NEGOTIATING CLIMATE CHANGE IN CRISIS

EDITED BY STEFFEN BÖHM
AND SIAN SULLIVAN

https://www.openbookpublishers.com

ISBN Paperback: 9781800642607
ISBN Hardback: 9781800642614
ISBN Digital (PDF): 9781800642621
ISBN Digital ebook (epub): 9781800642638
ISBN Digital ebook (mobi): 9781800642645
ISBN XML: 9781800642652
DOI: 10.11647/OBP.0265

Cover image: Photo by Thijs Stoop on Unsplash available at: https://unsplash.com/photos/A_AQxGz9z5I
Cover design by Anna Gatti

13. Environmental Change in Namibia: Land-Use Impacts and Climate Change as Revealed by Repeat Photography

Rick Rohde, M. Timm Hoffman and Sian Sullivan

This essay draws on repeat landscape photography to explore and juxtapose different cultural and scientific understandings of environmental change and sustainability in west Namibia. Change in the landscape ecology of western and central Namibia over the last 140 years has been investigated using archival landscape photographs located and re-photographed, or 'matched', with recent photographs. Each set of matched images for a site provides a powerful visual statement of change and/or stability that can assist with understanding present circumstances at specific places. The chapter shows in a practical way an innovative possibility for documenting and analysing environmental and social change, helping us to contextualise projected and predicted environmental futures, and sometimes offering complexity with regard to modelled climate change projections and scenarios.

 https://doi.org/10.11647/OBP.0265.13

Historicising Environmental Change through Repeat Landscape Photography

Fig. 7. Repeat photos of Mirabib inselberg in the Namib Desert. Composite image © Rick Rohde, drawing with permission on images by John Jay, Frank Eckhardt, Rick Rohde and Timm Hoffman.

The above composite image illustrates a key method drawn on in exploring environmental change in west Namibia. The image depicts the Mirabib rocky outcrop in Namib-Naukluft National Park at three different moments in time. The first view (the small black and white photo) is a still from the film *2001: A Space Odyssey* which director Stanley Kubrick used for some of the opening scenes. The film's still photographer, John Jay, took this photo in 1965. This image was re-photographed in 1995 (the image on the clipboard) by University of Cape Town geomorphologist Frank Eckardt; followed by a third retake in 2015 by Rick Rohde and Timm Hoffman.

Repeat landscape photography can be used to explore and juxtapose different cultural and scientific understandings of environmental change and sustainability. Sometimes this method reveals ecological markers of historical events and climate change trends that contradict both popular and scientific assumptions. The material brought together through this method can tell stories of environmental change that are different to those assumed in popular imagination and scientific predictions alike.

In this essay we summarise some findings from repeat photography research for changes in the landscape ecology of western and central

Namibia for a longer time period than the effects of recent drought reported for the same area in Lendelvo et al.'s chapter, this volume. We have revisited and re-photographed sites that were originally photographed as long ago as 1876, analysing ecological changes these 'matched' images record. We select examples from a large dataset of repeat images brought together since the 1990s by Rick Rohde and Timm Hoffman from the University of Cape Town. Each set of matched images for a site provides a powerful visual statement of change and/or stability that can assist with understanding present circumstances at specific places and across regions. They help us to contextualise projected and predicted environmental futures linked, for example, with understandings and assumptions about climate change.

Historical Ecology[1]

Given the dramatic events that have shaped the present socio-economic landscape of central and west Namibia—the establishment of colonial enterprise, a genocidal colonial war, seven decades of apartheid rule, and the ushering in of broadly neoliberal policies since independence in 1990—it is not surprising that traces of past impacts are inscribed on the landscape. These traces create layered landscape 'palimpsests'[2] in which past influences can be read and deciphered in the present.

In the archive image below, for example, we see the kraal of Maherero, the first Paramount Chief of the pastoralist ovaHerero, who was powerful in central Namibia prior to German colonisation in the 1880s. The photograph was made by the photographer who accompanied British colonial magistrate W. C. Palgrave as he travelled from Cape Town to central Namibia in 1876, seeking the possibility of establishing colonial 'Protection Treaties' with the diverse autochthonous peoples

1 For more detail on the research informing this first part of the chapter see Rohde and Hoffman 2012.

2 Human and cultural actions in relation to landscapes are sometimes framed metaphorically as akin to writing on a page, leaving behind signs that can be read by future inhabitants. The overlaying of multiple workings of the land thereby make a landscape something of a *palimpsest*—a text overlain by successive writings, the earliest writings never quite completely erased. In other words, landscapes are multi-layered and readings of them invite an unpicking of these layers, and an awareness of the influence and interplay of earlier inscriptions on those that follow (as explored more fully in, for example, Rohde 2010; Heatherington et al. 2019).

inhabiting the territory (Coates Palgrave 1877; Stals 1991). What was then a pastoral scene of grassland savanna with umbrella acacias (*Acacia tortilis*) providing some shade for dung-plastered dwellings and kraaled animals, is now a cluster of twenty-first-century settler houses built like Bavarian castles on high square stone or concrete plinths, surrounded by electric fences and barbed wire. The vegetation changes are astonishing. Where once there was a wide ephemeral river bordering the receding Namibian grasslands (centre left in the top image), there is now hardly an opening in the thornveld canopy. Some of the riverine Ana trees (*Fairdherbia albida*) in the bottom image are now gigantic—like old grandparents care-worn and haggard surrounded by a new generation of hungry dependents. The lush flowering grasses in the bottom image are breast-high in places.

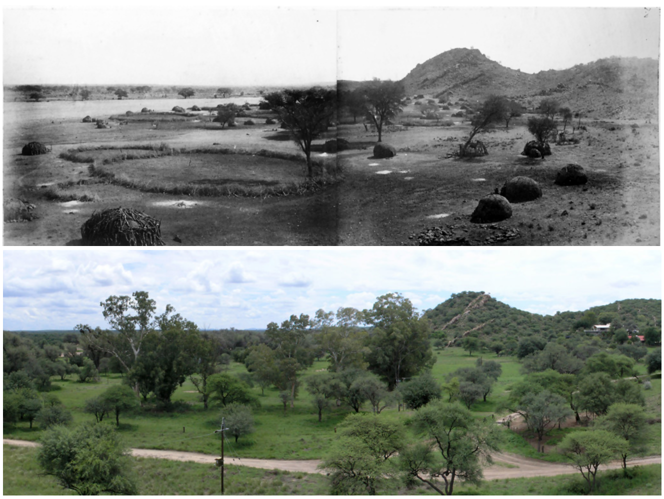

Fig. 8. Maherero's kraal (1876) above, and present day Okahandja (2009) below. Sparse riverine Ana trees and thornveld savanna have been replaced by alien tree species such as eucalyptus (Australian) and prosopis (North American) that now obscure the view of the upper reaches of the Swakop River. These social and environmental changes are emblematic of the reshaping of central Namibian landscapes since colonial times. (Above) W. C. Palgrave Collection (National Library of South Africa), out of copyright, used with permission; (below) © R. F. Rohde and M. T. Hoffman.

The photographic evidence from many sites in central Namibia reveals a complex story of radical political, cultural and socio-economic change amounting to an ecological revolution associated with colonialism and an expanding global capitalist economy.

In 1876 the grazing lands of central Namibia were more grassy and less woody; rangelands were highly shaped by large pastoral herds, transhumance routes, temporary settlements and the use of fire to manage grasslands. During the 1890s, however, several cataclysmic events converged to bring about radical change. These included the rinderpest epizootic of especially 1897, smallpox, and a colonial war of the German state against autochthonous Namibians that intensified in 1904–1907, all of which effectively decimated indigenous peoples and their herds (Esterhuyse 1968; Olusoga and Erichsen 2010; Wallace 2011). As illustrated in Figure 9, the resulting hiatus in land use resulted in ecological changes that persist in the landscape today as a signature of events of a century ago.

Fig. 9. River Skaap, Hatsemas Central Highlands, central Namibia. Matched photographs spanning 1876 (left) to 2005 (right). Camelthorn individuals have colonised previously bare or sparsely vegetated river terraces, probably in a single recruitment event. The increase in small trees and shrubs on the rocky pediments and hill slopes is indicative of regional bush encroachment patterns. For scale, note the white tent and ox-wagon of the Palgrave expedition at the bottom left quadrant of the 1876 image. (L) W. C. Palgrave Collection (National Library of South Africa) out of copyright, used with permission; (R) © R. F. Rohde and M. T. Hoffman.

The change in riverine habitats lining the margins of an ephemeral river in the pastoral landscape shown in Figure 9 is immediately apparent when viewing these images alongside one another. Considering the large size of individual trees and the uniform population structure of these long-lived camelthorn trees (*Acacia erioloba*), it is likely that they originated as a seedling cohort sometime between 1876 and 1910. It is reasonable to assume that they recruited in response to the sudden release of pastoral grazing pressure when indigenous pastoral groups were effectively displaced by disease, war and subsequent German colonisation. This woodland thus endures as an ecological marker of historical events with political, social and environmental dimensions.

Other repeat image pairs from this collection show the development of towns and settlements, such as in the open uninhabited savanna of central Namibia, now dominated by the Presidential Palace and the extensive southern suburbs of the capital, Windhoek: as shown in Figure 10.

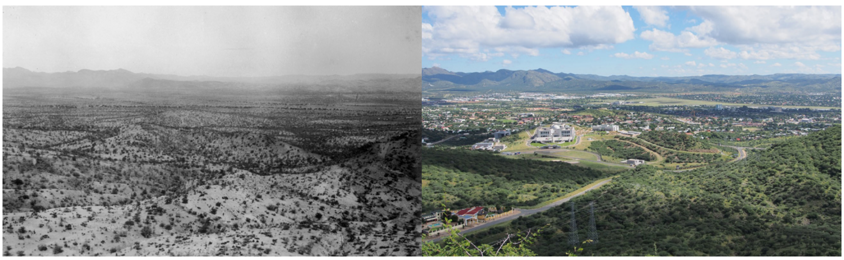

Fig. 10. Windhoek southern suburbs, looking south-west from Wassenberg. Matched photographs spanning 1919 (left) to 2014 (right). Bush thickening is evident throughout the landscape, not to mention the sprawl of urban residential housing and the new Presidential Palace built by a North Korean company, completed in 2008. (L) I. B. Pole-Evans (South African National Biodiversity Institute), out of copyright, used with permission; (R) © R. F. Rohde.

Bush thickening ('bush encroachment') has become an increasing problem in central Namibia, reducing the available grazing for cattle and in many instances closing the thornbush canopy to grazing altogether, as illustrated in the matched images in Figure 11. Palgrave's 1876 photo depicts a newly established mission station inhabited by several hundred indigenous pastoralists situated around a wetland in a tributary of the Swakop River. Intermittent conflict, cattle theft and violent confrontation took place between Nama and ovaHerero until the 1890s when a police station was established here by the German colonial administration. Otjisewa farm was bought from the local ovaHerero chief in the early 1900s and has remained a privately owned commercial cattle farm owned by a succession of German and Afrikaner families. Although a problem for cattle farmers, the thickening of thornbush savanna here forms a massive carbon sink that might be advantageous in a global context of increased anthropogenic greenhouse gases and atmospheric CO_2 fertilisation. At the same time, however, and illustrating the complex trade-offs involved between different production / protection choices, the management of bush encroachment often involves clearing woody plants for conversion to saleable charcoal (Dieckmann and Muduva 2010), or converting the "bothersome biomass" of bush encroachment into biomass fuel to power Biomass Industrial Parks (Heck 2021). Both strategies contribute significant emissions.

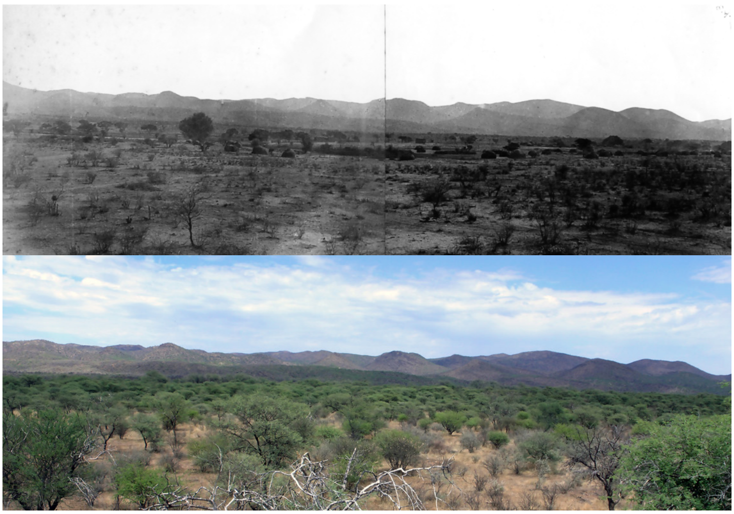

Fig. 11. Otjisewa, central Namibia. The change from the savanna landscape in 1876 (above) to the image of 2006 (below) illustrates how bush thickening typifies these more mesic (i.e. moist) highland areas of Namibia today. (Above) W. C. Palgrave Collection (National Library of South Africa), out of copyright, used with permission; (below) © R. F. Rohde and M. T. Hoffman.

In contrast, many of the more arid rangelands in the South of Namibia have remained stable and relatively unaltered over long periods of political, socio-economic and climatic change. The ephemeral Guireb River in the Karas Region of southern Namibia is a stunning example: see Figure 12. These more arid areas are less impacted by land use and have remained relatively stable over long periods of time. Patterns of little or no woody vegetation cover change are correlated with Mean Annual Precipitation (MAP) below a threshold of around 250 mm, regardless of land tenure system or land-use practice.

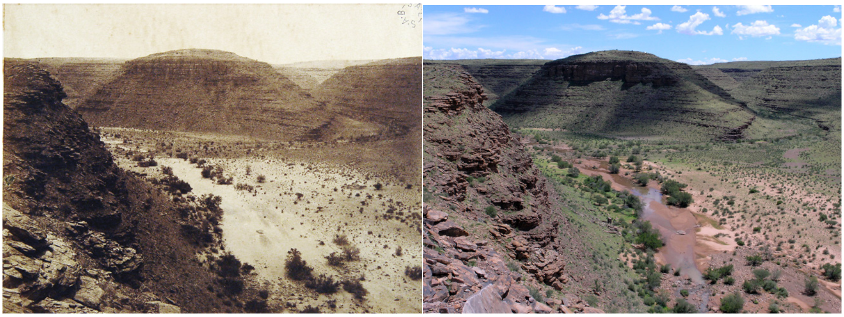

Fig. 12. Aub / Gurieb River, southern Namibia. In spite of the contrast of the dry, sparsely populated, pastoral landscape depicted in 1876 and the lush grass and flowing river during the exceptional rainy season of 2009, woody vegetation species and the extent of cover has hardly changed. (L) W.C. Palgrave Collection (National Library of South Africa), out of copyright, used with permission; (R) © R.F. Rohde and M.T. Hoffman.

Bush encroachment (as per Figures 10 and 11) is positively correlated with MAP above 250mm and associated with land-use practices such as commercial cattle ranching arising in the wake of colonialism, drought, and the epidemics and epizootics of the late-nineteenth and early-twentieth centuries. Legacies of demographic collapse, land-use change and landscape fragmentation are evident in these more mesic savannas. We see no evidence of recovery from bush-encroached to open grassland over the timescale of this study.

Repeat Photography and Assessing Climate Change

In order to assess the impacts of climate change in west Namibian landscapes we examined a dataset of one hundred repeat landscape images compiled over the past twenty-five years in the western desert landscapes of the Pro-Namib and Namib Desert. These arid and hyper-arid areas have been less impacted by human development and historical events than many of the more mesic parts of Namibia. A detailed vegetation survey was conducted and changes in dominant species cover was ascertained (Rohde et al. 2019).

One of the main obstacles to researching climate change in the Namib Desert is the paucity of historical climate data. Because woody vegetation in this relatively undisturbed environment is strongly influenced by climate, we regard long-term vegetation change as a proxy for changes in climate. These repeat photo sites cover an area of approximately 40,000 square kilometres and the average time between the date of the original image and the repeat photograph is seventy-eight years.

Illustrating the diversity of habitats characterising west Namibia, these sites were categorised into four broad groups: Large Ephemeral Rivers; Fogbelt, Grasslands & Shrublands, Savanna Transition—the latter three being largely determined by rain and fog. These groupings are shown in Figure 13, together with the locations of the repeat photographs used in our analysis.

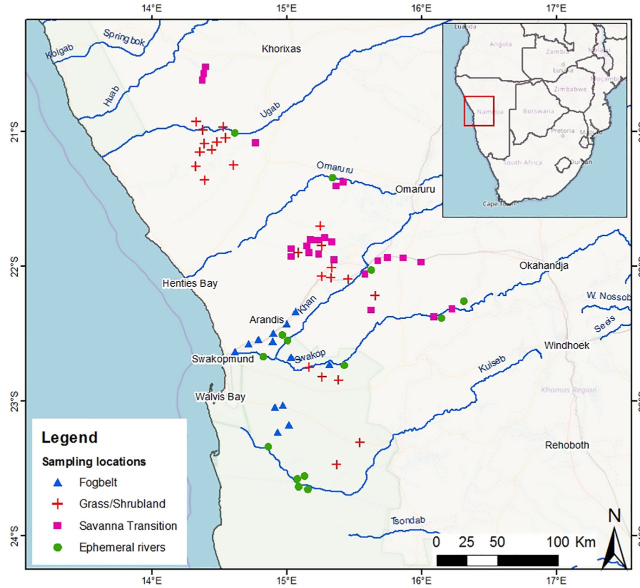

Fig. 13. Location of repeat photo sites in each of four vegetation types, west and central Namibia. Image by chapter lead author.

The region is characterised by a distinct environmental gradient from the hyper-arid coastal areas to the savannas of the plateau. Mean annual precipitation (fog and rain) is relatively low for sites in the coastal fogbelt and inland grass/shrubland sites, but increases in the savanna areas and sites within large ephemeral rivers farthest from the coast. Mean annual temperature is lowest in the first 60 km within the fogbelt zone and is higher further inland, although considerable variability exists between sites. The number of fog days declines steeply away from the coast and provides relatively little moisture input for sites further than 100 km from the ocean.

Fogbelt

The sparse woody cover in the coastal western portion of the Fogbelt (9 km to 35 km from coast) increased by 0.36% per year[3] while sites between 40 km to 74 km from the coast showed very little change (+0.003% per year) (Figure 14). Over the study period woody cover declined in only two of the thirteen fogbelt sites, both of which were located towards the eastern margin of this vegetation zone.

Fig. 14. Fogbelt site near Rössing uranium mine (33km from coast) showing examples of the long-lived shrubs between 1919 (top) and 2016 (below) displaying the same individuals in each image (white dots). The population of this species has doubled during the last ninety-seven years (green dots) due to increased fog. Mortality of individuals is shown as red dots. (Top) I. B. Pole-Evans (South African National Biodiversity Institute), out of copyright, used with permission; (below) © R. F. Rohde and M. T. Hoffman.

3 Woody cover change per year is calculated by dividing the total change over time by the total number of years between the original and repeat photo, recognising that vegetation growth increments are not necessarily smooth, i.e. they will not in fact be the same every year as they will be coupled with other dynamic factors.

Grasslands and Shrublands

The average percentage cover of woody vegetation in the grass/shrubland zone was more than twice the average value for the fogbelt zone. Unlike in the fogbelt zone however, woody cover in the majority of sites in the grass/shrublands did not increase over the sampling period (Figure 15). The average change in woody cover was only +0.007% per year. Variability in woody cover change was also relatively low in this vegetation zone. In seven of the eight sites located in the more eastern part of the grass/shrublands (i.e. 92 km to 125 km from the coast) woody plants, more typical of the savanna transition vegetation zone have increased in cover.

Fig. 15. Grass/shrublands (Aukas East). Matched photographs of *Euphorbia damarana*, *Calicorema capitata* shrubland (110km from coast) illustrating slight decrease in cover over ninety-seven years between 1919 (left) and 2016 (right). The replacement of *E. damarana* by savanna species (white dots) such as *Acacia reficiens*, *A. mellifera*, *Adenolobus pechuelii*, and *Maerua parvifolia* and *Commiphora spp*. is indicative of the westward expansion of savanna rainfall. (L) I. B. Pole-Evans (South African National Biodiversity Institute), out of copyright, used with permission); (R) © R. F. Rohde and M. T. Hoffman.

Savanna Transition

The savanna transition zone is comprised of a large number of woody species but is dominated by acacia and subtropical savanna tree and shrub species. In the repeat photographs, average values for woody plant cover were nearly twice those of the grass/shrubland zone (Figure 16). Woody plant cover declined in one site only and remained the same in four of the twenty-four sites in the savanna transition zone. The average rate of increase in woody plant cover was 0.07% per year.

Species composition in savanna transition sites varied in relation to latitudinal position where the hotter northern sites were dominated by *Colophospermum mopane* in contrast to southern sites where acacia species predominated.

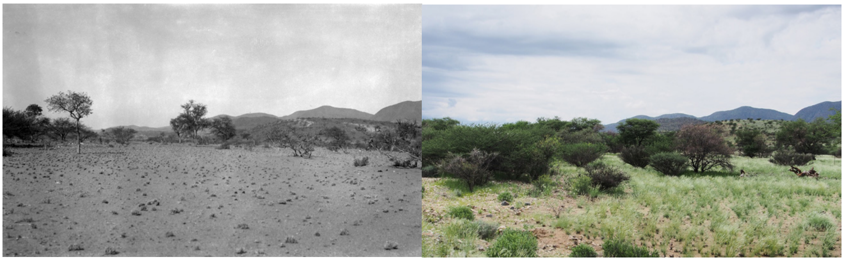

Fig. 16. North Usakos Railway. Savanna transition showing significant increase in woody cover between 1919 (left) and 2014 (right), indicating the influence of a westward shift in summer rainfall. (L) I. B. Pole-Evans (South African National Biodiversity Institute); (R) © R. F. Rohde and M. T. Hoffman.

Large Ephemeral Rivers

The sites located within or adjacent to large ephemeral rivers are dispersed throughout the fogbelt, grass/shrubland and savanna zones. Woody plant cover was greatest in this vegetation zone with values as high as 75% woody cover recorded at one location. A wide range of woody plants dominated the ephemeral rivers and although changes in woody plant cover varied considerably between sites in this zone, it nearly doubled over the study period with average values of 0.26% increase per year. Only two sites exhibited a decline in woody cover with relatively modest reductions in cover. Each of the five ephemeral rivers in the study area present distinct traits in relation to vegetation change: e.g. the Khan River is the most stable in terms of species and percentage cover (although this may have been affected since by the opening of Husab Uranium Mine in the area), the Kuiseb appears to be the most dynamic (see Figure 17), and the Swakop the most impacted by anthropogenic disturbance and alien species.

Fig. 17. Large ephemeral river (Kuiseb). Matched photograph from Gobabeb (55km from coast) illustrating significant thickening and size increase of riverine woody cover over fifty years between 1965 (left) and 2015 (right). Dominant riverine species: *Faidherbia albida, Tamarix usneoides, Acacia erioloba, Salvadora persica.* (L) photographer unknown (Gobabeb Namib Research Institute), out of copyright, used with permission; (R) © R. F. Rohde.

Discussion

Past climate trends are not predictors of future environments but they do inform our understanding of the causes of present conditions. A tipping point might reverse a historical trend, but at present we see no evidence of such a shift from our analysis of woody vegetation change in the Namib and Pro Namib.

For example, we see no evidence for the expansion of desert and arid shrublands into higher rainfall savanna areas, nor do we find any evidence of a predicted decrease in groundwater or increased evaporation as a result of global warming. Rather than an expansion of more arid-adapted species into more mesic environments, our analysis documents the incursion of savanna species into more arid environments and an increase in woody plant cover in most localities.

Preliminary analysis of the changes in woody vegetation lead us to the following four possible explanations:

- That increased vegetation in the fogbelt is associated with a change to a colder, more intense Benguela Current upwelling in the Atlantic Ocean off the coast of Namibia. This cooling in turn generates more coastal fog, making more moisture available to plants in the coastal areas of west Namibia. This enhanced fog moisture has combined with recent increased occurrences of the Benguela Niño climate fluctuation (associated with desert rainfall events) that have supported population recruitment of coastal fog dependent woody vegetation species such as *Arthraerua leubnitziae* and *Zygophyllum stapffii*.

- Further inland, increased temperatures in the grasslands/shrublands areas have resulted in the reduced incidence of fog and the desiccation of woody vegetation apart from the ecotone bordering the savanna where increased summer rainfall has resulted in an expansion of more savanna species.
- The savanna transition areas show increases in vegetation consistent with increased rainfall and atmospheric CO_2 fertilisation in the more eastern landscapes.
- The large increases in woody vegetation along the azonal large ephemeral rivers may be due to upstream dams and fewer recent large flood events (which can uproot and wash trees and shrubs downstream).

These observations add to current debates regarding trends that are predicted or contradicted by various modelled future scenarios and that posit intensification (or weakening) of cold Benguela Current upwelling, leading to increased (or decreased) fog near the coast and desiccation further inland. Researchers have described hypothetical scenarios based on the modelling of the climatic gradient across central and western Namibia. None have done so, however, by showing the relationships between woody cover change, climate change and land use derived from historical sources in order to substantiate past and present trends across different kinds of vegetation communities.

The research presented here thus offers a summary of the empirical evidence for historical changes in Namibia's vegetation and climate. It has significant implications for understanding global phenomena such as the effects of historical events on contemporary landscapes and vegetation diversity, bush encroachment, rainfall and temperature trends, and hence climate change. It can also contribute to understandings of the effects of global warming on the intensity of the Benguela Eastern Boundary Upwelling System, and its associations with global synoptic moisture fluxes from the southeast Atlantic, southwest Indian Ocean, Sea Surface Temperature (SST) anomalies and the El Niño Southern Oscillation (ENSO).

References

Coates Palgrave, William, *Report of W. Coates Palgrave, Esq., Special Commissioner to the Tribes North of the Orange River, of his Mission to Damaraland and Great Namaqualand in 1876* (Cape Town: Saul Solomon and Co., 1877).

Dieckmann, Ute, and Theodor Muduva, *Namibia's Black Gold? Charcoal Production, Practices and Implications* (Windhoek: Legal Assistance Centre, 2010).

Esterhuyse, Jan Hendrik, *South West Africa 1800–1894: The Establishment of German Authority in South West Africa* (Struik: Cape Town, 1968).

Heatherington, Catherine, Anna Jorgensen, and Stephen Walker, 'Understanding Landscape Change in a Former Brownfield Site', *Landscape Research*, 44(1) (2019), 19–34.

Heck, Peter, *Road Map to a Biomass Industrial Park: Biomass Partnership with Namibia* (Dasnamibia.org, 2021), https://www.dasnamibia.org/?wpfb_dl=117.

Olusoga, David, and Casper Erichsen, *The Kaiser's Holocaust: Germany's Forgotten Genocide and the Colonial Roots of Nazism* (London: Faber and Faber, 2010).

Rohde, Rick F., 'Written on the Surface of the Soil: West Highlands Crofting Landscapes of Scotland During the Twentieth Century', in *Repeat Photography: Methods and Applications in the Natural Sciences*, ed. by R. H. Webb, D.E. Boyer, and R. M. Turner (London: Island Press, 2010), pp. 247–64.

Rohde, Rick, and M. Timm Hoffman, 'The Historical Ecology of Namibian Rangelands: Vegetation Change Since 1876 in Response to Local and Global Drivers', *Science of the Total Environment*, 416 (2012), 276–88.

Rohde, Rick F., M. Timm Hoffman, Ian Durbach, Zander Venter, and Sam Jack, 'Vegetation and Climate Change in the Pro-Namib and Namib Desert Based on Repeat Photography: Insights Into Climate Trends', *Journal of Arid Environments*, 165 (2019), 119–31.

Stals, Ernst L. P. (ed.), *The Commissions of WC Palgrave Special Emissary to South West Africa 1876–1885* (Cape Town: Van Riebeeck Society, 1991).

Wallace, Marion, *A History of Namibia: From the Beginning to 1990* (London: Hurst & Co, 2011).