1835, with the Antiguan legislature petitioning the Crown on September 10th in solicitation of "such pecuniary relief… as the necessity of the case so urgently requires."[220] Despite later receiving a letter supporting the request from the Governor MacGregor,[221] the colonial office, at length, declined.[222] The legislature next raised the subject of overseas aid in June 1837. On the grounds of the additional burden of drought, recurrent crop failure and tax defaults, an unsuccessful appeal was made for British exports duties to be abolished.[223] Finally, local politicians discovered that the solution

[216] CO7/42, S. Warner and N. Nugent to Gov. MacGregor, 22 Aug 1835.
[217] CO7/47, Extract of assembly journal, 13 April 1837.
[218] CO7/47, Legislative minutes, 15 May 1837.
[219] CO7/47, Gov. Colebrooke to Lord Glenelg, 19 May 1837.
[220] CO7/42, Legislative memorial to the King, 10 Sept 1835.
[221] CO7/43, Gov. MacGregor to Lord Glenelg, 4 Mar 1836.
[222] CO7/44, Gov. MacGregor to Lord Glenelg, 20 Aug 1836.
[223] CO7/47, Legislative memorial to the King, 26 Jun 1837.

lay in avoiding any direct cost to the Crown. Thus, the following month, an act providing for a £10,000 loan to be raised privately in the homeland was formulated. With repayment secured by various new taxes and the Colonial Office required only to administer receipt of the funds, this scheme appears to have been far more attractive to metropolitan officials, who gave their consent within a few months.[224] It also seemingly succeeded in seeing the Antiguan treasury through until agro-economic resurgence commenced the following year. By the summer of 1840, the loan was reported to be fully repaid and the treasury "free from debt."[225]

The Antiguan authorities also sought relief, or sometimes simply condolence, from a higher power. Within days of removing import duties in August 1835, MacGregor issued another proclamation designating September 2nd "a day of Public Humiliation and Thanksgiving before God." This, he stipulated, was to acknowledge the colony's preservation from even more serious harm in the hurricane and to implore continuing divine protection.[226] Measures akin to this were taken two years later. By official decree, a fast was observed on April 28th 1837 in supplication for deliverance from drought,[227] while another day of public thanksgiving was called in mid-June in response to the arrival of rains.[228]

9.4.2. Survival strategies among the emancipated

Overall, it might be commented that the emergency procedures adopted by local government were, in the context of the previous chapter, relatively routine. The same cannot be said of the coping strategies employed by the African-descended masses, the potential diversity of which invariably expanded with the termination of slavery.

Increasing incomes through established wage-earning opportunities appears to have been one such strategy. As noted in Section 5.2, freedpeople's turnout at estates and work rate was largely displeasing to planters between emancipation day and the first half of 1835. The archives indicate a conspicuous reversal of this trend during the subsequent two and a half years. Though only a crude illustration of this point, it is notable that of the twelve items of consulted documentation commenting on the availability and efficacy of plantation labour between August 1835 and the end of 1837, only one recorded any major insufficiency on these terms. In contrast, this was the case of nine out of eleven equivalent items pertaining to the preceding twelve

[224] CO7/47, R. Horseford to Gov. Colebrooke, 21 Jul 1837; CO7/50, Gov. Colebrooke to Lord Glenegl, 27 Mar 1838.

[225] CO7/62, A. Musgrave to W. Walker, 16 Jul 1840.

[226] CO7/42, Proclamation of Gov. MacGregor, 20 Aug 1835.

[227] PA, Vol.14, p.446, St. John's mission diary, 18 Apr 1837; PA, Vol.15, p.180, Gracebay mission diary, 28 Apr 1837.

[228] PA, Vol.14, p.193, letter from Br. F. Thraen, 26 Jun 1837.

months. That weather conditions were an important contributor was highlighted in a government statement on agricultural affairs during 1836, which pronounced:

> The great drought which prevailed showed in a very prominent point of view the entire dependence of the labouring classes on the proprietors for the means of subsistence, or, in other words, the imperative necessity of their working for money-wages. … the necessities and privations of the parents have compelled them to withdraw, in many instances, their children from school, and to send them to plantation work, in order that their wages might go in aid of the general resources and means of subsistence and other urgent necessities of the family.[229]

Early in February 1837, the head of the Moravians' Gracehill mission likewise remarked that provision scarcities and the widespread return of children to fieldwork had considerably reduced attendance at Sunday schools and prayer meetings.[230] In a similar vein, Governor MacGregor's second proclamation issued after the 1835 hurricane noted:

> The late Tempest must have shewn [sic] that the various Ranks of the Community depend one upon another…. [A]s the Rich stand in need of the labour of the Poor, so must the Poor rely, for Employment, upon the Rich; and, in any dispensation of Affliction and Distress, for Assistance and Relief.[231]

Indeed, the change in the tone of comments regarding the progress of the free labour system immediately before and after the storm is quite remarkable. In July 1835, a panel of ten civil servants, planters and clergymen quizzed on the subject told almost exclusively of labour disputes, a poor work ethic among plantation employees and a shortage of hands.[232] However, just two months later, officers stationed throughout Antigua distinguished the labourers' conduct as "subordinate and well-behaved."[233] Unfortunately, the available records provide few insights into the connection between wet weather in 1838 and emancipated peoples' industriousness. However, in November 1837, it was observed that "great distress" as well as pleasing work rates persisted among the labour force in spite of plentiful rainfall.[234]

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[229] CO7/47, undated report on 1836 Blue Book, enclosed with letter from Gov. MacGregor, 13 Jun 1837.

[230] PA, Vol.14, p.134, letter from Br. G. Bayne, 6 Feb 1837.

[231] CO 7/42, Proclamation of Gov. MacGregor, 20 Aug 1835.

[232] CO7/42, responses to survey on agricultural labour, July 1835 [precise date unspecified], enclosed with letter from Gov. MacGregor, 1 Aug 1835.

[233] CO7/42, letter from R. Wickham, 3 Sept 1835.

[234] T/PH/swd/2, T. Foote to R.C. Tudway, 15 Nov 1837.

Increasing salaried working hours represented one possible means for Antigua's emergent working class to cope with escalating food prices. Another, it appears, was pilfering. Early in October 1836, inspector Wickham began to express concern over a surge in crime, particularly among those individuals "withdrawing from agricultural pursuits."[235] Police records indicate that this trend extended over several months, the total number of criminal indictments more than doubling between the end of the summer of 1836 through the start of 1837 (Figure 9.8a). Notably, while the combined number of theft and property damage cases increased almost fivefold during that period, the incidence of all other offenses did so by only around 50% (Figures 9.8b, 9.8c). Soaring frequencies of the aforementioned misdemeanours was a particular novelty for colonial officials, for these were commonly dealt with privately by plantation managers in the days of slavery.[236] The principal form of property damage—which itself accounted for a third of all crimes recorded from November 1836 to January 1837—was 'cane breaking.'[237] This was not simply an act of vandalism, as acting-governor Henry Light noted:

> On observing the number of commitments for injury to property, unless the reason was explained, our surprise might be excited. It will take some time before the younger part of the population can be prevented from giving way to [the] temptation, constantly before their eyes, of a luscious meal.[238]

Accounts of an official visit to the island by the British anti-slavery leaders Joseph Sturge and Thomas Harvey, though championing Antigua's rejection of apprenticeship, emphasised more clearly the connection between such transgressions and the impoverishment of agricultural labourers at the time. Of six criminal prosecutions the pair observed on November 30th 1836, five were for praedial larceny. With respect to one particular case—that of an elderly labourer who had stolen yams and cane trash from his employer while unwell and, thus, unable to work—it was explicitly noted that "want was the exciting cause for the offense." However, the Britons felt that leniency for "the high price of provisions, and low wages" then prevailing was notably lacking throughout the day's proceedings (Sturge and Harvey, 1837: pp.39-40).

Subsequent to January 1837, there were few clues as to rates of lawbreaking, though high indictment numbers and frequencies of cane stealing were again noted in

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[235] CO7/44, R. Wickham to Gov. Light, 6 Oct 1836.

[236] CO7/44, Gov. Light to Lord Glenelg, 15 Oct, 9 Dec 1836.

[237] CO7/46, R. Wickham to Gov. Light, 4 Jan 1837; CO7/48, R. Wickham to Gov. Colebrooke, 7 Sept 1837.

[238] CO7/44, Gov. Light to Lord Glenelg, 15 Oct 1836.

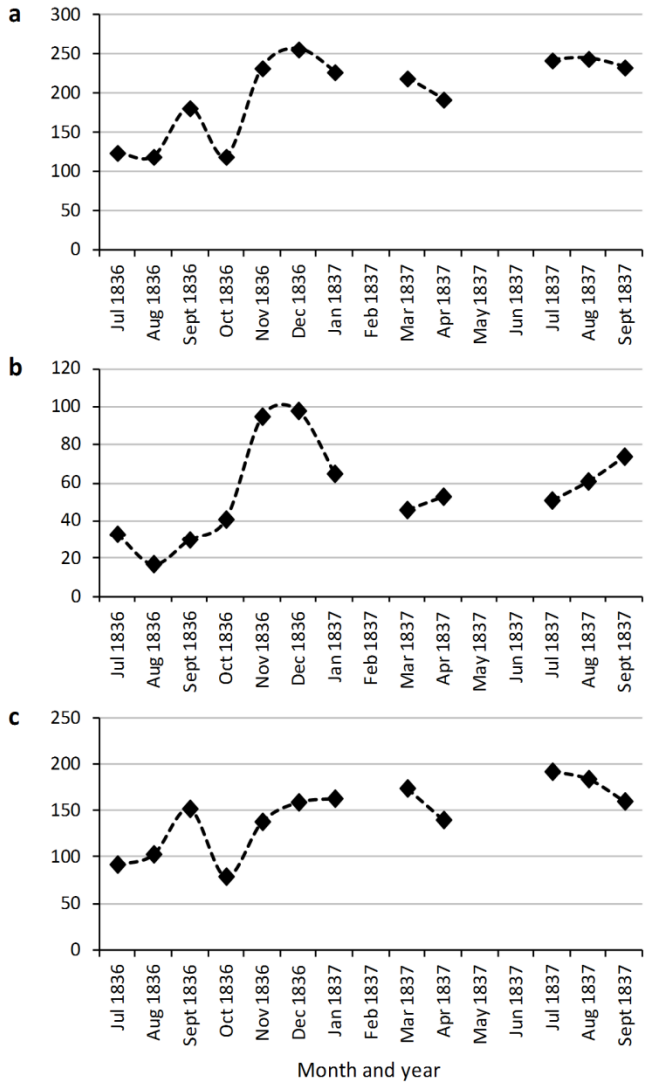

Figure 9.8. Number of criminal indictments in Antigua between July 1836 and September 1837 for (a) all offence types, (b) praedial larceny, theft and injury to property only and (c) all offences excluding praedial larceny, theft and injury to property. Plots include all available crime data for 1836-1837 recorded in police chiefs' monthly reports (CO7/43-50).

summer 1837 (Figure 9.8a).[239] It is possible that a rise in crime around this time of year in 1836 and 1837 may owe to food price spikes associated with the combination of drought-induced dearth and the seasonal ebb of maritime trade.

One response to adversity which had been all but impossible under slavery was to escape Antigua altogether. Accelerated rates of emigration to the southernmost Lesser Antilles colonies, where wages were high due to chronic labour shortages, was the subject of much commentary from the summer of 1836 through the following year.[240]

[239] CO7/48, R. Wickham to Gov. Colebrooke, 7 Sept 1837.

[240] E.g. CO7/43, R. Wickham to S. Warner, 6 Jul 1836; CO7/44, R. Wickham to Gov. Light, 6 Oct 1836; T/PH/swd/2, T. Foote to R. Tudway, 28 May 1837; PA, Vol.14, p.194, letter from Br. J. Morrish, 9 Jun 1837.

Reporting the various effects of the contemporaneous drought, civil servants explained the phenomenon as follows:

> The high price of provisions, compared with the low rate of wages, induced many mechanics and some field labourers to listen more readily to the artful and delusive enticements of speculators and unprincipled agents to migrate to Trinidad and Demerara.[241]

For his part, Governor Colebrooke, Macgregor's successor, claimed that "overseas emissaries" sought expressly "to take advantage of the distress which prevailed… during the prevalence of severe drought."[242] Total emigration numbers from Antigua have not been documented, but are believed to have been low compared with the experience of neighbouring islands in the mid-late 1830s (Hall, 1971). Nevertheless, several contemporaries avowed that Antigua's loss in 1836 and 1837 was by no means immaterial.[243]

There is some evidence to suggest that the exigencies of the mid-1830s may have played some part in the establishment of independent settlements by ex-slaves. Antigua's 'free village movement' is thought to have got underway late in 1836, with the procurement of small plots of land in the southeast of the island (Section 3.3.3). For Lightfoot (2007: p.215), the link with weather conditions is clear:

> The drought of 1836-37 which created hard times in the local marketplace also acted as a push factor fueling [sic] freedpeople's drive to gain further independence from plantations at the time.

While the present study has not uncovered direct support for this assertion, the following comments made by Governor Colebrooke about the agricultural workforce are revealing:

> since the abolition of slavery, they are much restricted in the opportunities they before had of raising small stock and produce on the estates; … they have but little opportunity of effecting a settlement for themselves, or of exerting their industry for the acquirement of property, and hence of raising themselves above indigence; if they had been differently situated in this respect, it is highly

[241] CO7/47, undated report on 1836 Blue Book, enclosed with letter from Gov. MacGregor, 13 Jun 1837.

[242] CO7/48, Gov. Colebrooke to Lord Glenely, 9 Dec 1837.

[243] CO7/46, R. Wickham to Gov. Light, 4 Feb 1837; CO7/48, Gov. Colebrooke to Lord Glenely, 9 Dec 1837.

> probable that the suffering they have experienced during the drought would have been materially alleviated…[244]

It seems plausible that the founders of free villages would have shared this thought process. Moreover, Colebrooke himself became an important proponent of these settlements, encouraging planters to make land available for their establishment (Hall, 1971).

9.4.3. Profiteering and philanthropy in civil society

Though more fragmentary than that relating freedpeople's coping mechanisms, there is substantial evidence of civilian attempts to profit from or alleviate the hardships endured by others in the mid-1830s. The sources indicate that profiteering may have been an option only for the wealthier echelons of society, for whom climatic shocks seemingly presented a minimal threat to physical well-being. For example, Antigua's Registrar General noted in the early 1840s that scarcities in 1837 had stimulated the establishment of several merchant houses dedicated to the importation of British provisions. These then wound up their operations in later years as demand fell.[245] The fact that drought-induced food shortages gripped the nearby island of Barbuda in 1837 also presented trade opportunities, an Antiguan "shipman" making it his business to vend foodstuffs to its needy inhabitants.[246] As noted earlier, local merchants were hired by the legislature to import water to St. John's. Some ostensibly engaged in this activity independently; plantation papers indicate that supplies were purchasable not only from the capital, but also Parham.[247] While not a method of profiteering per se, it appears that certain estate administrators reacted with considerable self interest to high food prices. Citing these expenses as his motivation, Thomas Foote noted in December 1836 that he had ceased dispensing rations to elderly ex-slaves due support under the Emancipation Act, instead providing monetary allowances with which to purchase the necessaries of life for themselves.[248]

Other accounts speak of more altruistic civilian behaviour. In 1839, Governor Colebrooke questioned a number of prominent local figures as to the state of freedpeoples' living conditions during the 1835-1837 drought. "As regards medical attention, the conduct of many proprietors was very praiseworthy," responded the Wesleyan missionary John Cameron, adding that in many cases this had been extended to aged and infirm blacks to whom they technically had no duty of care.[249]

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[244] CO7/47, Gov. Colebrooke to Lord Glenelg, 13 Jun 1837.

[245] CO7/68, J. Macphail to Lord Ross, 9 Aug 1841.

[246] COD/C31, J. Osborn to C.B. Codrington, 10 May 1837.

[247] T/PH/swd/2, T. Foote to R. Tudway, 28 May 1837.

[248] T/PH/swd/2, T. Foote to R. Tudway, 30 Dec 1836.

[249] CO7/58, Responses of Br. J. Cameron to Gov. Colebrooke's inquiry, 15 Jun 1839.

Planters also appear to have been actively involved in a collective recovery effort following the 1835 storm. On September 3rd, Richard Wickham observed that many "appear[ed] to contribute… to the comfort and health of their labourers, by rebuilding and repairing their several cottages."[250] At times, emancipated people were themselves behind charitable endeavours. For instance, on one occasion in the arid spring of 1837, congregation members were reported to have spontaneously donated water supplies—which were carried on foot over distances of up to two miles—for the use of Moravian missionaries at Gracebay.[251] Comparable action was taken at Gracehill Church one month earlier, with a group of workmen hired to dismantle an outbuilding damaged in the 1835 cyclone refusing to accept payment on completion of the task. Subsequently, others who had been unable to help at the time purportedly insisted on contributing monetarily, raising nearly £18—a significant total, acknowledged the missionaries, given the hard times.[252]

Despite the fact that the growth of charitable institutions was still in its early stages in the mid-1830s, a small number of records suggest that these played a notable role in alleviating the privations of the poor. Early in 1838, Henry Loving commented that the abnormally high number of burials registered in St. John's the preceding year owed to an "influx of Paupers" seeking the aid of the town-based Daily Meal Society, which offered lodging to "between 40 & 50 Inmates."[253] Meanwhile, in 1839, Antigua's police superintendent asserted that he was not aware of a single death in the island in 1836-1837 resulting from a lack of medical care. The explanation given was that the existence of the aforementioned society "must preclude but under extraordinary circumstances [people] dying of starvation or want of medical attendance," as it provided for "[e]very description or denomination of persons, and from all parts of the island."[254]

The plight of Antiguans also evidently stimulated charity from interested parties abroad. Severe thirst in the colony in 1837, for example, captured the sympathy of none other than its former governor. Early in April, Evan MacGregor—now based in Barbados—despatched a naval vessel laden with water aid.[255] Not dissimilarly, members of the Moravian Church in Britain, learning of the destruction wrought by the 'Antigua Hurricane,' arranged for educational picture-books to be sent for the school children of Cedar Hall.[256]

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[250] CO7/42, R. Wickham to Gov. Colebrooke, 3 Sept 1835.

[251] PA, Vol.15, p.180, Gracbay mission diary, 9 Mar 1837.

[252] PA, Vol.14, pp.133-134, letter from Br. G. Bayne, 6 Feb 1837.

[253] CO10/21, 1837 Blue Book.

[254] CO7/58, responses of M. Nanton to Gov. Colebrooke's inquiry, 11 Jun 1839.

[255] CO7/47, Extract of assembly journal, 13 April 1837.

[256] PA, Vol.13, p.384-385, letter from Br. C. Zellner, 8 Sept 1835.

9.5. Evaluating extremes, crisis responses and shifts in societal vulnerability

The mid-late 1830s in Antigua were remarkable in more than one way. The period witnessed both an unbroken succession of climate extremes, featuring drought, deluges and storms, as well as an unprecedented societal transformation, set in motion by the dissolution of a slave system that had reigned for two centuries. Among the former numbered some of the most severe events documented in reconstructions of Antiguan precipitation and tropical cyclone variability (Chapters 5, 6). The present analysis demonstrates that these had profound repercussions for colonial livelihoods. In particular, the hurricane and drought affecting the island between 1835 and 1837 eroded material conditions severely, devastating agricultural production and curtailing the material resources of the prosperous and poor alike. The societal ramifications of excessive precipitation in 1834 and 1838 were rather more mixed. Despite resulting in localised flooding, soil erosion and disruptions to terrestrial travel, as well as possibly contributing to certain disease outbreaks, descriptive and statistical accounts indicate wet weather in those years to have had positive net consequences for husbandry and commerce (e.g. Figures 9.2, 9.4, 9.7).

As the previous and following chapters focus on the implications of droughts and hurricanes, it is here worth including an account of flooding in 1842, which is the only year in the study period aside from 1838 when such an occurrence was documented. Government official Robert Horsford described the event as follows:

> The country had been refreshed by frequent showers through the month of July and the early part of August, towards the latter end of which last (the 25th) the island was visited by one of the heaviest falls of rain ever remembered—a perfect deluge—which in the course of a few hours overflooded [sic] the entire face of the country; in the flat lands to a depth of several feet, and in the towns actually swept away some of the smaller wooden tenements into the Sea.[257]

Notwithstanding these dramatic immediate effects, Horsford continued by noting:

> It was first supposed that this Deluge would prove most destructive to the Hopes of the Planters, the canes in many places being laid prostrate, and in others torn up and completely carried away, but these injuries, under judicious management having been partially repaired, and the Benefit derived by those lands not exposed to the so direct influence of the flood counterbalancing the apprehended evil, I am happy to say that the face of the country presents already a most improved aspect, and there is every Hope, with a continuance of favourable Weather, that the island may realize a more than average Crop.[258]

[257] CO7/74, Report of R. Horsford, 30 Sept 1842.

[258] Ibid.

This evidence would support the suggestion that even extraordinarily wet weather may have been beneficial for society overall, by raising agricultural yields (Section 7.4).

The period under scrutiny here is distinguishable as one in which climate-related phenomena triggered pronounced governmental and civilian reactions. As regards the former, much similarity is evident in the response types recorded during the late 1700s and early 1800s (Section 8.5.1). Despite the major structural transformation brought by emancipation, it is unsurprising that the procurement of resources needed to sustain popular livelihoods, as well as the appeasement of the supposed originator of natural disasters, remained the legislature's principal concern. What is significant, though, is that after the 1835 hurricane, legislators also invested considerable funds to ensure the receipt of essential supplies by the most disadvantaged Antiguans. Intervention of this kind was largely unnecessary prior to abolition, having then been the responsibility of slave-owners. The evidence suggests that change in the crisis responses of the Afro-Creole masses was more substantial. Novel behavioural trends documented among that community, such as emigration and the alteration of working habits, represent clear attempts to protect individual and family livelihoods in the face of subsistence difficulties and agro-economic downturn. As regards the coping strategies adopted by white elites, many of the specific measures outlined in this chapter were not documented prior to emancipation. This is, however, more likely to represent the incomplete nature of the historical archive than a major temporal shift in response patterns, as profiteering from scarcities and dispensing low-value allowances to dependent blacks would have been equally feasible previously. Finally, it is worth highlighting that not all civilian reactions to weather-induced hardship were motivated by self-preservation. Various philanthropic activities were recorded, many of which engaged or were directed to aid different social groups. These, as well as the other response types noted above, will receive further discussion in Chapter 11.

Although the mid-1830s witnessed an exceptional episode of meteorological stress and societal response, this by no means culminated in the most extreme climatic disaster in Antigua's colonial past in economic and demographic terms. To be sure, it was free of the mass starvation, morbidity and mortality that befell Antigua during comparable episodes at times of war in the late 1700s and early 1800s (Chapter 8). Moreover, the evidence indicates the recovery of agricultural operations, domestic provisioning systems, and fiscal stability to have been relatively swift (e.g. Figures 9.5-9.7). There are several possible reasons for this. Firstly and most importantly, as noted in Section 9.2, the climatic shocks of the mid-1830s unfolded against a backdrop of many favourable economic circumstances, both locally and regionally. Also significantly, those shocks which bore threats for socio-economic stability, though intense, struck within a relatively short time period and were succeeded by

favourable weather conditions. As such, it is quite possible that the responses enacted by the government and public—many of which offered short-term solutions only—succeeded in mitigating the crisis until climatic amelioration fostered the recovery of local resources.

Let us now consider how emancipation affected levels of vulnerability to climatic extremes within society. As noted above, the 1835 hurricane and subsequent drought severely circumscribed the livelihoods of all sectors of the populace. Nevertheless, suffering was unquestionably greatest among the recently-emancipated masses, for whom poorly remunerated employment and minimal material assets rendered resource scarcities most dangerous. The same broad pattern of human vulnerability is apparent in pre-emancipation Antigua, not only during the war-dominated 1770s through 1810s (see Chapter 8), but also the more geopolitically stable period spanning 1815-1834. The years 1821 and 1822 offer a noteworthy illustration, having witnessed a sequence of hazards very similar to that of the mid-1830s: an extremely destructive hurricane, followed by a multi-year drought that decimated crops and water supplies.[259] Once again, the available correspondence suggests in no uncertain terms that it was bondspeople who faced the greatest threat to physical well-being. For instance, the governor at the time, Benjamin D'Urban, was convinced that if strident emergency measures had not then been taken, "more than six thousand of the Slave Population must infallibly have starved… or been driven to maraud and rob." In contrast, the greatest concern of planters, he noted, was bankruptcy.[260]

The examples presented above suggest that the fundamental stratifications of societal vulnerability existing under slavery remained in place immediately after its abolition. Nevertheless, emancipation does appear to have palpably altered some of its finer contours. Most importantly, freedom relieved planters of the burden of providing the necessaries of life for the agricultural workforce. As such, these elites were spared one of the principal expenses that they had previously faced during phases of climate-induced dearth—that of acquiring food while it was most expensive. Of course, this change came at the detriment of the newly-formed working class, which had to stretch meagre salaries to cover subsistence costs. In some ways, planters even stood to gain from hardship, as it forced many freedmen and women, as well as their children, to accept guaranteed wage-earning opportunities in the sugar industry (Section 9.4.2). Put simply, emancipation reduced the economic vulnerability of whites to climatic deterioration, while enhancing that of former slaves.

Developments further supporting this argument are evident during periods of climatic stress in the 1840s. Late in June 1845, local politician Robert Horseford reported on the crop failures occasioned by a severe drought that had prevailed since the start of the year. Notably, he observed that the accompanying squeeze on

[259] CO7/8, Gov. D'Urban to Earl Bathurst, 3 Oct 1822 and all enclosures.

[260] CO7/8, Gov. D'Urban to Earl Bathurst, 3 Oct 1822.

livelihoods had resulted in estate work being undertaken more steadily and also speculated that the new demand for sugar labour would force freepeople to accept cuts to the high levels of pay that then prevailed.[261] Sure enough, four months later, the governor of the colony confirmed that the still-continuing dry weather had "enabled planters to effect some reduction in the rate of wages."[262] Due to a subsequent deterioration of commercial conditions throughout the British West Indies, plantation salaries only continued downwards thereafter (Section 3.3.3). Nonetheless, comments suggestive of greater commitment among freepeople to plantation work emerged during another phase of inclement weather in 1848-1850, yet again composed of a hurricane succeeded by two years of precipitation scarcity. In April 1849, for example, members of the legislature commented that though the "want of rain" had damaged crops widely, the canes had generally been well cared for, owing to "the easy obtainment of labour."[263] Moreover, the governor noted that after the 1848 cyclone demolished their homes, some labourers had abandoned free villages to take up residence on sugar estates. "Others," he added, "also returned to contract work" in preference of intermittent free-lancing for planters.[264]

It is perhaps predictable that phases of climatic stress weighed more heavily upon non-whites and offered some advantages to the established oligarchy after the abolition of slavery. An important reason for the legislature's initial decision to implement immediate freedom was, after all, the proclivity of the Antiguan climate to frequent, disruptive droughts (Section 9.2). Even at that early stage, it was recognised that these weather events would help to protect white hegemony by constraining the potential for independent livelihoods and, thus, confining emancipated people to estate work. Evidence from the mid-1830s and mid-late 1840s demonstrates such calculations to have been well founded. It also suggests that destructive storms may have represented another factor weighing against the establishment of what many scholars (after Mintz, 1974) refer to as a 'reconstituted peasantry' in post-emancipation society. Essentially, these extreme events forced ex-slaves right back where the plantocracy wanted them: bound to sugar labour for their very survival. It is, nonetheless, important to emphasise that not all coping mechanisms adopted by liberated people played to the advantage of the elite; there can be little doubt that behaviours like migration and theft were viewed by many Europeans as threats to the socio-economic order.

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[261] CO7/82, R. Horseford to Gov. Fitzroy, 30 Jun 1845.

[262] CO7/82, Gov. Fitzroy to Lord Stanley, 4 Oct 1845.

[263] CO7/92, minutes of a legislative committee meeting, excerpted from an unnamed Antiguan newspaper, 17 Apr 1849.

[264] CO7/92, Gov. Higginson to Earl Grey, 5 Apr 1849.

9.6. Closing remarks

This chapter has presented another case study centred on an exceptional phase of meteorological extremes that had pronounced implications for colonial Antiguan livelihoods. The archives illustrate that a severe hurricane and drought in the years 1835-1837 impinged acutely upon socio-economic wellbeing for the two major sectors of the island's populace—planters and emancipated people—stimulating strident action to mitigate personal and community losses. By contrast, episodes of extremely wet weather in 1834 and 1838 seem to have had positive consequences for agricultural and economic activities overall, notwithstanding localised disruptions associated with flooding. With regard to the state of emergency that materialised in 1836 and 1837, the evidence suggests that levels of suffering, as reflected by food availability, mortality rates and economic stability, did not reach the same heights as in earlier instances of environmental disaster in late eighteenth and early nineteenth century Antigua. This, it would appear, was due to a number of positive commercial circumstances in the 1830s, as well as the relatively short duration of inclement weather conditions.

The profound societal transformation heralded by emancipation shaped human experience of extreme events critically. It presented the formerly enslaved masses with new opportunities to cope with deteriorating material conditions—such as migration and altering working practises—and certain new challenges for government officials to manage resource scarcities and planters to protect their interests. Despite these novelties, the broad pattern of differential vulnerability to climate documented in colonial West Indian society was not disturbed; an African-descended underclass remained most susceptible to the onslaughts of climatic stress. What did change, however, was the economic exposure of that group and the plantocracy to such aberrations.

Although this chapter has focused principally on the mid-1830s, reference to records from the subsequent decade reveals consistent findings in terms of the heterogeneous effects of major climatic stress for the aforementioned groups. Parallels between these time periods are not altogether surprising. Local and regional histories often discern the years spanning 1834 through the end of the 1840s as being unified by relative prosperity for the sugar industry and newly-formed working class. The second half of the century, by contrast, is commonly portrayed as an era of ubiquitous decline in economic and social welfare (Hall, 1971; Green, 1976; Lightfoot, 2007). In the next chapter, the implications of these trends for islanders' experience of extreme climate events will be explored.

Chapter 10

Climatic calamities, decay and destitution in the austere 1860s and 1870s

10.1. Introduction

In spite of the apocalyptic predictions of pro-slavery campaigners, Parliament's 1834 Emancipation Bill proved to be far from the death knell for the British West Indian sugar industry. Thanks to the spatial and economic dominance of the plantation nexus, alongside a raft of local legislation devised to safeguard its hegemony, sugar labour remained the only stable livelihood available to the vast majority of liberated people in the region. As such, sugar production largely continued intact for another decade (Chapters 3, 9). Then, however, British lawmakers announced another reform which bore momentous implications for the industry: equalisation of duties on all sugar imported into the mother country—both colonial and foreign-grown. For many scholars of Caribbean history (e.g. Williams, 1970; Green, 1976; Mintz, 1985; Watts, 1987), this really was the beginning of the end for the fortunes of planters, as well as the wider colonial population, initiating processes of dramatic social and economic degeneration that continued until the century's end.

As ever, the ways in which these developments shaped human experience of climate phenomena, not to mention the possible influence of climate over the very trajectory of decline, have escaped detailed academic enquiry. This, then, is the remit of the present Antiguan case study. Its temporal focus is the decades of the 1860s and 1870s, which are situated in the midst of the austere latter half of the nineteenth century and marked by two discrete episodes of severe climatic stress. Like those preceding it, this chapter will first establish the socio-economic context of the studied timeframe, then explore the societal effects of and responses to contemporary meteorological extremes and, finally, evaluate the findings and reflect on the patterns of vulnerability that they convey. It differs, however, by offering a targeted assessment of the repercussions of adverse weather for the livelihoods of the Antiguan working class.

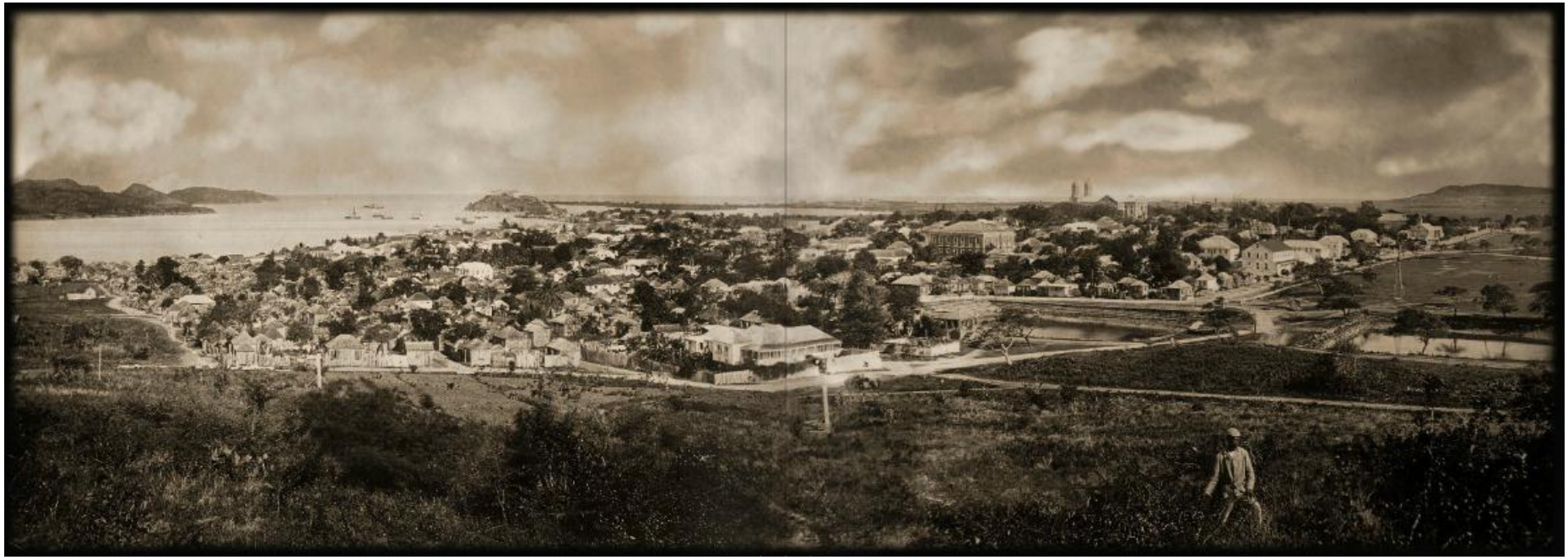

Plate 10.1. Photograph of the town of St. John's, circa 1870, by J.H. Horsey. Image available at www.caribbeanphotoarchive.com.

10.2. The preconditions of crisis: socio-economic decline in the mid-late 1800s

> It might not be too much to say that the fate of the British West Indies was sealed, once it became cheaper for the British masses to have their sugar from elsewhere, and more profitable for the British bourgeoisie to sell more sugar at lower prices. (Mintz, 1985: p.185).

The primary catalyst for the changes described in this quotation was parliament's 1846 Sugar Duties Act. The specific terms of the act, as well as its manifold socio-economic consequences in the West Indies were outlined in Section 3.3.3. At this stage, it suffices to note that by abolishing the protectionist structure of tariffs levied on sugar imports to Britain, the act eliminated colonial planters' monopoly over the home market. With competition from foreign planters becoming increasingly fierce over the second half of the 1800s, the colonies' share of the market and the retail value of the commodity gradually dwindled. The outcome was long-term contraction of the British West Indian plantation economy. In Antigua, as in much of the region, this was marked by the cessation of cane cultivation on less productive terrain, accelerated turnover in estate ownership and a reduction in the availability of and remuneration for plantation work (Green, 1976; Watts, 1987). With commerce and public prosperity deteriorating as a result, so too did government finances. While the proceeds from taxation fell notably from the late 1840s, spending remained as high as ever, owing not least to inefficient administrative processes and ongoing repayment of a £100,000 disaster-recovery loan acquired after a devastating earthquake in 1843. Predictably, Antiguan legislators simply raised taxes to cope. Of particular significance were import duties, which, following a series of increments since the early 1850s, came to account for half of tax revenues by the 1890s. In the meantime, funding to the island's vastly inadequate social services became increasingly scarce (Hall, 1971; Lowes, 1995; Dyde, 2000). Another important response to the fiscal predicament was administrative reform, which took place during the 1860s and early 70s (see Section 3.3.3).

Owing to the developments outlined above, the mid-late nineteenth century became an era of particular adversity for the African-descended working class. As the availability of salaried employment diminished—and with it the profitability of food cultivation and petty retail—this sector of the population was hit hard by tax rises and cuts in public spending. The shrinkage in disposable incomes also had a deleterious effect upon religious and educational participation. Notwithstanding notable variations year-to-year, the three major missionary societies operating in Antigua all experienced a decline in membership numbers and attendance at their schools (Farquhar, 1999). A floundering sugar industry did, however, give new impetus to growth of the autonomous Afro-Creole communities which sprung up after emancipation. By the

early 1860s, the free villages were inhabited by some 15,000 Antiguans—6,000 more than in 1846 (Green, 1976; Dyde, 2000). Yet, this too brought its own issues stemming from the lack of institutional investment in such development. It was in the mid-1850s that the authorities first investigated the material consequences of this neglect. Villagers, it was found, almost universally inhabited small, rudimentary dwellings, packed tightly together on marginal plots of land, in which small livestock roamed freely. Lacking basic amenities and easy access to water supplies, sewage was often allowed to accumulate in streets and walkways, themselves overgrown with "rank vegetation."[265] Although these deprived circumstances were observed to be common to the poorest urban neighbourhoods too, procuring medical help was reportedly most problematic in the isolated rural villages.[266]

With blacks accounting for some three-quarters of the population, and its white and 'coloured' elements long having been on the decline, officials turned to these conditions to explain another preoccupying contemporary trend: demographic decline. Despite having escaped regional cholera epidemics and any major instance of famine in the 1850s, the population of the colony shrunk by over 700 during that decade (Table 3.4). Burial and baptism records confirmed that it was high mortality rather than low fertility rates that were at the root of the problem.[267] As we shall see later, death rates continued worryingly high during the 1860s and 70s, by which point Antigua had become distinguished among the Lesser Antilles for its demographic inertia (Dyde, 2000).

10.3. Climatic shocks and socio-economic wellbeing, 1860-1880

10.3.1. "I never valued water so much": scarcity and sickness in the 1860s

Antigua began the 1860s in the grips of drought. When exactly it set in is unclear, but as early as January 12th 1860, George Westerby, the local head of the Moravian mission, commented that the colony was "much in want of rain."[268] By the end of spring, the continuance of dry weather was said to be causing widespread misery for people and livestock, due to water shortages and the withering of pasture and provision grounds.[269] The first of these problems was especially serious. Writing from

[265] CO7/104, Gov. Mackintosh to Duke of Newcastle, 1 Feb 1854.

[266] CO7/114, Address of Gov. Eyre to legislature, 16 Feb 1860.

[267] CO7/105, Gov. Mackintosh to Lord Russell, 22 May 1855; CO7/114, Address of Gov. Eyre to legislature, 16 Feb 1860.

[268] PA, Vol.23, p.324, Letter from Br. G. Westerby, 12 Jan 1860.

[269] PA, Vol. 23, p.451, Letter from Br. G. Westerby, 26 May 1860; PA, Vol.24, p.35, St. John's Female Training School report for 1860; CO7/114, Gov. Hamilton to Duke of Newcastle, 4 May 1860, Legislative Addresses, 10 May 1860.

Cedarhall late in June—just days before abundant summer rains brought an end to the dry spell—another Moravian clergyman noted:

> [Apart from] the northern division… all other parts of the island are quite parched up. Almost all the ponds and cisterns are empty. I pitied the poor people who came to the pond near our place, to fetch the greenish muddy water for drinking and cooking. Even this soon dried up. ... I never valued water so much as I do in Antigua.[270]

Antigua's "parched" condition during the first half of 1860 also curtailed sugar production noticeably (Figure 9.2b). Nevertheless, in 1863, members of the legislature reflected that planters had escaped relatively lightly, processing some 12,000 hogsheads of muscovado in both 1860 and 1861.[271] Others were not as fortunate; in August 1861, it was remarked by the governor of the colony, Ker Baillie Hamilton, that some of the poor "suffer[ed] privation by being deprived by the drought of their ordinary occupation."[272]

Notwithstanding the prevalence of wet weather in 1861 and the modicum of agricultural success that attended it (Figure 9.2b), islanders' fortunes were only to decline in subsequent years due to a range of local and international developments. From 1861 to 1865, civil war raged in the United States, producing a sharp reduction in West Indian imports of food, lumber and clothing. By the start of 1862, Brother Westerby estimated that this, in combination with a recent rise in Antiguan import tariffs, had caused a 20% increase in the cost of living.[273] Simultaneously, London sugar prices slumped (Figure 3.11) and smallpox swept across the island. Government medical officers attended to some 2,900 cases between November 1862 and July 1863, of which the vast majority were among "the lower classes" and 134 proved fatal.[274]

The picture of adversity became complete with the return of drought. On this occasion, it was of longer duration, extending from December 1862 through the summer of 1864 (Section 5.3), tempered only by "a brief and insufficient season of rain" in 1863.[275] The environmental ramifications were inevitable; subsistence and cane crops were decimated, driving already-elevated food prices higher, while water reserves all but dried up. In the context of an unrewarding sugar market, harvest

[270] PA, Vol.23, p.525, Letter from Br. J. Hasting, 25 Jun 1860.
[271] CO7/119, Legislative memorial, 12 May 1863.
[272] CO7/116, Gov. Hamilton to Duke of Newcastle, 8 Aug 1861.
[273] PA, Vol.24, p.590, Letter from Br. G. Westerby, 9 Feb 1862.
[274] CO7/120, Quarterly report of Board of Health, 1 July 1863.
[275] PA, Vol.25, p.210, St. John's congregation report for 1863.

failure resulted in operations being completely suspended on many plantations.[276] Indeed, in July 1864, it was remarked by Antigua's new governor, Sir Stephen Hill, that "large areas of country" lay "out of cultivation" causing much unemployment.[277] Seemingly, some planters even lacked the wherewithal to resume production after the drought had ended, one travelling Briton observing the colony to be dotted with "large tracts of abandoned land" in 1865 (Hart, 1866: p.219).

Such disruptions were bad news for a colonial treasury which, in recent times, had seldom been far from insolvency. Fresh anxiety over fiscal stability was registered when revenues began to fall in 1863. This, colonial auditor Oliver Eldridge felt, was attributable to deficient rainfall—which "materially affected the commerce of the Colony"—as well as recent changes in the structure of import duties.[278] Sugar production in 1863 was disappointing, but the following year it was an utter disaster. After declining moderately between 1862 and 1863, exports of the commodity dived to reach their lowest level of the 1800s in 1864 (Figure 9.2b). State finances followed a similar trend, the balance between revenue and expenditure dropping from over £2,500 to £45 during the same timeframe (Figure 10.1). Now, Eldridge attached the blame firmly to meteorological conditions:

> The unprecedented Drought extending over twenty months almost destroyed our entire Sugar Crop… this created a bad reaction in all branches of industry, and all suffered. Our tariff and tonnage dues realised some £250 short of the sum expected, while the general depression among the inhabitants caused the non-collection of taxes to the extent of nearly £2,000.[279]

The treasury fared far worse in 1865, when—even with the receipt of an emergency loan—incomings trailed outgoings by over £3,000 (Figure 10.1).[280] However, by this stage, the state of affairs had already improved in other respects. Seasonable weather in the latter half of 1864 and throughout 1865 "speedily restored vegetation to its wanted verdure," helping food prices, local commerce and sugar exports to recover.[281] At the same time, "a considerable extent of waste land" was replanted with cotton—

[276] CO7/120, Gov. Hill to Duke of Newcastle, 24 Aug 1863; PA, Vol. 25, p. 48, Letter from Br. G. Westerby; PA, Vol.25, pp.210-215, Antiguan congregation reports for 1863; CO7/123, Report on mortality rates, 21 Jul 1864.

[277] CO7/123, Gov. Hill to E. Cardwell, 21 Jul 1864.

[278] CO7/123, Report of O. Eldridge, 11 Aug 1864.

[279] CO7/126, O. Eldridge to Gov. Hill, 21 Aug 1865.

[280] CO7/127, E. Baynes to Gov. Pine, 19 May 1866.

[281] Ibid.; CO7/126, O. Eldridge to Gov. Hill, 21 Aug 1865.

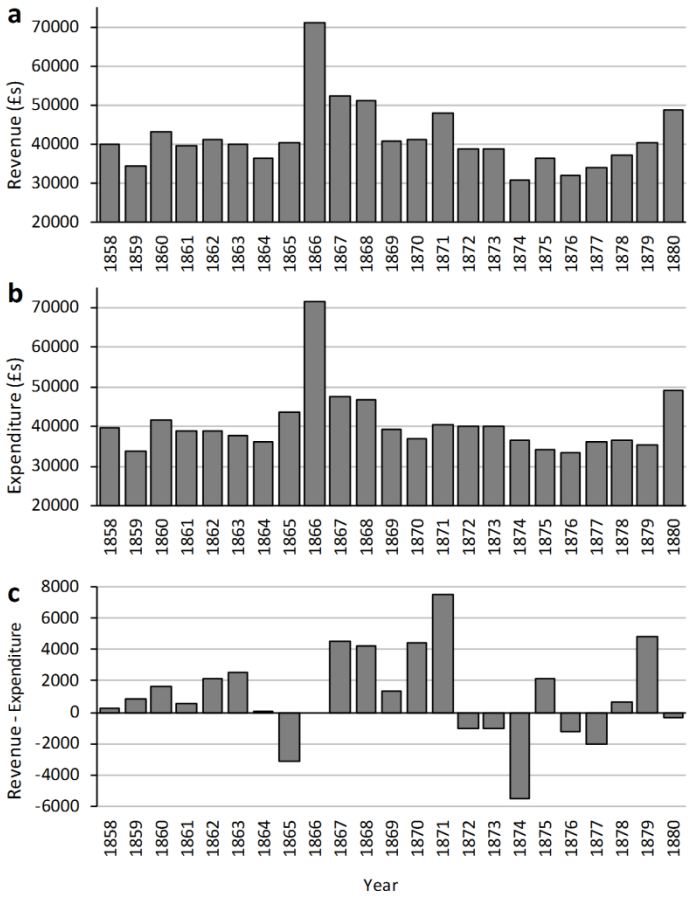

Figure 10.1. Annual (a) expenditure and (b) revenue of the Antiguan treasury and (c) the difference between the two, 1858-1880, in sterling. Note that data for the years 1866-1868 are skewed by the receipt and spending of a £30,000 loan (see Section 10.5). Data from yearly reports on the government Blue Books (CO7/112-143; CO152/107-136; Parliamentary Papers, C.1102, C.1335-1336, C.1622, C.1869), supplemented by other correspondence (CO152/131, Gov. Berkeley to Earl of Carnarvon, 9 Feb 1878; CO152/135, 'Minute paper' in letter from Gov. Berkeley to M. Beach of 11 Aug 1879; CO152/138, Gov. Berkeley to M. Beach, 24 Feb 1880).

which had become scarce due to the disruptions of the American Civil War—paving the way for a short-lived boom in production (Figure 10.2).[282] Yet, these developments were gains only in relative terms; sugar prices remained low (Figure 3.11) and provision scarcities, though eased, persisted.[283]

In 1866 and 1868, rainfall scarcity again brought agricultural decline (e.g. Figure

[282] CO7/127, E. Baynes to Gov. Pine, 19 May 1866.

[283] PA, Vol.26, pp.48-49, West Indian Reports for 1865, pp.126-128, Antiguan congregation reports for 1865.

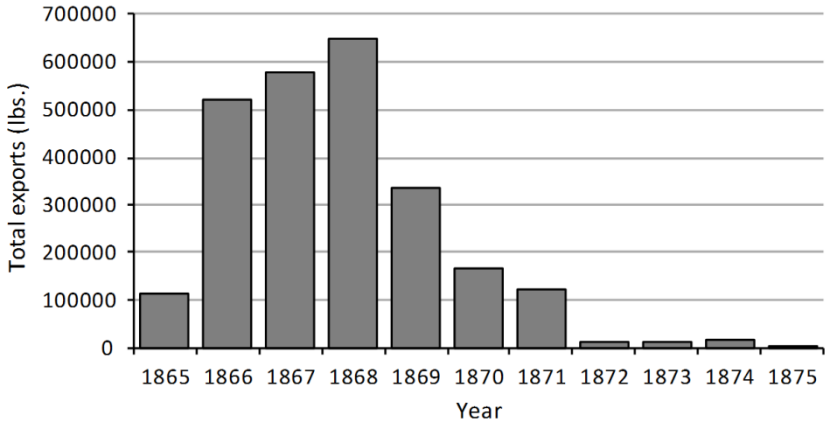

Figure 10.2. Cotton exports from Antigua, 1865-1875. Note that no data are available prior to 1865 and no cotton was exported after 1875. Data from Blue Books (CO10/49-59).

9.2), unemployment and shortages of vital resources.[284] Recurrent bouts of disease added to islanders' complaints. The Moravians reported "much sickness" across Antigua in 1866,[285] while, in every other year from 1865 to 1869, fevers were noted to have reduced public attendance at one or more of their churches. Interestingly, both in 1867 and 1868, spells of abundant precipitation were cited as the very cause of these outbreaks.[286] All the while, fiscal crisis lingered. For this, colonial officials blamed insufficient precipitation, the general economic downturn that commenced in 1864[287] and inefficient "administrative machinery."[288] Were it not for major financial interventions (see Section 10.5.1), account documents suggest that the excess of expenditure over revenue in 1867 would have amounted to no less than £15,000.[289] Finally, at the end of the decade, Antigua began to emerge from commercial depression[290] and state finances assumed "a healthy condition" once more.[291]

10.3.2. "The most severe visitations" of the 1870s

In 1871, within just a year of its proclaimed recovery, socio-economic wellbeing was shattered by an all too familiar weather sequence: hurricane followed by drought. On

[284] PA, Vol.26, p.228, pp.458-459 Antiguan schools report for 1866 & 1867; PA, Vol.27, pp.120-121, Antiguan schools report 1868; CO7/129, Legislative addresses, 13 Jun 1867; CO7/130, Report on 1866 Blue Book by O. Eldridge, 19 Aug 1867.

[285] PA, Vol.26, pp.187-188, Cedar Hall training school report for Sept 1865-Sept 1866.

[286] PA, Vol.26, pp.48-49, West Indian Reports for 1865, pp.460-461, Gracehill & Five Islands reports for 1867; PA, Vol. 27, pp.126, 374, Gracehill & Lebanon reports for 1868, pp. 374, 377, Gracehill & Lebanon reports for 1869.

[287] CO 7/137, Gov. Pine to Earl Granville, 8 Oct 1869.

[288] CO7/128, Address of Gov. Pine, 10 Oct 1866.

[289] CO7/133, Gov. Hill to Duke of Buckingham & Chandos, 12 Sept 1868.

[290] CO7/136, Legislative addresses, 28 Jan 1869.

[291] CO7/141, E. Baynes to Gov. Mundy, 6 May 1871.

this occasion, the former struck an Antiguan populace whom government officials deemed to be notably lacking in "experience of the disastrous effects of such visitations"; census data indicated that over 25,000 of the colony's 34,344 inhabitants had been born since the occurrence of the last "severe" cyclone in 1835 (that of 1848 having been "comparatively slight").[292] Thus, the vast majority, it was recounted, took no heed of the tell-tale signs that another approached on August 20th 1871. Only at 2 am the following morning, in the midst of gusts that been growing in force for hours, did they spring into action securing their property as best they could.[293]

Accounts of storm damage suggest that one newspaper editor may have been correct in proclaiming this "one of the most severe visitations" in Antiguan history,[294] at least during the period 1770-1890. Such evidence was assessed systematically in Chapter 6 and mapped in Figure 6.4, illustrating that all weak or small structures reported upon—including outbuildings and poorly constructed dwellings—were destroyed, while a considerable majority of sturdier buildings—such as churches, planters' houses and warehouses—were either seriously injured or completely ruined. The implications for livelihoods were devastating, with the sugar industry brought to a standstill and multitudes left without shelter.[295] Frustratingly, little information has been recovered regarding the resulting costs. Damages sustained by the Moravians' Antiguan missions and the Codrington family's estates were valued at £1,500 and £1,350 respectively,[296] but figures pertaining to other property owners—including the state—were notably absent. By contrast, detailed government statements on the loss of life were compiled, noting both the location and cause of fatalities across the island (Table 10.1).

Though the destruction and suffering were great, some Antiguans recognised that things could have been worse. With much of the crop having been processed before the storm, sugar exports suffered little.[297] Thanks also to recent administrative reforms, the colony's finances were said to be "in an increasingly prosperous condition" by December.[298] For their part, in 1871, the Moravians registered the first marked rise in membership subscriptions in over twenty years (Figure 10.3). However, chronic rainfall scarcity followed hot on the heels of the hurricane. It prevailed until the final quarter of 1874—the only spatially extensive break being a spell of moderate rains from November 1872 through to early 1873—amounting to the second longest episode of drier-than-normal conditions reconstructed in this research

[292] CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p. 1.

[293] Ibid., PA, Vol.28, pp.131-132, Letter from Br. G. Westerby, 25 Aug 1871.

[294] CO7/142, Extract from 'The Antigua Weekly Register', 22 Aug 1871.

[295] CO7/142, correspondence of Aug & Sept 1871.

[296] PA, Vol.28, p.135, Letter from Br. W. Batt, 26 Aug 1871; COD/C56, G. Holborow to G. Codrington, 2 Feb 1872.

[297] CO7/142, Gov. Mundy to Earl of Kimberly, 9 Sept 1871.

[298] CO7/144, Address of Gov. Pine, 21 Dec 1871.

Table 10.1. Fatalities during the hurricane of August 1871. Data from CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.2.

Parish	Physical injury	Exposure	Drowning	Totals
St. John's	16	4	1	21
St. George's	13	2	1	16
St. Peter's	2	2	-	4
St. Phillip's	1	-	-	1
St. Paul's	5	-	-	5
St. Mary's	-	-	-	-
Totals	37	8	2	47

(Chapter 5; Berland et al., 2013). Archival sources brim with details of the attendant agro-economic crisis. Notwithstanding the absence of major curtailments to imports from the United States and a modest increment in sugar's market value (Figure 3.11), parallels with the mid-1860s are clear. Edwin Baynes, private secretary of the governor, summarised the colony's fate as follows:

> A recurrence during 1873 and part of 1874 of the severe drought with which Antigua has of late years been visited, had the effect of reducing the sugar crop of 1874 to the smallest shipped from the Island since 1864. This almost complete failure of the staple production of the Island, following upon the short crops of 1872 and 1873, caused considerable depression in the commercial as well as in the agricultural interests, and also led to an unprecedented degree of distress and destitution among the labouring population.[299]

He later added that "many estates were entirely thrown out of cultivation," while operations were "considerably reduced" elsewhere, leaving "hundreds of labourers" without work.[300] Want of clean drinking water was, needless to say, another recurrent grievance.[301] Even in St. John's, where elaborate water works had been constructed in the late 1860s (see Section 10.5.1), shortages arose as the springs feeding them dried up (Table 10.2).[302] Fiscal havoc also ensued. Its first omen surfaced late in 1872, when tax revenues began to fall (Figure 10.1).[303] Over the next two years, government

[299] Parliamentary Papers, C.1335-1336, Papers relating to Her Majesty's colonial possessions: Part II, Report of E. Baynes, 11 June 1875.

[300] CO152/129, Report of E. Baynes, 14 May 1877.

[301] e.g. PA, Vol.28, p.252, Newfield report for 1871, p.466, Greenbay report for 1871; COD/C56, G. Holborow to G. Codrington, 2 Feb 1872; CO152/115, Letter from J. Freeland, 3 Dec 1873; PA, Vol.29, p.330, Cedar Hall report for 1874.

[302] CO7/142, E. Baynes to Earl of Kimberly, 26 Sept 1871 [II].

[303] E. Baynes to Earl of Kimberly, 9 Nov 1872.

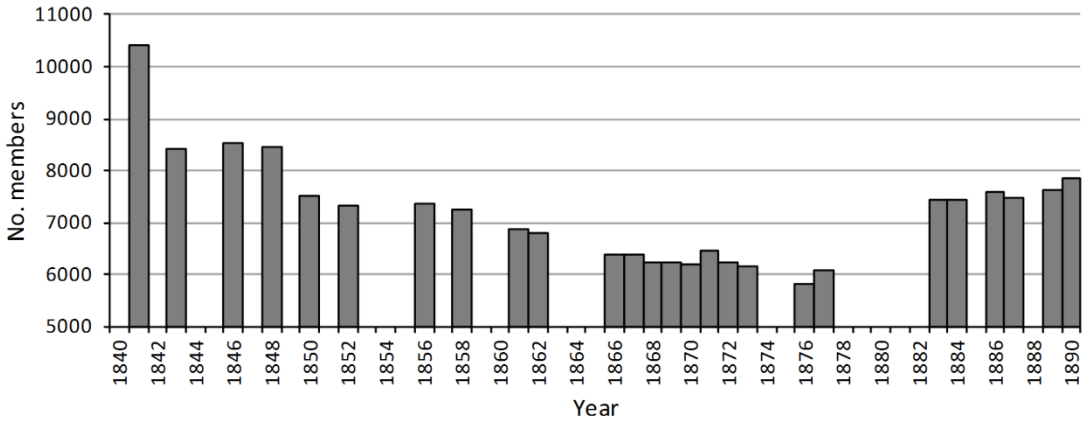

Figure 10.3. Moravian church membership in Antigua, 1841-1887. Data from 'Statistics of the Mission' inserts in PA, Vols.16-34.

income remained low as the economy slumped,[304] while expenses were incurred by repairing hurricane damage, providing aid to the poor and augmenting water supplies (Section 10.5). Finally, the net deficit of the treasury peaked at almost £5,500 in 1874 (Figure 10.1)—greater than in any previous year in the 1800s with extant data.

Although weather conditions improved from the autumn of 1874, inducing operations to be resumed on many estates, [305] lethargy persisted in the sugar economy for years to come.[306] As had been the case in the mid-late 1860s, it was not until the end of the decade that the recession had run its course, that labour was observed to be "abundant" in some districts [307] and that government finances returned to a "satisfactory" state.[308]

10.4. The working class in crisis

10.4.1. "Distress and destitution never before witnessed"

As illustrated in the preceding section, adverse weather in the years 1860-1880 had implications for agro-economic stability and resource availability broadly comparable

[304] CO152/120, E. Baynes to Earl of Carnarvon, 11 Sept 1874; Parliamentary Papers, C.1335-1336, Papers relating to Her Majesty's colonial possessions: Part II, Report of E. Baynes, 11 June 1875.

[305] CO152/120, E. Baynes to Earl of Carnarvon, 13 Oct 1874; CO152/123, Gov. Berkeley to Earl of Carnarvon, 11 Sept 1875 [II].

[306] PA, Vol.30, pp.1-5, 206, 400-401, Antiguan mission reports for 1875, 1876 & 1877; Parliamentary Papers, C.2149, Papers relating to Her Majesty's colonial possessions, Report of E. Baynes, 11 Jul 1878.

[307] PA, Vol.31, p.363, St. John's report for 1879.

[308] Parliamentary Papers, C.2598, Papers relating to Her Majesty's colonial possessions: Reports of 1877, 1878 and 1879, Report of E. Baynes, 11 Aug 1879.

Table 10.2. Yields of springs supplying the St. John's water works, 1871-1874, and total estimated range. Data from CO152/129, Report of E. Baynes, 14 May 1877.

Timeframe	Average yield (litres per day)
1872	85,921
1873	131,837
1874	93, 195
1875	69,664
1876	240,488
Lowest value in 1871-1874	36,368

to those documented earlier in the eighteenth and nineteenth centuries (Chapters 8, 9). The evidence suggests, however, that climatic stress now tolled with peculiar severity upon Antigua's black working class. Although some provision supply problems were reported during the early years of the American Civil War,[309] it was not until 1863 and 1864 that extreme suffering among the masses vis-à-vis scarcities of food, water and employment were reportedly widespread.[310] Echoing the comments of several other missionaries writing at the time, James Turner of Gracebay described the situation in 1863 as follows:

> the nine months' drought dried up the provision-grounds of the people, and therewith deprived them of their last resource… Many of our oldest members have assured me that 1863 has been the hardest year they have ever experienced. During this trying period, corn-meal, the only food at all within their means, rose to nearly double the ordinary price; then it became heart-rending to hear the children crying for bread, and to see the old people perishing for want of food. To several of the latter I was called, and hastened to administer food, but in many cases relief came too late, and death ensued.[311]

This poverty, many of the clergy observed, became manifest not just in life-threatening hunger, but also deteriorating attire.[312] As Brother Turner went on to explain:

[309] e.g. PA, Vol.24, p.303, 638, Female training school reports for 1861 & 1862.

[310] PA, Vol.25, p.48, Letters from Br. G. Westerby, 27 Aug, 26 Sept, 12 Oct 1863, pp.210-214, Reports from six stations for 1863, p.215, Female training school report for 1863, pp.442-443, Antiguan congregation reports for 1864; CO7/123, Gov. Hill to E. Cardwell, 21 Jul 1864.

[311] PA, Vol.25, p.212, Gracebay congregation report for 1863.

[312] PA, Vol.25, p.213, Letter from Br. G. Westerby, 27 Aug 1863, Newfield report for 1863, p.285, West Indies reports for 1863, p.442, West Indian reports for 1864.

> In consequence of the rise in the price of calico caused by the American war, our people are unable to purchase it, and some are quite without cloths beyond mere rags.[313]

Such was the situation early in 1864, that one veteran civil servant suggested that the combined assaults of dry weather and smallpox had culminated in "a degree of distress and destitution never before witnessed in Antigua."[314]

Great as the hardship may then have been, in less than a decade, equally disquieting tales were told. After the 1871 hurricane, few habitations belonging to the working class remained standing; one missionary estimated the proportion to be lower than 10%.[315] In St. John's, "hundreds of poor creatures" found themselves without shelter[316] and, like uncounted multitudes elsewhere, were "exposed for several nights to the inclemency of the weather."[317] For the London-based leaders of the Moravian church, the wider repercussions of the storm were patent:

> The ruin of many of the estates has deprived a large number of the means of earning a livelihood, and those who had by dint of steady labour raised themselves from the poverty to which the drought of the years 1864 and 1863 had reduced them, are now in worse circumstances than they were then.[318]

Of course, this was just the beginning of the troubles in the early-mid 1870s. As ever, the result of the subsequent drought for the colonial underclass was hunger, thirst, unemployment and—in spite of the recovery of the American textiles industry—ragged attire.[319] Come the middle of the 1870s, one minister simply lamented:

> The sufferings of our people from the long seasons of drought and poverty, which have followed one upon another since the hurricane of 1871, it would be useless to describe. Only they who have been eye-witnesses of it, can in any way realize their abject poverty.[320]

Another missionary decided to transmit the testimony of the sufferers themselves:

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[313] PA, Vol.25, p.212, Gracebay congregation report for 1863.
[314] CO7/122, E. Baynes to Gov Hill, 9 Feb 1864.
[315] PA, Vol.28, p.132, Letter from Br. G. Westerby, 25 Aug 1871.
[316] CO7/142, Extract from 'The Antigua Weekly Register', 22 Aug 1871.
[317] CO7/142, G. Black to N. Porter, 8 Sept 1871.
[318] PA, Vol.28, pp.128-129, Introduction to hurricane correspondence, Dec 1871.
[319] PA, Vol.28, pp.464-469, Antigua reports for 1872; PA, Vol.29, pp.109-113, 327-332, Antigua reports for 1873 & 1874.
[320] PA, Vol.29, p.329, Grachill report for 1874.

> The hills and valleys were alike destitute of vegetation, the ponds and streams all but dry; provisions were scarce, and the people had nothing to do. Our enquiries constantly received the answer: "Ah! Massa, Antigua never so bad yet." … When visiting the parents, and urging them to send their children to school, and to attend the services of the sanctuary, their mournful cry is, "Yes, Massa, me willing, but me short," i.e. of clothes; "times are so stiff, me cannot make out." Many of our aged sisters came to speak with us, literally in rags.[321]

The privations endured by the masses now received great scrutiny from the plantocracy, not least because of the mounting burden exerted on social services (Table 10.3). In the autumn of 1874, an inquiry was commissioned into the state of affairs in Popeshead—a district in the far northeast of the island where joblessness and famine were purportedly greatest.[322] The findings confirmed civil servants' worst fears; able-bodied adults somehow "eke[d] out a wretched and almost barbarous existence," while children, the elderly and infirm were "in rags or literally naked, and starving."[323] A situation in which a family of six laboured on estates for a combined weekly income of £1 was now considered a best case scenario.[324]

Despite the slight improvement in circumstances in the years after the droughts of the early-mid 1860s and 70s (Section 10.3), reports of extreme misery continued to cross the Atlantic until the recessions that they triggered had ended.[325] Writing of affairs at Cedar Hall in 1867, for instance, Brother William Mumford noted:

> Though the year has been blest [sic] with abundant rains, money has been very scarce in this part of the island, owing to the circumstances that only two or three estates are in cultivation. Sometimes we get disheartened, and think the people might do more [to pay church contributions]… but when we go to their homes, and witness their wretchedness—there being in many of them nothing in the shape of comfort—we wonder where the money comes from.[326]

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[321] PA, Vol.29, pp.330-331, Cedar Hall report for 1874.

[322] CO152/120, E. Baynes to Earl of Carnarvon, 13 Oct 1874 & enclosures.

[323] CO152/120, Rector of St. George to E. Baynes, 5 Oct 1874.

[324] CO152/115, Letter from J. Freeland, 3 Dec 1873.

[325] PA, Vol.26, pp.48-49, West Indies reports for 1865, pp.126-128, 222-228, 458-467, Antigua reports for 1865, 1866 & 1867; PA, Vol.27, p.119-128, 372-378, Antigua reports for 1868 & 1869; PA, Vol.30, pp.5-6, 206-207, 399-401, Antigua reports for 1875, 1876 & 1877.

[326] PA, Vol.26, p.463, Cedar Hall report for 1867.

Table 10.3. Number of individuals supported at Antigua's poorhouse, public hospital and lazaretto and receiving non-residential relief from those institutions, 1871-1874. Data from: Parliamentary Papers, C.1102, Papers relating to Her Majesty's colonial possessions: Part II, Gov Irving to Earl of Carnarvon, 24 Jul 1874; CO152/120, E. Baynes to Earl of Carnarvon, 11 Sept 1874.

Year	Poorhouse	Holberton Hospital	Leper Hospital	Receiving 'out-door relief'	Total
1871	171	62	18	150	401
1872	251	87	19	147	504
1873	210	31	19	189	449
1874	-	-	-	-	605

Meanwhile, more than five years after the 1871 hurricane, a recently-arrived preacher observed that some dwellings had yet to be repaired by their poverty-stricken owners.[327]

10.4.2. Demographic decline and sanitary conditions

Demographic instability, which had attracted some attention from Antiguan officials in the 1850s (Section 10.2), became the subject of great disquiet during the disastrous decades that followed. Between 1861 and 1881, the population of the colony fell by over 2,000 to reach a nineteenth century low of 34,321 (Table 3.4). Especially preoccupying were the spikes in mortality marking this period (Figure 10.4), which, notably, coincided with several major phases of environmental stress discussed earlier. Annual death rates consistently exceeded 30 per 1000 of the populace, but soared to around 48 in the early-mid 1860s and 53 in the early 70s (Figure 10.5)—more than twice the contemporary figure in England and Wales.[328]

Such trends spurred a series of highly detailed government enquiries into the material circumstances of the Afro-Creole underclass. In the resulting paperwork, three broad drivers of decline were commonly distinguished. The first were the perceived failings of non-whites in the areas of matrimony, childcare and use of institutionalised healthcare.[329] Accounts from across the island compiled in 1872 spoke of fatherless infants left without food from dawn till dusk, either unsupervised or in the care of relatives unfit for work, while their mothers toiled in canefields or

[327] PA, Vol.30, p.206, St. John's report for 1876.

[328] Parliamentary Papers, C.2598, Papers relating to Her Majesty's colonial possessions: Reports for 1877, 1878, & 1879, Gov. Berkeley to H. Beach, 11 Aug 1879.

[329] E.g. CO7/120, Gov. Hill to Duke of Newcastle, 27 Jun 1863; CO7/122, Gov. Hill to Duke of Newcastle, 8 Mar 1864.

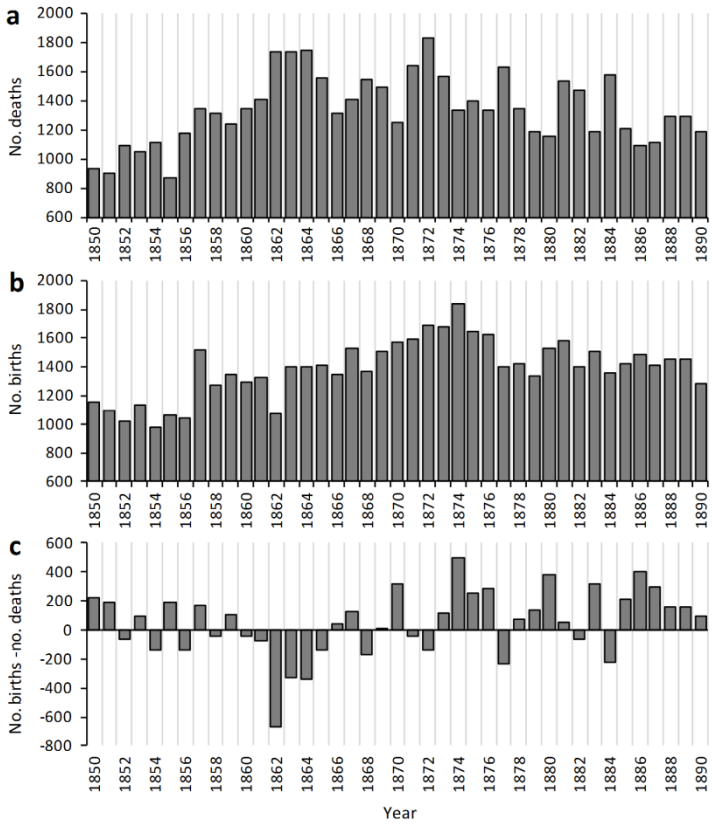

Figure 10.4. Number of (a) deaths and (b) births and (c) the difference between the two in Antigua, 1850-1890, as recorded in colonial Blue Books (CO10/34-71; CO157/2-4) and government correspondence (CO7/142, Report on 1871 census, 2 Apr 1871; CO152/146, Report on 1881 census, 11 Jul 1881).

provision grounds.[330] Under these circumstances, it was often days, sometimes weeks, after a family member fell ill that they could be taken to a medic, which was largely treated as a last resort.[331] The second major concern was the condition of housing in poor neighbourhoods. "In the majority of instances," it was observed in June 1864, five or six residents inhabited "a wretched hovel… containing but one room, and that unfloored and imperfectly ventilated," situated on a plot of 40 square feet (12.19 m^2).[332] A subsequent statement added that such dwellings were at best "filthy" if not "nearly uninhabitable."[333]

[330] CO152/115, Report on free village sanitary conditions, 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873.

[331] Ibid., Report for District 3, 3 Dec 1872.

[332] CO7/122, E. Baynes to Gov. Hill, 11 Jun 1864.

[333] CO152/115, Report on free village sanitary conditions, 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873.

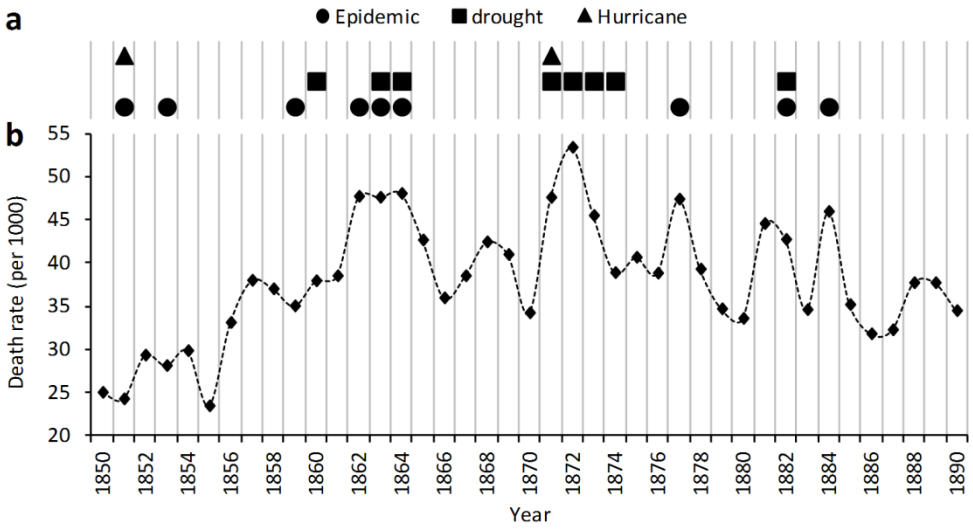

Figure 10.5. Chronology displaying (a) the incidence of major epidemics, severe droughts and hurricane-intensity tropical cyclones and (b) approximate annual death rates in Antigua, 1850-1890. Death rates calculated using census data as a baseline. Sources: CO10/34-71; CO157/2-4; CO7/142, Report on 1871 census, 2 Apr 1871; CO152/146, Report on 1881 census, 11 Jul 1881; CO152/179, Gov. Smith to Lord Knutsford, 3 Nov 1891.

The third problem identified was the deficiency—in terms of both quality and quantity—of food and water supplies.[334] With respect to high mortality rates in 1864, government specialists explained that consistently poor nourishment enhanced the susceptibility of the masses to the most common killer—disease. In particular, dysentery was said to be endemic in the dry season and pulmonary infections during episodes of heavy rains.[335] Similar observations were made eight years later.[336] One medical officer, who interviewed over eighty villagers and estate-dwellers in the parish of St. Peter's, found that many families prepared just one full meal per day, consisting normally of a pot of boiled flour and salted fish.[337] As they had done a century earlier, the rural poor relied entirely upon rain-fed ponds for water, which became "generally muddy, foul and stagnant" when precipitation was scarce.[338] Charles Dennehy, the medical chief of St. Mary's parish, offered a more graphic insight into the cleanliness of village ponds:

[334] E.g. CO7/123, Gov. Hill to E. Cardwell, 23 Jul 1864; CO7/142, Report on 1871 census, 2 April 1871; CO152/136, Gov. Berkeley to H. Beach, 12 Dec 1879 & enclosure.

[335] CO7/123, Commissioners' report on mortality rates, 21 Jul 1864.

[336] CO152/115, Report on free village sanitary conditions, 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873.

[337] Ibid., Report for District 3, 3 Dec 1872.

[338] CO7/122, E. Baynes to Gov. Hill, 11 Jun 1864.

> being mere surface drainage, [the water is] invariably contaminated by the village offal, by the wash from the roads, by the free access of horses and cattle, by pigs, by dogs, and even by human excreta, any one of which factors, is not only disgusting and poisonous, but in combination must be simply lethal; … such I believe to be the source of the lumbricoid worms, with which every child is infested …[339]

Several of Dennehy's colleagues provided equally alarming testimony.[340]

It is noteworthy that the richest accounts of working class living conditions in nineteenth century Antigua were written during the major phases of climatic stress examined in this chapter. As such, it is difficult to ascertain the extent to which meteorological parameters may account for the hardships described. However, there can be little doubt that by amplifying persistent poverty, malnutrition and water supply problems, they were at least an important contributor. Indeed, for the Registrar General of the colony, dry weather and smallpox were the principal factors behind depopulation in 1862-1864,[341] while, in the early 1870s, this trend was ascribed by many observers to the hurricane and drought.[342] Conversely, a drop in mortality in 1870 was credited to a combination of "more favourable seasons" and new healthcare legislation.[343]

10.4.3. Working class coping mechanisms

Working class Antiguans, though often portrayed as such by the plantocracy, were not passive victims of weather-driven livelihood crises; they actively sought to protect their physical and economic wellbeing through a variety of strategies. One such strategy is discernible in official crime statistics, which, notwithstanding some gaps and non-uniformity, exhibit conspicuous peaks in 1864 and 1874 (Figure 10.6).[344] The underlying causes were well-known to colonial administrators. Commenting on conviction rates in the first of these years, Oliver Eldridge asserted:

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[339] CO152/115, District 6 sanitary report, 14 Nov 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873.

[340] E.g. CO152/115, Report on free village sanitary conditions, 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873; CO152/129, Report of E. Baynes, 14 May 1877.

[341] CO7/142, Report on 1871 census, 2 April 1871.

[342] E.g. CO7/144, Minute on demographic figures for 1871, with letter from Gov. Pine to Early of Kimberley, 27 Mar 1872; PA, Vol.28, pp.467-468, Gracehill & Lebanon reports for 1872.

[343] CO7/142, Report on 1871 census, 2 April 1871.

[344] Another clear peak in numbers of 'summary convictions' in 1858-1859 (Figure 10.6a) is probably explained by a series of riots in the former year which followed an altercation between an Antiguan and a Barbudan immigrant in St. John's (see Lightfoot, 2007).

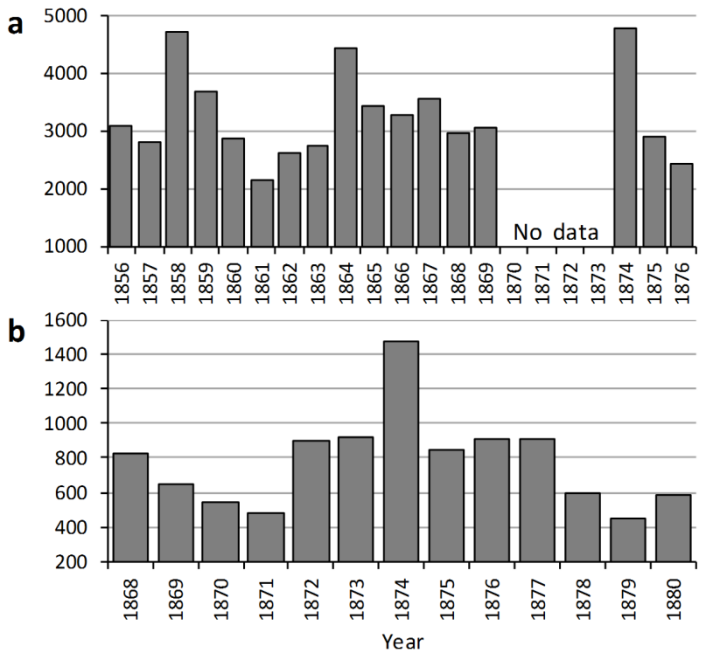

Figure 10.6. Antiguan crime statistics. (a) Number of commitments in common courts, 1856-1876, and (b) number of convictions to prison, 1868-1880. Data from: CO7/137, Gov. Pine to Earl Granville, 8 Oct 1869; CO7/1407, E. Baynes to Gov. Pine, 8 Oct 1870; CO7/41, E. Baynes to Gov. Mundy, 6 May 1871; CO152/122, Gov. Berkeley to Earl of Carnarvon, 9 Apr 1875; Parliamentary Papers, C.1869, Papers relating to Her Majesty's colonial possessions: Reports for 1876, Gov Berkeley to Earl of Carnarvon, 26 May 1877; CO152/144, Leeward Islands prisons report, 29 Mar 1881.

> There can be no doubt that owing to the distress in the island caused by the protracted drought, numerous offences were committed from want of the necessaries of life; the fine rains in the latter part of the year gave employment to large numbers and the number of prisoners in the jail were speedily reduced to nearly half the average of the year.[345]

Ten years later, the same trends were reported,[346] along with detailed statistics highlighting the frequency of offences "attributable to the extreme poverty to which the masses of the people were reduced"[347] (Figure 10.7). Most striking was an almost ten-fold increase in the number of prisoners convicted between 1870 and 1874 for 'damaging' canes (Figure 10.7c)—a crime typically motivated by hunger (Section 9.4.2). There is some evidence that high rates of certain crimes may have

[345] CO7/126, O. Eldridge to Gov. Hill, 21 Aug 1865.

[346] CO152, E. Baynes to Earl of Carnarvon, 26 Sept 1874, Prisons report for 1873; CO152/122, Prisons report for 1874; Parliamentary Papers, C.1335-1336, Papers relating to Her Majesty's colonial possessions: Part II, Report of E. Baynes, 11 June 1875.

[347] CO152/122, Gov. Berkeley to Earl of Carnarvon, 9 Apr 1875.

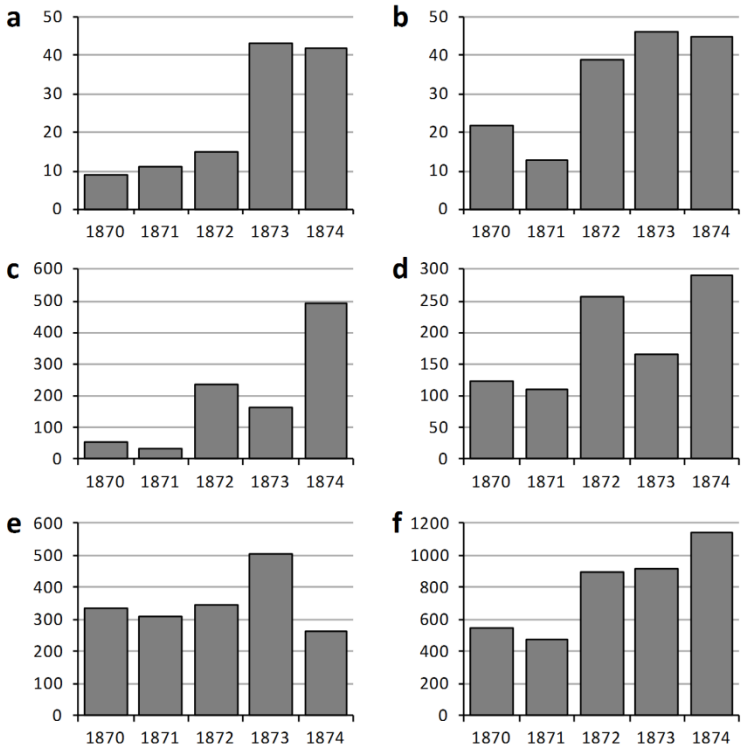

Figure 10.7. Annual number of commitments to prison for (a) debt evasion, (b) vagrancy, (c) damaging sugar canes, (d) other forms of theft, (e) other offences and (f) all offences. Data from CO152/122, Prisons report for 1874, enclosed with letter from Gov. Berkeley to Earl of Carnarvon, 9 Apr 1875.

characterised not only major episodes of extreme weather, but also the recessions that followed. While the theft of produce was commented to be rife again in 1868 and 1869,[348] an overall fall in lawbreaking in 1870-1871 and 1878-1879 (Figure 10.6b) reportedly stemmed from the recovery of food prices and demand for agricultural labour.[349]

Another means for poverty-stricken islanders to make ends meet was to minimise spending. Educational and religious activities were, it appears, among the first to be dispensed with. A topic discussed frequently by the Antiguan Moravians in the mid-late nineteenth century was the dramatic ebbs and flows in the turnout at their churches and schools, as well as in the value of the membership fees and donations received. These fluctuations closely match the broad patterns of economic downturn and resurgence outlined earlier (Sections 10.3, 10.4.1): a large fall in attendance and income was noted at many mission stations in the years 1862-1864 and 1872-1874; despite rising slightly, these figures remained unusually low for around half a decade

[348] CO7/137, Legislative addresses, 8 & 15 Jul 1869; see also CO 7/137, Gov. Pine to Earl Granville, 8 Oct 1869.

[349] CO7/141, E. Baynes to Gov. Mundy, 6 May 1871; CO152/138, Prison report for 1879.

afterwards; and, finally, they returned to satisfactory levels in 1870-1871 and 1879-1880.[350] Unfortunately, quantitative records of these trends are scarce, intermittently-reported membership totals being the only related statistics uncovered (Figure 10.3). Nonetheless, Moravian ministers commented frequently and in no uncertain terms that the observed variations had much to do with the effects of the weather upon popular livelihoods.[351]

Though seldom documented, the archives reveal several measures which simultaneously helped to cut costs and keep hunger at bay. In the early 1870s, for example, it was noted that some of the poorest islanders had resorted to consuming arrowroot and cactus leaves as a substitute for conventional staples.[352] A rather different tactic was employed by villagers in the neighbourhood of Lebanon Church during the scarcities of 1863; "not a few go out to labour in the morning with a cord bound tightly round the body," remarked the head of that mission station.[353] Interestingly, during a drought four decades previously, another Moravian observed Antiguan slaves to have done the same to "prevent digestion from proceeding too rapidly."[354] It is noteworthy that there is little evidence of working class islanders having responded to rising costs by increasing their working hours on sugar plantations, as they had in the 1830s and 40s (Chapter 9). While action of this kind may have gone undocumented, in the context of increasing estate abandonment, it is more likely that this was simply a rare option. Nonetheless, it was remarked in the late 1860s that many children across the island had suspended their studies in order to undertake field labour.[355]

Some members of the Afro-Creole community, rather than stay put and struggle for survival, opted for flight. The emigration of would-be agricultural labourers, principally to Guyana, Puerto Rico and Trinidad, attracted much attention in the 1860s and 70s. Antigua's Registrar General calculated the total figure to stand at over 1,100 during the former decade.[356] Although no such calculations were reported

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[350] These patterns are described in over seventy individual entries in PA, Vols.24-31.

[351] PA, Vol.25, p.48 Letters from Br. G. Westerby, 27 Aug, 12 Oct 1863, p.210, St. John's report for 1863, p.281, West Indies report for 1863; Vol.26, p.458, Antigua schools report for 1867; Vol.27, p.120, Antigua schools report for 1868, pp.122-123, Gracehill report for 1868; Vol.28, pp.464, 467, 468, St. John's, Cedar Hall & Newfield reports for 1872; Vol.29, pp.110, 111, Greenbay & Cedar Hall reports for 1873, pp.329, 330, 332, Gracehill, Cedar Hall & Newfield reports for 1874; Vol.31, pp.363, 365, St. John's & Greenbay reports for 1879.

[352] CO152/115, District 4 sanitary report, 26 Nov 1872, with letter from Gov. Irving to Earl of Kimberly, 27 Aug 1873; PA, Vol.29, p.330, Gracebay report for 1874.

[353] PA, Vol.25, p.281, West Indies reports for 1863.

[354] PA, Vol.8, p.19, Cedar Hall diary extracts from 1822.

[355] PA, Vol.26, p.463, Cedar Hall report for 1867; PA, Vol.27, pp.120-121, Antigua schools report for 1868, p.378, Newfield report for 1869.

[356] Parliamentary Papers, C.1102, Papers relating to Her Majesty's colonial possessions: Part II, Gov. Irving to Earl of Carnarvon, 24 Jul 1874.

subsequently, emigration seems a probable explanation for the fact that the 1871 census total exceeded that of 1881 by just 23 (Table 3.4), yet 1,347 more births than deaths were recorded in the island over the intervening ten years.[357] It was, however, explicitly noted that the drought-driven crisis of the 1870s had triggered a new wave of economic migration overseas,[358] which continued until the recovery of the local labour market at the end of the decade.[359]

10.5. The elite against crisis

10.5.1. Institutional solutions for water scarcity and fiscal insolvency

Over the 1860s and 70s, the Antiguan government implemented a diversity of measures to tackle climate-related economic, demographic, sanitary and social problems. Exploring every one of these is beyond the scope of the present chapter. This section, therefore, focuses on the management of water shortages and fiscal instability, which have been important themes earlier in the thesis.

Action to augment the island's water supplies first became necessary in 1860. Following the recommendations of a specially-created legislative board, £3,250 was invested that summer cleaning out ponds, sinking new wells and repairing "public reservoirs" throughout the island—"works which had been omitted for upwards of twenty years."[360] When, at the instruction of the governor, several churches in the colony were also provided with iron cisterns for common use, one Moravian entertained hopes that there would "never again be such a want of water."[361] But it was to not be; when dry weather returned three years later, widespread shortages arose once more. On this occasion, it seems that politicians considered themselves unable to afford further immediate help, for no comparable steps were recorded in 1863 or 1864. However, the arid year of 1872 saw "great expense" incurred by another island-wide campaign for the clearance of public reservoirs.[362]

Rainfall scarcity in 1863 and 1864 may not have stimulated instant relief measures, but it did serve as the catalyst for a remarkable feat of civil engineering: the provision of running water for St. John's. "The drought experienced this year and that of 1860, warns us that some provision should be made for supplying water irrespective of

[357] CO152/146, Report on 1881 census, 11 Jul 1881.

[358] PA, Vol.29, pp.110, 111, Greenbay & Gracehill reports for 1873, pp.330, 331, Cedar Hall & Gracefield reports for 1874; CO152/129, Report of E. Baynes, 14 May 1877.

[359] Parliamentary Papers, C.1869, Papers relating to Her Majesty's colonial possessions, Gov Berkeley to Earl of Carnarvon, 26 May 1877, C.2149, Report of E. Baynes, 11 Jul 1878, C.2598, Gov. Berkeley to H. Beach, 11 Aug 1879.

[360] CO7/116, Gov. Hamilton to Duke of Newcastle, 8 Aug 1861.

[361] PA, Vol.23, p.525, Letter from Br. J. Hasting, 25 Jun 1860.

[362] CO152/110, E. Baynes to Earl of Kimberley, 11 Dec 1872.

rain," Governor Hill wrote to Whitehall late in 1863, enclosing a thirty-page plan for the construction of urban water works.[363] With the help of its recipients, a loan of £30,000—which would today hold a value of £1.37 million—was secured from private parties in Britain and building commenced in September 1865. Over the next two years, eight kilometres of piping was laid to channel the outflow of springs in south-western Antigua downhill to a purpose-built, 230,000-litre reservoir near St. John's. This was linked to fourteen standpipes distributed throughout the town, from which water could eventually be procured without restriction. A direct supply was also furnished to a handful of public institutions and over sixty private premises in St. John's and its environs, where a new tax of unspecified value was charged for maintenance.[364]

The immediate practicalities of these works were celebrated emphatically by Antiguan bureaucrats and even cited as the cause of a reduction in mortality in 1870.[365] However, by that date, their reliability was also coming under question. Despite seasonable rains in the 1869 wet season, the total daily yield failed to exceed 160,000 litres—a fifth of what was expected at that time of year.[366] During the drought of the early-mid 1870s it fell even lower (Table 10.2), obliging £1,146 to be spent pumping additional water from a swampy valley 6.5 km south of the capital.[367] Accepting that the works could not be depended upon in the driest times, civil servants soon set about formulating a permanent means to expand their capacity.[368] Yet, it was not until the 1890s that any practical steps were taken.

Inciting action to tackle water shortages was just one way that drought incurred costs to the Antiguan treasury. Such circumstances may not have been rare in the 1800s, but when deficient rainfall in the early-mid 1860s succeeded a decade of general economic decline, exceptional measures became necessary. Emergency loans totalling £8,493 were then sought simply to reduce the fiscal deficit, with £3,000 obtained from a local savings bank and the remainder loaned by British financiers as a series of debentures.[369] Two years down the line, when these were due for settlement, Antigua's administration remained insolvent and had to borrow a further £7,168 from

[363] CO7/121, Gov. Hill to Duke of Newcastle, 10 Oct 1863.

[364] CO7/126, O. Eldridge to Gov. Hill, 21 Aug 1864; CO7/133, Gov. Hill to Duke of Buckingham, 12 Sept 1868; CO7/136, Half-yearly report of 'Water Commissioners' for 31 Jun 1868.

[365] Gov. Hill to Duke of Buckingham, 26 Aug 1867 & enclosures; CO7/142, Report on 1871 census, 2 Apr 1871.

[366] CO7/138, Gov. Pine to Earl Granville, 3 Nov 1869.

[367] CO152/109, E. Baynes to Earl of Kimberley, 26 Sept 1872; CO152/109, E. Baynes to Earl of Kimberley, 26 Jan 1875.

[368] CO152/129, Report of E. Baynes, 14 May 1877.

[369] CO7/126, O. Eldridge to Gov. Hill, 21 Aug 1865, Gov. Hill to E. Cardwell, 11 Nov 1865; CO7/127, E. Baynes to Gov. Pine, 19 May 1866.

domestic sources, such as British Customs and military accounts.[370] Of course, obtaining credit also meant raising the finance to settle up. New taxes were introduced on the best-paid professions, including merchantry, plantership and banking, while import duties were increased by 25%.[371] A far more radical contemporary austerity measure was administrative reform, which has been described at length elsewhere (see Section 3.3.3). Here, it is worth highlighting that both contemporaries[372] and modern historians (Green, 1976; Dyde, 2000) have commented on the significance of the 1863-1864 drought in exposing the financial frailties of the governmental system formerly in operation.

Predictably, another round of fiscal intervention became necessary in the wake of the climatic shocks of the early 1870s. In this instance, disaster relief schemes (Section 10.5.2) and augmentation of the water works added considerably to expenditure. Meanwhile, already-shrinking government income was further reduced by the removal of the recent 25% increase to import charges and suspension of "village taxes" for the benefit of the poor in 1872.[373] The legislature was forced to compensate for this in 1874 as harvest-ruining weather continued; export tariffs were increased by eight pence per hogshead, the cost of alcohol retailing licenses by 25% and import duties by 12.5%.[374] That year, a new British loan of £4,000 was also acquired,[375] but when this and other sums owing in 1875 could not be settled, there was little choice but to consolidate all of colony's debts into yet another tranche of debentures, now totalling £8,900.[376] Their repayment is not documented explicitly, but pleasing fiscal returns at the end of the decade (Section 10.3.1) suggest some progress.

10.5.2. State-sponsored disaster relief, 1871-1874

As we have seen, Antigua's governing body adopted a variety of strategies to tackle fiscal and water supply problems between 1860 and 1880. The early-mid 1870s are worthy of targeted examination, having also witnessed the provision of direct relief for the victims of climatic disaster. It was with this as his stated objective that Arthur Peel, Antigua's Chief of Justice, convoked an emergency meeting of the local elite the day after the 1871 hurricane. The outcome was a subscription for public donations and

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[370] CO7/130, Gov. Hill to Duke of Buckingham, 24 Dec 1867; CO7/133, Gov. Hill to Duke of Buckingham, 12 Sept 1868.

[371] CO7/126, Gov. Hill to E. Cardwell, 10 Nov 1865; CO7/130, O. Mann to Gov. Hill, 10 Dec 1867; CO152/110, E. Baynes to Earl of Kimberley, 9 Nov 1872.

[372] CO7/128, Legislative addresses, 10 Oct 1866, Gov. Pine to E. Cardwell, 23 Oct 1866.

[373] CO152/110, E. Baynes to Earl of Kimberley, 9 Nov 1872.

[374] CO152/119, Gov. Irving to Earl of Carnarvon, 27 May 1874.

[375] CO152/120, E. Baynes to Earl of Carnarvon, 11 Sept, 13 Oct 1874.

[376] CO152/123, Gov. Berkeley to Earl of Carnarvon, 26 Aug 1875.

Table 10.4. Summary of funds received by the Antiguan hurricane relief committee. Entries represent voluntary donations unless otherwise stated. Values rounded to nearest pound sterling. Source: CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.12.

Funding source	Date of receipt	Sum (£)
Antigua treasury (grant, originally £500)	Aug 1871	242
Antigua public subscription	Aug 1871	238
Antiguan homeless fund (grant)	Nov 1871	7
Barbados	Sept, Nov 1871	1,450
Barbuda 'Friendly Society'	Aug 1871	5
British Guyana	Sept 1871	646
Colonial Bank (grant)	Oct 1871	100
Glasgow, direct residents' contribution	Nov 1871	13
Gossage & Sons merchant house, Liverpool	Oct 1871	10
Montserrat	Sept, Dec 1871	57
London relief committee	Nov 1871-Jan 1872	5,098
London, direct residents' contribution	Nov 1871	47
St. Lucia	Dec 1871	71
Tobago	Jan 1872	197
Trinidad	Jan 1872	400
Total		8,581*

* £1,723 of the total was transferred to the legislatures of St. Kitts, Nevis and the Virgin Islands to aid their hurricane relief efforts.

formation of an emergency committee to administer its proceeds.[377] Over the next week, some £245 was raised and dispensed as food aid—an intervention that "saved a large number of persons from starvation."[378] In the meantime, the legislature opened several buildings to shelter the homeless and furnished the island's social services with £500 for the distribution of clothing as well as foodstuffs.[379] With immediate danger to life now judged to have been averted and pecuniary aid starting to pour in from overseas (Table 10.4), the so-called "Hurricane Committee" turned its attention to re-housing the masses.[380] After assessing applications made by the "labouring class," repair grants not exceeding one-fifth of the value of damage to each dwelling were disbursed.[381] Later, payments were also made to estate overseers, many of whom had struggled to restore their habitations on account of the "small salaries" they earned.[382] When the committee concluded operations in November 1872, over £6,800 of relief had been dispensed in the manner recorded in Table 10.5.

[377] CO7/142, Extract from 'The Antigua Weekly Register,' 22 Aug 1871.

[378] CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.3.

[379] Ibid.; CO7/144, Minutes of Legislative Council, 23 Aug 1871.

[380] CO152/116, Hurricane Relief Committee report, 15 Nov 1872, pp.3-5.

[381] CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.7.

[382] CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.6.

Table 10.5. Summary of expenditure of the Antiguan hurricane relief committee. Values rounded to nearest pound sterling. Source: CO152/116, Hurricane Relief Committee report, 15 Nov 1872, p.12.

Item	Sum (£)
Food aid	272
Distribution of clothing	152
Provision of shelter	57
Monetary grants to town and village residents	5,922
Monetary grants to labourers residing on estates	183
Monetary grants to estate overseers	94
Repairs to Orphanage	38
'Incidental expenses'	135
Total	6,853

Much of the committee's overseas income was donated expressly for the purchase of vital supplies and reconstruction of existing dwellings. Local government, however, had other ideas about relief spending and, late in September 1871, initiated a competing programme to accommodate the homeless. In view of the "need of labourers on Estates" and the "unsatisfactory character" of Antigua's villages, £4,000 was appropriated from a seldom-used 'immigration fund' to encourage planters to erect housing on their property.[383] From that sum, grants of £20 were paid for each newly-built dwelling that went on to be occupied by the former residents of independent settlements.[384] Ultimately, though, "an almost general disinclination… to abandon the freehold plots" was observed; fewer than 70 labourers' "cottages" were built, accounting for one-third of the available budget.[385]

Within the next eighteen months, the authorities again came to the assistance of the masses, this time in response to drought. With strains on social services mounting (Table 10.3), legislators granted the poorhouse and lunatic asylum an emergency allowance of £750 sterling in 1873[386] and, the following year, expanded the total budget for public care from £988 to £1,528 sterling.[387] Simultaneously, efforts were made to tackle distress at its root. Learning of the destitution prevailing in Popeshead district in autumn 1874, £1,000 was allocated to offer "as much employment as possible… on the repair of the public roads."[388] Comparable action appears to have been taken in 1873, state papers noting that some labourers were able to earn a wage

[383] CO7/142, Minutes of legislative council, 23 Sept 1871.
[384] CO7/142, E. Baynes to Earl of Kimberley, 25 Sept 1871.
[385] CO152/108, Gov. Pine to Earl of Kimberley, 12 Jul 1872.
[386] CO152/119, Gov. Irving to Earl of Carnarvon, 27 May 1874.
[387] CO152/122, E. Baynes to Earl of Carnarvon, 26 Jan 1875.
[388] CO152/120, E. Baynes to Earl of Carnarvon, 13 Oct 1874.

that year "on Government works, such as repairing the highways, cleaning ponds, &c. [etc]."[389] Though detailed information relating to the functioning of these schemes has not been uncovered, the Registrar General affirmed several years later that the "immediate wants" of the participants "were to some extent relieved."[390] It is curious that no intervention of this nature was recorded during the livelihoods crisis of 1863-1864. In 1860, however, the clearance of public reservoirs and digging of wells was commented to have served the secondary function of providing work for the unemployed.[391]

10.5.3. Community endeavour: acts of charity, heroism and worship

As in the 1830s and 40s, civilian efforts to protect community welfare from the effects of adverse weather were documented relatively poorly. A handful of sources do, nevertheless, offer some significant examples. The annals of the Moravian Church reveal that its clergy initiated an independent relief campaign the morning after the 1871 cyclone, providing all they could in the way of shelter, food and clothing. School buildings at Greenbay and St. John's were said to be crowded with destitute locals for two weeks. At the former, where Brother John Buckley also supported two families in his own residence, more than one hundred members of the public were accommodated.[392] It was not only Antiguan Moravians who participated in the effort; from September, society members overseas mounted appeals to collect donations for the calamity-stricken island.[393] Over £2,000 had been raised by the end of the year in Britain, Germany and North America alone,[394] which was spent repairing the property of the mission and its congregations.[395] It is probable that other religious and charitable institutions in Antigua acted similarly. For instance, according to one preacher, the work of the Dorcas Society—a local foundation established in 1867 to provide clothing for the poor—had been "greatly assisted by generous contributions of second-hand clothing."[396]

Some individuals reportedly risked their own safety to help others during the hurricane. A newspaper cutting enclosed with government papers recounted at length how a ship's captain, two sailors and a local man, braved the seething waters of St. John's harbour to rescue four mariners who clung to the remains of a sinking

[389] Parliamentary Papers, C.1102, Papers relating to Her Majesty's colonial possessions: Part II, Gov. Irving to Earl of Carnarvon, 24 Jul 1874.

[390] CO152/129, Report of E. Baynes, 14 May 1877.

[391] CO7/116, Gov. Hamilton to Duke of Newcastle, 8 Aug 1861.

[392] PA, Vol.28, p.135, Letter from Br. J. Thomas, 9 Sept 1871, pp.249, 250, 253, St. John's, Greenbay & Newfield reports for 1871.

[393] PA, Vol.28, p.250, Gracehill report for 1871.

[394] PA, Vol.28, p.253, Note on Antiguan reports for 1871.

[395] PA, Vol.28, p.249, 250, 252, St. John's, Gracehill & Lebanon reports for 1871.

[396] PA, Vol.28, p.250, St. John's report for 1871.

vessel.[397] Likewise, the head of Gracefield mission station told of one church helper who, seeing his step-mother and a young girl pushed by the wind into the sea, dived in to save them.[398]

Though scarcer, some evidence is available of civilian action to alleviate the hardship caused by drought. Amidst severe food shortages in 1863, a Falmouth-based merchant agreed to sell cornmeal at trade value to the head of Gracebay Church, enabling it to be resold "at a comparatively low price to the destitute."[399] Not dissimilarly, during the trials of 1874, missionaries at Cedarhall were able to furnish some of their congregants with new clothes thanks to "the kind assistance of a friend in Bristol."[400] Here too, a rather different practical response was elicited by dry weather in 1860: the digging of a 90,000-litre pond for common use in future times of need.[401]

One strand of state intervention not mentioned earlier was the organisation of collective worship. Days of "public humiliation and prayer" to request deliverance from drought were called by governing officials in August 1863 and July 1872.[402] Significantly, the local clergy also took action of its own accord. In the early 1870s, the Moravians held a series of private services in supplication for rain,[403] two of which additionally solicited "Divine protection during the hurricane season."[404]

10.6. Decline, disaster and social vulnerability in the late 1800s: an overview

The second half of the nineteenth century was an era of pronounced and persistent decline for the British West Indian sugar economy. The concurrent waves of estate turnover, commercial stagnation, unemployment and fiscal instability have been examined in detail by many scholars (e.g. Williams, 1970; Hall, 1971; Green, 1976; Watts, 1987). While supporting the suggestion that these trends were common in Antigua throughout the mid-late 1800s, the archives consulted in this investigation highlight a point which has previously received little attention: that, here, agro-economic turmoil reached its height during moments of intense climatic stress. Evidence from the 1860s and 1870s indicates that this stress was exerted in a manner which—in light of the findings reported in chapters 8 and 9—was somewhat routine; it disrupted husbandry and, with it, the profitability of all forms of industry, as well as the availability of life-sustaining resources. However, the resulting hardship was far

[397] CO7/142, Extract from 'The Antigua Weekly Register', 22 Aug 1871.
[398] PA, Vol.28, p.135, Letter from Br. J. Thomas, 9 Sept 1871.
[399] PA, Vol.25, p.212, Gracebay report for 1863.
[400] PA, Vol.29, p.330, Cedarhall report for 1874.
[401] PA, Vol.23, p.252, Letter from Br. J. Hasting, 25 Jun 1860.
[402] CO7/120, Government proclamation, 12 Aug 1863; PA, Vol.28, p.465, St. John's report for 1872.
[403] PA, Vol.28, pp.466, 468, Gracebay & Newfield reports for 1872.
[404] PA, Vol.29, p.113, Gracebay report for 1873, pp.237-238, St. John's report for 1874.

from typical. Phases of intense drought in 1863-1864 and 1871-1874, the latter punctuated by a major hurricane, culminated in the greatest levels of government insolvency, mass destitution and demographic decline documented in the island since the early nineteenth century. Another distinguishing consequence was the stifling effect these events had upon economic activity for years after their immediate effects had dissipated. By contrast, recovery from the depression caused by a similar sequence of meteorological hazards in the mid-1830s was relatively speedy, taking place over some twelve months (Section 9.3.2).

The severity of the studied agro-economic crises undoubtedly owed much to the harsh commercial circumstances that affected the whole of the British Caribbean. This is illustrated by the great suffering that marked 1863 and 1864, when a two-year drought—a common enough occurrence in colonial Antigua—coincided with interruptions to trade with North America and the collapse of already low sugar prices. Episodes of precipitation scarcity in 1860, 1866 and 1868 took place in years free of the disastrous effects of these political and commercial developments and had far less serious consequences for industry and financial stability. The duration and intensity of the 1863-1864 drought should not, however, be overlooked as a crucial influence; unfavourable market conditions and reduced provision imports alone cannot explain the abrupt plummet of sugar exports in 1864 (Figure 9.2). In the case of the early-mid 1870s, the severity of the hurricane and subsequent drought appears to account for disaster to a far greater degree. International circumstances were then more favourable than a decade earlier, the American Civil War having long been over, the market value of muscovado having risen modestly and administrative reform bringing certain budgetary savings. Nonetheless, the evidence suggests that the aforementioned weather events—which were among the most severe of their kind reconstructed from 1770 to 1890 (Chapters 5, 6)—culminated in almost unprecedented levels of poverty and state bankruptcy. Indeed, accounts of the extreme destitution of the Afro-Creole community at the time are startlingly similar to those pertaining to days of slavery.

A remarkable visual symptom of mass pauperisation was the deterioration of attire, which, on several occasions in the 1860s and 70s, was observed to reach the point of partial nudity. The psychological distress produced in this way has been explored by Pérez (2001: p.118), who found that the loss of clothing during hurricanes in 1840s Cuba engendered "a special type of angst, a vulnerability and a heightened awareness of the relationship between self-presentation and self-preservation." High mortality among the black working class was another feature distinguishing the crisis period examined in this chapter. The evidence indicates that this stemmed from a range of social and economic factors influencing material circumstances, many of which have been discussed in Brian Dyde's (2000) history of Antigua. However, what has not been highlighted previously is that the majority of the most detailed firsthand accounts of living conditions in the mid-late 1800s were compiled during episodes of

considerable climatic stress. Unquestionably, problems such as inadequate housing, marginal water supplies and the absence of sanitary systems would have been endemic in disadvantaged neighbourhoods. Nevertheless, archival sources leave little doubt that access to the necessities of life, as well as the amount of time and resources that could be devoted to childcare and home-maintenance, reached low points as a result of extreme weather. Although it has not been the central focus here, records suggest that disease also played an important role in triggering phases of increased mortality (Figure 10.5).

The thesis that weather patterns exerted a crucial influence over the pace of socio-economic decay during the mid-late 1800s is reinforced by considering developments in the years on either side of the case study period. Climate reconstructions indicate that the 1850s and 1880s witnessed a particularly low incidence of powerful cyclones and drought in Antigua, with just one hurricane and one rain-year of 'very dry' conditions recorded throughout both decades (e.g. Figure 7.1a). Notably, contemporary government and missionary papers are devoid of reports of the prodigious rates of liquidation, unemployment, deprivation and mortality that characterised the 1860s and 70s.[405] In contrast, there are striking similarities between the situation in 1890s Antigua described by Lowes (1995) and that documented in this chapter. When drought in 1892-1894 coincided with a drop in sugar prices, the result was another half-decade of recession. Some 40% of the agricultural workforce was laid off within one six-month period and mortality, emigration, subscriptions for poor relief and convictions to prison again soared (Lowes, 1995). Antiguans' experience of drought in the sixties and seventies may also have mirrored that of working-class populations elsewhere in the British West Indies. Reporting at the start of 1864, one anonymous Moravian noted:

> In Jamaica, as well as in Antigua and Barbados, the results of the long drought, and other causes of distress, continue to be felt in the impoverishment of the people, and their consequent lessened ability to perform in their duty in the way of paying school-fees, &c [etc].[406]

With respect to societal responses to climatic disaster, there is much resemblance between the findings of this and the previous chapter. It is, however, significant that governmental management of water shortages, public penury and state bankruptcy in 1860-1880 assumed proportions not previously recorded in Antigua. In fact, so costly were initiatives to tackle the first and second of these problems, that they seemingly exacerbated the third. The construction of the St. John's water works, for example, saddled the treasury with enormous debt that it was still bound to repay when drought

[405] See document series CO7/95-112; CO152/138-176; PA, Vols.19-23 & 32-34.

[406] PA, Vol.25, pp.280-281, Reports from the West Indies for 1863.

struck again several years later. Disaster relief schemes then exerted additional financial pressure. In the context of long-term sanitary and economic decline, this presented somewhat of a ‘catch-22’ conundrum: legislators could either protect public welfare at the risk of state bankruptcy or minimise spending and jeopardise demographic stability. In the end, a precarious balancing act was struck, with the net result that neither the treasury nor populace escaped unscathed. Further discussion of social responses at this time is provided in Chapter 11.

The findings of this case study, when seen within in the context of the two preceding it and the broad socio-economic trends documented in other West Indian histories (e.g. Williams, 1970; Green, 1976; Lightfoot, 2007), suggest that the latter half of the nineteenth century represented a phase of particular vulnerability to climatic stress in Antigua. At its root, this stemmed from the adoption of imperial policies which exposed the plantation economy to the full force of increasingly hostile market conditions. Meanwhile, temporary collapses in the retail value of its staple export and disruptions to provision imports seem, as ever, to have further heightened the sensitivity of human systems to extreme weather. Notwithstanding the distinct nature of the problems that society then faced, some parallels are discernible between the mid-late 1800s and the phase of warfare spanning the 1770s through 1810s (see Chapter 8). In both timeframes, persistent threats to local livelihoods posed by international forces were aggravated to the point of total ruin by short-lived climatic and commercial vicissitudes. However, one major difference was that, unlike the disruption produced by war, the turmoil resulting from market liberalisation was permanent. Thus, it could be argued that while the sugar industry remained the foundation of the colonial economy, higher levels of societal vulnerability represented not a temporary aberration, but a new status quo.

As regards the relative position of the white elite and the predominantly black working class, the dark decades of the late nineteenth century appear to have brought comparatively little change. If anything, the distress that materialised among the Afro-Creole community during phases of climatic stress points towards further entrenchment of racial and social stratifications of risk. This was, perhaps, inevitable, given the squeeze now exerted on popular livelihoods by commercial decline and austerity measures implemented by the plantocracy, such as lowering wages and increasing taxes (Section 10.2). Moreover, as exemplified by the legislature’s scheme to re-house hurricane victims on sugar estates in 1871, the privileged retained the power to manipulate unfavourable climatic and economic circumstances to serve their own interests. That this particular scheme was ultimately a failure indicates that such action was obdurately resisted. Nevertheless, as noted by Hall (1971), by this stage any dreams once entertained that the abolition of slavery would galvanise a social mobility revolution had long been shattered.

10.7. Closing remarks

The present chapter has narrated a third and final case study of climatic disaster in colonial Antigua. Attention has centred upon intense episodes of drought in the years 1863-1864 and 1871-1874, the latter coinciding with a major hurricane in 1871. These weather events destabilised societal wellbeing through a now well-rehearsed set of mechanisms: the devastation of plantation agriculture and the exhaustion of local supplies of food and water. Such effects may have been as routine as their stimuli, but amidst the deceleration of an already-floundering sugar economy were peculiarly calamitous; they unleashed agricultural, financial, subsistence, sanitary and demographic crises seldom paralleled in the island's nineteenth and late eighteenth century past. When considered alongside contemporary patterns of social and economic development in Antigua, these findings indicate that the mid-late 1800s represented an era of heightened human susceptibility to the threats posed by climatic deterioration. Much like it always had been, vulnerability was borne disproportionately by the Afro-Creole masses, owing to the stringent socio-economic marginalisation they suffered by the plantocracy. Finally, some evidence has also been uncovered to suggest that the case study presented here, like those preceding it, offers a vision of human experience of extreme weather within a broader spatial and temporal framework—namely, that of the British sugar colonies during the austere second half of the nineteenth century. With this period constituting the final portion of the 120 years studied in the thesis, it now remains to evaluate the analyses conducted here and earlier.

Chapter 11

Discussion

11.1. Introduction

The present climate history, which has focused on the Lesser Antilles Island of Antigua, has incorporated two major empirical elements: firstly, the reconstruction of precipitation variability and hurricane activity from 1770 to 1890 and, secondly, an examination of the societal consequences of meteorological extremes during three case study periods within this broad timeframe. Based on the latter, factors mediating the vulnerability of Antiguan livelihoods to climatic stress in distinct contexts have been identified. These different components of the thesis will now be evaluated. The discussion is structured around four major themes; it focuses first on the climate reconstructions, next on the socio-economic effects of extreme climate events, then on the responses that these generated and, finally, on patterns of human vulnerability to climate, both over time and across society. The chapter concludes by reflecting on some of the strengths and limitations of the research project and identifying themes that merit further investigation. Although attention centres primarily on the findings conveyed in previous chapters, some new empirical evidence is included in this discussion to enhance the assessment of certain subthemes.

11.2. Climate reconstructions

Chapters 5 and 6 dealt respectively with the reconstruction of precipitation and tropical cyclones. Chronologies representing annual, and in some cases seasonal, variability in these elements of climate were developed, documenting nine episodes of prolonged and/or severe drought, six of equivalent precipitation abundance (Section 5.3) and forty-two tropical cyclones affecting Antigua (Section 6.4). The trends captured by both reconstructions appear to have been influenced significantly by data availability. Few major wet or dry phases were apparent in the early 1800s, when direct weather references were scarcer than in other periods (Figure 5.2). Meanwhile, socio-economic breakdown from the late 1700s through early 1800s and administrative reform in the 1860s and 70s may have contributed to the low number of cyclones documented then (Section 6.6). Notwithstanding such limitations, both reconstructions are inherently valuable, representing the first for Antigua extending coverage beyond the observational record.

Sections 5.5 and 6.5 began to consider the regional palaeoclimatic significance of this research. In the case of the rainfall reconstruction, efforts have been considerably

hampered by the fact that only four comparable published studies for the Caribbean are known of—one focused on the Yucatan Peninsula, one on southern Belize, one on Jamaica and one on Puerto Rico. None of these showed correspondence with Antiguan findings. In contrast, many reconstructions of Caribbean tropical cyclone variability have previously been published. Despite documenting fewer individual events than investigations dedicated solely to that end, the record developed here captures some of the major peaks in cyclonic activity identified by others at regional, sub-regional and local scales (e.g. Figure 6.7).

It is also fitting to consider linkages between the Antiguan chronologies and SST reconstructions, a considerable number of which have been undertaken in the Caribbean (e.g. Winter et al., 2000; Haase-Schramm et al., 2003; Kilbourne et al., 2008; Saenger et al., 2009; Vásquez-Bedoya et al., 2012). SSTs are an important influence of the potential for convective precipitation and tropical cyclogenesis in the region. Other factors being equal, warmer (cooler) SSTs tend to be associated with higher (lower) rainfall levels and rates of cyclone formation (Section 3.2). The nearest available proxy SST record which provides continuous coverage for the study period has been presented by Kilbourne et al. (2008). This is based on annual $\delta^{18}O$ values and Sr/Ca ratios in a coral colony sampled near Parguera, Puerto Rico. It exhibits an overall trend of gradual warming from 1751-2004, with negative (positive) shifts in the isotopic and chemical markers associated with warmer (cooler) SSTs. Comparison of this reconstruction with the Antiguan chronologies of tropical cyclone activity and predominant island-wide precipitation levels reveals no consistent correspondence (Figure 11.1). It should be recognised that such a comparison is inherently problematic as samples of the coral were centred roughly on January of each year—part of the cyclone-free dry season. Some significant peaks and troughs in $\delta^{18}O$ and Sr/Ca values do, however, coincide with rain-years of above- and below-average rainfall levels as might be expected (highlighted in Figure 11.1). Other Caribbean SST reconstructions spanning 1770-1890—which have been have been published for the Bahamas (Saenger et al., 2009), Florida (Swart et al., 1996) and the Yucatan Peninsula (Vásquez-Bedoya et al., 2012)—exhibit no coherence with the Antiguan chronologies (Figure 11.2).

The lack of clear relationships between the tropical cyclone and SST records considered above may owe partly to the low overall number of storms documented in this thesis. However, as noted above, the Antiguan cyclone chronology appears to reflect certain peaks in cyclone activity documented regionally. It is worth highlighting that some consistency is evident in the occurrence of phases of warmer (cooler) temperatures in the Puerto Rican coral-based reconstruction and episodes of high (low) tropical cyclone frequencies throughout the Lesser Antilles indicated by another document-based reconstruction (Figure 11.3a; Chenoweth and Divine, 2008).

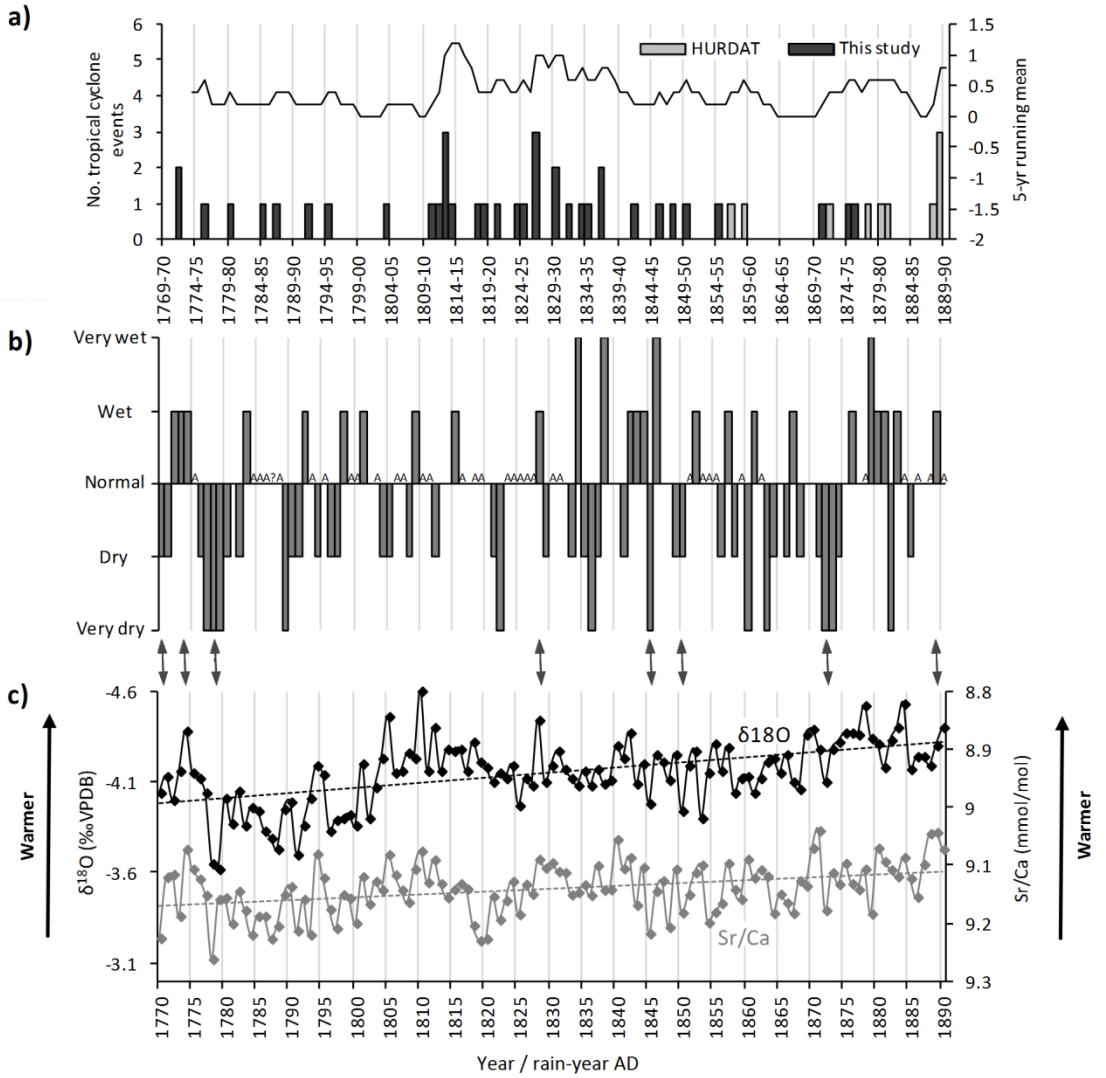

Figure 11.1. (a) Frequency of tropical cyclones affecting Antigua, rain-years 1769-1770 to 1889-1890, as documented in this study and HURDAT. (b) Chronology of average rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. *A* denotes rain-years of assumed 'normal' conditions. *?* indicates an unclassified rain-year. (c) Variations in $\delta^{18}O$ and Sr/Ca based on annual samples centred approximately on January from a *Montastraea faveolata* coral at Turrumote Reef, southwest Puerto Rico (after Kilbourne et al., 2008). Dotted black and grey lines represent long-term trend in the datasets. Grey arrows indicate instances of correspondence between high/low coral-based SSTs and above/below average rainfall levels.

The same is also true when comparing that Lesser Antilles cyclone chronology with a reconstruction of North Atlantic hurricane formation potential inferred from coral and foraminifera proxy records from multiple sites across the Caribbean (Figure 11.3c; Nyberg et al., 2007).

Section 3.2.3 identified several oceanic-atmospheric cycles which, either directly or through their inter-regional teleconnections, are associated with annual- to decadal-scale climate variability in the North Atlantic. High resolution proxy-based indices

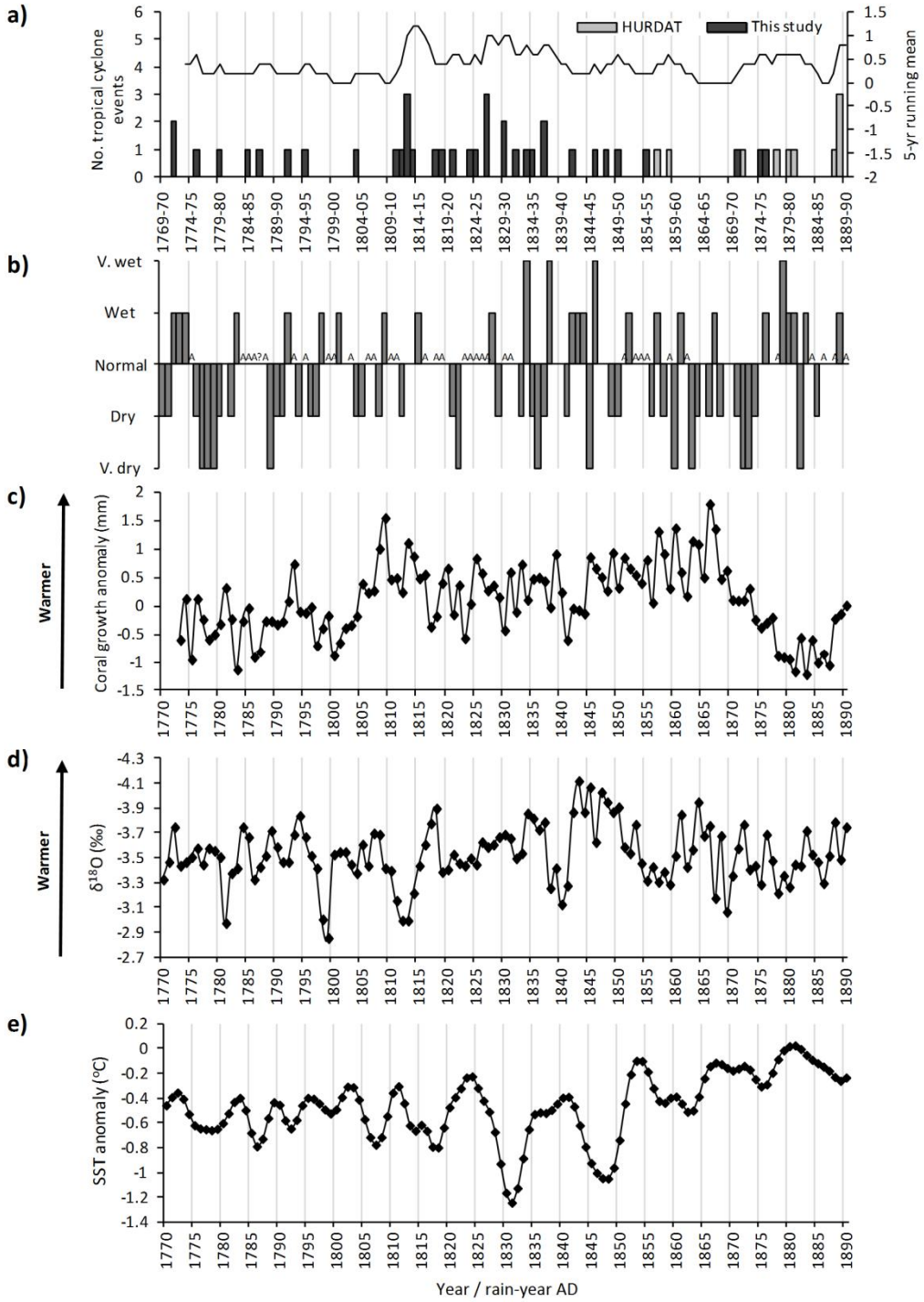

Figure 11.2. (a) Frequency of tropical cyclones affecting Antigua, rain-years 1769-1770 to 1889-1890, as documented in this study and HURDAT. (b) Chronology of average rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. (c) Annual growth anomaly averaged from three *Siderastrea sidereal* coral colonies located in Puerto Morelos Reef Park and Punta Marmona, Yuacatan Peninsula, Mexico (after Vásquez-Bedoya et al., 2012). (d) Annual variations in $\delta^{18}O$ centred on July recorded in a *Montastraea faveolata* coral from Alina's Reef, Biscayne National Park, Florida (after Swart et al., 1996). (e) SSTs inferred from annual growth variations in a *Siderastrea sidereal* coral from Gingerbreads Reef, Bahamas (after Saenger et al., 2009). Plots *c-e* ordered latitudinally, with *e* representing the southern-most site. See Figure 3.4, for regional summer and winter SST charts.

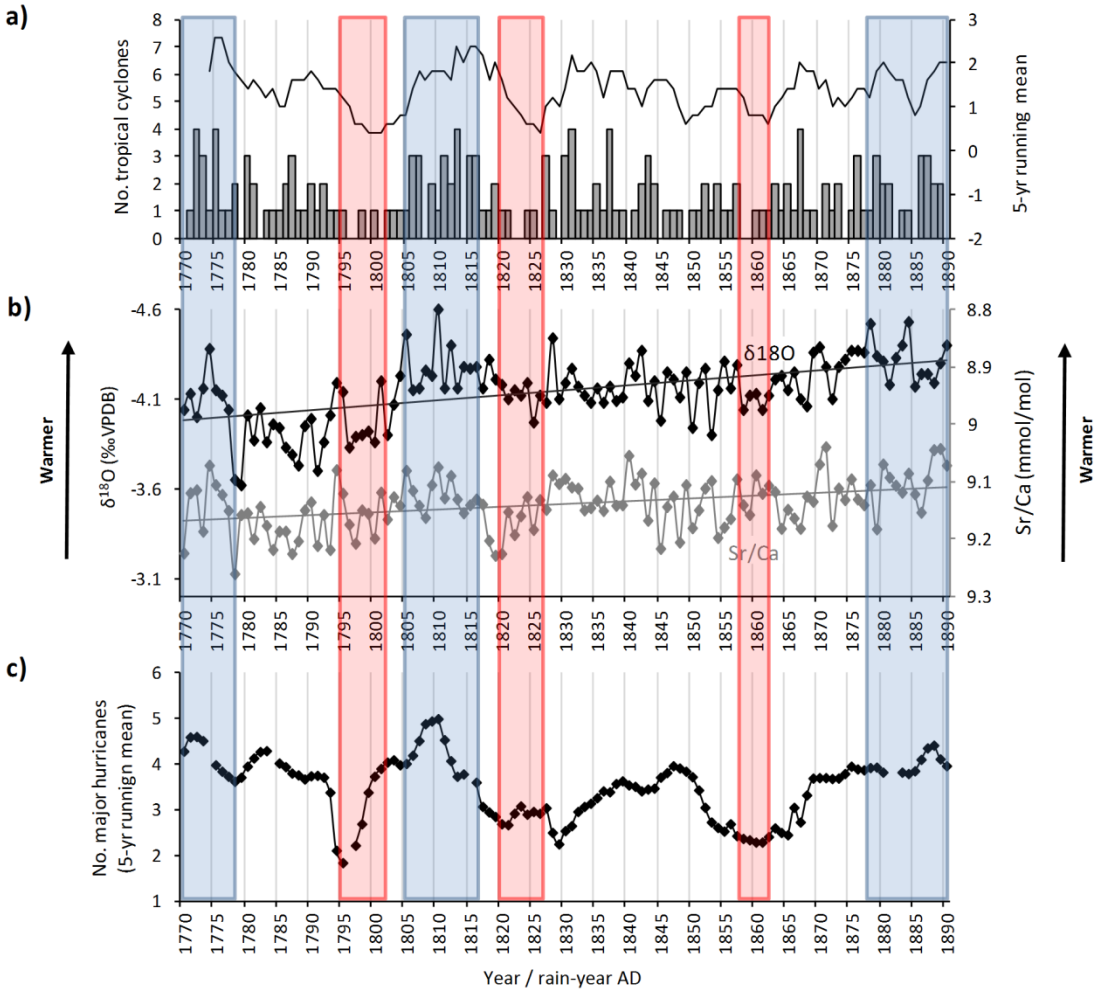

Figure 11.3. (a) Documentary-derived chronology of annual tropical cyclone frequencies in the Lesser Antilles (after Chenoweth and Divine, 2008). (b) Annual variations in $\delta^{18}O$ and Sr/Ca centred on January recorded in a *Montastraea faveolata* coral at Turrumote Reef, southwest Puerto Rico (after Kilbourne et al., 2008). (c) 5-year running mean of estimated annual frequency of major hurricanes in the North Atlantic inferred from four coral and marine sediment records of regional vertical wind shear (after Nyberg et al., 2007). Apparent phases of correspondence highlighted, with blue (red) shading indicating periods of higher (lower) tropical cyclone frequencies in the Lesser Antilles, Puerto Rican reconstructed SSTs and reconstructed Atlantic major hurricanes numbers.

have been presented for the AMO (Gray et al., 2004), NAO (Trouet et al., 2009) and combined net effects of the ENSO and PDO, which have comparable regional effects (McGregor et al., 2010). No clear relationships between these indices and the chronologies developed here are evident (Figures 11.4, 11.5). When considering the timing of individual drought years in Antigua relative the occurrence of discrete El Niño events, as recorded in the widely-cited chronologies of Quinn and Neal (1995) and Ortlieb (2000), some limited correspondence can be discerned (Figure 11.5). Of the 25 episodes of below-normal precipitation levels identified in the island-wide

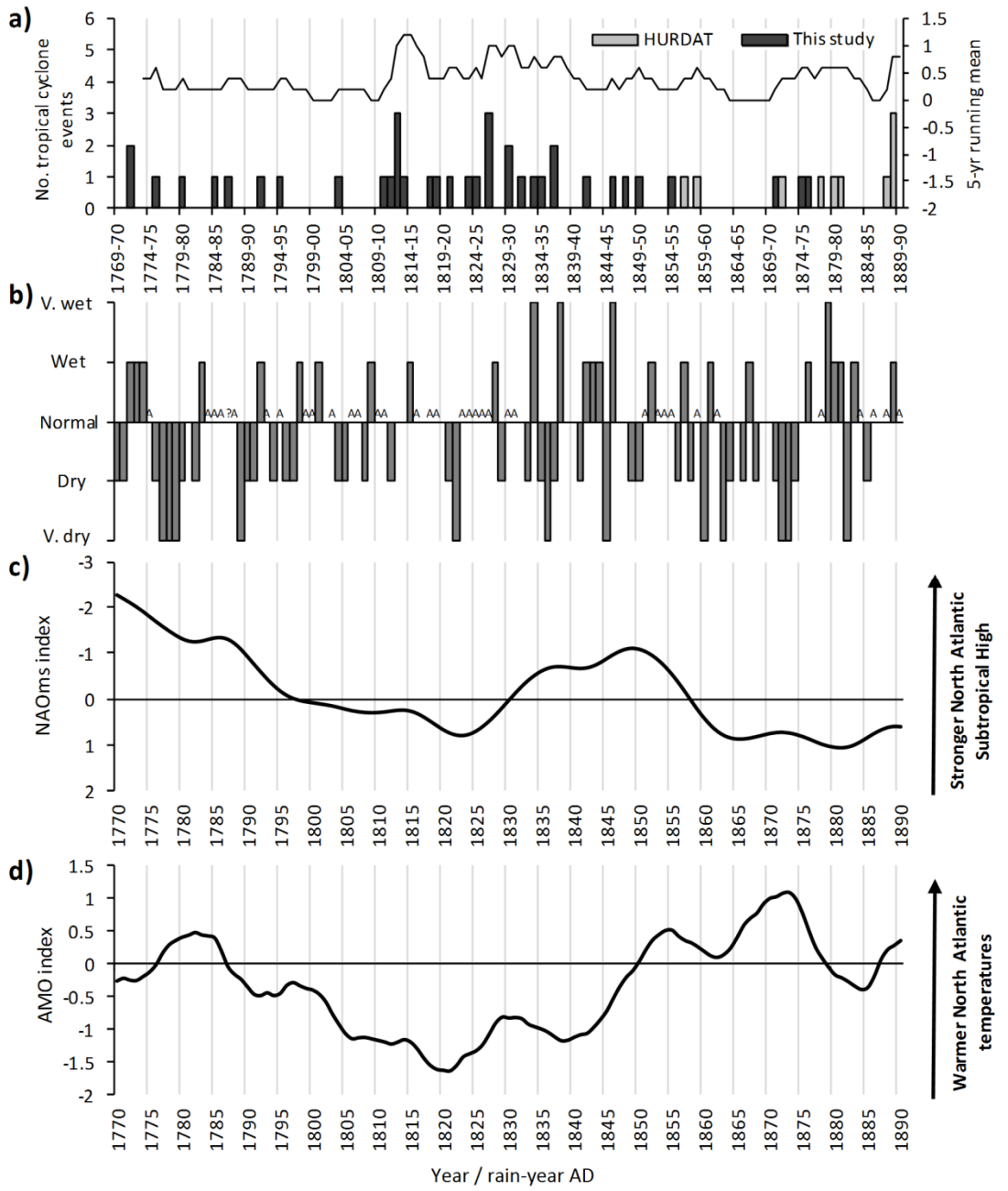

Figure 11.4. (a) Frequency of tropical cyclones affecting Antigua, rain-years 1769-1770 to 1889-1890, as documented in this study and HURDAT. (b) Chronology of average rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. (c) Annually resolved NAO index inferred from precipitation reconstructions from Morocco (tree-rings analysis) and Scotland (speleothem analysis) (after Trouet et al., 2009). (d) Annually resolved AMO index inferred from twelve tree-ring records from North America, Europe and the Middle East (after Gray et al., 2004).

chronology, 14 coincide with El Niño years registered by Quinn and Neal (1995) and/or Ortlieb (2000). The relationship is, however, weaker for individual rain-years, with 16 of 42 characterised by drier-than-normal conditions concurring.

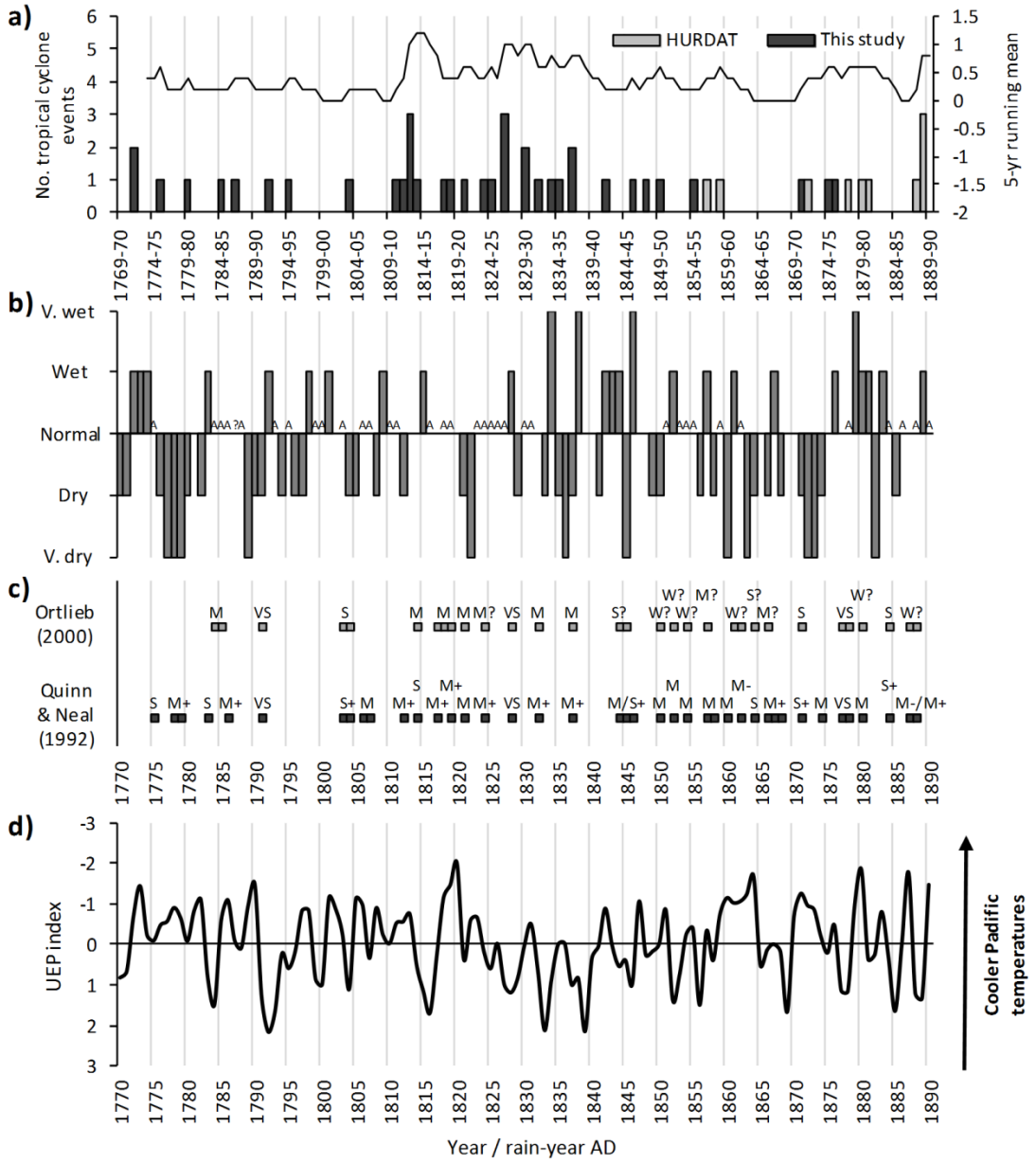

Figure 11.5. (a) Frequency of tropical cyclones affecting Antigua, rain-years 1769-1770 to 1889-1890, documented in this study and HURDAT. (b) Chronology of average rainfall conditions throughout Antigua, 1769-1770 to 1889-1890. (c) El Niño events recorded in archive-based chronologies of Quinn and Neal (1995) and Ortlieb (2000) for western South America. *VS*, *S*, *M* and *W* denote very strong, strong, moderate and weak events respectively. +/− signs indicate relative intensity. *?* indicates uncertainty over intensity. (d) Annually resolved combined index of the ENSO and PDO (UEP) derived from ten original ENSO proxy-based reconstructions (after McGregor et al., 2010).

Overall, there are no straightforward correlations or simple causal mechanisms evident from the comparisons made in this section. These results are not wholly surprising, given the relatively small geographical area which the present research has focused upon and the fundamental differences in the nature of datasets derived from

documentary sources and environmental proxies. The persistent shortage of weather-related archival evidence in certain portions of the study period (e.g. see Figure 5.2b) may be another contributor, potentially obscuring patterns associable with historical climate indices. It is also significant that the major drivers of climate variability discussed above—the NAO, AMO, ENSO and PDO—manifest themselves in the North Atlantic principally through fluctuations in SSTs (Gianni et al., 2001a; McCabe et al., 2004; Knight et al., 2006). As shown earlier (Figures 11.1, 11.2), available SST reconstructions for the Caribbean themselves exhibit little, if any, coherence with annual precipitation variations and tropical cyclone occurrences registered in Antigua. The very fact that the region is influenced simultaneously by these and other drivers of climate variability, which interact dynamically, is a final source of complexity. How far observed local variations reflect many of these remains uncertain.

Although the correlation between dry spells in Antigua and El Niño events cannot be regarded as significant numerically, just over half of the former coinciding with the latter, it is noteworthy that several of the major droughts recorded are synchronous with powerful El Niños that appear to have had a global footprint. El Niño events of at least moderate intensity identified by Ortlieb (2000) and Quinn and Neill (1995) in 1791, 1844-1846, 1850, 1860, 1864 and 1871 corresponded with major phases of precipitation deficiency in Antigua and have also been associated with droughts in parts of the Kalahari Desert, Southern Africa, by Nash and Endfield (2008). Meanwhile, El Niños in 1791, 1844-1846 and 1850 also coincided with major and widespread monsoon failure in northwest India (Adamson, 2012: p.120). Such trends in southern Africa and India are consistent with what is understood of ENSO's teleconnections based on twentieth century data (Glantz, 2001). The period 1789-1793, which witnessed three years of deficient rainfall in Antigua, was seemingly marked by anomalous weather globally, with reports of major droughts in parts of Mexico, Asia, Africa, Australia and other Leeward Islands, as well as extremely cold winters in Europe (Grove, 2007; Endfield, 2008). While Ortlieb (2000) and Quinn and Neill (1995) both record a 'very strong' El Niño in 1791, it has been suggested by Grove (2007) that 1789-1793 was a phase of persistently intense warm ENSO activity.

There is some evidence that the whole second half of the eighteenth century was a time of climatic abnormality in the northern hemisphere, possibly connected with ENSO variability. As noted in Section 8.6, Johnson (2011) has drawn attention to the simultaneity of successive climatic disasters in the Caribbean with a roughly fifty-year warm phase occurring near the end of the Little Ice Age, seemingly marked by an exceptional number of El Niño and La Niña cycles (Gergis and Fowler, 2009). Similarly, Barriendos and Llasat (2003) identify the period 1760-1800 as one of frequent precipitation extremes in Mediterranean Europe, which may have been associated with persistent and intense anticyclone activity over that region and Scandinavia. Could high ENSO variability at the time also be implicated in this

European anomaly? While the sources examined in the present thesis cannot address this possibility, they indicate that Antigua was another location that experienced a string of hydrological extremes—specifically drought—during the final decades of the 1800s.

11.3. Socio-economic effects of extreme weather and phases of climatic stress

The precipitation and tropical cyclone chronologies discussed above are not only of scientific value, but have also served as an essential foundation for completing the second objective of this research: to examine the implications of extreme weather events for colonial Antiguan society. Section 7.4 opened the investigation of this theme by identifying effects of meteorological extremes that were common throughout the study period. Phases characterised by major droughts and/or cyclones, as well as environmental problems such as harvest failure, water shortages and disease epidemics (Figures 7.1 and 7.2), were identified as possible phases of climate-related crisis. Subsequently, case studies (Chapters 8-10) focused on four such episodes—1776-1783, 1835-1837, 1863-1864 and 1871-1874—to document the precise manner in which adverse weather impacted upon human wellbeing in distinct contexts. Parallels between these and other moments of climatic disaster in eighteenth and nineteenth century Antigua were also outlined, the most prominent being 1789-1791, 1803-1804, 1821-1822, 1848-1850 and 1892-1894.

Taking a step back from the context-specificities of each case study, collectively these reveal notable homogeneity in the basic mechanisms through which drought and hurricanes undermined human livelihoods: they disrupted agriculture, resulting in financial instability and subsistence problems due to the failure of cash and food crops. Such continuity over the course of some 120 years is not wholly surprising in the light of the colonial history of the British Caribbean. As explained in Chapter 3, the plantation complex underpinned virtually all economic activity in the region throughout the 1700s and 1800s. Despite witnessing some important changes in its profitability, labour base and mechanical components during these centuries, the fundamental agricultural, industrial and human elements of the model went unchanged. Society remained essentially agrarian and geared overwhelmingly towards the cultivation of an exportable crop, rather than ensuring self-sufficiency in food supplies. Of course, the pattern of agricultural, followed by ubiquitous socio-economic decline is not unique to the colonial West Indies, but the well-documented sequel of severe climatic shocks in myriad pre-industrial societies (Lamb, 1982; Pfister and Brázdil, 1999; Davis, 2001).

The agro-economic crises spawned by extreme climate events exposed all sectors of Antiguan society to a degree of what contemporaries referred to as ‘distress’ or ‘suffering.’ The archives leave little doubt that scarcities of provisions and interruptions to sugar production were a universal grievance, either directly or as a

result of rising living costs and commercial stagnation. For the white elite—that is to say, planters, merchants and high ranking government officials—these difficulties, and even the devastation wrought by hurricanes, rarely posed a major threat to physical well-being. Despite seeing its levels of prosperity substantively curtailed by some extreme events, the material wealth of this group seemingly acted as a buffer against serious harm and hunger. In sharp contrast, the African-descended underclass faced real danger from major droughts and storms, as a result of their deprivation and inadequate living conditions. Some climate-induced disasters generated pronounced peaks in mortality among this group, such as those reported during the American Revolutionary War and in the 1860s and 1870s (Chapters 8, 10). After emancipation, the Afro-Creole majority may not have been limited to the rations afforded by slave-owners, but they often faced reduced employment opportunities and wages as a result of meteorological perturbations, thus impinging on their ability to secure essential resources (Chapters 9, 10). Unfortunately, little evidence has been uncovered of the relative position of the colonial middle class, composed of the likes of clerks, shop-keepers and small-time merchants. The fact that estate overseers received state aid following the 1871 hurricane, but only after the neediest non-whites (Section 10.5.2), supports the logical suggestion that such individuals also suffered in accordance with their standing in the socio-economic hierarchy.

In contrast to the climatic hazards discussed so far, episodes of abnormally abundant rainfall appear to have had fairly limited negative implications for the agro-economy. Such effects, which were documented in 1773, 1774, 1833, 1834, 1838, 1842, 1846, 1879, 1880 and 1881, included localised flooding, soil erosion, the ‘drowning’ of cane plants and damage to road networks (Sections 7.4, 9.3, 9.5). At an island-wide scale, these do not appear to have been severe; none of the aforementioned years corresponded with the pronounced drops in sugar production that typically followed severe droughts or cyclones and some were even followed by peaks in yields (Figure 7.1). Moreover, several observers underscored the overwhelmingly positive influence of precipitation excess on agricultural activity and economic prosperity (Sections 9.3, 9.5). This may be explained by Antigua’s predominantly limestone bedrock and lack of large surface water features, which reduce the greatest threat conventionally associated with excessive rainfall—widespread flooding (Section 5.4).

A difficulty associated with drought in particular was water scarcity. This too affected the populace at large, but especially those of modest means; while all were reliant on a limited number of rain-fed water bodies, most non-whites lacked the autonomy or wherewithal to establish private storage systems and procure imported supplies. Naturally, the availability of water was a function not only of rainfall levels, but also consumption. Comparison of reconstructed precipitation variability with the incidence of widespread water scarcities (Figure 7.2) reveals no clear temporal trends

as regards the frequency of the latter. However, findings presented in Chapters 9 and 10 (see also Section 11.4.1) suggest that shortages in St. John's became particularly acute in times of dry weather from the early-mid 1800s. These tentatively-identified trends are consistent with the shifts in demand that would be associated with contemporary demographic development; there was no net growth in the population of the colony over the study period as a whole, but that of its major port towns expanded, most notably in the decades after emancipation (Section 3.3; Dyde, 2000).

Archival findings also provide support for a subtle, yet significant relationship between extreme weather events and the emergence of disease among human populations. This connection has been identified in climate histories from across the globe (e.g. Davis, 2001; Acuña-soto et al., 2005; Endfield, 2008; Myllyntaus, 2009; Engler, 2013; see also Section 7.2.2) and has become the subject of much analysis in the context of contemporary climate change (e.g. Zell et al., 2008; Costello et al., 2011). The intricacy of the relationship, which stems from the fact that climate is one of multiple environmental and social factors influencing human health, is borne out by the somewhat inconsistent correspondence between island-wide disease outbreaks and different forms of meteorological stress over the study period (Figure 7.2). With respect to the incidence of sickness amongst different socio-ethnic groups, the picture is also complex. Despite being most susceptible to infectious diseases due to poor sanitary conditions and diets, much of the black populace possessed inherited immunity from yellow fever and malaria—the two most lethal diseases for whites in the West Indies (McNeill, 2010).

There is some evidence that certain forms of extreme weather were associated with the emergence of particular diseases. As we saw in Chapters 9 and 10, contemporaries attributed some outbreaks of fevers to spells of wet weather. In the case of malaria and yellow fever, McNeill (2010) notes that precipitation excess, especially in the wake of drought, provides ideal conditions for a boom in populations of their mosquito vectors. A review of the weather conditions that coincided with the emergence of different types of disease between 1770 and 1890 reveals some long-term consistency in such linkages. In total, 24 distinct outbreaks of 'fevers' of some variety were recorded. Of these, 17 coincided with rain-years of above-average precipitation across the island or short phases of precipitation excess in the midst of drier conditions (Table 11.1). In six cases, wet conditions were actually cited by observers as the cause of the fevers. Other ailments may also have been associated with meteorological patterns featuring abundant precipitation. For instance, several thousand Antiguan slaves were said to have caught "severe Colds" in a major hurricane in 1772.[407] Not dissimilarly, Antiguan prison inspectors claimed that unusually heavy rainfall in 1879 "hasten[ed] the death of several [inmates]… from Plithisis and other lung

[407] DD/TD/15/6, F. Farley to C. Tudway, 28 Sept 1774.

Table 11.1. Details of all outbreaks of fevers recorded in Antigua, documented weather conditions at the time of outbreak and any contemporary observations as to the cause of the outbreak, 1770-1890. Fever types specified here are those which are reported in the archives, as information which could enable identification of particular strains was rarely available.

Timing	Fever type	Extent	Rainfall rating for corresponding rain-year(s)	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Winter 1790-1791	Unspecified	Island-wide	Dry in both years		
Late 1792-autumn 1793	'Malignant'	Island-wide	Wet in 1791-92, assumed normal in 1792-93	Heavy rains in October 1793	"The great wetness of the weather has made it uncommonly sickly"[a]
Nov 1802 to mid-1803	Yellow fever	Island-wide	Normal in 1801-02, assumed normal in 1802-03	Abundant rains mid-Oct 1802-Jan 1803	"The uncommon wetness of the weather, has caused the great sickness"[b]
1816 (precise timing unclear)	Yellow fever	General	Assumed normal		
1823 (precise timing unclear)	Yellow fever	Island-wide	Assumed normal		
Nov 1827-Jan 1828	Unspecified	General	Assumed normal in 1826-27, wet in 1827-28	Two hurricanes and one tropical storm in Aug.	
Autumn 1828	Unspecified	General	Wet	Abundant rains throughout year	
Jan 1834	Unspecified	Island-wide	Very wet	Abundant rains in 1833 wet season also	
Sept 1835-1837	Yellow fever	St. John's	Dry	Major hurricane on August 12th, punctuated dry weather	

Timing	Fever type	Extent	Rainfall rating for corresponding rain-year(s)	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Late Dec 1837-Jan 1838	Unspecified	General	Dry in 1836-37, very wet in 1837-38	Dec 1837 and early Jan 1838 wetter than usual	"..the rain has brought much fever with it"[c]
1839, for much of year	Yellow fever	General	Normal	Consistently abundant precipitation throughout 1838; Unusually heavy rains in Nov-Dec 1839 also	
Oct-Nov 1842	Yellow fever	'Primarily' St. John's	Wet	Very heavy rains in autumn after dry spring and summer. Tropical storm on August 25th brought extremely heavy rains.	
Nov 1847	Unspecified	General among Portuguese residents	Normal	Dry weather at start of year, abundant rains in Aug and parts of autumn	Linked with abundant rains in autumn[d]
Aug-Dec 1849	Yellow fever	Unclear	Dry		
Dec 1850	Unspecified	General	Dry		
Jun-Aug 1853	Yellow fever	General, especially among newcomers	Assumed normal	Unusually abundant rains in May	Weather described as "calm, intensely hot & sickly"[e]
Oct 1858-Jun 1859	Yellow fever	Primarily St. John's	Dry in 1857-58, assumed normal in 1858-59	Weather "extremely hot and dry" at time of outbreak[f]	
Oct 1861-Jan 1862	Unspecified	General	Wet	Weather was consistently wet in 1861	

Timing	Fever type	Extent	Rainfall rating for corresponding rain-year(s)	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Late 1865-early 1866	Unspecified	St. John's	Normal in 1864-65, dry in 1865-66	Abundant rains in summer 1865 and at start of 1866	
Oct-Dec 1867	Unspecified	West and south Antigua	Wet	Abundant rains April-Dec	Fever "arising from the heavy rains which have continued to fall ever since April"[g]
Early 1869	Unspecified	West Antigua	Normal	"The year opened with very bleak cold weather"[h]	
Autumn 1876	Unspecified	General	Wet	Heavy rains for much of year; tropical storm on sept 12th	
1879 (precise timing unclear)	Unspecified	Island-wide	Very wet	Excessive rainfall throughout year	Two references to fevers resulting from excessive rainfall[i]
Jul 1881-Aug 1882	Unspecified	General	Wet in 1880-81, very dry in 1881-82	Abundant rain throughout 1881 and early in 1882	

(a) T/PH/swd/1, S. Elliot to C. Tudway, 23 Nov 1792; (b) T/PH/swd/1, S. Elliot to C. Tudway, 31 Dec 1802; (c) T/PH/swd/2, T. Foote to R. Tudway, 16 Jan 1838; (d) T/PH.swd.3, T. Foote to R. Tudway, 27 Nov 1847; (e) COD/C28, O. Nugent to C. Codrington, 10 Jun 1853; (f) CO7/112, Board of health semi-annual report, 31 Mar 1859; (g) PA, Vol.26, p.461, Gracehill report for 1867; (h) PA, Vol.27, p.461, Gracehill report for 1867; (i) PA, Vol.31, p.366, Lebanon report for 1879; CO152/136, R. Griffith to E. Baynes, 24 Nov 1879

Table 11.2. Details of all outbreaks of colds, flus and respiratory infections recorded in Antigua, documented weather conditions at the time and contemporary observations as to the cause of the outbreak, 1770-1890.

Timing	Ailment type	Extent	Rainfall rating for corresponding rain-year	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Autumn 1772	'Severe colds'	Island-wide, approx. 3000 slaves	Wet	Major hurricane on August 31st	Slaves caught colds in the hurricane[a]
Early summer 1773	Pleurisy	Island-wide	Wet		
Spring and early summer 1783	Measles	General	Wet	Outbreak coincided with a spell of drought	
Spring 1803	Measles	Island-wide	Assumed normal	Dry weather in Feb-April 1803 followed heavy rains in winter	
October 1823	Influenza	General among blacks and whites	Assumed normal		
May 1832	Influenza	Missionaries at all Moravian stations	Normal		
Late Aug-Dec 1851	Influenza	Island-wide among blacks and whites	Assumed normal	Wet weather during Aug, hurricane on Aug 17th	Commenced after hurricane
Oct 1861-Jan 1862	Colds	General	Wet	Weather was consistently wet in 1861	

Timing	Ailment type	Extent	Rainfall rating for corresponding rain-year	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Oct 1861-Jan 1862	Measles	General	Wet	Weather was consistently wet in 1861	
April-May 1871	Whooping cough	St. John's, especially among children	Dry		
1879 (precise timing unclear)	Lung infections	Prison in outskirts of St. John's; 12 deaths	Very wet	Excessive rainfall throughout year	Unusually heavy rainfall "acted in a great manner in hastening the death of several who were for some time past suffering from Plithisis and other lung complaints"[b]
Jul 1881-Aug 1882	Whooping cough	General, whooping cough among children	Wet in 1880-81, very dry in 1881-82	Abundant rain throughout 1881 and early in 1882	
'Early' in 1884	Measles	Island-wide	Assumed normal	Wet weather Jul 1883-Jul 1884	

(a) DD/TD/15/6, F. Farley to C. Tudway, 28 Sept 1774; (b) CO 152/138, W. Edwards & A. Edwards to E. Baynes, 9 Apr 1880

Table 11.3. Details of all outbreaks of dysentery recorded in Antigua, documented weather conditions at the time and any contemporary observations as to the cause of the outbreak, 1770-1890.

Timing	Extent	Rainfall rating for corresponding rain-year	Additional notes on weather conditions around time of outbreak	Contemporary observations on cause
Autumn 1778-Autumn 1780	Island-wide, claimed lives of 20-25% of slave population	Very dry in 1777-78 and 1778-79, dry in 1779-80	Followed drier-than-normal conditions in 1776 and 1777 also. Major water shortages recorded.	Postulated that bad water quality due to drought could compromise slave health[a]
Autumn 1845	General, especially St. John's	Very dry	Severe drought starting in Feb persisted for remainder of year. Major water shortages recorded.	
1872	General	Very dry	Major water shortages recorded.	"Sickness and mortality from bad food and filthy water"[b]; "the long drought has caused much povetry, sickness and death in our village"[c]
1877 (precise timing unclear)	General	Normal	A relatively dry rainy season in 1877	

(a) DD/TD/15/6, R. Martin to C. Tudway, 1 Jun 1777; (b) PA, Vol.28, p.467, Gracehill report for 1872; (c) PA, Vol.28, p.468, Lebanon report for 1872

complaints."[408] Of thirteen distinct spates of colds, flus and respiratory infections documented between 1770 and 1890, ten were synchronous with wetter-than-normal periods and/or storm occurrences (Table 11.2). Conversely, accounts presented in Chapter 8 indicate that the spread of dysentery may have stemmed from deteriorating water quality as a result of drought. Dysentery epidemics were documented only four times between 1770 and 1890. Nonetheless, in all but one case they corresponded with 'very dry' rain-years (Table 11.3). Overall, these findings suggest that precipitation excess may have enhanced the potential for the propagation of mosquito-borne fevers, common flus and respiratory diseases, while drought-related water shortages increased that of bowel infections.[409]

11.4. Human responses to climatic stress

The ramifications of adverse weather for society are determined not only by its environmental and economic impacts, but also the ways in which populations react to these effects. Such reactions have been documented at a range of temporal and spatial scales in this thesis. Here, attention will be divided between three areas: governmental measures, public responses and social unrest as a possible result of climate-related hardship.

11.4.1. State intervention

Thanks to an abundance of administrative source material, governmental measures to tackle weather-related difficulties were well documented. Taken as a whole, findings reveal some uniformity in the objectives of the procedures enacted; they involved securing supplies of resources vital for the civilian population, obtaining British funds to cope with financial crisis and requesting divine protection from meteorological hazards. However, as will now be considered, notable changes in the manner in which the first two of these were achieved are discernible over time.

Let us first consider the acquisition of monetary aid from Britain. The £20,000 rescue loan received in the midst of drought and warfare in the 1770s, which was far larger than any other recorded previously in the colony's past, ostensibly established a precedent; it prompted similar loans to be sought during subsequent phases of climatic and geopolitical stress (Section 8.6). In the wake of a severe hurricane and drought in the mid-1830s, the Colonial Office rejected an appeal to borrow £10,000 from the royal treasury, but agreed for credit to be obtained from private financiers in the homeland (Section 9.4.1)—the first time Antigua was documented to have received

[408] CO152/138, W. Edwards & A. Edwards to E. Baynes, 9 Apr 1880.

[409] The disease types mentioned in this section correspond to those which were reported in the archives. This is because information enabling contemporary diagnoses to be confirmed or critiqued was rarely available.

funds in this manner. Following devastating droughts in the early-mid 1860s and 1870s, Antiguan administrators proceeded directly to solicit private, rather than Crown funds. The source of relief received by British colonies in the 1800s has heretofore attracted little scholarly attention. Nevertheless, the pattern outlined above is in keeping with the rise of laissez-faire imperial policy during that century, associated with a less paternalistic state and the encouragement of market freedom (Williams, 1970; Mintz, 1974).

In order to procure emergency supplies, the most common step reported during the late 1700s and early 1800s was to suspend mercantilist regulations by allowing imports from foreign territories. This appears to have been a common procedure throughout the Caribbean during the colonial period (Pérez, 2001; Mulcahy, 2006; Johnson, 2011). With slave-owners responsible for supporting the Afro-Creole masses, little appears to have been done by the Antiguan authorities to guard against famine once provisions arrived as a result of their intercession. By contrast, during the hardships of the mid-1830s, legislators not only de-regulated trade temporarily, but also granted emergency funds in aid of the needy (Section 9.4.1). This may be explained by the fact that emancipation created a vast independent underclass potentially requiring succour. Finally, in the early-mid 1870s, there was no need authorise foreign imports, for free trade had become the norm. To counteract the suffering then experienced, unprecedented state-sponsored hurricane recovery and public employment schemes were initiated (Section 10.5.2). It is curious that a climate-driven subsistence crisis one decade earlier stimulated no comparable measures. Although possibly owing to the fiscal difficulties then prevailing, this may also represent experimentation with a more neo-liberal approach to food scarcity—namely, allowing markets to respond to rising demand for provisions without intervention.

Slightly different drivers appear to have underpinned shifting approaches to the management of water shortages. The cleansing and creation of water bodies in times of scarcity—documented in the 1830s, 1860s and 1870s (Sections 9.4.1, 10.5.1)—may well have been a common practise; the Registrar General commented in 1877 that this had been undertaken intermittently throughout Antigua's colonial past.[410] When it came to responding to moments of extreme thirst in St. John's, more strident action was recorded, such as the shipping of water supplies from overseas in 1837 and the construction of elaborate water works in the 1860s. While the latter represented the first such scheme of its kind, the former was documented on only one other occasion in the consulted archives—during a short but intense drought in 1833.[411] That these efforts targeted St. John's is consistent with the suggestion made in Section 11.3 that pressure on urban water supplies gradually mounted over time.

[410] CO152/129, Report of E. Baynes, 14 May 1877.

[411] Ibid.

A rather different government response to meteorological threats was to invoke collective acts of worship. This took the form of colony-wide thanksgiving ceremonies for protection received from destructive hurricanes, prayers for cyclone-free rainy seasons and fasts to request deliverance from drought. Comparable practises have been widely documented elsewhere in the colonial Americas (e.g. Pérez, 2001; Mulcahy, 2006; Garza-Merodio, 2006; Endfield, 2008). It is significant that these actions continued through the mid-late nineteenth century. Fleming (1998) has suggested that by the late 1700s, early climate science began to undermine popular notions of inclement weather as manifestations of God's providence. Understanding of the physical nature and causes of weather phenomena only became more sophisticated over the following century, with several landmark developments in hurricane climatology and weather monitoring (Fleming, 1998; Mulcahy, 2006). Notwithstanding these, it is evident that a number of New World functionaries retained certain beliefs born from earlier intellectual paradigms about the origin of meteorological extremes.

11.4.2. Responses among civil society

Chapters 8-10 identified a range of public reactions to climate-induced hardship, primarily among the African-descended underclass and the white elite. Overall, it is clear from the archives that the vast socio-economic polarity of these groups was a key factor underlying the diversity in the coping mechanisms available to them.

The most common responses documented among the Afro-Creole population represented survival strategies, oriented towards fighting hunger and poverty. The stealing of livestock and produce by slaves appears to have been common in several times of climate- and war-related dearth (Section 8.6), while some bondspeople reportedly took to binding a cord around the waist to slow digestion during a drought in the early 1820s (Section 10.4.3). Such examples aside, there was a notable lack of evidence of coping mechanisms implemented under slavery. This is probably explained by two main factors: firstly, the individuals who compiled the majority of the available documentation had little reason to be concerned by the everyday feeding and free-time habits of the masses prior to emancipation and, secondly, the extent of control that whites had over all aspects of slave life left little room for major adaptive strategies. The latter of these points is evinced by the fact that when established food supply systems failed during the American Independence War, hundreds of slaves starved to death (Chapter 8).

Other measures of self preservation taken by slaves may not have been reported explicitly, but novel behavioural trends observed during climatic crises after 1834 indicate that abolition precipitated profound change in this regard. Common strategies inferable from such trends included migration, increasing individual and family incomes and reducing expenditure on leisure activities and food, all of which would

largely have been impracticable under slavery. Over the decades that followed emancipation, the gradual decline of the sugar economy seemingly reduced opportunities for poor Antiguans to secure more plantation labour when times were hard. Consequently, the other coping methods noted above may have become more important. The available documentary evidence is, unfortunately, insufficient to confirm this supposition conclusively. Nevertheless, Green (1976) notes that crime rates were seldom a concern in the British West Indies before the late 1840s, but increased considerably thereafter. Importantly, he attributes a surge in praedial larceny in 1860s Jamaica to the misery arising from disease epidemics, drought and the American Civil War—conditions also affecting Antigua at the time.

Unlike the black underclass, white elites rarely struggled for survival in the wake of extreme weather events. Accordingly, their responses aimed principally to preserve social and economic privilege, rather than life itself. In Chapter 8, various plantation-level reactions to unfavourable weather conditions were recorded, such as adaptation of sugar production regimes, increasing dependence upon British suppliers for provisions and, it might be argued, cultivating crops more resistant to drought. The fact that comparable practises were rarely recorded subsequently likely reflects their routine nature and the abundance of estate correspondence dating from the late 1700s and early 1800s, rather than their having become unnecessary. The establishment of a free labour market in 1834 presented new opportunities for planters to cut their losses when harvest-threatening weather struck. Namely, they could hire fewer labourers and reduce wages. Whites commanding shipping and overseas commercial ties could evidently even profit from local scarcities, importing food and water at moments of escalated retail value (Section 9.4.3). It is noteworthy that these methods of coping with and capitalising on environmental disturbances came at the expense of the African-descended working class, seemingly contributing to the differential vulnerability of these two groups.

Some action stimulated by climatic deterioration was not targeted at self-preservation or profiteering, but to the contrary, alleviating the plight of others. Chapters 9 and 10 presented numerous examples of ‘social capital’ responses—those which facilitate collective involvement through the sharing of knowledge, financial risk, market information or claims for reciprocity (Adger, 2003). In some instances, planters provided medical care for blacks not legally due their support; missionaries sheltered, fed and clothed the needy; those of modest means shared what resources they could; and all, it appears, united in prayer. The middle-class ‘free coloured’ community also seemingly played an important role in charitable endeavour, having founded a number of institutions such as the ‘Daily Meal Society’ during the 1820s and 30s (Dyde, 2000), which offered vital support to the destitute in times of exigency (Sections 9.4.3, 10.5.1). Some catastrophic events stimulated monetary and material donations from private parties not only in Antigua, but also abroad. Findings suggest

that the scale of voluntary international aid grew considerably over the nineteenth century. The sum of money thus received, as well as the diversity of its donors, was considerably greater following the 1871 hurricane than in any other case documented. In the context of the late 1700s, Mulcahy (2006) posits that the internationalisation of disaster relief stemmed from increasing globalisation of news media and commodity acquisition. During the second half of the 1800s, it is quite possible that a similar trend resulted from technological advances such as the advent of telegraph communication and steam-driven shipping, as well as the global expansion of the missionary societies operating in Antigua.

It is interesting that manifestations of community engagement and philanthropy were most discernible in the wake of major hurricanes. It has been suggested that high-intensity, short-duration hazards of this kind—by producing immediate and dramatic disruptions to daily routines for all members of society—may have been especially conducive to co-operative recovery efforts (Peréz, 2001; Pfister, 2009; Prieto, 2009). As noted by Endfield (2008: p.174) with respect to flood responses in colonial Mexico, actions of this type "raise interesting questions over the way in which shared environmental values and concerns might have transcended social and class divides." This is especially true given the antagonistic character of colonial race relations conventionally portrayed.

11.4.3. The question of social unrest: climate and complexity

Social unrest is a phenomenon worthy of assessment as a possible indirect reaction to extreme weather. There exists a well-established academic tradition of linking meteorological stress with outbursts of civil disorder, rebelliousness and conflict (e.g. Davis, 2001; Zhang et al., 2005; Endfield, 2008; Gill, 2008; Parker et al., 2013). In the colonial West Indies, it has been highlighted that climatic deterioration featured among numerous unfavourable circumstances preceding several major slave rebellions (Westergard, 1917; Baralt, 1948; Sheridan, 1976; Gaspar, 1985). Correspondence reviewed in Chapter 8 demonstrated that several Antiguan whites were convinced that local drought- and war-related food shortages during the American revolutionary period might trigger such an occurrence. Although this did not ultimately transpire, smaller-scale violent dissent—namely, the poisoning of plantation superintendents—was documented on two occasions in the late 1770s.

This was not the only time in Antigua's colonial past when climatic deterioration appears to have contributed to the potential for rebellion among the disenfranchised. An especially notorious example is the foiled slave conspiracy of 1736, in which scores of bondspeople planned to massacre the white elite on the night of a ball and then take the island by force. Historian David Gaspar (1978, 1985) has explored the possible drivers of the plot at length. Aside from structural factors propitious for revolt, such as decreasing ratios of whites to blacks and the emergence of a

charismatic slave leadership, he argues that "a conjunction of adversity pushed slaves' sense of exasperation and injustice to a high point" (Gaspar, 1985: p.226). This adversity included financial recession, disease, crop blight, a hurricane in 1733 and recurrent drought from 1730-1736. Interestingly, Gaspar (1985) also draws attention to a surge in the incidence of attempted escapes, murders and felonies among slaves during the 1730s and the fact that an abortive plot to stage an island-wide insurrection in 1728-1729 followed an earlier phase of drought-related deprivation.

Another well-documented, though rather different case worth considering is that of a succession of plantation fires that affected all but one of the island's six parishes over a fortnight in April 1850. For Natasha Lightfoot (2007: p.295), this was the work of "purposeful incendiaries" manifesting discontentment with the decay of freepeoples' living standards that attended the passage of the 1846 Sugar Duties Act and drought in 1849-1850. The sources consulted in this research not only reinforce the picture of early 1850 as a time of great hardship associated with protracted rainfall deficiency,[412] but also that the island had not fully recovered from the devastation occasioned by a hurricane in 1848.[413] Furthermore, some islanders believed that fire-starting represented a direct response both to dry weather and unemployment, with some would-be labourers "going about to destroy property in the hope of more work and to raise wages."[414] Parallels are evident with another wave of incendiary activity coinciding with severe drought and economic depression in the mid-1890s, which historical geographer Bonham Richardson (2004) argues also symbolised both protest and material opportunism by unemployed black Antiguans.

Of course, it is neither possible nor good academic practice to search for a climatic explanation for all acts of defiance to established power structures. While historical sources are often insufficiently detailed for a comprehensive assessment of the manifold environmental, social and economic factors which may account for unrest, the crucial role of human agency should not be overlooked (Paar, 2009). This is clear from Table 11.4, which lists all instances of unambiguous civil dissent documented through primary archival research. Of twelve such cases, only four coincided unequivocally with episodes of major climatic stress. Furthermore, many other circumstances which may partly or fully explain specific outbursts were also identified (fourth column of Table 11.4). A further complication is that certain meteorological extremes may have been more conducive to mutinous behaviour than others. Mulcahy (2006) contends that hurricanes, for example, represented unlikely triggers for slave insurrection in the British Caribbean, due the immediate and unforeseen struggle for survival that they precipitated. This research does not

[412] E.g. CO7/95, Gov. Higginson to Earl Grey, 21 Feb 1850; PA, Vol.19, p.351, Letter from G. Westerby, 10 Apr 1850.

[413] CO7/95, Gov. Higginson to Earl Grey, 26 Mar 1850.

[414] T/PH/swd/3, T. Foote to R. Tudway, 27 Apr 1850.

Table 11.4. Details of all cases of violent dissent in Antigua recorded in archival sources, 1870-1890, and possible contemporary stresses and contributors identified from primary and secondary sources.

Date	Case	Details	Evidence of contemporary stresses and possible contributors to unrest
Autumn 1778	Poisoning of a plantation manager	Two slaves poisoned the manager of Tuites plantation[a]	• Severe drought since 1776 • Major curtailments to trade due to American Independence War • American revolution and recent slave insurrections in other Caribbean islands providing inspiration for rebellion (see Sheridan, 1976) • Possible tendency towards antagonistic behaviour by plantation manager—the same individual was subject to another poisoning in 1780 (see below)
Early 1780	Poisoning of plantation managers	Three slaves poisoned water supplies on one of the Codrington estates in an attempt to kill three plantation managers and one overseer[b]	See above
Spring 1786	Slave uprising on one estate	A group of slaves mounted an "insurrection" on an unnamed estate belonging to assemblyman Lockhart Russel[c]	No unusual environmental or socio-economic stresses documented
1799 (precise timing unclear)	Murder of plantation manager	A group of slaves murdered Adam Ogilvie, the manager of an unnamed plantation owned by John Ogilvie[d]	• Recurrent food scarcity during French Revolutionary Wars (1793-1802) • An especially harsh regime on John Ogilvie's estate and/or a particularly rebellious attitude among his slaves; there was another attempted murder of a manager on the plantation in 1802
May/Jun 1802	Attempted murder of plantation manager	A group of slaves attempted to murder an unnamed manager on the plantation of John Ogilvie[e]	See above

Date	Case	Details	Evidence of contemporary stresses and possible contributors to unrest
Jan 1825	Overseer murdered	A slave named Cambridge belonging to John Duer murdered James Brown, one of Duer's plantation overseers[f]	• Recession in British West Indian economy due to credit crises and falling sugar prices (Ward, 1988) • Growing social tension associated with rise of abolitionism (Dyde, 2000)
Jan 1825	Poisoning of planter family	Two slaves poisoned the family of plantation owner Thomas Spencer Edwards[g]	Same as above
Jan/Feb 1829	Attack on plantation manager	A group of slaves from Betty's Hope and Cotton plantations attacked and wounded manager Robert Jarritt. Another manager attributed the outburst to unspecified "new rules" introduced on the plantation.[h] Jarrit blames local anti-slavery press for instigating insubordination among slaves.[i] Antigua's governor highlighted that some Codrignton slaves were treated with "severity and inhumanity" prior to the attack.[j]	• Same as above • Provocative messages in anti-slavery press (see previous column) • Harsh slave treatment on Codrington estates (see previous column) • Major harvest failures on Codrington estates in 1828 due three tropical cyclones in August 1827 followed by two months of drought[k] • A drought of unspecified duration had injured sugarcane crops and destroyed ground provisions on the Codrington estates by February 1829[l]
20-27 Mar 1831	Protest and cane burning	Riotous protest of several hundred slaves in St. John's on 20th March in response to the banning of slaves' regular Sunday markets. Over the following week, cane burning took place on at least sixteen estates in the island.[m]	• Recession in British West Indian economies due to credit crises and falling sugar prices (Ward, 1988) • Growing social tension associated with rise of abolitionism (Dyde, 2000) • The banning of slaves' weekly Sunday markets, which had been held since the early-mid 1700s (Lightfoot, 2007)
Apr 1850	Arson on plantations	Fires started on many plantations throughout Antigua during a fortnight in April. Some islanders regarded this an attempt to create more demand for plantation labour.[n]	• Sharp decline in labourers' wages and rising unemployment due to 1846 Sugar Duties Act (Lightfoot, 2007) • Drought in 1849-1850, causing crop losses and food and water shortages, preceded by a destructive hurricane in 1848[o]

Date	Case	Details	Evidence of contemporary stresses and possible contributors to unrest
22-26 Mar 1858	Riots in St. John's	On March 22nd, an altercation took place in St. John's between an Antiguan and a Barbudan stevedore, because the latter was procuring work at the expense of the former. Four nights of rioting followed, with Antiguans attacking Barbudans and destroying their property in the town. Eight rioters were killed, fourteen wounded and 172 arrested by police.[p]	• Continuing depression in sugar economy, resulting in high rates of unemployment and low wages (Lightfoot, 2007) • Increasing presence of commercially successful immigrants in Antigua (Lightfoot, 2007)
Mid-Feb 1870	Ransacking of Portuguese property in St. John's	A Portuguese baker killed his black assistant unintentionally by punching him in the stomach in an argument. Shortly afterwards, blacks plundered and burned Portuguese houses and businesses throughout the capital until stopped by police.[q]	• Continuing depression in sugar economy associated, resulting in high rates of unemployment and low wages (see Chapter 10) • Black resentment of the success of Portuguese in retail and business after having arrived in the1850s as indentured plantation labourers[r] • Severe deterioration of material conditions for the working class during the mid-late1860s associated with a fall in sugar prices, the American Civil War, a smallpox epidemic and recurrent drought (See Chapter 10)

(a) COD/C10, R. Clarke to W. Codrington, 30 Mar 1780; (b) COD/C10, R. Clarke to W. Codrington, 30 Mar 1780; (c) CO152/66, Extract of council minutes, 5 Jun 1786; (d) T/PH/swd/1, S. Elliott to C. Tudway, 19 Jul 1802; (e) T/PH/swd/1, S. Elliott to C. Tudway, 19 Jul 1802; (f) CO7/12, S. Athill to Lord Bathurst, 12 Feb 1825; (g) CO7/12, S. Athill to Lord Bathurst, 12 Feb 1825; (h) COD/C29, G. Dean to C.B. Codrington, 5 Feb 1829; (i) COD/C29, R. Jarritt to C.B. Codrington, 6 Oct 1829; (j) CO7/25, Gov. Ross to H Twiss, 30 May 1829; (k) COD/A13, Accounts for 1828, J. Osborne; (l) COD/C29, G. Dean to C.B. Codrington, 5 Feb 1829; (m) CO7/31, Gov. Ross to Viscount Goderich, 1 Apr 1831; (n) T/PH/swd/3, T. Foote to R. Tudway, 27 Apr 1850 (for a detailed account see Lightfoot, 2007); (o) CO7/95, Gov. Higginson to Earl Grey, 21 Feb, 26 Mar 1850; PA, Vol.19, p.351, Letter from G. Westerby, 10 Apr 1850; (p) CO7/109, Gov. Hamilton to Lord Stanley, 27 Mar 1858; CO7/110, Court proceedings, 10 May -11 Jun 1858; (q) CO7/139, Gov. Pine to Earl Granville, 26 Feb 1870; (r) CO7/139, Gov. Pine to Earl Granville, 26 Feb 1870

contradict his claim, although the cases of unrest in 1736 and 1850 mentioned earlier indicate that the disruption caused by cyclones, like other environmental shocks, might have threatened social harmony in the long-term. For its part, drought may have been more likely to produce overt, confrontational reactions to oppression, as severe hunger, thirst and high temperatures—all hallmarks of drought in colonial Antigua—are known to increase irritability and restlessness (Berkowitz, 1972; Dirks, 1980). Critically, their effects are also felt over longer time periods. Notwithstanding these complexities, primary and secondary evidence suggests that by exacerbating and highlighting social inequality, extreme weather was at times an important factor enhancing the potential for acts of dissent against groups monopolising power and wealth. As such, climatic stress represents a possible contributor to rebellious sentiment—or, to invoke the lexicon of geo-strategy, a 'threat multiplier' (CNA, 2007).

11.5. Vulnerability to extreme climate events

Chapter 3 established basic biophysical and societal determinants of vulnerability to climatic hazards in present-day Antigua. These ranged from the island's proclivity to highly variable inter-annual precipitation and location in a zone of tropical cyclogenesis, to factors limiting local human capacity to mitigate and cope with natural disasters, such as insularity, a small population and limited natural resources. Structural features of colonial Antiguan society mediating the risk posed by adverse weather were then highlighted, among which the foremost were excessive economic dependence upon the sugar industry and the profound inequalities inherent in the colonial socio-economic hierarchy (Sections 3.3, 3.4). Assessment of the societal ramifications of climatic hazards, both within and beyond case study periods, indicates that the occurrence of extreme events itself enhanced vulnerability to subsequent strains, climatic or otherwise; it was during successive major meteorological perturbations that some of the greatest excesses of human suffering and economic degeneration were identified in archival research (Chapter 8-10).

Empirical research focused in particular upon the drivers of social vulnerability to extreme weather events. The socio-economic particularities of each case study period and the manner in which these mediated relative levels of human susceptibility and resilience were evaluated critically at two main scales: across Antiguan society and between different groups within it. These analyses offer snapshots of points along a conceptual 'trajectory of vulnerability' (Section 2.4.2) spanning 1770-1890. Three broad thematic periods characterising this trajectory can be tentatively identified. These are as follows:

(1) *A phase of recurrent warfare between major New World powers during the late 1700s and early 1800s*. Conflict heightened the vulnerability of Antiguan

society to the effects adverse weather, severely curtailing the in- and out-bound maritime trade underpinning the local economy and human subsistence. Intense climatic stress was attended by harvest failure, protracted economic depression and famine.

(2) *A peaceful period of relative economic success spanning the mid-1810s through mid-1840s*. The populace was now largely more resilient to meteorological shocks as no prolonged ruptures in international trade were experienced. The most intense spells of extreme weather were still attended by harvest failure, but no financial crises and instances of human mortality as severe and protracted as previously were documented. During the decade after emancipation, regional commercial resurgence appears to have further buffered society from potential losses associated with climatic deterioration.

(3) *An era of progressive social and financial decline from the mid to late 1800s*. The removal of protectionist tariffs on British colonial sugar at a time of increasingly fierce international competition in production undermined prosperity and living standards, rendering society more vulnerable to climatic strains. Powerful episodes of extreme weather culminated in enduring commercial recessions marked by unprecedented levels of agro-industrial stagnation and unemployment, as well as extreme destitution and demographic decline. The permanent nature of imperial economic reform, compared to the transience of the wars in the early 1800s and economic success in the 1830s, appears to have resulted in the normalisation of higher vulnerability levels.

A case could be made for splitting the second of these periods into two shorter timeframes, one comprising the decade following emancipation and the other spanning the preceding twenty years. Historical scholarship suggests that the latter was distinctly less prosperous, due to growing competition in the metropolitan sugar market and several credit crises (Williams, 1970; Ward, 1988; Dyde, 2000). These developments would conceivably have enhanced social vulnerability, though probably not to the same extent as international conflict prior to 1815. Of course, further research would be needed to substantiate this argument.

While the broad temporal trends discussed above can be said to apply to the Antiguan populace as a whole, distinctive patterns of vulnerability within society are also evident. What emerges most clearly from the archives is the vast disparity between the white minority and the African-descended masses in exposure and sensitivity to climatic stress. Factors explaining the disproportionate toll that extreme weather events took on the latter were outlined earlier in Section 11.3. Such findings are by no means new, but have been documented in slave societies throughout the colonial West Indies (Pérez, 2001; Mulcahy, 2006; Johnson, 2011; Smith, 2012). The present study, which is the first to offer a detailed exploration of this theme after the

abolition of slavery, demonstrates that emancipation did little to shake the fundamental structure of socially differential vulnerability in Antigua. Nevertheless, freedom did alter its finer dynamics by eliminating former slave-owners' duty of care to the majority of Afro-Creole people, who now had to support themselves (Section 9.5). The homogeneity in intra-societal vulnerability which is otherwise apparent over time is not wholly surprising; it is widely recognised that emancipation failed to eliminate the vast social, economic and racial inequalities that defined British West Indian society. In short, the monopolisation of political power by individuals whose livelihoods had depended upon black slave labour—or, more particularly, the draconian policies they introduced to protect their hegemony—ensured that this was so (Williams, 1970; Mintz, 1974; Green, 1976).

The case studies presented in this thesis have demonstrated that the dependence of colonial livelihoods upon the sugar industry was a crucial and consistent determinant of societal vulnerability to adverse weather. Here, it is worth emphasising that the history of the British West Indian plantation economy from the late eighteenth through late nineteenth centuries is one of net decline. In the long-term, this was attended by gradual deterioration of levels of prosperity and, for some sectors of the populace, standards of living (Sections 3.3.2, 3.3.3). As such, it might be argued that there existed a strong tendency towards increasing social vulnerability over this timeframe. Demographic development may have contributed to this tendency. The period 1770-1890 saw the gradual enlargement of Antiguan port towns, particularly through the growth of neighbourhoods composed of working-class migrants from rural areas (Dyde, 2000; Section 3.3.3). As argued by Schwartz (2005) and Mulcahy (2006), the same trends placed more people and property in a setting highly sensitive to hurricane strikes throughout the West Indies. Conceivably, the expansion of an urban poor unable to cultivate its own food, but still reliant upon cheap locally-grown produce, would also have increased pressure on supplies, exacerbating the consequences of all forms of harvest-threatening weather. While these developments speak of an upwards trajectory of social vulnerability in the long-run, the examined case studies demonstrate that short-term ebbs and flows in socio-economic welfare acted critically to intensify, palliate or offset base levels of susceptibility. For example, an abrupt slump in sugar prices in the midst of ongoing financial downturn in the early 1860s appears to have predisposed the populace to extreme subsistence and pecuniary difficulties when dry weather struck in 1863-1864 (Chapter 10). Conversely, in 1835-1837, notwithstanding the ongoing shrinkage of Antigua's share of the British sugar market, a rise in the value of the commodity and the receipt of emancipation compensation funds seemingly strengthened the economy against meteorological onslaughts (Chapter 9).

In assessing long-term drivers of agro-economic vulnerability to extreme events, it is worth questioning how suitable Antigua really was for sugarcane cultivation. While

numerous West Indian historians have pointed out that the island is drier and more drought-prone than the other important sugar islands, only Lowes (1995: p.32) has suggested that its climate was "poorly suited to that crop." Though perhaps a slight overstatement, this contention is supported by the precipitous drops in production evident after phases of deficient rainfall throughout the study period (Figure 7.1), as well as modern records, which indicate that mean annual rainfall is 22% lower than the figure ideal for cane (Section 3.3.1). Thus, it would seem that human choice comprised an important dimension of human vulnerability to climate. Reasons for the lack of agro-economic diversification in the colony despite these circumstances are probably the same as those which underlay commitment to sugar throughout the region generally; there was no equally remunerative alternative and plantation operations, after being established at great expense, were not easily adaptable (Sheridan, 1974; Watts, 1987).

Evidence presented in Chapters 9 and 10 strongly suggests that the rise of laissez-faire colonial policy from the middle of the nineteenth century was a crucial factor accounting for increasing vulnerability at the time, both across society and among Afro-Creoles in particular. The 1860s and early-mid 1870s—a period of recurrent drought following a decade of relative quiescence (e.g. see Figure 7.1a)—could be seen as a phase of what Leichenko and O'Brien (2008) refer to as 'double exposure.' In short, this refers to the coeval and interacting effects of climate change and globalisation upon a given system. Though not representing a time of globalisation in the contemporary sense, the mid-late 1800s certainly witnessed major internationalisation of trade. There can be little doubt that opening the British market to foreign produce with the 1846 Sugar Duties Act, or more specifically the enduring downturn in the plantation economy that it precipitated, intensified the detrimental impacts of extreme events upon Antiguan society. To adopt Leichenko and O'Brien's terminology, both freedpeople and the plantocracy were 'losers' in the context of coincidental climatic and commercial degeneration. However, working class blacks might be regarded as 'double losers,' for they not only suffered from recession itself, but also the elite's attempts to recoup its losses by reducing wages, hiring fewer workers, increasing taxes and minimising social investment (Chapter 10). Such developments were likely mirrored elsewhere in the empire. Davis (2001) and Kelso (2010), for instance, argue that the rise of laissez-faire policy in the second half of the 1800s intensified the vulnerability of certain marginalised populations to climatic hazards in British India and South Africa.

Finally, it is important to consider how adaptive reactions to climatic risk shaped vulnerability. A variety of crisis responses intended to reduce personal or collective vulnerability were documented (see Section 11.4). Unfortunately, the case study approach makes structural adaptations to climate variability more difficult to discern. Nevertheless, evidence presented in Chapter 8 points towards an important adjustment

of this kind implemented from the late 1700s: the cultivation of crops more resistant to drought. While coping strategies and lasting adaptations—whether documented or undocumented—were ostensibly sufficient to avert disaster in the wake of low intensity meteorological shocks, the case studies illustrate that this was not the case when the most severe droughts and storms struck. Such a state of affairs is consistent with the 'Catastrophe Hypothesis' of Bowden et al. (1981), which states that societal advances acting to lessen the detrimental impact of minor meteorological shocks do not substantively reduce vulnerability to major shocks with a return period of over one hundred years (Section 2.4.2). Technically, this research does not allow for the calculation of long-term event return intervals. It does indicate, though, that the severity of phases of climatic stress in 1776-1783 and 1871-1874 was unmatched at any other time during the 121-years under study and saw the adaptive capacity of Antiguan society overwhelmed catastrophically.

11.6. Closing remarks and areas for further study

This thesis has investigated diverse subject matter of relevance to the sub-discipline of historical climatology; it has involved climate reconstruction, assessment of the socio-economic implications of extreme weather and exploration of patterns of human vulnerability to climatic perturbations. Limits to the scope and completeness of this research should, nonetheless, be acknowledged. A study which attempts both to investigate climate variability and its wider effects must inevitably divide attention, evidence and workload between these separate objectives, rather than channelling them towards just one. There is, for example, much indirect archival evidence of rainfall fluctuations (e.g. water availability, livestock health and agricultural production) which could be used for reconstruction purposes, as it has been by other researchers (e.g. Nash and Endfield, 2002; Kelso and Vogel, 2007; see also footnote 49). Other methodological caveats have already been considered at length, including the fragmentary and subjective nature of documentary evidence (Section 4.5; Figures 5.2b, 15.3b), the sources of error associated with particular approaches to climate reconstruction (Sections 5.2.4, 6.3.3) and the analytical deficiencies of focusing on short case studies (Section 7.3). The fact that the Antiguan climate chronologies developed seem to reflect both climate trends and the availability of archival evidence has also been pointed out (Sections 5.3.1, 6.6, 11.2).

As is often the case, the research process has highlighted many areas requiring further investigation. It is clear, for instance, that there remains a need for more high-resolution reconstructions of historical precipitation variability in the American tropics. Expanding the coverage of such work would facilitate the exploration of the climatic drivers of observed weather extremes—something which this research has only begun to assess. Because certain regionally important climatic modes, such as the ENSO and NAO, are known to exert seasonally differential influences, other studies

examining intra- as well as inter-annual variations in rainfall would be of great value. As regards the exploration of historical climate-society interactions, there is undoubtedly ample scope for further research in the Caribbean. A topic meriting particular attention would be the implications of climatic stress for the colonial middle class—both white and 'coloured'—as this has been consistently understudied here and elsewhere in the literature. With respect to Antiguan historical climatology specifically, extending the study period forwards beyond 1890 would be especially worthwhile. This would allow for greater overlap with instrumental data, which could be used to calibrate climate reconstructions, and would also offer a novel environmental perspective on other well-studied historical developments, including the (re)industrialisation and eventual collapse of the sugar industry (Dyde, 2000). Of course, many other themes which this thesis has not been able to address fully could be listed, but those mentioned here are considered to be of particular note.

There are several archival collections which, owing to time restraints, have not been employed here, but show much potential for addressing some of the aforementioned investigative lacunae. Firstly, eighteenth and nineteenth century West Indian newspapers are available at several British and American institutions.[415] A number of these publications, including the *Antigua Free Press*, were established and edited by prominent figures of the coloured middle-class (Dyde, 2000) and may, thus, afford greater insights into the experiences of that community. Second, there are the Original Letters of the Moravian Missionaries. While those available in London have been analysed here, the vast majority are held at the central Moravian archive in Hernhut, Germany. Using these may enable details lost through synthesis in the production of church's Periodical Accounts to be recaptured (L. Parsons [Moravian Archivist], personal communication, 23 Feb 2012) and could also help to compensate for the dominance of plantocratic perspectives in the archive (Section 4.5). Thirdly, certain governmental document series await consultation. Of particular note are the West Indian Sessional Papers (i.e. legislative minutes), which span almost the entire colonial period.[416] Excerpts of this material encountered in other document collections offered numerous useful insights into the socio-economic effects of climate events and related institutional responses (e.g. see footnotes 107, 157, 185, 261, 337, 381). Lastly, there are ships' logbooks, both military and commercial. Like newspapers (Chenoweth, 2007) and missionary records (Demarée and Ogilvie, 2008), these are documents of proven value for climate reconstruction (Wheeler, 2014).

Notwithstanding the openings for further study and limitations outlined, the research presented here has, in modest but diverse ways, contributed to the historical climatology literature. A new dataset of climate variability which can be compared

[415] E.g. British Library, UK National Archives, US Library of Congress, American Antiquarian Society Library.

[416] Held at the National Archives, UK.

with other palaeoclimate indices has been produced (Section 11.2); a detailed investigation of social, economic, political, and epidemiological dimensions of climate-society interaction has been conducted (Sections 11.3, 11.4); and, finally, patterns and drivers of vulnerability have been explored, revealing important synergies with developments in the British Empire and beyond (Section 11.5). This work is especially relevant because the location and data sources under scrutiny have previously received little attention in the field (Sections 1.1, 1.2). Having now reviewed the salient findings of the thesis, contextualised them with reference to scientific and historical scholarship and reflected on areas for further development, it remains only to conclude by bringing these diverse research strands together.

Chapter 12

Conclusions

12.1. Addressing research aims and objectives

The aim of this thesis was to present a climate history of Antigua for the period 1770-1890, investigating the physical characteristics of extreme climate events, their societal implications and patterns of human vulnerability to them. Attention has focused principally upon tropical cyclone and drought hazards. Evidence was derived from documentary archival sources in the form of government, plantation and missionary records and scholarly publications. This thesis contributes to the existing historical climatology literature by presenting the first primary archival investigation assessing annual-decadal scale climate variability and climate-society dynamics for an individual Lesser Antilles Island. It also represents one of few in the Caribbean at large.

In Section 1.2 of this thesis, three research objectives were formulated. The ways in which these have been addressed will be considered in the following sections.

12.1.1. Reconstruction of precipitation and tropical cyclones

By building upon established methodologies for analysing archival climate evidence (Nash and Endfield, 2002; Chenoweth, 2007), chronologies of relative precipitation variations and tropical cyclone activity in Antigua spanning 1770-1890 have been developed. With regard to precipitation, two time series of variability were produced, one documenting the predominant annual balance of rainfall across the island between the rain-years 1769-70 and 1889-90 and the other focusing on seasonal fluctuations in central-eastern Antigua from 1769-70 to 1853-54. The island-wide chronology corresponded well with two separate series of unstandardised instrumental data from the island covering the 1870s and 1880s. Collectively, findings indicated nine major periods of drought, occurring in the rain-years 1775-80, 1788-91, 1820-22, 1834-37, 1844-45, 1859-60, 1862-64, 1870-74 and 1881-82, and six of precipitation excess, in 1771-74, 1833-34, 1837-38, 1841-44, 1845-46 and 1878-81 (Chapter 5). Reconstruction of the incidence and intensity of tropical cyclone winds experienced in Antigua served as the basis for the second type of climate chronology developed. A total of 42 storm events were recorded between 1770 and 1890, with peaks in frequencies discerned in the early-mid 1810s, late 1820s and 1830s. A highlight of this research area was the identification of ten tropical cyclones not previously

documented in the Leeward Islands in the most complete published databases of historical North Atlantic storms (Chapter 6).

Efforts to establish connections between the aforementioned chronologies and other historical climate reconstructions from the region have met with mixed success. There are few comparable records of rainfall variability for the Caribbean. Those which are available pertain to distant locations in the Greater Antilles and Central America, and exhibit no correspondence with the findings of this study (Section 5.4). The Antiguan tropical cyclone chronology—though recording realtively few storms overall—exhibits some temporal trends in event frequencies that are present in several other document-based chronologies of North Atlantic cyclones (Section 6.5). Neither the Antiguan precipitation nor tropical cyclone reconstructions revealed any straightforward relationships with indices of known drivers of regional climate, such as the AMO, NAO, PDO-ENSO and SSTs. Nevertheless, one Lesser Antilles cyclone record (Chenoweth and Divine, 2008), which the Antiguan time series to some extent mirrors, showed coherence with certain reconstructions of Caribbean SSTs and hurricane formation potential inferred from environmental proxies (Nyberg et al., 2007; Kilbourne et al., 2008). It is possible that some dry episodes in Antigua were connected with the occurrence of El Niño events; 14 of 25 episodes of below-normal precipitation levels in the island-wide chronology coincided with El Niños identified from South American documentary sources (Quinn and Neill, 1995; Ortlieb, 2000; Section 11.2).

Some major phases of precipitation deficiency in Antigua may have been associated with phases of anomalous weather beyond the Caribbean. For example, six such phases corresponding with El Niños also coincided with droughts in north-west India and/or southern Africa. Like the Caribbean, these are zones of known teleconnections to El Niño. Meanwhile, the identification of several particularly severe dry phases in Antigua between 1770 and 1800 is in keeping with suggestions that the Caribbean experienced anomalously frequent climatic extremes in the second half of the eighteenth century (Johnson, 2011), as, it seems, did Mediterranean Europe (Barriendos and Llassat, 2003).

12.1.2. Socio-economic effects of and human responses to extreme climate events

Investigation of the effects of extreme events on Antiguan society and the responses that they generated centred on three episodes of climate-related crisis. These were 1775-1783—a time of protracted drought in Antigua and regional subsistence and economic crisis associated with international warfare (Chapter 8); 1834-1838—a period of varied meteorological extremes and profound socio-economic transformation as a result of slave emancipation (Chapter 9); and 1860-1880—two decades marked by several intense droughts and a major hurricane, situated within a half-century of persistently deteriorating colonial livelihoods (Chapter 10). The

political, commercial and cultural idiosyncrasies of these specific timeframes were demonstrated to be critical determinants of the nature of the disasters spawned by adverse meteorological events. Nevertheless, the case studies, as well as evidence pertaining to several other periods of extreme weather between 1770 and 1890, suggest some commonality in the basic mechanisms through which droughts and hurricanes undermined socio-economic wellbeing in the colony. Most significantly, they disrupted agriculture—the cornerstone of the economy and popular subsistence. Many droughts also resulted in serious shortages of potable water, while climatic stress in general was frequently accompanied by disease epidemics. Notwithstanding evidence of a link between phases of precipitation excess and outbreaks of fever and respiratory infections, wet weather—unlike droughts and cyclones—appears to have had largely positive consequences for society, favouring cash crop and subsistence agriculture. Invariably, some costs were incurred by localised inundations, but Antigua's physical geography seems largely to have ruled out the possibility of catastrophic, widespread flooding (Sections 5.4, 11.3).

The extent to which individual Antiguans were affected by the difficulties discussed above was influenced critically by their command over material resources, as dictated by the racial and socio-economic colonial hierarchy. Hunger, thirst, disease and storm winds often posed a real threat of harm to the marginalised non-white population, both before and after the end of slavery. This was not the case for the white elite, who, possessing the wherewithal to procure expensive vital commodities at times of scarcity and recession, principally saw their economic rather than physical wellbeing compromised (Section 11.3).

A diverse set of reactions to climate-induced hardship was identified at varying scales. Government responses have been the most fully documented. Though tailored to meet particular contexts of emergency and fiscal (in)stability, these consistently involved three basic elements: (1) procurement of overseas supplies essential for sustaining civilian livelihoods, (2) acquisition of British funds to counteract disaster-related financial crisis and (3) supplication for divine protection (Section 11.4.1). At the level of civil society, reactions ranged from acts of self preservation to altruistic endeavours in aid of the wider community. The precise form they took closely reflected the heterogeneous impacts of inclement weather on different social groups. For instance, many coping mechanisms implemented by the colonial underclass, including the theft of sellable or consumable goods, migration and increased reliance on wage labour, simply represented survival strategies. Meanwhile, the white elite principally sought to preserve economic privilege through steps such as adapting agricultural regimes, reducing investment in the workforce and increasing reliance on oversees provisions (Section 11.4.2). Finally, there is evidence that climatic stress at times acted as a contributor to violent dissent among the disenfranchised Afro-Creole community. This connection is, however, recognised to be extremely complex owing

to the manifold environmental and societal parameters which may or, indeed, may not be implicated in social unrest (Section 11.4.3).

12.1.3. Patterns of vulnerability over time and across society

At the most basic level, biophysical vulnerability to climatic hazards in Antigua stems from its location in a region of seasonal tropical cyclone activity and potentially considerable inter-annual precipitation variability. The latter is exacerbated by the island's relatively low topography, which results in little dependable relief-induced rainfall, while an absence of major surface water features enhances society's sensitivity to the hazard (Section 3.2.4). However, the evidence suggests that these features, as well as Antigua's porous limestone bedrock reduce vulnerability to episodes of precipitation excess by reducing the potential for severe floods (Sections 5.4, 11.3). As illustrated by the three case studies discussed earlier, the potential for harm to colonial Antiguan society was also mediated by time-specific climatic circumstances; sequential extremes eroded human resilience by placing strains on local resources. Although this research does not afford evidence of clear links between wider climatic mechanisms and local conditions, modern climatology suggests that frequencies of extreme events are driven by certain macro-scale oceanic-atmospheric cycles, including the ENSO, NAO and AMO (Section 3.2.3). As such, these may also have been implicated in temporal shifts in vulnerability.

The domination of the physical and economic landscape of colonial Antigua by the plantation system encapsulates a key area of overlap in biophysical and social vulnerability to climate. Associated features which made meteorological vicissitudes especially disastrous included a lack of agricultural diversification, reliance on overseas demand for the cash crop, persistent neglect of subsistence agriculture and pronounced social inequalities (Section 3.4) Furthermore, given the frequent occurrence of severe drought and the fact that mean annual rainfall in the instrumental period is 22% lower than the optimum for sugarcane, the island may not have been entirely suitable for its cultivation (Section 11.5).

The thesis focused in particular on the ways in which human factors influenced vulnerability to extreme climate events over time. Based on evidence pertaining to the case studies and beyond, three broad thematic periods comprising Antiguan society's 'trajectory of vulnerability' over the years 1770-1890 were proposed. These were:

(1) the late 1700s through early 1800s, when recurrent warfare in the region heightened vulnerability by stifling maritime commerce and destabilising the economy and subsistence systems;
(2) the mid-1810s to mid-1840s, when relative geopolitical stability and economic success—particularly in the decade following emancipation—rendered the populace largely more resilient;

(3) the mid to late 1800s, when liberalisation of the British sugar market at a time of fierce international competition undermined colonial livelihoods, aggravating the disastrous potential of climatic stresses.

These trends appear to have been superimposed on others mediating socio-economic well-being in the longer-term. The continuous rise of overseas sugar production and exploitation of soils contributed to a net decline in the profitability of local plantations over the eighteenth and nineteenth centuries, while increasing rural-urban migration among disenfranchised Antiguans concentrated ever-greater numbers in crowded coastal settings where they could no longer practise subsistence agriculture. With regard to the evolution of societal structures and coping mechanisms over time, the study offers an illustration of the 'Catastrophe Hypothesis' of Bowden et al. (1981). This suggests that advances which lessen the detrimental impacts of minor meteorological shocks do not substantively reduce vulnerability to high-amplitude, low-frequency shocks (Section 11.5).

The effects of extreme events upon different sectors of the colonial populace discussed earlier (Section 12.1.2) speak of a highly polarised society in terms of vulnerability. The non-white majority suffered most from inclement weather owing to its political, economic, social and environmental marginality, whereas the wealth and power of the plantocracy largely buffered it against negative impacts. This broad division was discernible throughout the 121 years under study. Nevertheless, its finer dynamics were altered by emancipation. Freedom dramatically expanded the scope of the coping strategies available to the black underclass, but also saddled that community with the costs of procuring vital resources in moments of climate-induced dearth—a responsibility previously held by slave-owners. Owing to white planters' retention of a landownership and political monopoly, this group could further transfer the economic burden incurred through climatic stress onto freedpeople by raising taxes, reducing wages for estate labour and hiring fewer workers. Thus, as far as racial, economic and political inequities persisted after emancipation, so too did a socially differential vulnerability reminiscent of slavery (Section 11.5).

12.2. Final thoughts

It is, of course, important to recognise that this research is not without methodological limitations and has left many investigative avenues unexplored. These matters have been discussed where appropriate throughout the thesis and reviewed in Section 11.6. However, as outlined in the previous section, the present study has contributed meaningfully to scientific and historical understanding. This investigation is also significant for a reason not highlighted above; it has employed climatic hazards as a lens through which to examine colonial West Indian society and, in this way, has made it possible to reinterpret a number of well-studied historical developments. In

some cases this has challenged conventional narratives of their dynamics and stimuli. For instance, the evidence presented suggests that climate played an important contributory role in the demographic, economic and political crises experienced in Antigua during the American War of Independence (Chapter 8) and the austere mid-late 1800s (Chapter 10), as well as in maintaining the hegemony of the local elite after the abolition of slavery (Chapter 9).

Further to its precise empirical contributions to the literature, this thesis represents one of few studies which integrate both natural and social science approaches to the investigation of past climate. In light of current anthropogenic pressure on the natural environment, not to mention the costliness of environmental change for human systems, it is clear that comprehending the complex interplay between processes in the domains of 'society' and 'nature' is critical. This, Messerli et al. (2000: p.460) argue, necessarily "implies a need to bridge the gulf between the two cultures of science." Geographers in particular have been encouraged to engage with this challenge because of their inherently interdisciplinary background and sensitivity to space and place. Hulme (2008: p.8) contends that these traits make geographers uniquely able to reveal "the local roots of climate meanings" and find "ways of allowing climate to travel and cross scales without losing these essential anchors and narratives." Similar arguments have been put forward about the contribution that historians can make by addressing the temporal dimensions of this subject matter (Howe, 2011). It is hoped that this thesis has helped to illustrate the value of uniting disparate elements of historically-oriented physical and human geography—specifically, climate reconstruction and climate impacts assessment.

It is, perhaps, fitting for a study of this kind to finish by reflecting on the relevance of findings to the 'Big Story' of contemporary climate change. To this end, one might be tempted to invoke the popular metaphor of small islands as natural laboratories in which processes at work in the wider world can be observed (Fitzhugh and Hunt, 1997). The picture of climate-society dynamics in eighteenth and nineteenth century Antigua unquestionably addresses issues of great currency. Is today's world not a place where vulnerability to climatic stress is driven critically by over-exploitation of limited natural resources, market globalisation and stark socio-economic inequality? Although such parallels would serve as an evocative advert for the importance of historical climate research, the climate histories presented here convey a somewhat complicating central message: context matters. In fact, it is pivotal. The time-specific anatomy of Antiguan society and an ever-shifting milieu of economic, political and environmental conditions powerfully influenced how islanders were affected by and able to react to climatic perturbations. These structural circumstances and functional contingencies themselves dynamically shaped the disasters that emerged in the wake of phases of meteorological extremes. Crucially, such complexities do not obviate the need for climate histories. Rather, as many scholars have suggested previously (e.g.

Meyer et al., 1998; Messerli et al., 2000; Orlove, 2005; Endfield, 2008), they underscore the value of detailed, critical examinations of the myriad ways in which different human-environmental systems, present *and* past, have experienced and responded to climate changes and events.

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