



## Research article

# Long-term drivers of vulnerability and resilience to drought in the Zambezi-Save area of southern Africa, 1505–1830

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## ABSTRACT

Historical studies of human interaction with climate are one approach through which to understand responses to environmental stress today. Most studies of vulnerability are based upon short timeframes in the recent past and so may focus on its symptoms rather than its underlying causes, or derive exclusively from systems-based approaches that can present historical change without recourse to human agency. This paper makes extensive use of the historical written record to analyse the comparative root-causes of the vulnerability and resilience of rural farming communities to drought over a period of three centuries (1505–1830) in the area between the Zambezi and Save rivers in southern Africa. The paper first considers vulnerability, resilience and adaptation as temporal frameworks, and analyses evidence for drought and its impacts in the pre-colonial past. It then reconstructs agro-ecosystem, livelihood and institutional vulnerability for six societies and settlements over the long-run using an indicator approach. The resultant trajectories of vulnerability are discussed in the context of the differential impacts of past drought, through which the decisive drivers and constraints of vulnerability and resilience are identified. The paper concludes with a number of key themes from this long-run analysis for contemporary vulnerability and adaptation to climate change, and points to the importance of institutional adaptation, normative goals, and uneven distributions of power.

## 1. Introduction

Analyses of social engagement with past environmental change offer one approach through which to understand the responses of communities to equivalent stresses today (Adamson et al., 2018). Most studies of vulnerability and resilience to climate and climatic changes are based upon short timeframes in the recent past and so may fail to capture that the root-causes of vulnerability can be highly context-specific, path dependent and underpinned by power (Wise et al., 2014; Fazey et al., 2015). A longer-term view, by contrast, can provide a rich baseline to understand the emergence of vulnerability and resilience in a particular place (Kelman et al., 2016). Where sufficient source material is available, the past can provide a “laboratory” to systematically test theoretical assumptions about the factors that drive and constrain vulnerability and resilience, for example wealth and power inequality, or to test frameworks derived from the contemporary global change literature and thus contribute to new theory formation (Van Bavel and Curtis, 2016). Historical time-depth can also uniquely allow for an analysis of effective adaptation, as the outcomes of particular responses to environmental change may only become evident decades or even centuries later, not least in the case of climatic events with long return periods (Adamson, 2014; Kelso and Vogel, 2015).

This paper analyses the decisive factors that underlay the vulnerability and resilience of rural farming communities to drought over a period of three centuries (1505–1830) in the area between the Zambezi and Save rivers in southern Africa (Fig. 1). Notwithstanding the significant differences between this region then and now, three factors render this region and timeframe of particular interest for a long-term study. First, the area experienced both periodic droughts and long-term climatic change during this period (Hannaford and Nash, 2016), while also being exposed to emerging global market forces (Pikirayi, 2017). This has parallels with the contemporary notion of “double exposure” (O’Brien and Leichenko, 2000; Kelso and Vogel, 2015), i.e. the intersection between stress caused by environmental change and economic globalisation. Second, although a degree of attention has been given to the emergence of climate-related vulnerability and adaptation from nine decades of colonial rule (Iliffe, 1990; Scoones, 1996; Alexander, 2006), far less is known about social engagement with climate in the “pre-colonial” world. Third, and of more practical significance, the region possesses a continuous stream of primary documentation covering several centuries – a claim scarcely possible in most areas of the African interior prior to the mid-nineteenth century (Jones, 1987). These historical accounts are used here to conduct a comparative investigation of the root-causes of vulnerability and resilience to drought across past

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Fig. 1. Area of southeast Africa considered in this study, with past societies and settlements.

societies within this region, and the drivers of vulnerability and resilience over time. This historical time-depth will be used to provide reflections on vulnerability, resilience and adaptation to contemporary environmental change.

## 2. Vulnerability and resilience as temporal frameworks

A large body of theoretical literature is available on vulnerability, resilience and the related concepts of risk, coping and adaptation. Use of this terminology is nevertheless inconsistent and occasionally ambiguous between disciplines and contexts (Füssel, 2010; Kelman et al., 2016). Vulnerability, the term most frequently adopted in this analysis, is defined here as the “state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt” (Adger, 2006, 268). Vulnerability therefore refers to the level of environmental exposure and an individual’s entitlements (Bohle et al., 1994), but is also a manifestation of adaptive capacity, defined as “the ability of an individual or community to evolve or change its response in relation to stress” (Adger, 2006, 270). Resilience has its origins in the ecological sciences and refers to the capacity of an individual, community, or, most often, a system, to respond to and recover from adverse conditions (Folke et al., 2002; Berkes et al., 2003). Unlike vulnerability, resilience is an entirely internal property of a system and relates to shifts between states rather than structural changes within the system (Engle, 2011). The two frameworks are thus not simple opposites but complementary framings (Turner II, 2010). Adaptation transcends these frameworks and is used here to refer to “the adjustments that populations take in response to current or predicted change” (Nelson et al., 2007, 397). Adaptation is a process that emerges over time and can occur at various spatial scales and levels of society, but not all adaptations succeed in reducing vulnerability or enhancing resilience over the long-term (Adger and Vincent, 2005; Hinkel, 2011). A distinction is sometimes observed between adaptation and coping, where the latter may involve short-term responses (e.g. a temporary change in food source) as opposed to the development of formalised relief structures, but this distinction can break down as extreme events are repeated over time (Agrawal, 2008).

Representations of vulnerability, resilience and adaptation in practice often derive solely from the recent past and hence tend to be seen

more as a function of space rather than historical process. However, if people can be made vulnerable over time, then static or ahistorical characterisations of vulnerability can focus attention on its symptoms rather than its underlying causes; this may have consequences for adaptation planning (Bankoff et al., 2004; Pelling, 2011; Fawcett et al., 2017). Likewise, if adaptation is a process that develops through repeated experience of a hazard over time rather than after singular events or policy prescriptions alone (Mauelshagen, 2009; Wise et al., 2014), recourse to longer periods becomes essential if we are to “particularise” adaptation in different contexts (Adamson et al., 2018).

These concepts have nevertheless been slower to gain traction amongst historians and social scientists dealing with climate-society interactions in the longer-term past. Pfister (2010) identified the vulnerability of past societies as a focus for historical climatology – a field that has conventionally focussed on reconstructing past climates from documentary material (e.g. Nicholson, 1979; Vogel, 1989; Kelso and Vogel, 2007; Nash and Endfield, 2008; Nash and Grab, 2010; Nash and Adamson, 2013; Nash et al., 2016; Hannaford et al., 2015; Allan et al., 2016). Yet studies of vulnerability remain a relatively minor component of historical climatology. Where analyses do employ vulnerability as a conceptual framework, they tend to view the past as an end in itself, so historical vulnerability is isolated from contemporary vulnerability, and the manner in which the former may relate to the latter is seldom examined. There also remains a degree of unease amongst historians over the concept of “adaptation” due to its historiographical links to climate determinism (Livingstone, 2012). This detachment between past and present has left historical climatology approaches on the margins of “mainstream” global change research (Adamson et al., 2018).

In the absence of detailed historical studies from the humanities and social sciences, archaeologists and palaeoclimatologists have assembled case studies of climate-induced “collapse”, i.e. major societal shifts that correlate with climatic changes (e.g. Tyson et al., 2002; Holmgren and Öberg, 2006; Huffman, 2008 in the southern African case), while ecologists have developed models of climate-society relationships in the distant past that seek to inform contemporary processes (O’Connor and Kiker, 2004). Yet both approaches have been criticised as they tend to simplify complex interactions and downplay human agency. Such approaches also often reduce the past to individual known “collapses”, which can distort the nuances of more gradual change (Butzer, 2012;

Butzer and Endfield, 2012; Hannaford et al., 2014), and emphasise the physical characteristics of the extreme climatic event itself at the expense of key social mechanisms (Van Bavel and Curtis, 2016).

This paper instead makes extensive use of the regional historical record to provide a comparative assessment of vulnerability and resilience to drought over an extended temporal trajectory (Section 5). This analysis is contextualised quantitatively by a vulnerability indicator approach to facilitate systematic comparison between six societies and settlements with divergent social structures, which will then enable identification of the key drivers of vulnerability and resilience (Section 6). The paper will also provide a finer-grained analysis of social engagement with environmental stress over the long-run (following Wise et al., 2014; Adamson et al., 2018). This will cover the role of inequality, multiple exposures and power in vulnerability, resilience and adaptation. The data and methods used to address these aims are now outlined.

### 3. Materials and methods

#### 3.1. Historical documents

Research for this paper was based primarily on Portuguese historical documentary sources, including missionary accounts, travellers' and explorers' diaries, chronicles, letters and administrative records relating to African society and climate. The production of detailed and continuous accounts in the region began with Portuguese settlement at Sofala (Fig. 1) in 1505 as they sought to gain a monopoly over the Indian Ocean gold trade, and became formalised as part of the administration of the Portuguese crown, church and mercantile capital across its *Estado da Índia*. Recording of these documents followed a similar pattern. This involved a qualitative description of the situation in a specific area, typically with details of its main economic activities and the status of relations with its ruler. These documents then followed a bureaucratic chain that ultimately led to Lisbon or the Vatican.

Fig. 2 illustrates the temporal coverage of the documents consulted in this study. This reflects the overall pattern of recording until 1752, after which the separation of Mozambique from the Viceroyalty of Goa led to an increase in the number of documents recorded. The proportion of documents consulted post-1752 therefore resembles a lesser share of the total number in existence; however this increase related largely to the administrative matters of the Portuguese.

Fig. 3 shows the geographical coverage of sources used in this study according to the number of accounts that describe an area at “first-hand” (where the writer had visited the area), or were the product of “second-hand” information. Note that this distinction is not a definitive indicator of reliability, for a vital source of information were African

traders, contact with whom could provide information on a territory over a sustained period (Beach, 1987). First-hand reports are abundant for areas within the Portuguese jurisdiction on the Zambezi, including the Tonga communities between Luabo and Tete, and on the Mozambique coast. There are a high number of accounts on the political units of Mutapa and Manyika, but there are fewer first-hand than second-hand accounts.

The bulk of the documents used here are collated within published and unpublished source compilations (Theal, 1898–1903; Silva Rego and Baxter, 1962–1989; Beach and Noronha, 1980) and other published texts (e.g. Newitt, 1965). References to agro-ecosystems, livelihoods, institutional arrangements and climate within the documents were recorded verbatim, entered into a database, and sorted thematically and chronologically. This produced a large volume of historical data (1478 records) with which to reconstruct trajectories of vulnerability and analyse resilience and responses to drought. The wider range of published sources relating to Portuguese activity were assessed, but minimal additional information on African society or climate was uncovered.

A reliance upon colonial records for the study of African society presents challenges. The most important of these is that they reflect Portuguese interest in, and understanding of, African society. In most cases this meant that their descriptions ultimately related in some way to exploitation of the land. Although this means that agro-ecosystems and livelihoods were recorded systematically, some accounts were written with the purpose of convincing the crown that its money would be better spent in Mozambique than in Brazil or Angola, meaning that exaggeration and bias are issues that are (often overtly) endemic. The skewed representations of African communities that result from such biases have been dealt with at length elsewhere (Beach, 1987), though many of these can be addressed with careful contextualisation and textual criticism (Henige, 1987).

#### 3.2. Reconstructing past vulnerability

This study will use an indicator approach to operationalise the concept of vulnerability over time. This method draws from the development studies literature (Füssel, 2007; Hahn et al., 2009; Yoon, 2012), but has recently been applied to the past to assess vulnerability to individual extreme events (Engler et al., 2013; Nelson et al., 2016), over the long-run (Gil-Guirado et al., 2016), and to historical change more broadly (Câmpeanu and Fazey, 2014). The approach involves the assignment of numerical judgements to characteristics associated with exposure and sensitivity to environmental stress (Hinkel, 2011), but also those related to adaptive capacity (Birkmann, 2007). This paper employs the three dimensions of vulnerability proposed by Fraser

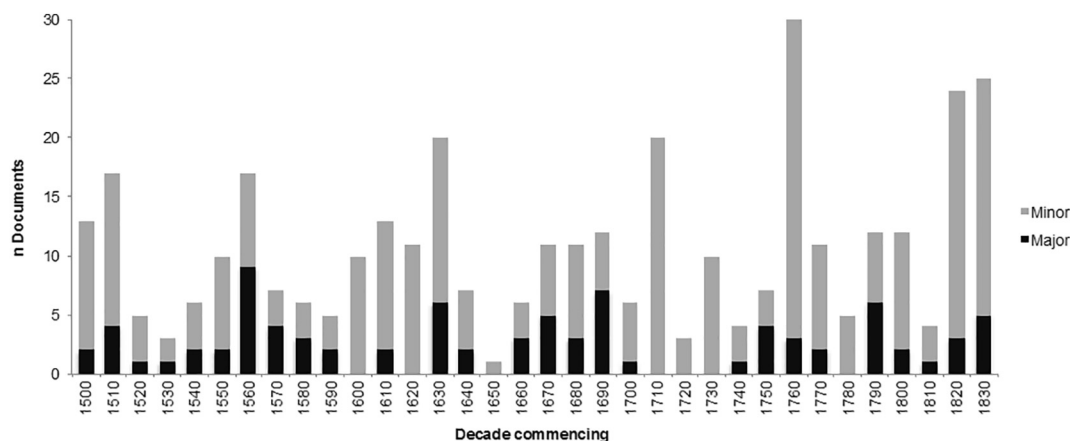


Fig. 2. Temporal distribution of written sources used in this study. “Major” documents refer to those where several paragraphs are devoted to African society, and “minor” texts deal primarily with the Portuguese administration but comment on matters relevant to African society.

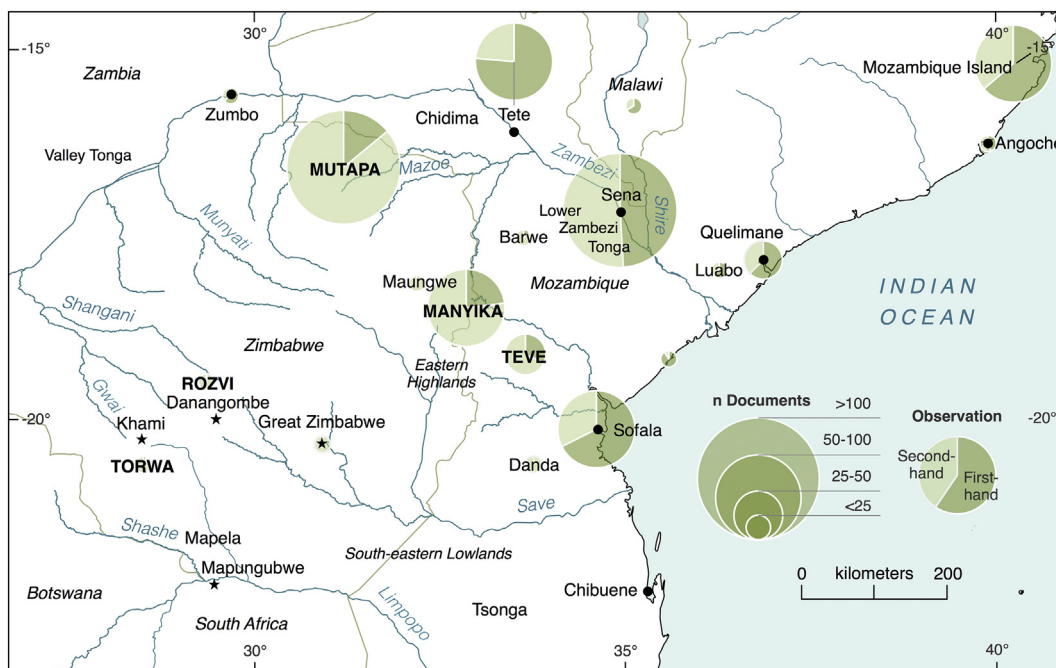


Fig. 3. Geographical distribution of “first-hand” and “second-hand” documents used in this study.

(2007) as a point of departure, which are agro-ecological capacity, livelihood entitlements and institutional flexibility. Vulnerability is increased when the agro-ecological component of a system becomes more specialised, livelihood options decrease and/or institutional capacity

weakens.

Table 1 displays the 21 indicators employed in this analysis, with seven indicators from each of the three dimensions proposed by Fraser (2007), and summarises the rationale behind each indicator. Most of

Table 1

The twenty-one vulnerability indicators used in this study.

Indicator	Rationale
<b>Agro-ecosystem</b>	
1. Crop diversity	Crop diversification is widely recognised an effective strategy for managing risk. Crops respond differently to climatic variables and have varying storage capabilities, thus greater diversity can decrease the sensitivity of the agro-ecosystem (O'Brien et al., 2004; Kandji et al., 2006; Reidsma and Ewert, 2008).
2. Domestic animals	A large stock and diversity of domestic animals provides a source of food that outlasts the agricultural cycle and so can act as a buffer in times of harvest failure (Beach, 1977; Pikirayi, 2003).
3. Hunting and fishing	Hunting and fishing provide additional sources of food in times of scarcity (Beach, 1977; Manyanga and Pangeti, 2017).
4. Gathering	The availability and use of wild plants, such as fruits, roots and herbs, provide a further source of food (Scudder, 1975; Beach, 1980).
5. Cultivable territory	Groups that control a larger cultivatable territory can draw on this if affected by environmental change, or if land is lost in conflict.
6. Fertility and growing season length	Suitability of land for crop cultivation and the length of the growing season has an important impact on harvest outcomes.
7. Environmental hazard prevalence	Settlement in an area more prone to environmental hazards, such as drought, floods and tropical cyclones, increases exposure.
<b>Livelihoods</b>	
8. Minerals	The availability of and access to mineral resources, particularly gold, offer non-food-related livelihood opportunities. This means that past societies could spread the risk of seasonal rainfall variability through local trade (Bhila, 1982; Paavola, 2008).
9. Gold prices and terms of trade	Lower prices and unfavourable terms of trade decreases returns, including cloth, beads, and in turn, foodstuffs (Beach, 1980).
10. Elephant populations	See indicator 8, with respect to elephant populations and ivory.
11. Ivory prices and terms of trade	See indicator 9, with respect to ivory.
12. Alternative livelihoods	See indicator 8, with respect to other non-food related livelihoods.
13. Inter-continental trade	Access to and participation in the Indian Ocean trade network provided opportunities for economic diversification, and in turn the local exchange of cloth and beads for foodstuffs (Bhila, 1982).
14. Local trade	See indicator 13. Local trade focussed on iron and cloth manufactures, salt and foodstuffs. This could act as an extended social network to help spread risk.
<b>Institutional</b>	
15. Formal relief systems	Formal relief systems, such as centralised grain storage, can alleviate hunger in times of scarcity (Mudenge, 1988).
16. Informal relief systems	Informal relief systems, such as food sharing at the village level, can alleviate hunger in times of scarcity (Bhila, 1992).
17. Leadership contention and stability	Power or leadership struggles reduce the efficacy of governance and the ability of social networks to respond to crises effectively (Beach, 1980).
18. Autonomy	Loss of autonomy to another polity or the Portuguese could result in a loss of direct decision-making. This could also give rise to (violent) labour coercion and reduce food entitlements (Newitt, 1995).
19. Local conflict	Localised or civil conflict and violence can lead to the paralysis of political structures and loss of local trade options (Barnett, 2006).
20. External conflict	“External” conflict with the Portuguese or another group outside of the region could cause demographic stress or involve the destruction of food (Mudenge, 1988; Klein et al., 2018).
21. Slavery	Slavery (whether the system of clientship that operated on the Zambezi or the forced expropriation of people) gave individuals a subordinate position in society and reduced food entitlements (Newitt, 1995).

the indicators derive from links established in the development and African historical literature, for example that greater diversity of cultivated crops or the existence of robust food-related relief systems improve adaptive capacity and so act to buffer the impacts of drought (e.g. Beach, 1977; Ford et al., 2006). Other indicators, such as the presence of mineral resources, are more subjective and are based on the value judgement of the author. For example, minerals could be exchanged for foodstuffs with other areas in times of dearth, however the possession of mineral resources also exposed communities to the potentially destructive influence of mercantilism. For assessment of vulnerability to drought, minerals are viewed as a livelihood opportunity that could alleviate scarcity through local exchange, and so decrease vulnerability. This discussion will be returned to in the context of “double exposure” in Section 6.

Each of the 21 indicators in Table 1 are classified with a simple numerical index based on the situation inferred from the primary sources, with equal weighting assigned to all subcomponents. Although no quantitative judgement is made on the relative importance of each indicator, low vulnerability in one indicator does not simply nullify high vulnerability in another. Instead, this weighting system allows a clearer view of the overall picture, while its constituent components can be subject to interpretation (Section 5). A load of “1” is assigned when evidence relating to the indicator is considered to increase vulnerability, “0” when it is adjudged to have neither a positive nor negative influence, and “-1” when it is ruled to decrease vulnerability. Where evidence is too sparse to allow for judgement, it is left blank. The full assessment and evidence used for quantification is detailed in Tables S1–S3.

Only societies for which data are available throughout most of the period are considered in the indicator assessment. This limits the study to the Shona-speaking Mutapa and Manyika polities, the smaller-scale Tonga-speaking polities on the lower Zambezi, and the Afro-Portuguese populations at the settlements of Sofala, Sena and Quelimane. In each of these six cases, the population under consideration are rural farming communities residing within the hinterland of the state capital or settlement, as these areas were both well-documented and most tied to its centralised organisation. The temporal resolution of the data is generally insufficient to provide information at a level comparable with contemporary indicator approaches, which means that periodisation is necessary. The five selected periods (Table 2) are organised around “breaking points” in the political history of southeast Africa, i.e. fundamental changes in regional political relations and power (Beach, 1980; Bhila, 1982; Mudenge, 1988; Newitt, 1995; Mazarire, 2009). It is important to note that the resultant values for each period will serve as points of departure rather than end-states of analysis; indeed perhaps the main limitation of an indicator approach is that it simplifies a complex reality, and so must be embedded within rigorous qualitative interpretation. The next section provides context on these societies and the impacts of drought over the period.

**Table 2**  
Five periods under consideration and key events.

Years	Key events	Spatial coverage
1505–1560	Post-Great Zimbabwe decline, Portuguese settlement on the Mozambique coast, African-Portuguese contact	Mutapa, Sofala
1561–1628	Portuguese expansion on the Zambezi and penetration of the interior polities, external conflict with the Maravi, civil conflict in the Mutapa state	Mutapa, Manyika, Lower Zambezi, Sofala, Sena, Quelimane
1629–1693	Portuguese “conquest” of the Mutapa state, expansion of gold trading fairs in the interior, establishment of the Zambezi <i>prazos</i> (estates)	Mutapa, Manyika, Lower Zambezi, Sofala, Sena, Quelimane
1694–1760	Rise of the Rozvi state, expulsion of the Portuguese from Mutapa and Manyika, Mutapa relocation to the semi-arid Zambezi lowlands	Mutapa, Manyika, Lower Zambezi, Sofala, Sena, Quelimane
1761–1830	Mutapa recovery of land and independence, breakdown of the <i>prazo</i> system, growth of the slave trade, migration of Nguni-speaking polities north of the Limpopo	Mutapa, Manyika, Lower Zambezi, Sofala, Sena, Quelimane

## 4. Historical and environmental context

### 4.1. Economy, society, and the Portuguese 1505–1830

At the turn of the sixteenth century, the Zambezi-Save area was dominated by the Mutapa (“Monomotapa”) state in the north and the Torwa state in the southwest (Fig. 1). Various other “Zimbabwe culture” political units, including Manyika, Teve, Barwe and Danda, also established political independence in this area (Beach, 1994; Pikirayi, 2001). Rural communities within these polities generally practiced mixed farming, supplemented by hunting and gathering. Cattle had an important social function as they were used as payment in bride-price and tribute to rulers. In areas rich in mineral deposits and elephant herds, gold and ivory were exported to the Mozambique coast in exchange for imported cloth and beads. The establishment of these trade links with Muslim traders on the Indian Ocean coast from the tenth century allegedly played a vital role in stimulating social stratification and shifts towards state formation (Huffman, 2009).

The period following the onset of the sixteenth century was one of substantial political and economic change. The Portuguese settled at Sofala in 1505, and by the 1560s they had gained control of much of the coast (Newitt, 1995). At this time, they also established a permanent presence inland at the trading centres of Sena and Tete, to which gold and ivory were brought, and in later decades gold fairs were established inside the Mutapa and Manyika territories (Newitt, 1973). After a failed mission to introduce Christianity to the Mutapa state in 1560–61, the Portuguese adopted a more aggressive approach towards the interior polities, though this again ended in failure as the Barreto-Homem expeditions of the early-1570s were struck down by disease (Monclaro, 1573). It was instead the more individualistic Portuguese traders who held sway in African politics, and an intervention in a civil war during the 1620s led the Mutapa ruler to sign the “capitulations” which handed control of the state to the Portuguese (Mudenge, 1988). The remainder of the seventeenth century marked the highpoint of Portuguese expansion in the region, though this came to an abrupt end with the rise of the Rozvi state – the successor to the Torwa state (Fig. 1) – who in the 1690s expelled the Portuguese from the interior plateau area and set into play new relations between the Portuguese and the African polities (da Conceição, 1696). In the early-eighteenth century the Mutapa state relocated to the semi-arid Zambezi lowlands, and along with the Manyika polity it endured as a smaller-scale political unit until the eve of colonial rule (Beach, 1980), whereas the Rozvi and Teve polities were defeated by migratory Nguni-speaking groups from the south in the 1830s.

Portuguese settlement on the Zambezi was more extensive and enduring. From the 1560s onwards, many of the Tonga chiefdoms were incorporated into the jurisdiction of the *Rios de Cuama* (Rivers of the Zambezi), and in the early-seventeenth century these lands were carved up into *prazos* (estates), which were populated by traders, Jesuits, Dominicans and other settlers from Portugal and Goa. The main populace on the *prazos* though were the Tonga communities of the formerly independent chiefdoms, who became attached to *prazo*-holders as

“*captivos*” (slaves) or “*colonos*” (free Africans) and far outnumbered the small Portuguese population (Newitt, 1973). The *prazo* system survived in this form until the early-1830s, however it was fatally undermined by the growth of the slave exports from the Mozambique coast – reported to grow from around 1000 people per year in 1781 to upwards of 30,000 in the two years before the Anglo-Portuguese treaty of 1830 which prohibited slave exports to Brazil – and the effects of a severe multi-year drought and famine from 1824 to 1830 (Isaacman, 1972; Newitt, 1988).

#### 4.2. Climate variability and its impacts

The Zambezi-Save area is located within the southern African Summer Rainfall Zone (SRZ), where > 66% of mean annual precipitation occurs between October and March. Drought occurs on intra-seasonal, inter-annual and longer timescales (Hannaford and Nash, 2016). The instrumental period in this region began in the late-nineteenth century, and so our knowledge of climate variability prior to this comes primarily from low-resolution palaeoclimate proxy records, however recent work has advanced understanding of rainfall variability on inter-annual timescales back to the early-nineteenth century (Neukom et al., 2013; Hannaford et al., 2015; Nash et al., 2016). Although climate-related data within the Portuguese accounts are too patchy to produce comparable reconstructions, they do provide a guide to severe, region-wide, multi-year droughts during this period (Table 3), the latter two of which (1795–1801 and 1824–1830) correspond to dry periods in independent rainfall reconstructions from elsewhere within the SRZ (Nicholson et al., 2012; Hannaford et al., 2015). This, as well as the absence of any clear-cut relationship between the frequency of recorded droughts and the temporal coverage of the sources (Fig. 2), provides confidence that the Portuguese accounts capture severe and protracted droughts relatively well.

The impacts of these droughts were also recorded (Table 3), although descriptions were generally limited to the presence of hunger, famine and mortality rather than its precise effects. When combined with evidence on responses to drought, however, we see a clearer picture of the differential impacts of drought on society across the

region. In the drought and locust plagues of the early-1590s, for example, the “great scarcity of provisions” meant that people on the lower Zambezi “came to sell themselves as slaves merely to obtain food, and exchanged their children for an *alqueire* of millet”, while “those who could not avail themselves of this remedy perished of hunger, so that at this time a great number of the inhabitants of these lands died” (Santos, 1609, 319). The result of this was the accelerated incorporation of the lower Zambezi into the Portuguese jurisdiction centred at Sena, which alleviated its own food shortages by importing grain from Goa (Newitt, 1995). In the Mutapa state, however, we only see deeper signs of social stress and political change in the mid-1590s when drought coalesced with large-scale conflict with Maravi armies, which led the Mutapa ruler to request assistance from the Portuguese in return for concessions (Pikirayi, 2003; Hannaford, 2015). There is insufficient evidence to detail the full effects of this drought in Manyika, but there were no comparable structural changes as a result.

There are few reports of drought or famine in the seventeenth century, despite good source coverage (Fig. 2). This does not mean that drought did not occur, but that its impact was limited, as drought was generally recorded when it led to hunger or famine. The eighteenth and early-nineteenth centuries, though, witnessed a series of single and multi-season droughts that led to famine and mortality. Evidence is again particularly rich for the Zambezi valley and adjacent areas, where during the mid-eighteenth century Miranda (1766) reported that drought, locust plagues and hunger were driving ever larger numbers to submit themselves into enslavement in search of food. By the late-1820s the situation had worsened altogether, and the breakdown of the *prazo* system was linked by contemporary writers to the “great famine which has reigned there for four successive years...” and as there were “no hands to do the cultivating because all the slaves are scattered through the various lands” (Newitt, 1988, 34). This drought was experienced in the neighbouring Mutapa state, yet there was no parallel breakdown of society. Conversely, the state began to recover land it had previously lost and exerted greater power over the Portuguese (Beach, 1980).

Thus we have a stark contrast between the Mutapa state, where drought did cause significant impacts such as mortality but did not contribute to any real breakdown of society in the absence of warfare,

**Table 3**

Documentary evidence of climatic extremes and impacts in southeast Africa, 1505–1830. Confidence intervals follow Kelso and Vogel (2007), where “1” represents low confidence as reports derive from a single observer, and “3” where multiple observers gave specific dates and locations.

“Rain year(s)”	Event	Location	Impacts and responses	Confidence	Sources
1515–1516	Drought	Sofala	Scarce provisions, increased price of sorghum	2	Almada, 1516, 277
1516	Tropical cyclone	Sofala	Damage to fort, destruction of palm groves, loss of livestock, food scarcity	2	Almada, 1516, 279
1560	Floods	Inhambane	Inundation of coastal plains	2	Fernandes, 1560, 475
1561–1563	Drought, locusts	Mutapa, Zambezi, Inhambane	Failure and destruction of crops and fruit trees, famine, mortality	1	Fernandes, 1562, 151; Sousa, 1697, 260–261
1563–1565	Floods	Zambezi, Mutapa	Inundation, end to famine	1	Sousa, 1697, 260–261
1571–1573	Drought, locusts	Zambezi, Manyika	Destruction of crops, food scarcity, hunger	2	Monclaro, 1573, 385; Carneiro, 1573, 233–235; Anonymous, 1573, 211–215
1589–1595	Drought, locusts	Southeast Africa-wide	Failure and/or destruction of crops, famine, enslavement and exchange of family members for grain on lower Zambezi, mass mortality	3	Lavanha, 1593, 327, Santos, 1609, 319
1642–1647	Drought, locusts	Mozambique coast	Failure and/or destruction of crops, famine	2	Feyo, 1647, 352
1663	Drought	Mozambique island	Water shortages	1	Mascarenhas, 1663, 141
1698	Drought	Teve	Food shortages	1	Assumpção, 1698, 270
1714–1715	Drought	Mutapa, Zambezi	Famine, mortality	2	Viceroy of India, 1715 in Mudenge, 1988
1736–1745	Locusts	Lower Zambezi	Destruction of crops, mortality, enslavement	2	Miranda, 1766, 93–106
1758–1759	Drought	North of Tete	Famine, abandonment of mines	2	Castro, 1763, 63, Miranda, 1766, 94
1765–1766	Drought	Rozvi	Famine	2	Anna, 1767 in Mudenge, 1972
1795–1801	Drought, famine	Southeast Africa-wide	Famine, remembered as the <i>mahlatule</i> famine south of the Limpopo	2	Almeida, 1798, 34, 62, 163; Diniz, 1801 in Mudenge, 1972
1822–1823	Floods	Delagoa Bay	Flooding of Maputo river, inundation of coastal plains	2	Owen, 1823, 467–468
1824–1830	Drought, locusts	Southeast Africa-wide	Failure and destruction of crops, desiccation of river channels, famine, mass mortality, breakdown of social order on the <i>prazos</i>	3	Silva, 1827; Ferrão, 1828; Silva, 1831 in Newitt, 1988

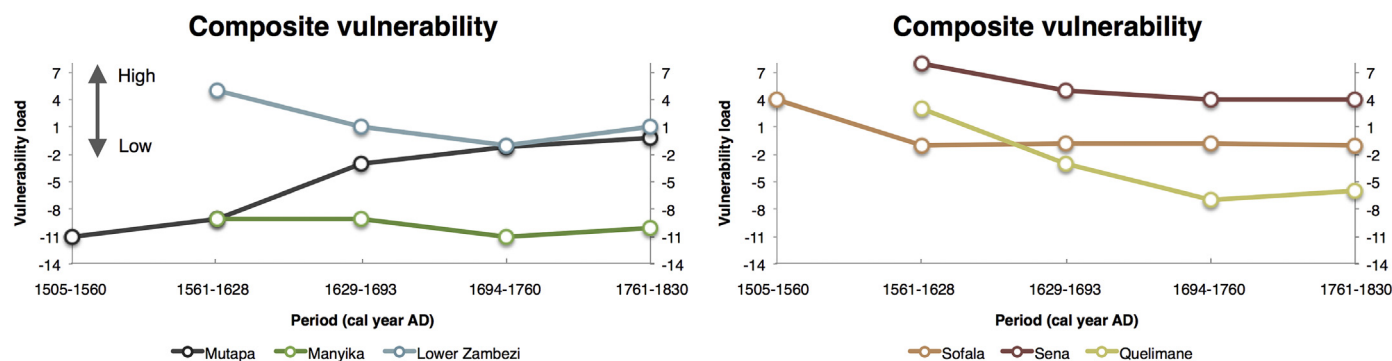


Fig. 4. Trajectories of composite vulnerability in African political units (left) and Afro-Portuguese settlements (right), 1505–1830.

and the Tonga chiefdoms and the *prazo* system on the Zambezi, where drought was explicitly implicated in societal breakdown. Why was this the case? And what were the decisive factors that accounted for the apparent resilience of the Mutapa and Manyika polities to drought, particularly after the Mutapa state had relocated to the semi-arid Zambezi lowlands? These questions, amongst others, are now addressed.

## 5. Results

### 5.1. Trajectories of vulnerability

The overall outcome of the vulnerability assessment is shown in Fig. 4. According to the criteria assessment, it is immediately clear that there were significant changes in vulnerability across the period in several areas. At the extreme end of the spectrum were farming communities in the Mutapa state, who moved from a position of low vulnerability, with a composite figure of  $-11$  at the beginning of the period, to relatively high vulnerability, reaching a figure of  $0$  at its end. A reverse but less sharp trend was observed for the Tonga communities on the lower Zambezi, who moved from a composite value of  $+5$  in 1561–1628 to a lower value of  $-1$  by 1694–1760, although this rose to  $+1$  during the final period. Vulnerability in Manyika witnessed little change over time, moving from  $-9$  to  $-10$ . African and Afro-Portuguese communities around Sofala and Sena experienced modest declines in vulnerability during the first half of the period, which thereafter flat-lined; however the lowest vulnerability values at these settlements were still substantially higher than those for Mutapa and Manyika during the sixteenth century. Around Quelimane, vulnerability underwent a more significant decline ( $3$  to  $-7$ ) from 1561 to 1628 to 1694–1760, although it slightly increased during the last period.

The convergence in levels of vulnerability between the Mutapa state and the lower Zambezi during the middle of the period further brings into question the factors that underlay the disparity in the impacts of the multi-year drought in the 1820s (Table 3). It is therefore instructive to analyse the results of the indicator analysis for each of component – agro-ecosystem, livelihood and institutional – individually.

#### 5.1.1. Agro-ecosystem

Trajectories of agro-ecosystem vulnerability reveal differences in food production strategies and environmental exposure (Fig. 5). Environmental differences underlay crop cultivation and herding. Large tracts of the lower Zambezi upstream of the Shire confluence, for example, were highly drought-prone (Fig. 1). These areas had a shorter growing season, and, away from the fluvisols on the riverbanks, they could not support an agriculture as reliable as the better-watered and more fertile areas of the interior plateau and eastern highlands (Table S1). The coastal areas around Sofala and Quelimane were relatively well-watered, but during the early periods they were hemmed into

small cultivatable territories. Coastal areas were also exposed to tropical cyclones, such as that recorded at Sofala in February 1516 (Table 3), which could inflict substantial damage on the agricultural system.

In the sixteenth century, the general picture of crop cultivation across the region was one of dependence on sorghum, finger millet, pearl millet, vegetables and beans, but there were variations across space. Drought-resistant sorghum thrived in semi-arid areas, though it was grown in smaller quantities in gardens in the Mutapa and Manyika areas where its importance was outweighed by that of the two millets. Rice was grown in well-watered areas such as Luabo and further up the Zambezi towards Sena, where during the late-sixteenth century it was said to be cultivated to sell to the Portuguese (Monclaro, 1573, 383–385). It was also of principal importance around Sofala. Rice was mentioned in several accounts of the Mutapa area, but the riverbank fields and marshes were too sparse to support significant rice cultivation (Beach, 1980).

Crop cultivation in the three centuries before region-wide colonial rule was, however, far from static. While the variety of crops cultivated by most communities in the Mutapa and Manyika areas was relatively conservative, the growth of the *prazo* system along the Zambezi during the seventeenth century brought with it a gradual increase in cultivated crop diversity and consequent reduction in sensitivity. The crop of most apparent importance was not maize – the suggested “miracle crop” south of the Limpopo – but winter wheat. Macedo was the first to write of experimentation with this crop in 1633. In 1648 Gomes wrote that while wheat held an inferior status amongst Africans, it had become widespread along the banks of the lower Zambezi, though by 1667 Barreto reported that wheat was beginning to be preferred to millet around Sena and Quelimane (Barreto, 1667, 505–506). The introduction of maize to southern Africa is clouded by ambiguity over the terminology and subsequent translations used to describe its presence. Probably the first clear-cut reference to its actual cultivation were the references to maize *zaburro* and “Morocco maize” on the Zambezi in the mid-seventeenth century (Gomes, 1648, 98–99). Yet even one century later, Miranda (1766) emphasised its rarity and the inferiority of its dietary status compared to wheat, sorghum and millet.

The documents also reveal clear differences in the diversity and quantity of domestic animals. In the sixteenth century, the Mutapa and Manyika areas were reported to contain vast herds of cattle and goats (Barbosa, 1518, 363; Barros, 1552, 272; Zevado, 1580, 37), while in Manyika sheep were widely possessed. Much of the lower Zambezi was affected by the tsetse fly, which prevented the build-up of cattle herds on a large scale, although inventories from the *prazos* between Sena and Tete reported limited numbers of domestic stock by the eighteenth century, with 47 head of cattle reported at Tete, and 40 at nearby Marangue (Rea, 1976). One critical change came in the early-eighteenth century when the core of the Mutapa state relocated to the Zambezi valley in the Chidima area (Fig. 1; Beach, 1980). Significantly, the presence of the tsetse fly in this area would imply that, as

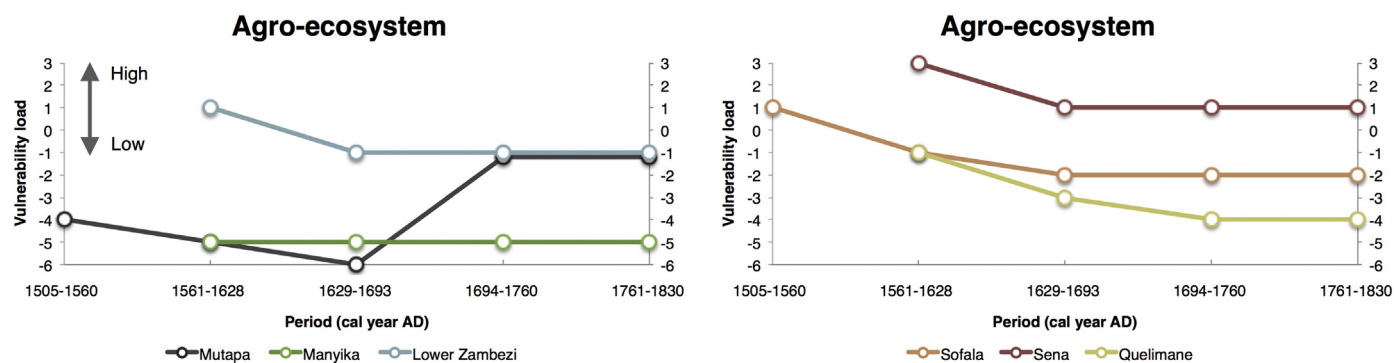


Fig. 5. Trajectories of agro-ecosystem vulnerability in African political units (left) and Afro-Portuguese settlements (right), 1505–1830.

corroborated by the patchy records at this time, the state had lost much of its cattle, which was part of the reason the state moved from initial low agro-ecosystem vulnerability to the joint highest by the penultimate period (Fig. 5).

Hunting and fishing provided valuable dietary additions, even in non-drought years, and were practiced widely across the region. Fishing was of particular importance at Sofala and Quelimane, however it is difficult to ascertain the relative importance of hunting. It is nevertheless noticeable that in areas where cattle were not possessed in great numbers, there exist descriptions of highly organised hunts, which suggests that hunting was of amplified importance (Santos, 1609, 208; Miranda, 1766, 91). This also holds for the gathering of wild plants, fruits and roots, which was practised by women and children throughout the region but took on a particular significance on the Zambezi, where the use of wild produce was one of the widest in Africa (Scudder, 1962; Iliffe, 1990). As with the change in crop diversity on the Zambezi in the seventeenth century, there was an increase in the diversity of fruit production, which added further nutritional value and helped reduce overall agro-ecosystem vulnerability (Table S1).

### 5.1.2. Livelihoods

A further safeguard against drought lay in non-food-related livelihoods and local channels of exchange. In the Manyika and Mutapa areas during the sixteenth century, one such livelihood was the mining of gold, iron and copper, which was exchanged for grain with nearby mineral-poor areas such as Barwe in times of scarcity and helped reduce vulnerability (Barros, 1552, 267; Carneiro, 1573, 235–247). Other livelihood specialisations included cotton production and the manufacture of *machiras* (cotton cloth) on the lower Zambezi. This accounted for a substantial proportion of local trade between the Zambezi and the Mutapa state (Monclaro 1573, 381), which in turn provided access to ironware such as hoes, salt and foodstuffs. On the Sofalan coast, numerous writers referred to the collection of amber and seed pearls (Figueroa, 1505–11, 599; Rezende, 1634, 405; Coutinho, 1698, 262–263), while at Quelimane there was reference to timber, tobacco, and craft manufactures such as straw mats (Gomes, 1648, 56–57; Xavier, 1758, 41). Such non-food-related livelihoods were an important means of acquiring foodstuffs; this is reflected in the low to moderate livelihood vulnerability observed in the Mutapa, Manyika and lower Zambezi areas during the first two periods (Fig. 6).

The settlements of Sofala, Sena and Quelimane instead relied on integration into the Indian Ocean trade network and grain imports from Goa, the Comoros and Madagascar. This trade was a vital source of adaptive capacity prior to the seventeenth century, although it was never assured, and the loss of a ship or blockade of a trade route could place stress on the food supply and raise prices (Santos, 1609, 269–270). Nevertheless, this acted to dampen the otherwise high livelihood vulnerability around Sofala and Sena (Fig. 6).

From the third to the fourth period, several changes caused a major divergence in the trajectories of livelihood vulnerability (Fig. 6), with

the Mutapa state, Manyika, Sofala and Sena experiencing increases and the other areas reductions. The sharp increase witnessed in the Mutapa area warrants particular explanation. One reason for this was a shift in the domain of mining. First, the Portuguese exerted greater power over the terms of trade as the expansion of gold fairs in the interior led to ever more aggressive salesmanship and a move towards forced labour in the mines. This left the Mutapa population with little return for often dangerous mining operations. Second, and in contrast to livelihoods such as cloth manufacture, the gradual working-out of near-surface gold deposits meant that there was less gold to be had in any case. Third, the relocation of the Mutapa state to the mineral-poor Zambezi lowlands in the early-eighteenth century resulted in the loss of this livelihood and resultant adaptive capacity altogether. During the final period, greater emphasis across the region was placed on the ivory trade as demand and prices grew (Alpers, 1975). Yet this was unlikely to have provided the same opportunities for specialisation as gold mining as elephant populations were far more widely and evenly spread, which reduced the incentive for localised trade.

### 5.1.3. Institutional

Institutions and social networks also shaped responses to environmental stress. Formal and informal systems of relief are well-documented (Table S3). In the Mutapa, Manyika and Teve areas, organised labour cultivated fields in the capital hinterland and brought grain to the capital from “all the villages and all the kraals” across the territory (Santos, 1609, 207–208; Barros, 1552, 271). This was stored at a central granary and redistributed in times of scarcity, and therefore in theory helped reduce vulnerability. Problems of transport, however, limited widespread participation in this custom, especially in large territories. In this sense, the capital was able to rely on tribute from its hinterland but less so from the fringes of the state. Significantly, detailed description of these systems provided by da Conceição (1696, 207) and Castro (1763, 71) indicate that they outlived Portuguese conquest in the Mutapa state and its move to the Zambezi, which helped reduce overall institutional vulnerability back to lower levels. We lack evidence of similar practices on the lower Zambezi during the sixteenth century, though we know that centralised grain storage was practised on the *prazos* (Gomes, 1648, 109–110), and that grain imported to Sofala, Sena and Quelimane was stored in granaries, providing a source of adaptive capacity (Couto, 1609–16, 382; Gomes, 1648, 45).

The documents also offer insight into informal relief systems, in particular collective action in agriculture at the household and village levels. Household grain storage was widespread, and grain bins were often situated on rocks or high poles to evade termites. This gave sorghum and the two millets a storage timeframe of two to three years (Beach, 1980). Beer cooperative parties – a practice that regularly appeared in Portuguese accounts as “feasts and drunken merry-making” (Monclaro, 1573, 385) – were a central feature of village life. At these events, weeding of the gardens and threshing of the grain was undertaken cooperatively on each holding in succession. Those that took part



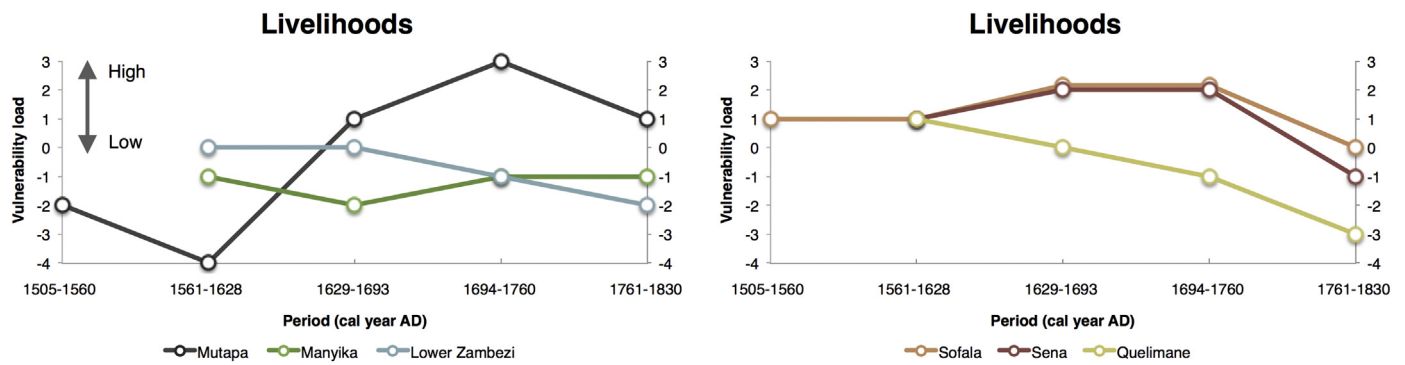


Fig. 6. Trajectories of livelihood vulnerability in African political units (left) and Afro-Portuguese settlements (right), 1505–1830.

were then rewarded with beer brewed by the householder. Grain could also be borrowed on the understanding that it would be refunded without interest the following season (Bhila, 1992). Another activity with a strong collective element was hunting. In the Teve area, Santos (1609, 208) noted that this could involve “all the men of the city in which he [the ruler] dwells”, and on the lower Zambezi Miranda (1766, 91) wrote that during the slack part of the agricultural cycle “the natives set the bush alight with the purpose of catching game”. The apparent continuance of numerous forms of collective action in conjunction with formal relief systems helped suppress vulnerability in the Mutapa and Manyika areas across the period.

Access to assistance through such institutions could be haphazardly or systematically disrupted by political instability, loss of autonomy, or conflict. Of particular importance in shaping the trajectories in Fig. 7 were changes in autonomy and in the operation of slavery. (Note that slavery in the Zambezi context was akin to the form of clientship familiar in other African societies; this arose in times of war or famine when people sought the “protection” of the wealthy or powerful in return for service; Newitt, 1973). In the Mutapa state, loss of autonomy began in the late-sixteenth century with the concessions given to the Portuguese, including tracts of land around Tete, in return for military support. This reached its height during the mid-seventeenth century, but began to recover at the beginning of the next century when the Portuguese were expelled from the state. Slavery did not operate in the Mutapa area as it did on the Zambezi, however the drive towards forced labour in the mines during the seventeenth century led to reports of the “many injustices” committed in the area (Freire, 1673, 147), which increased contextual levels of institutional vulnerability. When the core of the state shifted to the Zambezi, however, its social structure underwent radical change, with the growth of a class of domestic slaves (Castro, 1763, 71). These groups, while tied to wealthier individuals and occupying a subordinate position in society, maintained access to formal relief systems within the state. Manyika escaped some of the more destructive aspects of Portuguese penetration in the interior; its trajectory of institutional vulnerability was consequently lower and of

less amplitude than the other areas (Fig. 7).

Elsewhere, institutional vulnerability was relatively high throughout the period. At Sofala, Sena and Quelimane, lack of autonomy and the operation of slavery from the earliest period onwards had a pervasive influence on food entitlements. The situation on the *prazos* was more complex, and entitlements could vary down to the individual estate. The Jesuit *prazos*, for example, promoted a level of investment in the agro-ecosystem, such as the expansion of fruit crops, in comparison to other *prazo*-holders (Rea, 1976). There were nevertheless general patterns that prevailed across the system. The growth of absentee landholders during the eighteenth century, for example, accentuated exploitation, reduced investment in the agro-ecosystem, and was a major factor in the enslavement and exportation of many “free Africans” to the international slave trade during the early-nineteenth century.

Political instability and conflict could also disrupt access to food. The impact of episodes of conflict on food security and vulnerability were most keenly felt at Sofala, Sena and Quelimane, where the local outbreak of warfare could leave the settlements and their small arable hinterlands with limited supplies and reliant on imports from afar, as it did multiple times at Sofala during the first period (Silveira, 1518, 545–573; Sepúlveda, 1542, 137). In the second period, much of the region experienced both “local” conflict between African political units and “external” conflict between these units and the Portuguese. At times these short-lived but high intensity conflicts involved the destruction of food, for example in the Mutapa-Maravi conflicts in the 1590s. This stood in contrast to the more drawn-out leadership struggles or civil wars, which were said to revolve heavily around the harvest cycle (Rezende, 1634, 419). Local conflicts and instability on the Zambezi *prazos* had greater potential to inflict more serious consequences not only on access to food, but on food production itself (Newitt, 1988). Evidence of such conflicts became frequent during the final period, when Miranda (1766) and Ferrão (1810) wrote of the increasing frequency and scale of disorder, violence and migration between slave groups attached to each *prazo*, and reached its climax

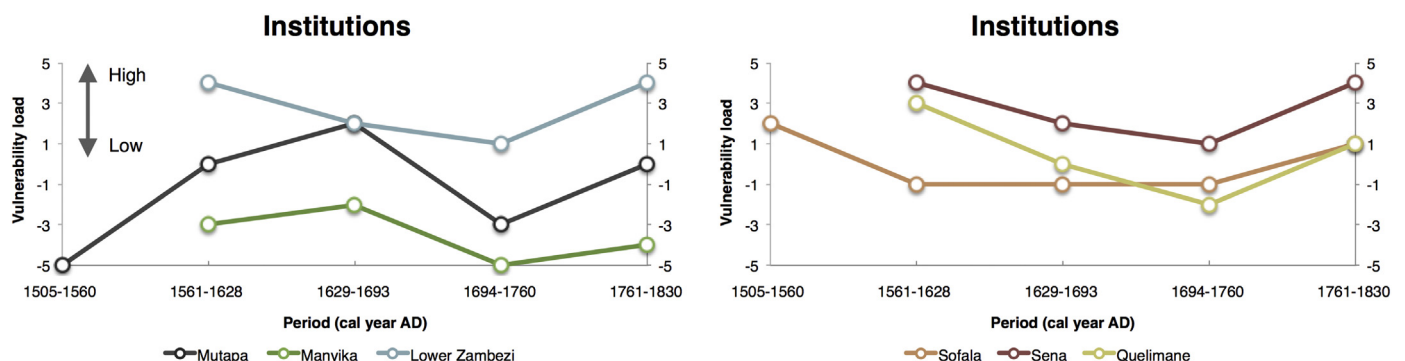


Fig. 7. Trajectories of institutional vulnerability in African political units (left) and Afro-Portuguese settlements (right), 1505–1830.

during the late-1820s. The interaction of these institutional factors explains the high vulnerability assigned to the lower Zambezi and Sena areas in Fig. 7.

## 6. Discussion: the root-causes of vulnerability and resilience

The previous section systematically explored differences in vulnerability across space and time. This section builds on the findings of the indicator assessment to identify which of these “types” or specific sub-components of vulnerability were decisive at various points in time and over the long-run, with particular reference to the divergent impacts of drought in the Mutapa state and on the lower Zambezi. In doing so, it considers more explicitly the drivers and constraints of resilience and adaptation, including the role of power, inequality, and double exposure in the context of drought and colonial expansion (following Kelso and Vogel, 2015).

The first well-documented period of region-wide drought to allow for comparative analysis is that of 1589–95, which partly led to societal breakdown on the lower Zambezi, though only had deeper social effects in the Mutapa state when it coalesced with warfare. Differences in vulnerability during this period were substantial and widespread (Fig. 4), with an overall difference of some 14 points. Although this was derived in almost equal measure from the three meta-components of vulnerability, the disparity in agro-ecosystem vulnerability was particularly high. Lack of agro-ecosystem diversity on the Zambezi likely enforced a reliance on gathering at an earlier stage of the drought. Gathering, hunting, fishing and the exchange of *machiras* were usually sufficient to avert hunger during seasonal droughts on the Zambezi, but these alternative sources of food became less viable as localised seasonal rainfall deficiencies turned into widespread back-to-back years of drought. Indeed, evidence of high importance attached to hunting or gathering in agricultural communities may be seen as an indicator of adaptive capacity within a more vulnerable agro-ecosystem, rather than lower vulnerability per se. Institutional capacity also weakened through conflict with the Portuguese in the 1560s–1580s, and the ability to hold groups together became ever more limited in the face of drought and neighbouring settlements with access to grain imports. Agro-ecosystem diversity and livelihood opportunities in the Mutapa area were high and vulnerability was low. The combination of this diversity with robust relief systems were the key sources of resilience that enabled the state to avoid deeper social effects of drought alone, however the combination of food shortages with a weakening in institutional capacity through large-scale conflict led to the decision request assistance from the Portuguese in return for politically and economically damaging concessions.

There is minimal evidence of drought or famine in the seventeenth century despite consistency in the recording of documents. The reasons for this may in part relate to increased agro-ecosystem diversity on the Zambezi, in particular the spread of wheat cultivation. One major advantage of this crop was its winter growing period. Wheat was sown at the time of the “last rise” of the Zambezi in April–May and was harvested in August–September (Gomes, 1648, 66). This new seasonal rotation reduced the reliance on summer crops during the rainy season, while its lower rainfall requirements meant that even during the drier winter season it could be cultivated in most years. Institutional capacity was relatively weak on the Zambezi, but at this time there was minimal conflict and the *prazos* were governed on the basis of local and more direct power, which led to levels of “investment” in agro-ecosystem diversification (Rea, 1976). This was nevertheless a resilient system in which vulnerability was not only relatively high (Fig. 4), but one that was dependent on the entrenchment of institutional vulnerabilities and power inequalities of its largely African population.

The Mutapa state of the seventeenth century was exposed to both drought and Portuguese mercantilism. The state maintained its agro-ecosystem diversity throughout the period of Portuguese conquest, and although its population experienced a forcible reduction in other

livelihood opportunities such as mining, Portuguese penetration had little effect on the functioning of its relief systems and social networks. This was indicative of the weaknesses of the Portuguese presence as much as the resilience of internal agrarian institutions. The lack of wealth that typified Portuguese southeast Africa before 1890 was insufficient to threaten the agricultural base of the state, while lack of people meant that no viable Afro-Portuguese community ever evolved on the plateau. The mechanisms through which exposure to drought and colonialism became active were therefore highly sensitive to the social and historical context of both the stressor and the exposure unit.

Drought and locust plagues in 1824–1830 were linked by contemporary witnesses to the breakdown of social order on the Zambezi *prazos* and ultimately the system itself; however deeper political effects were not seen in the Mutapa area, which instead underwent a period of rejuvenation. The prazo system was established as a means of permanent settlement for the Portuguese from which to access the mineral wealth of the Zimbabwe plateau, however it was recognised by numerous Portuguese that the long-term sustainability of the system lay in “keeping the natives” and ensuring a stable food supply. After the Portuguese were expelled from the plateau and hopes of the gold trade had waned, there was a growth in absentee landholdings. This led to greater power inequality and loss of voice, together with an accentuation of the exploitative aspects of the system at the expense of its core agricultural activity. Indeed, in the mid-eighteenth and early-nineteenth centuries it was reckoned that even in normal years one third to one half of the year was spent gathering wild plants (Miranda, 1766, 94; Ferrão, 1810, 372). Vulnerability had therefore shifted from its earlier agro-ecosystem state towards heightened institutional vulnerability (Figs. 5–7). Weakening institutional capacity took place against the backdrop of the growing Mozambique slave trade, in which increasing numbers of prazo-holders sought to make instant gains by enslaving the “free Africans” residing on the estates and exporting them to coastal traders. This destructive drive towards short-term gain undermined the ability of the *prazos* to maintain a robust food supply, which was vital in holding their populations together. When drought arrived in the mid-1820s, it therefore struck a system with less acute vulnerabilities than during the sixteenth century, but one that had lost its resilience. The gradual nature of this loss of resilience may have been masked by the reduction in certain vulnerabilities, such as access to grain imports – a process similar to that observed in other colonial contexts (Adamson, 2014).

In the Mutapa state, the reverse pattern becomes clear, where people had acquired acute vulnerabilities through a loss in agro-ecosystem and livelihood diversity, but the system had built resilience. The decisive factor in this process was a transformative reorganisation of society, which can be viewed as an adaptation to the semi-arid setting of the Zambezi valley and to the political pressures, or “multiple exposures”, of the eighteenth century, including slave raiding to the north and Rozvi aggression to the south. Specifically, in the sixteenth and seventeenth centuries when the state was based on the plateau, cattle brought economic security and occupied a central place in society as they were exchanged by young men as bride-price to obtain wives. In the Zambezi lowlands, however, emphasis was placed on agriculture and related labour service, while the loss of livelihood opportunities in herding, mining and trade led to a further increase in wealth inequality. This meant that there were no shortage of people who lacked cattle to obtain wives and were forced to enter the service of others as “bondsmen” (Beach, 1980). These groups formed the bottom tier of society and served local rulers as semi-professional soldiers (“*nyai*”) in return for wives, and took part in other activities such as hunting, herding small stock and trading ivory or robbing traders. A major part of their value, however, was as a fighting unit, which enabled the state to repel Portuguese threats and extend its influence. It is in the context of these changes that we may view reports of banditry and raiding as a new response to drought (Table 3). As on the lower Zambezi during the seventeenth century, the resilience of the Mutapa state now depended

on the entrenched vulnerability of a large part of its population, whose material circumstances were substantially worse than during the sixteenth century. The price of this vulnerability was the survival of the state in the face of the multiple exposures of drought, the growth of the slave trade and increasing conflict.

A number of themes from the forgoing analysis are now summarised in the conclusion, including the changing nature of vulnerability, the importance of institutions and their normative goals, the relationship between vulnerability and resilience over the long-run, “multiple exposure”, and adaptation in history.

## 7. Conclusions

This paper has explored the comparative roots of vulnerability and resilience to drought over an extended temporal trajectory in southeast Africa. We have seen that it was region-wide, multi-year droughts that most challenged past societies, but that these droughts had differing impacts across the region. These differences in impacts are most clearly brought out by the changing nature of vulnerability between the Mutapa state – an African state structure that occupied part of northern Zimbabwe and the adjacent Zambezi valley for over four centuries – and the communities on the lower Zambezi that came under Portuguese rule from the late-sixteenth century. Agro-ecosystem vulnerability increased markedly in the Mutapa state over this period, however the combination of well-entrenched drought relief systems together with transformative institutional adaptation brought increased resilience to drought after the period of Portuguese conquest in the seventeenth century. On the lower Zambezi, agro-ecosystem vulnerability underwent a long-term decrease, but weakening local institutional capacity and the prevalence of short-term exploitation by absentee landlords eroded the resilience of the system, which manifested in the disastrous impacts of the 1824–30 drought. Of the three “types” of vulnerability considered, therefore, it was institutional vulnerability that was the most pervasive and affected all other aspects of vulnerability. Agro-ecosystem diversity and livelihood opportunities were not unimportant, and could sustain the functioning of a system with the presence of power inequality and loss of decision-making. However, these factors could only go so far in explaining divergent impacts of drought over the long-run. Instead, it was the normative goals embedded within institutions – a path dependent function of the social context within which they were formed and evolved – that could override vulnerability or resilience derived from agro-ecosystem diversity and livelihood opportunities.

Such synergies between different types of vulnerability reveal how apparently resilient systems could be constituted of, and dependent on, systematically entrenched individual vulnerabilities, as was the case in the seventeenth century *prazo* system and the eighteenth and early-nineteenth century Mutapa state. One important implication of this finding is that systems approaches that present historical trajectories without recourse to uneven distribution of power, human agency and social-historical context risk offering only a shallow view of resilience. At worst, this reductionism can perpetuate existing uneven power relationships (Cannon and Müller-Mahn, 2010; Adamson et al., 2018). A focus on historical path dependence within institutions, on the other hand, can permit identification of how these institutions evolve towards the needs of restricted interest groups, and how the interests of these groups shape the emergence or suppression of vulnerability and resilience over time. The proliferation of detailed, empirically-rich studies of past climate-society interactions is one way to bring such issues to the fore.

A final word relates to the concepts of “double” or “multiple exposure” and adaptation. The past tells us that “adaptations” are often responses to multiple exposures, and that particular exposures may present more immediate risk than climate-related exposure. Therefore we cannot fully understand the latter without considering the deeper nature of the former. Moreover, adaptations that prioritise agro-

ecosystem diversity or livelihood opportunities without consideration of institutional arrangements and social context may be ineffective over the long-run, as they may promote effective responses to short-term stress and mask more fundamental losses of resilience that become apparent in periods of more exceptional climatic extremes. Historical studies can therefore offer important perspectives on adaptation and exposure as adaptation moves from a contingent, long-term process into a policy imperative (Rohland, 2017; Adamson et al., 2018).

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gloplacha.2018.05.001>.

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