

Historical climatology in Africa: A state of the art

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Collections of written materials from the 16th century onwards have been used to explore the historical climatology of Africa. Studies include decadal- to seasonal-scale reconstructions of past rainfall and temperature, and analyses of societal responses to historical extreme events.

Rainfall reconstructions (1500-1800)

Relative to the wealth of documentary evidence available for Eurasia, there are comparatively few collections of written materials through which to explore the historical climatology of Africa. Documents containing "climate knowledge" for periods prior to the 19th century focus on the Sahel, coastal West Africa, and pockets of southern Africa. Except for small numbers of diaries and naval accounts, few sources contain systematic weather records. Instead, entries comprise references to extreme events and generic descriptions of climates and landscapes. Information about extreme events is of most use for climate reconstruction, which is limited during these centuries to the identification of seasonal or decadal wetness and climate-related events such as locust outbreaks.

Nicholson (1978) produced centennial-scale timeseries of drought and famine for the Sahel using chronicles from Timbuktu, Bornu, Walat, and Tichitt. These chronologies identify climatic "periods" and suggest that wetter conditions interspersed by droughts prevailed from the 16th through 18th centuries, before a trend towards drier conditions began in the late 18th century. Adopting a similar approach, Norrgård (2015) produced an interdecadal-scale wetness series for coastal West Africa (from

Ghana to Benin) during the late 18th century. Like the Sahel chronologies, this reconstruction suggests abrupt changes in rainfall during the 1780s (wetter) and 1790s (drier). Miller (1982) used Portuguese colonial records to produce a chronology of wetness, locusts, and epidemics for modern-day Angola from 1560 to 1830. Intense droughts were found to be present during the 1580s, 1650s, and 1790s. However, caution must be applied to parts of this chronology, since references to warfare are sometimes included as indirect evidence for drought (due to the frequent coincidence of drought and conflict). Less material exists for Mozambique than Angola, but documents are available for most decades following Portuguese settlement in 1505. A chronology of extreme events shows pronounced droughts during the late 16th century, few droughts in the 17th century, and particularly severe droughts in the 1790s and 1820s (Hannaford 2018).

Climate reconstructions (1800-1900)

The quantity of sources available for climate reconstruction in Africa during the 19th century is much greater than for earlier periods. This is mainly attributable to the expansion of European colonial activity across the continent from the late 18th century onwards. Records include colonial and missionary papers, newspapers, travelogs, personal

diaries, and letter collections. Most climate information in these sources is in the form of narrative descriptions but, beginning in the 1850s, selected newspapers also included instrumental meteorological data.

Information from these materials has been used to generate continent-wide and regional rainfall reconstructions based on classifications of "wetness". The main continental series (Nicholson et al. 2012) combines documentary evidence, rain-gauge data, and secondary literature – mostly relating to sites within 500 km of the coast – to explore spatio-temporal variations in historical rainfall. The most striking feature of the reconstruction is the tendency for increased aridity in the opening decades of the 19th century. A notable period of above-normal rainfall is identified in the Sahel in the 1880s and early 1890s, but drier conditions commenced elsewhere around 1880.

The greatest numbers of regional rainfall reconstructions are available for southern Africa. Some, such as Hannaford et al. (2015), use wind data digitized from ships' logbooks to capture regional atmospheric circulation and produce quantitative chronologies. Others rely mainly on narrative evidence within historical sources (Fig. 1). These include chronologies for the Kalahari, Lesotho, South Africa (including the Western and Eastern Cape, Namaqualand and KwaZulu-Natal; see Nash 2017 for sources), Malawi (Nash et al. 2018), and Namibia (Grab and Zumthum 2018). Most studies reconstruct annual rainfall only, but where information density permits, seasonal reconstructions have been attempted. Recent work on the historical climatology of the Cape has produced a daily surface-pressure series from 1834 onwards from early instrumental records (Picas et al. 2019).

A compilation of annually resolved rainfall series for mainland southern Africa for the period 1850-1900 is shown in Figure 2. This includes seven series based on documentary evidence, three regional series from Nicholson et al. (2012) and, for comparison, a tree-ring-width-based rainfall reconstruction for western Zimbabwe (Therrell et al. 2006). All are for areas that receive most rainfall during the austral summer months (October-March). The compilation shows that relative rainfall levels were geographically variable across southern Africa. However, droughts that affected large areas can be identified (e.g. ~1850, early to mid-1860s, late 1870s, early to mid-1880s and mid- to late 1890s), in addition to a smaller number of coherent wetter years (e.g. 1863-1864 and 1890-1891). Multiproxy analyses indicate that the early to



Figure 1: Excerpt of a letter dated 17 February 1868, written by the missionary Rev. A. Chiswell at present-day Toamasina, showing contemporary settlements along the east coast of Madagascar. (Source: Oxford, Bodleian Libraries, United Society for the Propagation of the Gospel Papers D38.)

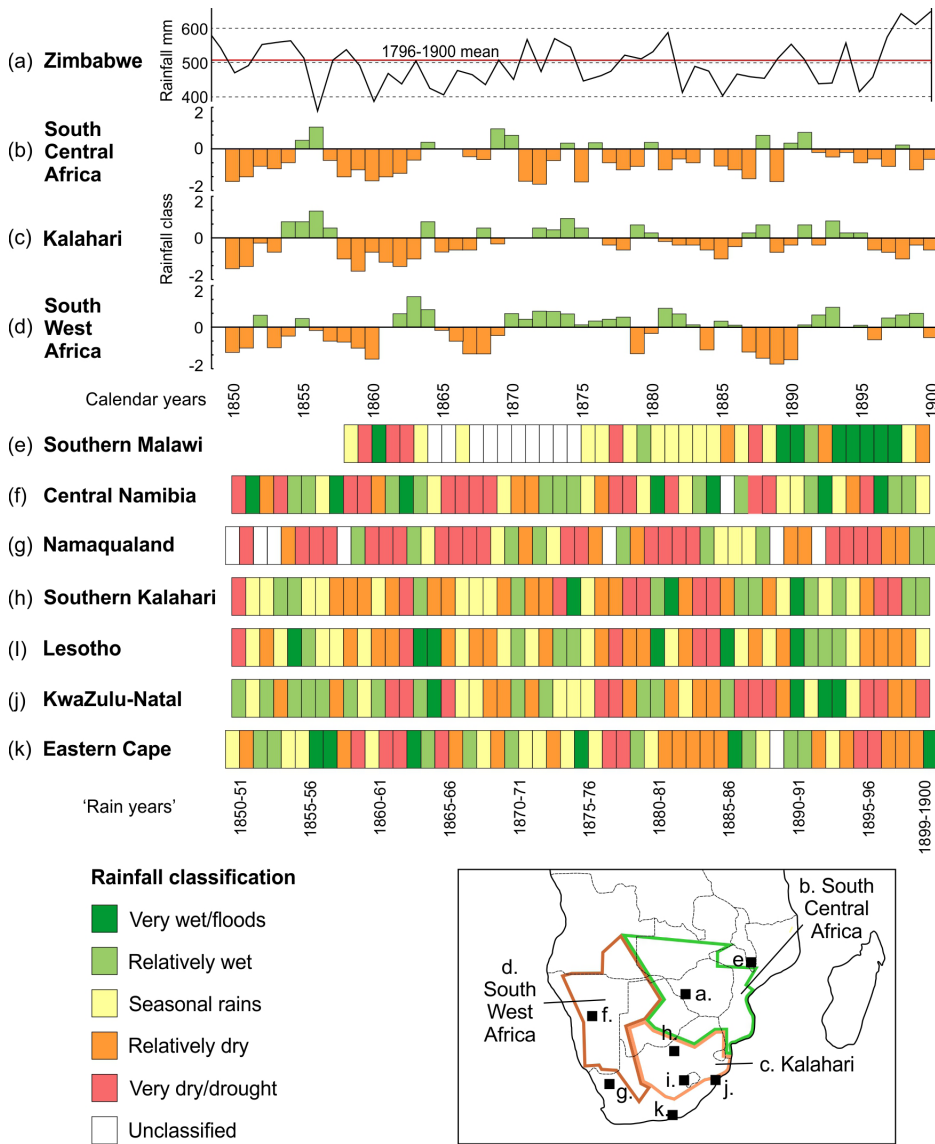


Figure 2: Annually resolved rainfall reconstructions for southern Africa during the period 1850–1900 (for more details, see the online version of this article).

mid-1860s' drought was the most severe of the 19th century, and that of the mid- to late 1890s the most protracted (see Nash 2017).

To date, the only study exploring historical temperature variations is a chronology of cold season variability for Lesotho (Grab and Nash 2010). This reveals more severe and snow-rich cold seasons during the early to mid-19th century (1833–1854) compared with the latter half of the 19th century. A reduction in the duration of the frost season by over 20 days during the 19th century is also identified.

Climate impacts and perceptions

The climate reconstructions described above provide important baselines from which to consider climate impacts, exploration of which has largely taken place within the disciplines of economic and social history. Perhaps the best documented impact of climate on society is on agricultural production. Historical studies of drought-related famine and its societal effects are reasonably widespread, with most research focusing on the 19th century and some longer-term studies back to the 16th century. Increasing use has been made of vulnerability frameworks,

which consider a multitude of socio-environmental factors (including the characteristics of agro-ecosystems, diversity of human livelihoods, and level of societal organization) that shape the consequences of climatic impacts. Such approaches have demonstrated that while "material" factors such as crop diversity were important in reducing sensitivity to drought in the lower Zambezi area of southeast Africa, institutional rigidity or adaptability were the principal determinants of societal vulnerability in the long run (Hannaford 2018). The introduction of American crops, especially drought-intolerant maize, is also thought to have impacted upon food security, with implications for population growth, drought exposure, and famine vulnerability.

In relation to conflict, the period of state formation in eastern South Africa during the 18th and 19th centuries has been linked to drought-intensified competition over cattle and grazing land, in turn generating conflict and the organization of societies into defensive states (Hannaford and Nash 2016). Africa has largely been absent in pre-20th-century quantitative studies on climate and conflict, but quantitative approaches have

argued that increases in slave exports during the 19th century were a result of increased temperatures in slave-exporting areas of Africa that reduced agricultural productivity (Fenske and Kala 2015).

The influences of climate on health and disease have been explored through the lens of European perceptions of African climates, who saw them as unhealthy and disease ridden, with most of the literature focused on the late 18th and 19th centuries. Some literature has explored linkages between climate and epidemics (e.g. Eldredge 1987), usually situating drought as a driver of malnutrition or contaminated water supplies, which in turn increased susceptibility to infectious diseases.

Future work

Despite the advances in African historical climatology reported here, there is still scope for future climate reconstruction work. Nicholson et al. (2012), for example, identified major spatial gaps for equatorial and arid regions of Africa. Finding documentary evidence to address these gaps may be challenging, although large collections of available primary materials may help for western and eastern Africa. By exploring links to cognate subdisciplines such as historical archaeology, future research may better contextualize climate impact analyses. Finally, there is considerable potential for using documentary sources in different regions to explore spatial variations in the signatures of global phenomena, such as El Niño, or for specific time periods such as the end of the Little Ice Age.

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