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Environmental history: introduction

Simon Goldhill and Georgie Fitzgibbon

Abstract: The papers presented here serve as examples of intellectual, political, and social responses to climate-related phenomena and their consequences. They grapple with several key issues including the agency of nonhuman nature and environmental determinism, environmental governance, climate as a cultural construction, the history of environmental ideas and discourse, environmental narratives, and the commodification of nature.

Keywords: History, geopolitics, Anthropocene, deep time, water, Gondwanaland, Cherokees, Antarctica.

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This issue of the *Journal of the British Academy* showcases some of the excellent work historians, geographers, and other specialists in the humanities and social sciences are doing on climate and environmental history. Together these articles demonstrate the benefits of including perspectives on environmental history in wider conversations on climate change, as part of a series of special issues curated by the British Academy in the lead up to COP26.

This issue demonstrates that it is timely and welcome to intensify historical research into climate change and climate as factors of history. While climate change is often presented as something new, controversial, and technical, historians have much to contribute. Natural climate fluctuations predate human history; and the politics and policy of climate change have their parallels in previous environmental and social issues. What stories can we tell to move the conversation forward?

The articles presented here serve as examples of intellectual, political, and social responses to climate-related phenomena and their consequences. They grapple with several key issues including the agency of nonhuman nature and environmental determinism, environmental governance, climate as a cultural construction, the history of environmental ideas and discourse, environmental narratives, and the commodification of nature.

In the first article Alison Bashford *et al.* (2021) explore Gondwanaland's modern history, its unexpected political and cultural purchase since the 1880s. Originating with geological and palaeontological research in the Gond region of Central India, 'Gondwana' has become recognisable and useful, especially in settler colonial contexts. This prospectus sets out a program for a highly unusual 'transnational' project, involving scholars from India, Australia, Antarctica, southern Africa and South America. Unpredictably across the five continents of former Gondwanaland, the term itself signals depth of time and place across the spectrum of Indigenous land politics, coal-based extractive politics, and, paradoxically, nationalist environmental politics. All kinds of once-living Gondwanaland biota deliver us fossil fuels today – the 'gifts of Gondwana' some geologists call southern hemisphere coal, gas, petroleum – and so the modern history of Gondwanaland is also a substantive history of the Anthropocene.

The second article explores the traditional ecological knowledge of the Cherokee people. Gregory Smithers argues that in their traditional homelands, located in the southern Appalachian Mountains, Cherokees have accumulated vast repositories of knowledge – known as traditional ecological knowledge (TEK) – about changes in geology, fluctuations in local ecosystems and the importance of biodiversity. This knowledge, collected and stored in oral traditions, sacred beliefs, and daily life, ensures the resilience of Cherokee communities. Water stories are key to this resilience. As this article reveals, water stories are sacred stories, part of a living body of knowledge that connects the Cherokees to the landscapes and waterscapes of southern Appalachia.

Water stories flow through Cherokee scientific and spiritual knowledge. They are stories thousands of years in the making and provide vital insights that can inform the co-governance of rivers and clarify strategies for living in balance and harmony *with* local ecosystems. In the old stories of the Cherokee people are fresh insights that can guide climate resilience into the future.

The third article (Howkins *et al.* 2021) uses the history of New Zealand's Vanda Station in Antarctica to make a case for the inseparability of human history and environmental change in the epoch of the Anthropocene. Vanda Station was built in the late 1960s to promote New Zealand's sovereignty claims to Antarctica and to promote scientific research in the predominantly ice-free McMurdo Dry Valleys region. The McMurdo Dry Valleys (MDV) are the largest ice-free region in the Antarctic continent and have become an important centre for scientific activity. Since the early 1970s, the region has been at the forefront of debates over the environmental protection of the Antarctic continent and in 2004 the MDV became an Antarctic Specially Managed Area (ASMA). Over the course of the 1970s and 1980s, the levels of the nearby Lake Vanda rose dramatically and in the early 1990s the decision was taken to close the station. Rather than seeing the closure of Vanda simply as a consequence of the rising lake levels, Adrian Howkins suggests instead that it was the result of a number of interconnected social, political, scientific, and environmental factors. In this way, the 'biography' of Vanda Station is used to add depth and nuance to our understanding of the geological 'age of humans'.

To inspire more environmental history research on climate, this special issue highlights diverse new research and underscores accomplishments, deficiencies, discrepancies, and debates about climate history. The articles presented here demonstrate the opportunities to incorporate insights from the humanities and social sciences into environmental management, provide historical 'data' about past human activity (environmental impact), and aid in the production of historically informed policy suggestions.

This issue forms part of the British Academy's COP26 series which aims to raise awareness of the importance of the humanities and the social sciences in understanding the complex human and social dimensions to environmental challenges and their solutions. The authors are drawn from a range of Academy programmes, including the *Global Professorships* scheme, which enables researcher mobility and collaboration, and the *Knowledge Frontiers* scheme, which aims to enable different communities of knowledge and practice to illustrate the unique added value of international and interdisciplinary collaboration, as well as from the Fellowship of the British Academy.

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Bashford, A., Chakrabarti, P. & Hore, J. (2021), 'Towards a modern history of Gondwanaland', *Journal of the British Academy*, 9(s6): 5–26. https://doi.org/10.5871/jba/009s6.005

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Towards a modern history of Gondwanaland

Alison Bashford, Pratik Chakrabarti and Jarrod Hore

Abstract: Gondwanaland was a southern mega-continent that began to break up 180 million years ago. This article explores Gondwanaland's modern history, its unexpected political and cultural purchase since the 1880s. Originating with geological and palaeontological research in the Gond region of Central India, 'Gondwana' has become recognisable and useful, especially in settler colonial contexts. This prospectus sets out a program for a highly unusual 'trans-national' project, involving scholars of India, Australia, Antarctica, southern Africa and South America. Unpredictably across the five continents of former Gondwanaland, the term itself signals depth of time and place across the spectrum of Indigenous land politics, coal-based extractive politics, and, paradoxically, nationalist environmental politics. All kinds of once-living Gondwanaland biota deliver us fossil fuels today – the 'gifts of Gondwana' some geologists call southern hemisphere coal, gas, petroleum – and so the modern history of Gondwanaland is also a substantive history of the Anthropocene.

Keywords: Gondwanaland, deep history, geopolitics, Aboriginality, environmental history, Anthropocene, coal.

Notes on the authors: see end of article.

Earth scientists know a great deal about the ancient geological history of the megacontinent Gondwanaland and its breakup commencing 180 million years ago, eventually creating present-day Africa, Australia, New Zealand, South America, South Asia and Antarctica. Most of the southern hemisphere of the earth was once connected, a pre-human global south. Fast-forward 180 million years BP to 1885, and we find that Gondwanaland has a modern history too. As historians, we join geologists – our fellow scholars-of-time – with thoughts on Gondwanaland's history over the 19th, 20th and 21st centuries, scoping its significance across science, culture, literature and politics. Gondwanaland suggests a new antipodal history for the Anthropocene, but an unusual one: at once entirely pre-human and deeply human; at once indigenous, nationalist and neo-colonial; at once environmentalist and extractive.

Our modern history of Gondwanaland is inspired by a strange gap between national understandings of Gondwanaland in the present. The modern history of Gondwanaland starts in, and is named for, the Gond region of central India, the ancient and present homeland of the *adivasi* Gond people. As Chakrabarti (2019) has shown, the Austrian geologist Eduard Suess named Gondwanaland in 1885, building on Indian fossil evidence linked to other geological and palaeontological research that had accumulated across the southern hemisphere over the 19th century. It would be difficult to think of a more literally and locally grounded term for a hemispheric phenomenon. And yet many Australians consider the term Gondwana to have an origin local to them, invented as a vaguely Aboriginal one, and in ignorance, usually, of its central Indian history. 'Gondwana' has everyday currency and positive purchase in Australian cultural politics, something that, in turn, would surprise the members of the Gondwana Ganatranta Party (for example), which seeks a separate Indian state. How, why and with what effect does the ancient megacontinent Gondwanaland retain popular currency in multiple national and continental contexts? Extending beyond South Asia and Australasia, what if we bring Gondwanaland back together again, so to say, and consider its modern history in South Africa, South America and Antarctica too?

The deep past and the modern present are linked through Gondwanaland in a further way. On the one hand, Gondwanaland offers a pre-human time to the order of hundreds of millions of years, the deepest of environmental histories in temporal terms. On the other, its remnants fuel our present in every literal sense. All kinds of once-living biota deliver us fossil fuels today. Coal was formed, then discovered, then mined, becoming the great driver of industrialisation. Global modernity's favoured energy source, coal and carbon define the Anthropocene epoch. Gondwanaland thus folds the deep past directly into the contemporary world offering an important substantive case for a new historiographical interest in deep time (e.g. Currie 2019; Shryock & Smail 2011), and reminding us of the origins of the phrase 'deep time' in

John McPhee's study of American geology (1981). This is the closest of material linkages between a pre-human past and the present. The place-time, 'Gondwanaland', is mythic too, and powerfully so, inviting cultural analysis.

Here we offer a prospectus, an initial exploration of a modern (or an Anthropocene-era) history of Gondwanaland. What cross-humanities and cross-science possibilities emerge when we take this particular part of the Earth's past out of geology and think about it not just as global environmental history, but also as modern cultural, political, colonial and postcolonial history? Gondwanaland even has a literary history. We begin with an explanation of how and where the ancient megacontinent Gondwanaland was discovered and named, and how knowledge of it fits within the history of geosciences and the human sciences: it is linked to geology, anthropology, and biogeography. We then discuss the geopolitics of Gondwanaland, beginning with *adivasi* of modern Gondwana in which deep past-in-place is part of the high politics of belonging, of land-claiming, and even land-rights. Yet depth of time and depth of place is characteristically useful for appropriative settler colonialism too. Little wonder that in some contexts 'Gondwana' is a high-value brand used by organisations and companies across the spectrum from environmental to extractive politics. Ironically for an ancient megacontinent, Gondwanaland has served as a much-used idea within nationalist cultures as well. Finally, we consider the significance of Gondwanaland in and for the Anthropocene, for its multiple temporalities, and for a new antipodal history of coal and global capitalism.

Discovering Gondwanaland: modern geologies of the South

The Swiss geologist Eduard Suess adopted and adapted the term Gondwanaland from the Gondwana region of India, observing similarities in the geological formations across the southern regions of the earth: they resembled those of Gondwana. The proposition was based on the discovery of certain plant fossils in the distant continents, which suggested that these were all once connected. The most significant of these were within the *Glossopteris* genus, a fossil fern found initially in the coalmines of Central India, South Africa and later in Australia, South America, and finally in Antarctica. Thus Gondwanaland became a global category through the geological imaginations of an ancient landmass that encompassed different parts of the southern hemisphere. The term Gondwanaland, however, provoked debates among earth scientists since this geological name was derived from an existing region in Central India. The debate invoked a rare sojourn by 20th-century geologists into the 18th- and 19th-century world of the East India Company 'discovery' of Gondwana, its Marathan then British rule, and the long history of the Gond tribes in India. They debated the

appropriateness of using the term 'Gondwana' – the 'land of the Gonds' – as a geological category for the Palaeozoic megacontinent of the southern hemisphere, which had little to do with the Gond tribes. Some geologists argued that the term Gondwana should be used instead for the ancient continent, as the 'land' in Gondwanaland was redundant since Gondwana already denoted a place. Eventually, consensus emerged among geologists that the two terms should signify two different entities. Gondwana should refer to the historical region of India while Gondwanaland to the ancient continent (Sorkhabi 1996).

Prior to Suess's geological work, supposed similarities between southern fauna and peoples had for some time fuelled fanciful speculation regarding lost land bridges, ancient explorers and sunken continents (Ramaswamy 2004). But Suess's Gondwanaland theories were more substantiated and became the precursor to the early 20th-century idea of 'continental drift' proposed primarily by Alfred Wegener and Alexander du Toit and suggesting that the southern continent had split into several different continents. This idea itself morphed into plate tectonics theory in the 1960s (Oreskes 1999; Frankel 2012; Greene 2015). On the research foundation of Gondwanaland, then, continental drift and plate tectonic theories developed successively over time, based originally on shared southern hemisphere exploration of the Earth's stratigraphic archives and occasionally the people who lived among them.

While Gondwana drifted into the megacontinent of Gondwanaland, the specificities of the different 'Gondwanas', as discovered in the 19th century, were not entirely lost. An analysis of Gondwanaland research from botany, geology and physics, to geography, petrology and palaeontology provides rich information about the creative syntheses of sciences. All kinds of stratigraphers, mineralogists and palaeontologists undertook fieldwork in multiple former Gondwanaland sites, creating a considerable network of researchers. W.T. Blanford (1832–1905), for example, was a longstanding member of the Geological Survey of India, geologist of Indian coalfields, student of *Glossopteris* subspecies in South Asia, who then travelled across Africa, developing a theory of the Indo-African continent as the genesis of the idea of the southern continent. E.J. Dunn (1844–1937) was a mining geologist, surveyor and anthropologist charting coal reserves in southern Australia, mineral deposits in the Cape Colony, and Gondwanan rocks in Victoria. Alexander du Toit (1868–1948), South African geologist and continental drift theorist, stratigrapher and mining consultant, mapped the Karoo region, and undertook fieldwork in Paraguay, India and Brazil, as well as visiting Australia in 1914 to study the Gondwana beds and the Great Artesian Basin (Chetty 2021). The imperial geologist, Lewis Leigh Fermor (1880–1954) was Director of the Geological Survey of India, and fieldworker on Gondwana coal in India, Kenya, South Africa and Southeast Asia. He spent his entire career in the first half of the 20th century exploring the mines of Indian Gondwana, in Kenya,

South Africa and Malaya, suggesting that the key difference between Gondwanaland and 'non-Gondwanaland' was the considerable mineral wealth that the former presented to the latter (Fermor 1944). And to take a final example, I.C. White (1848–1927) was involved with the expeditions leading up to the first Geological Survey of Brazil (1907) and in 1908 identified the Gondwanan *Glossopteris* flora within the Brazilian coal beds.

This network continued to confirm and extend knowledge of Gondwanaland through fossil evidence, and was key to the many geological surveys that established and developed Gondwana coal deposits. Linked to the distinguishable *Glossopteris* fossil leaf, southern coal deposits stretch right across former Gondwanaland – across the Global South – from the Paraná basin in Brazil, to the Bowen basin of Queensland, through the Karoo basin of South Africa. Searching for coal and petroleum drove the many mineralogical and geological surveys both before Gondwanaland's 'discovery' in 1885 and in the light of it: in Brazil (1818, 1876, 1907), Colombia (1822, 1887, 1916), Argentina (1823, 1904), Peru (1827, 1876, 1924), India (1851), Tasmania (1859), Victoria (1861), North and South Queensland (1868), New South Wales (1875), the Western Cape in South Africa (1895), the Transvaal (1897), the Cape of Good Hope (1889). In Antarctica too, there were surveys to look for Gondwana coal; the Chilean Antarctic Expedition (1947) and the British Antarctic Survey (1962), for example. Such early economic geology continued and continues in commercial coal and petroleum exploration and extraction, through Cerro Corporation and ExxonMobil in South America, for example, and through the state-owned Brazilian oil giant Petrobras (Figueirôa 2019). Gondwanaland has thus featured in the modern history of minerals and in contemporary international mining extraction. In Australia today, one mineral exploration company is even named after the ancient megacontinent, Gondwana Resources Ltd.

Thinking through Gondwanaland suggests a new antipodean orientation for the history of modern geosciences, challenging the northern orientation of canonical histories of geology, mineralogy and palaeontology (e.g. Secord 2018; Oreskes 1999; Bowler 2000; Rudwick 2014). What does the history of modern Earth sciences look like when investigated by historians of Australasia, South Asia, southern Africa, Antarctica and South America? At the very least, 'Gondwanaland' may help us see a new geography for the colonial history of Earth sciences, opening up the history of geology through intersecting colonial histories, not just that of the British Empire and Anglophone world, but of the Iberian and Dutch imperial world as well. 'Gondwanaland' enables a multi-continental geography for histories of imperial geosciences. At the same time, it expands our knowledge of 'whole Earth' thinking, our understanding of how a hemispheric geography emerged. South African Gondwanaland theorist Alexander du Toit (1937), for example, understood his

southern geology to completely rewrite 'the elaborate architecture of the Globe' (see also Chetty 2021). Presumably, this altered conceptualisations of the northern hemisphere as well. And yet, we are hardly the first southern hemisphere scholars with northern lives and connections to be enticed by the fabrication of a northern/southern globe. 'A Laurasian Looks at Gondwanaland', Amherst-based uranium geologist George W. Bain titled his lecture to the Geological Society of South Africa (1964), referring to the ancient northern continent, Laurasia, equally real, equally mythic.

Chakrabarti (2019) has shown that from the beginning, Gondwana geological research was intricately linked both to theology and to early anthropology in India. In original usage the term and idea 'Gondwana' came to represent the ancient, primitive and prehistoric across South Asian geological and ethnographic records (Leviton & Aldrich 2012). While the intellectual and disciplinary transition from geology to anthropology – 'from rocks to race' – is well recognised (e.g. Griffiths 1996; Strange & Bashford 2008), one question is whether the geology-aboriginality connection that Chakrabarti tracks in India's Central Provinces was duplicated in other sites of former Gondwanaland. In early Australian public science at least, Indigenous involvement seems to have been limited, however there are suggestions that more complicated interactions took place on the margins of official science, in zoology and botany, and in the field (Hoffenberg 2019; Olsen & Russell 2019). The key question remains: how were connections between land and people or between geology and Indigeneity constructed in 19th-century theories of this massive southern continent that turned into multiple continents, and over modern times into empires and nations, including what in some contexts came to be called First Nations?

We know that in general the connection between 19th-century geology, deep human history and Indigenous presence is a close one. And it is clear that Gondwanaland geological research became one repository for various colonial imaginations of prehistory and (different) aboriginalities. In South African history, Dubow (2004; 2014a) has been instrumental in analysing the convergence of 19th-century geology, palaeontology and anthropology in the Gondwanaland Karoo region, with a particular interest in human origins (that is to say, deep time in human history, but shallow time in Earth history). In South America, historians have shown how palaeontologists and geologists were jointly involved in ancient continent surveys (e.g. Figueirôa 2007), in the process developing new ideas of Antiquity, as in the Indian case, inventing, for example, an 'Anthropozoic' period of planetary history (Appelbaum 2013). A modern history of Gondwanaland will tell not just the story of geology's connection to early ethnography and palaeo-anthropology, but also (and related) to settler-colonial geopolitics too.

There is an historical biogeography, or perhaps a political biogeography, to be analysed through Gondwanaland as well. In some contexts, the biogeography of

Gondwanaland has become strangely tied to separated national(ist) environmental histories. For many science communicators and historians of geological sciences, Gondwanaland offers a useful origin point, a narrative of ancient connection from which separations and distinctions created unique flora and fauna ecologies that now 'belong' to particular territorially and politically separated humans. It is a kind of nationalist environmental individuation. In the geological history of Australia, *Shaping a Nation,* Gondwanaland gave birth to the nation; the island-continent continent came 'Out of Gondwana' (Bradshaw *et al.* 2012): true enough. For Libby Robin (2007), the Australian continent-that-became-a-nation broke away, like a rebellious teen. But Gondwanaland turns out to be fickle, even adulterous, belonging to New Zealand too, for example in George Gibbs' historical biogeography *Ghosts of Gondwana: The History of Life in New Zealand* (2006). Here, New Zealand is proudly now 'unique on Earth' in biogeographical terms: also true enough. Tim Flannery's *The Future Eaters* (1994) has been influential, explaining the biogeographical and geological links between modern-day Australia, New Zealand and Antarctica. But like many Australian scholars Flannery only occasionally observes the larger links to South America, southern Africa or South Asia. This is an attenuated modern Gondwanaland. Environmental historian Tom Griffiths (2001), by contrast, has suggested that a 'Gondwanan' regional identity has served to destabilise long-held notions of Australian isolation, serving a kind of anti-nationalist agenda: inevolutionary and geological time Australia is neither European, nor Asian, nor even Australasian but 'of' the southern hemisphere. He has extended this observation to Antarctica too (2007). But where are the Gonds here? Nonetheless, it is a foundational insight to carry forward as we seek to both connect and compare the ancient and modern histories of Australasia, South Asia, South America, southern Africa and Antarctica.

The geopolitics of Gondwanaland: between indigenous, environmental and national histories

Unearthing a modern history of Gondwana offers the exciting conceptual prospect of folding a geologically ancient phenomenon not just into 19th-century conceptions of Earth's deep history (Rudwick 2014), but also into more recent and even current landscape-based nationalisms. Gondwanaland has remained a dynamic category in the geopolitics of India and Australia especially. But this is a strange geopolitics in the present, a mobile idea that is sometimes continental and sometimes signals place-of-origin, a homeland, even a land right. On occasion, 'Gondwanaland' signifies a loosely environmental idea, while at other times it means precisely that. It can be nationalist

and subaltern in different places. It can be mythic at the same time as recalling the actual megacontinent of the deep geological past. And yet through all this malleability, the present-day geopolitics of 'Gondwanaland' rarely, if ever, signals a connection between people across the polities of what was once the megacontinent. Indeed for the most part, it is deployed locally in ignorance of the significance of Gondwanaland elsewhere. Paradoxically, then, we perceive sharply separate 'national' histories of Gondwanaland. The two cases we summarise here are firstly India's aboriginal or *adivasi* significance of Gondwanaland; and secondly Australia's imagined or invented Aboriginal reference on the one hand, and its environmental reference to, and use of Gondwanaland on the other.

'Gondwanaland' as an idea operates firstly in the culture and politics of Indigenous, *adivasi* and aboriginal origin and belonging – the geopolitics of homeland. In Central India, Gond activism is longstanding, one current expression being the Gondwana Homeland Party. And it is intergenerational. Gond leader Shatali Shedmake, for example, follows her parents, activists in the 1970s, extending their work into a new world of digital activism, currently leading the Humans of Gondwana facebook group. Yet at least since the 1980s, Gond *adivasi* have claimed their homeland with explicit and complex reference to ancient 'Gondwanaland' and even to the 19th-century geologists who 'discovered' it (Patankar 2018; Chakrabarti 2020: 186–8). Faced with sustained political and economic marginalisation, contemporary Gond leaders have adopted Gondwanaland as a key theme for their articulation of rights over land. Since the 1990s, the Gondwana movement, which began in response to the growing sense of loss of tribal land, became more politically active with demands for a separate Gondwana state for the Gonds (Poyam 2017). In this complex search for an *adivasi* homeland within the modern geopolitical nation state, Gond political leaders, artists and poets have turned to the deep past of Gondwanaland. As Mayuri Patankar has shown, in contemporary Gond oral, visual, and literary traditions, Suess and Wegener's ideas of Gondwanaland feature as the original homeland of the Gonds (Patankar 2016).

Patankar (2018) explains how Gond popular literature and visual art from the mid 1980s 'mobilises a geological map-making of a deep past toward a revivalist narrative of origin in which Gondwana is imagined as the birthplace of the Gondi people, their ancestral homeland, which later broke into five continents.' A key source and inspiration, she explains, was a 1916 account of Gondwana, penned by Eyre Chatterton, the Bishop of Nagpur, and read by Gond activists in the 1980s. This book details the long and complex history of the Gonds, working mainly from Muslim chronicles, their four kingdoms, ruled in the 18th century within the Marathan Empire, and from 1818 the British Empire. There is no mention in *The Story of Gondwana* of late 19th-century geology or of ancient megacontinents. It is a local story of human history, not a

global story of Earth's history. And yet, as Patankar tells us (2018; 2020), the book mobilised new religious and political identities seventy years' later that folded the Gond's belonging to land, even authorised it via Gondwana*land* and even via Suess. In this convoluted and inter-textual way, present-day Gond homeland politics redeploys 19th-century geology very directly.

The Australian geo-cultural meaning of Gondwanaland is entirely different, its relationship to the depth of time and place of Indigeneity less direct, and more twisted, to the extent that it is likely a construction of white Australia not Indigenous Australia at all. Most importantly, the term Gondwana is strongly recognised. It has powerful cultural purchase and most people hold some knowledge of the ancient megacontinent to which it refers, and of which the nation-continent of Australia was once a part. Almost no-one, however, is aware that it was in fact named for a Central Indian region and people: even Australians of Indian descent know of 'Australian' Gondwanaland but do not link it to Gond people, with whom they are also familiar enough. On the contrary, 'Gondwana' is commonly understood – misunderstood – to have an Aboriginal resonance, perhaps to be an Aboriginal term, or an instance of the quotidian wrangling of Aboriginal place-names, a constant across the continent. It is clear that this misconstrual – unwitting enough – holds for many non-Aboriginal and 'white' Australians. It is not yet clear, however, what 'Gondwanaland' means to highly differentiated Aboriginal people across the country. For some it may well mean nothing at all. For others, it seems to be a reference point of some significance: for the CEO of Indigenous-owned wine company Gondwana Wines, for example; or for Tasmanian Aboriginal man Gary Worete Deverell, author of *Gondwana Theology* (2018). Occasionally, then, Australian Aboriginal people themselves deploy the term Gondwana as their own, explicitly or implicitly.

What is clear is that the term is immensely popular across a wide spectrum of endeavours. It is one of Australia's more successful and recognisable 'brands'. If it were copyrightable, it would have been. In broader Australian cultural politics, and *ex post facto,* 'Gondwana' has come to mean 'ancient' and 'pure' and 'untouched', an idea vaguely connected to a pre-contact Indigenous semi-mythic, semi-real land-before-time, or possibly to an even purer land-before-time-and-people. It is – ironically – a strongly insular idea, referencing depth of time and place on the island-continent. The sense of ancient environmental and ancient Aboriginal belonging has been absorbed and owned by white Australia and turned into a version of 'good' nationalism. It always registers positively, for almost any branding use – 'deeply ancient, deeply Australian'. And so, there is a folk-rock band Gondwanaland, that notably combined the Aboriginal didgeridoo with western instruments; a land and environmental management company Gondwana Consulting that includes (Aboriginal) Cultural Heritage Management; Gondwana Galleries, Alice Springs, Central

Australia; and Gondwana the children's choir, perhaps the closest welding of purity and antiquity.

There is also a more authentic 'Gondwanaland', so to say, linked to land and environment, and thus also to ecology, biota and resources. The term 'Gondwana' is familiar within the domains of conservation, environmental protection, eco-tourism and resource extraction. On the one hand, the 'gifts of Gondwana' – coal, gas, petroleum – give rise to Gondwana Resources Ltd, the Melbourne-based mineral exploration company. On the other, Gondwana Link in Western Australia has since 2002 sought to restore and protect biota in the south-west of the continent. It works and reworks the landscape with local Aboriginal groups.

On the other side of Australia from Gondwana Link's inclusive project of landscape restoration, the identification of relic populations of Gondwanaland-derived flora has given rise to a different kind of geo-heritage and geo-conservation. The Gondwana Rainforests across New South Wales and Queensland are a UNESCO World Heritage Area now stretching across fifty-six protected reserves along the escarpment of the Great Dividing Range. The 1986 World Heritage listing recognised the remarkable living links to geological and biological Gondwanaland, lineages which, alongside the distribution of the reserves over five hundred kilometres, have drawn comparisons to the Galapagos Islands (IUCN 1993). Coal is not the only remnant of life 180 million years ago when the megacontinent started to break up. The *Araucaria* pine and southern beech of the remaining subtropical and temperate rainforests in Eastern Australia are Gondwanaland-derived and are linked to similar South American and New Zealand forests, one basis of the World Heritage status. Scientists have traced a faunal lineage too, in freshwater crustaceans and isolated communities of the velvet worm, which is descended from the Onychophera phylum, with origins in the Cambrian period 500 million years ago. The most significant cluster of reserves surrounds the erosion caldera of the Wollumbin-Mt Warning volcano in the Tweed Valley, which provided refuge for rainforest species as the Australian continent drifted north and became increasingly arid after its final break with Antarctica approximately 30 million years ago. Although World Heritage status was endorsed on the basis of a range of criteria that included scenic interest and endangered species protection, the technical evaluation carried out by the International Union for the Conservation of Nature accentuated the 'Gondwana element' as the truly distinctive and valuable argument for nomination (IUCN 1986). This distinctiveness was only recognised in name in 2007, when the 'Central Eastern Rainforest Reserves (Australia)' became the 'Gondwana Rainforests of Australia' as a result of an expansion of the protected areas (Valentine 2019: 80–93).

These rainforests initially came onto the World Heritage agenda in the 1980s as a threatened wilderness and were therefore freighted with all the cultural baggage that

accompanied such designations in a settler society. The key difference here was that Gondwanan biota, in particular, were at risk not just from the modern expansion of settler agricultural frontiers but also from a much older encroachment of dry sclerophyll forest, which evolved alongside Aboriginal fire ecologies to outcompete rainforests in nutrient-deficient soils. By the late–20th century these two factors had combined to replace all but 0.3 per cent of the rainforests that had once covered much of Australia, and the sub-tropical and temperate rainforests represented in the World Heritage Area were but a tiny fragment of this. For ecologists like Len Webb and Geoff Tracey (1981), this trajectory was profoundly threatening. As continental drift became accepted in the 1970s scientists began to revise their hypotheses about the origins and environmental history of the Australian rainforests, which had originally been understood to have spread quite recently from the Indo-Malayan rainforests in the north. Webb and Tracey argued instead that the sub-tropical and temperate rainforests of eastern Australia were an 'archipelago of refugia' from far more 'primitive' Gondwanan flora (Webb & Tracey 1981: 609, 661). Conservationists and politicians quickly seized on this insight and the rainforests became that potent symbol of nationhood: a vulnerable wilderness in need of protection (Sanderson 2008).

This new southern history of the remnant eastern rainforests also secured their position within an older settler colonial wilderness frame that typically failed to note the significance of any of these sites to the First Nations people to which they belonged (Hore 2019). State governments, which hold most responsibility for national parks and conservation in Australia, have since begun to remedy this foundational exclusion. The secret/sacred Mt Warning, for instance, is now well known by its Bundjalung name, Wollumbin, the cloud catcher, and New South Wales Parks and Wildlife discourages trekking to its summit. Despite recent moves to recognise and celebrate the Gondwana Rainforests as significant cultural and ceremonial landscapes (McIntyre-Tamwoy *et al.* 2010), the original criteria for World Heritage listing remain unchanged from 1986. As grounds for conservation and therefore for wider value, geology, biology, ecology and scenic beauty remain at the heart of what Gondwana (rarely 'Gondwanaland') means in this contemporary Australian case.

'Gondwana' seems to have an important purchase beyond India and Australia too. It evidently has a useful environmentalist and conservationist connotation for the owners of the Gondwana Lodge in the Karoo, South Africa, and in the Gondwana Game Reserve in the Western Cape. We note also that the South African political leader and philosopher Jan Smuts referred to Gondwana to stress the centrality of Africa in an original southern hemisphere (Dubow 2014b: 208). Elsewhere in 'Gondwanaland', Greenpeace named a vessel *Gondwana,* used in its 1980s Antarctic campaign. These are all appropriate enough. Antarctica itself was the heart of the ancient megacontinent. And what is known as the Karoo Supergroup is a large

stratigraphic region in southern Africa, formed originally from a rift valley across southern Gondwanaland, stretching from southern Africa to South America and eastern Antarctica.

Together, this signals an unknowing transnational modern deployment of 'Gondwanaland' across cultural, touristic, creative and resource industries and identities that is quite different to the kinds of transnationalism that have come under examination from historians of empire, colonialism and migration (Bayly *et al.* 2006). Linkage, movement and circulation certainly explain some of the purchase of the idea, but connection and exchange cannot account for the independence and sheer diversity of the groups that now assemble under the notion of this ancient megacontinent. There are Gondwanaland stakeholders of different kinds right across the southern hemisphere, occupying entirely different positions of power, from subaltern to high capitalist, from young to old, from colonised to stridently nationalist and neo-colonial. They are also – again ironically for a megacontinent – often entirely localised, unaware of similar, simultaneous mobilisations elsewhere on the former Gondwanaland. This is not to suggest that Gondwanaland the idea has equal purchase in all parts of its former self. It is not apparent yet what Gondwanaland means culturally in Chile or Peru – although there is a Chilean reggae band, Gondwana – including to Indigenous people across South America. But the Indian and Australian cases alone indicate intriguing but strangely separated 'national' histories of Gondwanaland.

Why is the idea of a megcontinent in deep time so familiar in contemporary popular consciousness? What political work does the imagined landscape of Gondwana perform in different contexts? The cultural claiming of Gondwanaland speaks of modern searching for depth over surface: deep history, deep time, deep earth. Some people claim and hold depth of time and depth of place with more authenticity and authority than others, of course, and in this sense perhaps have more of a 'claim' to Gondwanaland. Depth of time and depth of place is a familiar and powerful Indigenous ontology and epistemology across many contexts, part of a newly recognised global Indigenous history (Guha 1999; Head 2000; Pearce & Louis 2008; McGrath & Jebb 2015). For the Gond, time-on-land *is* belonging and thus ownership: right to that land is underscored precisely through the depth of time that Gondwanaland offers. The Gond claim 'Gondwanaland' because it was named for them, even if this is sometimes turned into a proposition that they were named for it. The Gond have even been called, in passing, the 'First Nations' of Gondwanaland.[1] And yet something of Gondwanaland's power to signal ancient and deep is shared across other

[1] 'Gondwanaland and Antipodal Histories', AHRC project meeting 21 November 2020: Alison Bashford, Linda Andersson Burnett, Pratik Chakrabarti, Saul Dubow, Jarrod Hore, Bodhisattva Kar, Mayuri Patankar.

southern lands too, both within other Indigenous mindscapes and landscapes (Madan 2017; Clarke 2004; Mandala 2017), *and* within settler neo-colonialism-turned-nationalism.

The real and imagined landscape of Gondwanaland continues to inform all kinds of 'southern' political and cultural lives. In perceiving, and then researching that phenomenon, we obviously need to grapple with different knowledges: on the one hand with a geoscience that knows that the megacontinent Gondwanaland predated *Homo sapiens* by at least 200 million years; and on the other with multiple Indigenous epistemologies and ontologies based on always-presence and living landscapes that telescope and collapse and invert deep time and now (e.g. Donaldson 1996). In this temporality there is no necessary distinction between 180 million years ago when Gondwanaland broke up, 300,000 years ago when *Homo sapiens* emerged, the present and even the future. On the third hand, land, belonging and ownership is problematically the core business of settler colonialism, and so in other instances, that Gondwanaland signals deep time, deep earth and deep history is crude neo-colonialism. The twists and turns of modern Gondwanaland reveal a highly differentiated southern hemisphere, a diverse colonial history from classic British settler colonialism of southern Africa, Australia and New Zealand (in one version the original modern 'antipodes'), to aboriginality in South Asia invaded by Mughals and then Britons, the latter with their expedient geological surveys, to Iberian colonialism in South America.

Standing apart is unpeopled Antarctica, that was nonetheless suddenly claimed, explored, lightly extracted and then 'saved' by mid-century scientific internationalism: the 'greening of Antarctica' (Antonello 2019).

In more and less problematic ways, the different political geologies of Gondwanaland traverse a spectrum of truth and myth. Gondwanaland landscapes and mindscapes have a cultural as well as a natural heritage that extends to literature; the phenomenon of Gondwana fiction, science-fiction and non-fiction from 1880 to the present. This begins at the entirely mythic end of our imaginations. 'Gondwana' is a fantastic place occupied by fantastic creatures: in Jules Vernes, *La maison à vapeur* (1880), for example, with its 'fierce tribes of the Gondwana'; in Craig Robertson's Otway-set science fantasy, *Song of Gondwana* (1989); and more recently in the children's author J.B. Rowley's series, *Trapped in Gondwana* (2013). Predictably enough, Gondwana science fiction involves time travel, lost continents and journeys to the centre of the earth. In some ways, it is a 'prehistoric fiction' of the kind that Nicholas Ruddick (2009) has analysed. In *Trapped in Gondwana,* a crack in the present opens up, the central character falls through landing in the strange place-time 'Gondwana'. It is primeval in this version, without people, but appropriately with ferns, as well as fearsome animals, mythic creatures and spirits of the underworld. Little wonder that Gondwanaland has inspired poets. For American Nathaniel Tarn

(2017), 'Gondwana' is ancient Antarctica, prompted by his journey in 2008.

> Here, now, as ever, going out again
> from *Finis Terre*, final of earth, or
> "end of world" they call it here,
> consumption left behind.

And Gond poetry today occasionally locates itself within transnational Indigenous poetry (Patankar, 2020). However – and here thinking through Gondwanaland forces another twist – this transnational link is with North American First Nations' poets, not with southern hemisphere indigenous poets of former Gondwanaland.

Finally, there is a Gondwana history, geography and travel literature to analyse that spans the 20th century; Indrajit Singh, *The Gondwana and the Gonds* (1944), and Lahar Singh, *Gondwana: A Journey to the Centre of India* (2009), for example. Importantly, Eyre Chatterton, the Bishop of Nagpur published *The Story of Gondwana* in 1916, a book that made a remarkable and unlikely comeback in the 1980s, inspiring Gond revivalist pilgrimages, as we have seen (Patankar 2018; 2020). Gondwana has inspired literature across many genres. Belgian Yves Sente's comic *The Gondwana Shrine,* translated also as *El santuario de Gondwana* (2008) is an African-Antarctic Blake and Mortimer adventure. Stuart Cooke's 'Echoes of Gondwana' (2016), is an essay-musing on Chile-Australian connections, via the *Araucaria* pine or Monkey Puzzle tree, the Chilean national tree and native of the Araucanía region. It is the 'only living ancestor' of the *Glossopteris* fern*,* found in Australia as the Norfolk Island pine, Moreton Bay pine, bunya pine, and, slightly removed, the Wollemi pine. The Wollemi Pine or *Wollemia nobilis* was only discovered in living form in 1994, previously known only through its fossil records dating to 200 million years ago. It has now been cultivated, is easily purchasable in commercial nurseries (not infrequently as a living-but-easily-disposable Christmas tree) and is curated in the Gondwana Garden of the Royal Botanical Gardens Victoria, where we can 'step back 200 million years'.

Gondwanaland in the Anthropocene

200 million years certainly counts as deep time. Gondwanaland offers a substantive case through which the many recent theoretical and methodological calls for 'deep history' can be substantively filled out. There have been multiple stimulants for historians' current fascination with deep time, most of which predated the nomination of the Anthropocene, but the latter has most significance for scholarship on Gondwanaland. Both 'Gondwanaland' and 'the Anthropocene' hold ancient and recent, geological and human temporalities tightly together. There is a particular

geography, temporality and spatiality of knowledge here (Mayhew & Withers 2020) that offers a very real, very material instance of the Anthropocene's 'multiple regimes of historicity' (Kelly 2019: 4).

'Anthropocene' the term arrived in the mid 2000s, and arguably has had more impact in the humanities than in its geoscience discipline of origin. It nominates an earth systems phenomenon sometimes understood to be seventy years old (*c.* 1950 CE onwards), sometimes 220 years old (*c.* 1800 CE onwards). Itself a 'strata', the Anthropocene recalls and links to longstanding scholarship on the history of geosciences, which as a matter of course explored and explained geo-history, the chronology of non-human and human time that emerged through 18th- and 19th-century stratigraphy and palaeontology. Time literally expanded as the history of the Earth receded apace from the scriptural 6000 years. 'Bursting the limits of time', Martin Rudwick (2005) called this phenomenon and his masterful book.

Many historians' interests have missed this scale, however. Their interest in 'deep' time is scaled as *human* time (Costanza *et al.* 2007; Smail & Shryock 2011) based on the questioning of a conventional distinction between prehistory and history. This has certainly been challenging and rewarding enough. But far more challenging is the altogether vaster scale of non-human, pre-human time of planet Earth that is the everyday business of geologists, of evolutionary biologists of life-origins and of physical scientists of earth-origins. In environmental humanities and critical geography scholarship too, historians have been hard pressed to consider 'earth-without-humans' (e.g. Clark 2011; Cohen 2015). Unsurprisingly, it is environmental historians who are most likely to take on the phenomenon of earth-without-humans. 'Gondwanaland', broadly conceived, is one geo-historical site and time that presents itself for just this analysis.

For historians, 'the Anthropocene' sometimes stands for, or loosely suggests 'deep time' simply because it is a geological epoch. But the more salient point is that the Anthropocene is *recent,* whether dated from 1800 or from 1950. The Anthropocene is *modern* history (Bashford 2013; Jonsson 2012). In other words, the Anthropocene is, by another name, the everyday business of economic and environmental historians of industrialisation, and of local then global energy transitions that have transformed the modern world. In many ways, modern historians cede their own territory when they consider the Anthropocene as deep history not modern history. And yet when it comes to Gondwanaland, this confusion and slippage between deep and modern is both apt and useful. This is where Gondwanaland serves us well, and impeccably so; in short because of coal. Gondwanaland directly and materially connects the history of fossils to the history of fossil fuels. It thus connects the Palaeozoic and Mesozoic Eras, the Carboniferous and the Permian periods directly to the Anthropocene. Gondwanaland folds together the truly ancient Earth world – pre-human to the order

of hundreds of millions of years – to the modern world, the fossil-fuelled world post *c.* 1800, otherwise known as the Anthropocene.

Gondwanaland was and is about coal, and everything coal means to modernity, to wealth production and distribution, to energy transitions, and particularly to the modern geological south. Whole economies have been underwritten by the coal and petroleum formed in the time of Gondwanaland and its breakup. Indeed in certain southern contexts, geoscientists sometimes call coal, petroleum and gas the 'gifts of Gondwana' (e.g. Bradshaw *et al.* 2012). Yet while those 'gifts' traverse the southern continents, their extraction and transformation into wealth has been highly differentiated. 'Economic geology' of yester-year always was, and is, political geology (Bobbette & Donovan 2019).

Still nominated sometimes as 'Gondwana coal', southern hemisphere deposits make up about 25 per cent of all known reserves. British Petroleum (2019) has Australia, India, Brazil, and New Zealand holding 24.4 per cent of known deposits of anthracite/bituminous coal. It is ancient, formed more than 250 million years ago in the Carboniferous, the geological period itself named in 1822 for (northern hemisphere) coal (Conybeare & Phillips 1822; Beerling 2007). Tertiary coal is far younger, formed up to 60 million years ago. Upper Carboniferous coals of eastern Australia (Bowen, Sydney, Cooper, Galilee and satellite basins) and southern Africa (Karoo Basin) resemble one another in their general composition. In India what are still named Gondwana coalfields form around 98 per cent of India's total coal reserves. In one geoscience journal, their importance was put this way: 'As an indigenous energy source they are thus highly significant in terms of a strong industrial base for the third-world countries. They are also important in terms of the internationally traded coals and as such occupy a unique position in the world's economy' (Sanders & Brookes 1986).

250 million years ago in the Carboniferous, and today in the Anthropocene, Gondwana coal is one measure of distinction between the northern and southern hemispheres of planet Earth. There is a material difference between southern and northern hemisphere coals, deriving from the completely different environments in which they were formed. Petroleum geologists explain:

> Southern Hemisphere coals share common characteristics that differ significantly from their Northern Hemisphere counterparts. Most Gondwana coal-forming environments were arctic or subarctic, and associated with glacial diamictite, proglacial braidplains, mixed-load fluvial systems, and lacustrine delta-plain facies. Available precipitation tended to be bound up as ice, and as a consequence peat marshes were dominated by stunted Glossopteris flora. Northern Hemisphere swamps developed under humid tropical conditions and were characterized by trees and dense undergrowth of Lepidophyta forests. As a result of differences in flora and hydrology,

> Gondwana peats were more oxidized before burial and the coals have higher proportions of inertinite macerals than the inertinite-rich Northern Hemisphere coals (Hobday *et al.* 1993a; see also Hobday 1987).

The climates and environments of a 'deep time south' are not what we expect. This was an ancient earth made up of a tropical global north and an arctic global south. Time-travelling forward hundreds of millions of years, when late 19th-century geologists were uncovering, discovering and naming Gondwanaland, environments had completely reversed: they worked and thought in a tropical global south and a temperate north, climates which for generations of environmental determinists shaped the characters, drives and potential of peoples, nations and economies (Bashford 2000; Chakrabarti 2012).

That Gondwanaland coal beds were discovered and mined across the 19th-century global south challenges a (north) Atlantic-oriented history of fossil-fuelled industrialisation. For example, we might well consider Gondwana and its coal within a history of global capitalism and globalisation (e.g. Pomeranz 2000; Osterhammel 2014; Malm 2016), usefully qualifying the northern hemisphere focus that such 'global' perspectives often hold. They typically consider north-west European coal in the history of industrialisation, especially surface coal deposits in Britain. An antipodean focus on Gondwanaland helps us consider the place of southern sources of fossil energy in 19th- and 20th-century growth trends. These were highly differentiated within the geographic global south: Australia became rich from coal. India did not. And, as we have seen, geologists themselves thought of the whole economic world as Gondwanaland and Non-Gondwanaland, the former offering its mineral wealth to the latter (Fermor 1944). Such distinctions offer the possibility of a new economic history of a geographic global south, perhaps a new history of coal and global capitalism.

Conclusion

We are moving towards a modern history of Gondwanaland that invites and requires not just humanities-science conversation, but also strong collaborative analysis amongst humanities and social science disciplines, from political economy to geography to literature and history. Understanding Gondwanaland new and old is also an idiosyncratic 'area studies' venture, of a different order to the old international relations versions, requiring expertise from what are (only now) five different continents. Bringing scholars together from right across the former ancient continent, our project aims to explain and fill the strange gap between national understandings

of Gondwanaland in the past and present.[2] We hope to investigate a new political economy of a fossil-fuelled world that recognises the significance of Gondwana coal beds, challenging prevailing northern-oriented theses on global energy. And by straddling the entire southern hemisphere, Gondwanaland offers a broad foundation for critical contemplation of the earth's past, with and without humans. For historians, Gondwanaland challenges now-orthodox transnational methodologies, including transnational Indigenous histories. If historians debate the usefulness of 'transnational' in pre-nation-state eras, modern Gondwanaland confounds the prospect even more, casting backwards to very deep geological time, not just pre-national, but pre-human. At the same time, it explores the paradox that Gondwanaland has become part of modern cultural nationalism.

Our Gondwana/Land Project will contribute an empirically and conceptually rich case study to the current fascination with deep time, with relations between human and geological history. In the Anthropocene era, humanities scholarship is acutely cognizant of geological timescales, though often the penchant for 'deep history' is backed up by a shallow understanding of the history of geology. Most importantly, perhaps, the ancient history of the southern megacontinent as studied by geoscientists is transformed by recognition that it has a modern political and cultural history too.

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Water stories: deep histories of climate change, ecological resilience and the riverine world of the Cherokees

Gregory D. Smithers

Abstract: Cherokee people understand climate change. In their traditional homelands, located in the southern Appalachian Mountains, Cherokees have accumulated vast repositories of knowledge – known as traditional ecological knowledge (TEK) – about changes in geology, fluctuations in local ecosystems and the importance of biodiversity. This knowledge, collected and stored in oral traditions, sacred beliefs, and daily life, ensures the resilience of Cherokee communities. Water stories are key to this resilience. As this article reveals, water stories are sacred stories, part of a living body of knowledge that connects the Cherokees to the landscapes and waterscapes of southern Appalachia. Water stories flow through Cherokee scientific and spiritual knowledge. They are stories thousands of years in the making and provide vital insights that can inform the co-governance of rivers and clarify strategies for living in balance and harmony *with* local ecosystems. In the old stories of the Cherokee people are fresh insights that can guide climate resilience into the future.

Keywords: Cherokees, southern Appalachia, traditional ecological knowledge (TEK), deep time, climate change, water, rivers.

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'The earth is a great island floating in a sea of water, and suspended at each of the four cardinal points by a cord hanging down from the sky vault, which is of solid rock'. So wrote James Mooney, an American ethnographer employed by the Smithsonian Institution to record the oral traditions of Native American people during the late 19th and early 20th centuries.[1] Mooney's report was the culmination of several years living among, and talking to, Cherokee informants at the 'Qualla Boundary' during the 1890s. His informants included Elders and Medicine Men such as Ayunini (or Swimmer), John Ax, and the interpreter James Blythe. These men represented a small cohort of Cherokee knowledge keepers who lived in the mountains of western North Carolina at the Qualla Boundary, or 'The Qualla', the homeland of the Eastern Band of Cherokee Indians.[2]

The Eastern Band fought the federal government for decades after the passage of the Indian Removal Act (1830) and the infamous Trail of Tears in the late 1830s to remain connected with this precious piece of their ancestral homeland.[3] Located in *Shaconage*, a translation of the Cherokee *tsakonage*, the 'place of the blue smoke', Americans today call this ancient landscape the Great Smoky Mountains. It is a section of the Appalachian mountain chain that stretches from upstate New York in the Northeast to Georgia in the Southeast.[4] The Qualla is over 2,000 feet above sea level and constitutes a vital link to the mountain peaks, rivers, watersheds, and cultural traditions that once formed the historic 'out towns', one of five major regional clusters that comprised the traditional homelands of the Cherokee people.

When Mooney visited the southern Appalachian Mountains, Eastern Band Cherokees understood *Shaconage* as a living piece of their ancient homeland, 'a great island floating in a sea of water'. Cherokees told Mooney of how 'the Buzzard' created the valleys and mountains by striking the ground with its flapping wings. In listening to Cherokee knowledge keepers tell this and other origin narratives, Mooney learned what Cherokee people and their ancestors had known for thousands of years: Native towns, villages, and farms nestled along the rivers of the southern Appalachians belonged to delicately balanced ecosystems.[5]

James Adair witnessed these webs of ecological vitality when he interacted with the Cherokees in the 18th century. Adair observed how seriously the Cherokees took their responsibility toward the rivers and mountain watersheds of their homeland. Adair wrote, the Cherokees were 'strongly attached to rivers,– all retaining the opinion

[1] Moses (1984).
[2] Mooney (1992: 239); Bender (2015: 247–57); Rodning (2007: 464–84).
[3] On the legal and political struggles of the Eastern Band of Cherokee Indians see Finger (1991).
[4] Linzey (2008: 31); Faust (2010: 208–17).
[5] Aftandilian (2011).

of the ancients, that rivers are necessary to constitute paradise'.[6] In contrast to Western scientists, 18th-century Cherokees did not objectify and commodify the land and waterscapes; they lived *with* them, nurturing biodiversity as they maintained what Cherokee Scholars Heidi Altman and Thomas Belt refer to as reciprocal relationship with the mountains that they viewed as sacred and rivers which they saw as part of an extended kinship system.[7] Water (*ama)* stories reminded Cherokee people of both the environmental sensitivity of mountain biomes and their interconnectedness to floodplains. For as long as Cherokees could remember, they and their ancestors strove to live in balance and harmony – or to use the Cherokee language, *tohi* and *osi* – with their mountain homeland.[8] The flow of a local river (*uweyv*) provided Cherokees with a constant reminder of the delicate nature of ecological balance and harmony.

Such beliefs live on today. Like other Native communities throughout the Southeast, such as the neighboring Catawbas, Muscogee (Creek), or the people who today refer to themselves as the Lumbee, storytelling remains critical to Cherokee ecological philosophies. Through oral traditions, song, dance, petroglyphs, and ceremony, Cherokees continue to develop, refine, and renew their ecological knowledge.[9] Cherokee stories are not mere 'myths'; they contained moral lessons, didactic histories of human and nonhuman relationships, religious beliefs, places, and scientific knowledge. They are, as anthropologist Dave Aftandilian observes, 'sacred stories'.[10] Cherokees continue to embed water stories in sacred beliefs and ceremonies, in everyday interactions, and in their clothing, jewelry, and body art. 'The river was highly respected,' Cherokee beloved man Jerry Wolfe explained in 2015. 'If we didn't have water,' Wolfe added, 'everything would die – plants, animals, people, all things would be gone.'[11] Water stories, in other words, are integral to Traditional Ecological Knowledge (TEK), a living body of knowledge that informs philosophical and governing frameworks and gives cultural meaning to Cherokee sovereignty. TEK, as it has always done, teaches Cherokees that they lived *with* the land and the rivers, not *on* the land and adjacent to waterways.[12]

This essay places Cherokee storytelling in conversation with geological and archaeological evidence, climate histories, and written archives traditionally associated with historical analysis. This approach re-centres our attention on a neglected aspect

[6] Adair (1775: 248).
[7] Wazinyatawin (2012: 35).
[8] Altman & Belt (2008: 90–98); Chapman *et al.* (1982: 115–21); Wang & Leigh (2012: 1061–66)); Ellis *et al.* (2020: 2–19). For a point of comparison on this point see Gelles (2010: 119, 121).
[9] Anderson (2016: 1–26); Smithers (2019); Loubser & Ashcraft (2020: 247–69).
[10] Aftandilian (2011: 192).
[11] Wolfe quoted in Kays (2015).
[12] Similar philosophies exist throughout Native America. See Umek (2004: 17, 71); Duncan (1993).

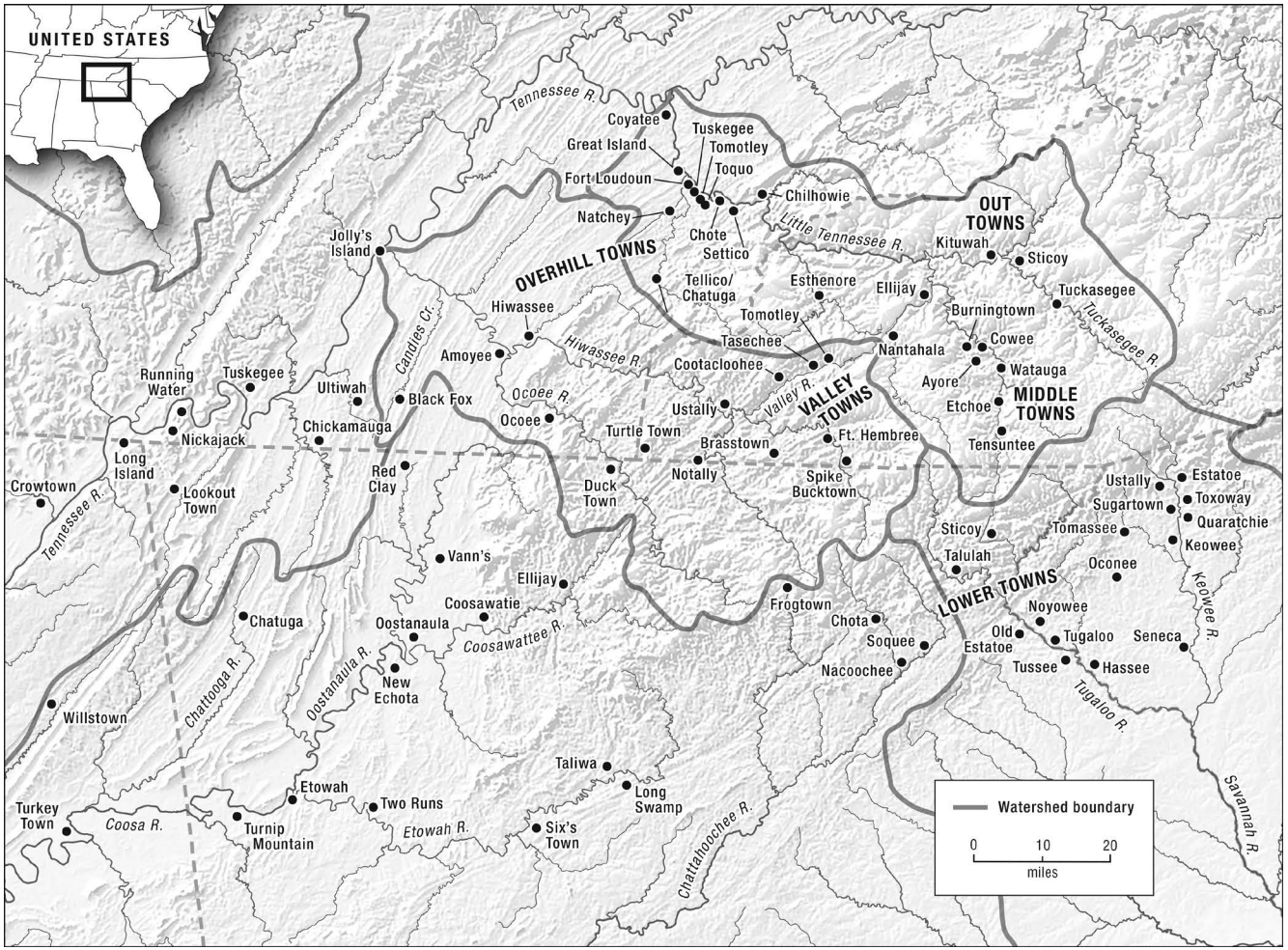

Figure 1. Eighteenth-century Cherokees located their towns and farms along rivers and the watersheds of southern Appalachia. Map by Erin Greb Cartography.

of Cherokee history and culture: the importance of water stories to TEK and the role that these narratives have played, and can continue to play, in ensuring healthy biomes and in meeting the challenges of climate change.[13] TEK is a body of environmental knowledge developed, adapted, and innovated by Native American people for at least 16,000 years.[14] It is knowledge refined through close observation of environmental cycles, experimentation, and adaptation. It is also knowledge that is shared among the members of kinship communities through stories and practical engagement with local ecosystems.[15] In other words, TEK is Indigenous scientific and spiritual knowledge; it is law and lore that Cherokee ancestors used to enhance the biodiversity of their homeland.[16]

TEK is part of a holistic, moral, and spiritual worldview, an aspect of Indigenous knowledge that Western scientists have either dismissed or written off as irrelevant to the serious work of empirical knowledge making – the recording and publishing of 'hard' scientific facts.[17] In the current era of climate crisis – or the Anthropocene era, characterised by the 'great acceleration' in humanity's impact (most notably in the form of increasing carbon emissions) on global climate systems since the 1940s[18] – there is too much at stake to maintain such rigid positions. We need to decolonise environmental science, our knowledge of 'deep time' (or 'geological time'), and climate history, if we are to ask the right questions, and devise the best solutions, to ensuring sustainable climate futures.[19]

The United Nation's has recognised the potential impacts of human-induced climate change on the world's Indigenous people. The UN's Department of Economics and Social Affairs makes it clear that 'Indigenous peoples are among the first to face the direct consequences of climate change'.[20] The UN Declaration on the Rights of Indigenous Peoples (UNDRIP) adds that Indigenous communities must be involved in decisions pertaining to water. Such governance must include consultation and co-management with Native nations on fisheries and watersheds, recognition of the rights of rivers (as occurred in New Zealand with the legal acknowledgment of the personhood of Te Urewera, or the Whanganui River), and the cultural and spiritual significance of rivers (as outlined by First Nations communities in Australia with the

[13] Loftin & Frey (2019: 83–98).
[14] The latest scientific consensus contends that Native Americans were living in the Americas by *c.* 15,000–16,000 years ago. See Braje *et al.* (2017: 592–94).
[15] Berkes (1993: 1–9).
[16] Martin (2019: 36–57).
[17] Berkes (1993: 4); Berkes, Colding, Folke (2000: 1251–62); Moller *et al.* (2004).
[18] McNeil & Engelke (2014).
[19] Peña (2019: 276–99); Emmanuel & Wilkins (2020: 1–37).
[20] United Nations, Department of Economic and Social Affairs (2020).

incorporation of 'cultural flows' into protocols for the co-management rivers).[21] Such changes in water and river co-governance are needed now; they also underscore the importance of Indigenous sovereignty to ensure that transparent consultation practices with non-Indigenous governments are adhered to and effectively meet the challenges of climate change. As a recent study by an international team of scholars reveals, time is running out. If human behaviour remains unchanged, it may only take five generations to reach levels of greenhouse gas emissions and global temperatures similar to those of the Paleocene-Eocene Thermal Maximum (PETM) – 'hothouse earth' of *c.* 56,000 years ago.[22] Interdisciplinary histories and co-management strategies on climate change adaptation, watershed biodiversity, and the resilience of rivers are urgently needed.[23] High in *Shaconage*, among the river cane and the cool flowing waters at the centre of Cherokee life, we can follow the lead of Cherokee knowledge keepers and draw wisdom from the deep history of the mountains, and their changing climates, to start planning for a more ethical and resilient climate future.[24]

Deep time meets spiritual time

Cherokee environmental philosophies emphasise the interconnectedness of human and nonhuman life. This is a spiritual as well as scientific worldview. In fact, traditional Cherokee knowledge keepers view the physical and spiritual worlds as interconnected. Cherokee stories give ecological and geological philosophies their meaning by firstly emphasising the vertical connections among the Upper World (*Galunlati*), Middle World, and Under World. The cycles of time – from 'origins' to 'the now' – are woven together in these interconnected worlds. Cherokees with special training and knowledge, such as shamans or medicine people, were once thought to possess great powers and could access these different realms through gateways, usually located in caves, waterfalls, whirlpools, and river bottoms. For example, gateways to the Upper World took one to knowledge possessed by deceased human and animal spirits. In the Middle World, all living spirits, including humans, resided. And in the Under World there existed great power and also immense danger, for this was the domain of evil spirits and horned serpents.[25]

Balancing these three interconnected worlds constituted a daily obligation and a sacred duty. Overhunt the whitetail deer, pick too many strawberries, fail to observe

[21] Lurgio (2019).
[22] American Geophysical Union (2019).
[23] Sherwood *et al.* (2020).
[24] Hill (1997: 316).
[25] Irwin (1992: 237–57); Fradkin (1990: 292–93); Altman (2006: 67); Loftin & Frey (2019: 87).

sacred ceremonies, or pollute a river, and Cherokees risked destabilising their worlds. The members of traditional Cherokee communities viewed a prolonged drought or an earthquake as physical signs of a world out of balance.[26] By the time the Spaniard Hernando de Soto led the first European invasion through Cherokee country in the Spring of 1540, Cherokees had nurtured these geological, ecological, and historical worldviews in their watershed towns and among clan members for 'time immemorial'.[27] Guided by their town and clan identities, Cherokees build on the knowledge of their ancestors and renewed their environmental philosophies over thousands of years of observation, experimentation, innovation, and connection to place.[28]

Historians usually view the Cherokee people as mountain dwellers who embedded their identities in the landscape.[29] That is true, but it tells us only part of the story of the Cherokee people, their ancestors, and their place-based identities and philosophies.[30] To get a fuller appreciation of this history we need to understand the dynamic nature of Cherokee philosophy and how Cherokee knowledge systems were, and are, shaped by their deep history as watershed dwellers.

Rivers and watersheds were, and remain, the lifeblood of Cherokee history and culture. For at least 8,000 years, the Cherokees and their paleo-Indian ancestors located towns and base camps in caves or at the headwaters of rivers.[31] These rivers included the Oconaluftee, Cheoah, Soco, Tuckasegee, Tennessee, Little Tennessee, Hiwassee, and many others. Cherokee TEK holds that flowing rivers are alive. In 1791, the botanist William Bartram observed that the waters of Cherokee Country flowed from the mountains and ran 'rapidly' downstream to the fields below.[32] Cherokees acted as riverkeepers to these fast-flowing waterways, ensuring that the shifting riverbanks and seasonal floods nourished the watershed landscapes they lived with. Cherokees therefore kept a close watch on the health of the rivers, rivulets, creeks, whirlpools, waterfalls, shoals, and rapids – all teeming with biological and spiritual life. For Cherokees, whose population ranged from a high of approximately 35,000 in the late 17th century to about 16,000 by the early 19th, flowing rivers irrigated crops and helped Cherokees nurture biodiversity in landscapes that were transformed from

[26] Aftandilian (2011: 191–207).

[27] Traditional Cherokee society comprised seven matrilineal clans. Although Cherokees understood the Western concept of linear time, their knowledge systems emphasised the cyclical nature of time/seasons. Hence, specificity of dates was folded into, and subsumed by, an emphasis on the cyclical nature of time. The 'past', in a Western sense of 'history', was often spoken about as 'time immemorial'.

[28] Lawson (1709); Adair (1775); Bartram (1791); Perdue (1998: 170).

[29] Hatley (1995: 13); Thornton (1990: 25); Perdue & Green (2007: 10).

[30] Fogelson (1989: 133–47, and espec. 140); Debo (1934: 110).

[31] Kehoe (2017: 13, 25).

[32] Bartram (1791: 278).

Figure 2. The Oconaluftee River begins life high in the Appalachians at Newfound Gap near the Tennessee-North Carolina border. It flows westward and eventually connects with the Tuckasegee River. The cool, shallow waters of the 'Luftee' flow through the centre of the Qualla Boundary, home to the Eastern Band of Cherokee Indians. Photograph by author.

closed canopy deciduous forests during the early Holocene to a mosaic landscape by the late Holocene.[33]

Waterways also connected Cherokee people. Prior to European colonisation, Cherokee country was geographically diverse and ecologically dynamic. It included parts of modern-day Tennessee, Mississippi, Georgia, South Carolina, North Carolina, Virginia, West Virginia, and Kentucky. The waterways that connected Cherokee towns and irrigated crops sprang to life in the mountains. Winter snow covered domed peaks and cool microclimates sustained boreal forests of pine and spruce among mountains that reached over 6,500 feet above sea level. Cherokees viewed these higher elevations as sacred places, while at the lower elevations they built communities, hunted, and experimented with cultigens throughout the Appalachian Plateau, the Interior Low Plateau, and the Piedmont region. Fast-flowing rivers and streams sliced through a landscape which included open parklands and hickory-oak forests.[34] The Cherokees watched, listened, and worked with these different ecosystems. Some used cool, slow-burning fires to clear underbrush and encourage seed germination. Men constructed weirs and stone fish traps in the shallows of rivers and rivulets.[35] Women and children walked through sumptuous landscapes picking strawberries, collecting seeds and nuts, and harvested wild onions (ramps) and mushrooms. The most skilled and knowledgeable women experimented with cultigens on the rich soils of the Appalachian Plateau – notably the three sisters of beans, corn, and squash – and crops such as peaches and sweet potatoes that arrived with European colonisers and enslaved Africans. Cherokees did all of this not to commodify and claim possession over the landscape and rivers, but to constantly renew their commitment to living in balance and harmony with local ecosystems. Nurturing Native ecologies and enhancing regional biodiversity involved an ongoing and dynamic set of practices and horticultural adaptations.[36]

Origin narratives reminded Cherokees that adherence to the harmony ethic required vigilance, introspection, and a willingness to adapt to the seasonal cycles. This meant that innovation was vital. When local ecologies showed signs of strain, older forms of knowledge were built on and rewoven into new stories. This dynamism in storytelling traditions underscored the reciprocal relationship that Cherokees felt they had entered into with the life and spirits of their homeland.

[33] Wood (2006: 58, 89); Smithers (2015: 28).

[34] The Hickory-Oak forests predominated these lower elevations from about 8,000 years ago. Delcourt *et al.* (1985: 1–28).

[35] Fesenmyer & Christensen Jr. (2010: 662–70); Yarnell (1998: 8).

[36] Bartrum (1791: 48; Lawson (1709: 55, 78, 178); Brickell (1737: 17); Davis (2000: 47–50); Smithers (February 2019: 265–90).

The land and the rivers also carried memories. Cherokees made a point of listening to the stories that the earth shared with them. Sometimes, the stories Cherokees heard contained warnings. To overhunt, to misuse food staples, or to pollute waterways with human waste risked falling short of the Cherokees' responsibility to keep the cosmos in balance. Failure was not an option. As Cherokees taught Mooney, 'when the world grows old and worn out, the people will die and the cords will break and let the earth sink down into the ocean, and all will be water again'. The Cherokees, Mooney wrote, 'are afraid of this'.[37]

Before *Shaconage*

Human history at *Shaconage* is short. Evidence of human interaction with the biosystems of southern Appalachia date back a mere 12,000 years – the blink of an eye in geological time. Still, Cherokees have a long history of respecting the earth's agency and looking for clues about its pre-human past. Cherokee Elder Freeman Owle reminds us of this, instructing 'that if you're quiet enough, still enough, long enough, that you become part of nature'.[38] That is exactly what small bands of hunter-gatherer ancestors did, people known to archeologists as paleo-Indians, when they hunted, foraged, and made lives for themselves in these mountain ecosystems. We have no record of what these small communities called themselves, but we do know that throughout southern Appalachia the paleo-Indians established base camps in caves to facilitate hunting. Unlike paleo-Indians in other parts of North America, the people of *Shaconage* did not hunt the megafauna typically associated with this time period. Instead, they crafted fluted projectile points and hunted small game such as deer, birds, and fish.[39]

The paleo-Indians began adapting human life to the ecosystems of southern Appalachia after the last glacial maximum peaked around 18,000 years ago. Ice sheets that once reached as far as modern-day New York on the Atlantic coast and stopped just north of Cincinnati, Ohio, began to slowly recede over the following 10,000 years. As the ice retreated, the paleo-Indians began inhabiting the mountains of southern Appalachia. Between 12,000 and 8,000 years ago, life for small bands of Native people looked very different from the types of agricultural communities that eventually developed in Cherokee country in the centuries after 800CE.

[37] Mooney (1992: 239).
[38] Duncan (2008: 57).
[39] Tankersley (1990: 73–142); Chapman (2014: 38–41).

Shaconage's story is much deeper than its human history. It extends into the mists of the geological past and is part of the earth's sensitive climate history. This deeper history begins on the Precambrian supercontinent, a world in which ocean salinity was 1.5. to 2 times greater than it is today, and stromatolites ruled supreme. These soft-bodied, layered mounds transformed a planet filled with poisonous greenhouse gases by pumping life-sustaining oxygen into the earth's atmosphere.[40]

About 750 million years ago the Precambrian supercontinent Rodinia thinned and began pulling apart. These shifts in the earth's crust exploded around 540 million years ago. Volcanoes burst to life, spewing molten rock and a chemical cocktail of sulphur dioxide and greenhouse gasses (like carbon dioxide) into the atmosphere. Volcanic activity shaped the formation of the Appalachian Mountains, the same peaks that Cherokees later associated with great serpents such as *Uktena* and *Ustutli.* Cherokees spoke about the power of these serpents and their ability to navigate rivers and ravines. These ancient serpents reminded Cherokees of the power held within the mountains – the location of the headwaters of the rivers that brought their crops to life.[41] Archaeologist also tell a story about the power of these mountains, albeit a drier tale involving measurements of earth's migrating sediments and shifting layers. They observe that shifting tectonic plates continued the violent migration of the earth's continents and caused splits in the earth's crust. When water poured into low-lying areas between crustal plates, multicellular animal life began emerging. The Cambrian period had burst to life.[42]

Paleoarchaeologists contend that the formation of the mountain landscapes and watersheds that eventually became home to the Cherokee people sparked a global ice age.[43] But if paleoarchaeology teaches us anything it is that the earth's climate history is dynamic. The biodiversity of the Appalachians evolved as the pieces of the geological world continued their migrations. Long before the famous supercontinent Pangaea formed around 250 million years ago, the rocks at the core of the southern Appalachian Mountains had already been set in place.[44] However, a deep basin, known as the Ocoee Basin, also formed. It carried vast quantities of clay, silt, sand, and gravel-like deposits as far as the Gulf of Mexico. Hitching a ride on fast-flowing sheets of water, these torrents of surface water began at the highest elevations. In Cherokee stories, these high peaks became the home to serpents like *Uktena* and contributed to the formation of the rivers and fertile soils that Cherokees ultimately used to irrigate crops and enhance the biodiversity of their watershed towns.[45]

[40] Torsvik & Cocks (2017: 84).
[41] Mooney (1992: 299, 303); Chapman (2014: 19, 21, 30).
[42] Walker (1990: 261–89); Casting (2005: 119–29); Sheldon (2006: 148–55).
[43] For a summary of this scholarship see Minkel (2006).
[44] Pangaea formed during the Permian epoch, an epoch that ended with a mass extinction event of global scale.
[45] Montgomery & Bilke (2016).

Before this, at about the time the Appalachian Mountains tripped the world into an ice age, something else was going on. It began approximately 450 million years ago when a climate stalemate gripped the planet. Again, the Appalachian Mountains were at the centre of this drama. Scholars of earth's history have pointed to a paradox: cooling temperatures that precipitated an ice age on one hand, and on the other hand, rising CO_2 levels that sparked a mass extinction event among marine species.[46] The paradox is partly explained by volcanic activity spewing greenhouse gases into the atmosphere and rapidly increasing the temperature of sea water as the Atlantic Ocean continued expanding.[47] At the same time, the weathering of the Appalachian Mountains acted as a carbon sink as rocks and forests absorbed greenhouse gasses and cooled air temperatures. It was an environmental tug-of-war, made possible in part by the Appalachians location in a warmer and wetter part of the world known as the tropical rain belt. The Appalachians lush tropical ecosystem and the weathering of its rock faces produced that carbon sink, sequestering climate warming greenhouse gases. However, as the continents continued drifting and pulling apart, the Appalachians migrated out of the tropical rain belt – reducing their carbon sequestration capacity – and moved slowly toward the geographical position that Native Americans, and ultimately European colonisers, found them.[48]

That geological and environmental world still lay far into the future at the start of the Mesozoic era. Beginning between 266 and 252 million years ago, the Mesozoic saw warmer oceans and fluctuating sea levels. Marshland was not as common as deserts, and air temperatures were generally warmer, sometimes tropical. In the Mesozoic world, ferns were commonplace, small mammals foraged for food, turtles ambled over the landscape, and new vertebrate groups that resembled the powerful serpents of Cherokee oral tradition emerged: the dinosaurs.[49] By the Triassic Period, Pangaea experienced hot summers, its vast interior comprising mostly desert, while monsoon rains flooded coastal plains. The earth between 251–199 million years ago was also a world of stony corals, lizard-like reptiles, and giants like the 16-foot long *Prestosuchus chiniquensis.* Hardy ferns continued flourishing, and at higher latitudes, conifer forests soared above the Appalachian Mountains like ancient skyscrapers.[50]

But the earth is nothing if not ever changing; its pulses opening new epochs of ecological change that demand adaptation. As the Atlantic Ocean continued to widen and alter global ocean currents between 200,000 to 170,000 million years ago, Europe,

[46] This is referred to as the Ordovician mass extinction of *c.* 445 million years ago. Sutcliffe *et al.* (2000: 967–70); Sheehan (2001: 331–64).
[47] Bartlett *et al.* (2018: 5896–901).
[48] Macdonald *et al.* (2019: 181–84).
[49] Philander (2012: 918); Summerhayes (2015: 63–65).
[50] Philander (2012: 1357); Vakhrameev (1991: 243–46); Tanner (2018: 59–90).

Africa, and North America migrated apart. South America eventually follow the northern half of the Americas, and between 100,000 to 50,000 million years ago the continents took the rough shape and location that most of us are familiar with today. The continents, though, are never paused for long. They continued to move during the Jurassic epoch (*c.* 145 million years ago), and the Cretaceous (*c.* 65 million years ago).[51]

These processes – or geological history – are measured in millions, not tens or hundreds, of years. The southern Appalachian Mountains that the Cherokees associated with such beauty and power emerged out of this geological history. Cherokees have long known that *Shaconage* has a story of its own, an agency that played an important role in the planet's climate history. The stability of the seasonal cycles that eventually characterized the Holocene (from *c.* 11,700 years ago) throughout Appalachia operates on a relatively predicable timeframe that is based on the earth's eccentricity, obliquity, and precession cycles. These cycles are collectively referred to as the Milankovitch Cycles, so named for the Serbian geophysicist, Milutin Milanković.

The Milankovitch Cycles adds another layer to more nuanced understandings of glacial and interglacial epochs in earth's climate history. These cycles focus our attention on the rotation, tilt, and wobble of the earth as it rotates around the sun, and the eccentricity, or amount of solar radiation, that the earth receives from the sun on a 100,000-year cycle of the earth's orbit around the sun in either a circular or elliptical orbit. Obliquity occurs on a 41,000-year cycle and refers to the tilt of the earth. Over the cycle, the earth tilts between 24.5 degrees and 22.5 degrees, the former placing the northern hemisphere closer to the sun. Finally, precession takes place on a 26,000-year cycle. Precession refers to the wobble of the earth and can contribute to much cooler winters and hotter summers.[52]

Understanding the Milankovitch Cycles and mapping the impact of continental drift provides a framework for identifying the natural cycles of the earth's climate systems. It also provides a deeper, albeit macrolevel, understanding of climate change based on insolation (or solar radiation received from the sun).[53] For the Cherokees and their ancestors, observing these cycles and the impacts they had on southern Appalachian biomes were fundamental to the balance and harmony of daily and spiritual life. Climactic observations became the basis for Cherokee science and

[51] Vakhrameev (1991: 54); Hubbard (1988: 49–72); Cloudsley-Thompson (2005: 9); Saidi *et al.* (1997: 198–208).

[52] Bennett (1990: 11–21); Muller & MacDonald (2000: 11, 136, 270). The Milankovitch Cycles have raised debates about environmental determinism. A 2012 review of this literature suggested understanding macrolevel dynamics in earth's climate remain vital to grasping their localised impacts. See Campisano (2012).

[53] Priest & Forbes (2002: 313–77); Carlowicz & Lopez (2002).

ecological knowledge, an accumulated body of knowledge that continues to guide the Cherokee peoples' stewardship of their ancient and ever-changing mountain landscapes and waterways.

Indigenous knowledge keepers

When the Cherokees began living with the watersheds of southern Appalachia, they inherited a world previously bordered by the Atlantic Ocean in the east and the warm waters of a massive inland sea to the west. The Western Interior Seaway once divided North America between Laramidia in the west and Appalachia in the east. When the Rocky Mountains formed in North America's west between 80 million and 55 million years ago, this enormous sea began receding and ultimately dried-up at the end of the Cretaceous (*c.* 66,000 years ago). The draining of the Western Interior Seaway revealed lands that we know today as the Great Plains and the states of the Gulf South.[54]

This deep history of major environmental changes and geological formations is today embedded in rock, sediment, and soil. Some of it now lies under roads, cities,

Figure 3. Historic postcard of Judaculla (or *Tsul Kalu*) Rock. Author's collection.

[54] Kauffman (1984: 273–306); Hay *et al.* (1993: 297–318).

and dams that flooded ancient rivers. But before the physical structures of settler colonialism were built on the North American landscape, the Cherokee's ancestors tried to comprehend the geological and environmental secrets of their world. Their ancestors saw mountains populated by thick wooded forest. Cherokees also read the rocks and imprinted their own stories on the landscape by rendering petroglyphs – such as those at Judaculla (or *Tsul Kalu*) Rock in Jackson County, North Carolina – on cave walls and rockfaces.[55]

Eventually, Cherokees constructed towns and tended farms, thereby living with the layers rocks, sediment, and mineral deposits – copper, zinc, iron, and sulfur – and the bones of long deceased dinosaurs. Appalachia's weathering occasionally revealed the remains of Jurassic monsters. Some of these long-deceased creatures included those who flew above the mountain peaks, such as the toothy sea-bird *Ichthyornis*, or walked atop the landscape, such as the fearsome *Lophorhothon*, a duck-billed giant who grew to thirty-six feet in length.[56]

Faint outlines of creatures resembling the giants of the Triassic Period populate Cherokees stories. By living with the land and waterscapes of Appalachia over thousands of years, the Cherokee people made sense of these remains by weaving them into their origin stories and developing a holistic understanding of a world filled with beings and spirits that inspired awe, fear, and wonder. Traditional knowledge was both cumulative and innovative. Elders shared this knowledge with future knowledge keepers. They did so fully aware that to keep traditional knowledge alive it must not remain static; it must build on the philosophies of the ancestors by evolving with the biomes they shared with other living spirits.

For the Cherokees, storytelling is alive with meaning because the geology and environment of their homeland is alive. Cherokee storytellers constantly add new layers of insight to their ecological knowledge as observation, investigation, and speculation encourages new stories. Cherokee storyscapes recount tales of monsters that resemble earth's Triassic occupants, spirits (both good and bad), and *yvwi tsunsdi* (the little people) that helped past generations of Cherokees make sense of changes in the biosphere. Among the most important of the Cherokee's narrative traditions were water stories, tales that connected worlds both physical and spiritual, past and present.

Throughout the Southeastern culture zone, water stories flowed through traditional philosophies. All of the Five Nations – the Cherokees, Creeks, Seminoles, Choctaws, and Chickasaws – and smaller Native polities viewed water as central to their everyday

[55] Blackmun & Williams (1977: 28–30). The Judaculla petroglyphs date to between 2,000 to 3,000 years ago.

[56] Olson (1985: 91–2); Fastovsky & Weishampel (2005: 211–15); Chatterjee (2015: 152).

lives and their spiritual wellbeing. These sovereign communities inherited stories, ceremonies, and use-practices stretching back to the paleo-Indians.[57]

For example, Muskogee-speaking people wove water into their language, their sense of place, and their worldviews. The *este maskoke* – the Muskogee people, or 'people of the swampy ground' – lived in what are today the states of Alabama and Georgia. Here they shared origin narratives of a primordial world covered by water and formed a decentralised confederacy with Indigenous peoples such as the Hitchitis, Yuches, Cowetas, and many others during the 17th century.[58] Most people clung so closely to the rivers and creeks of the region that English colonisers referred to them as 'Creeks'.[59] Although 'Creek' is a colonial term that detracts from the linguistic and cultural diversity of the 17th- and 18th-century Creek people, it nonetheless underscores the importance of rivers and watersheds to the communities who formed the Creek Confederacy.[60]

The importance of water is evident in the Muskogee language. The Muskogee word *hacci*, for instance, is used as a noun to indicate a river, while *oki* refers to water.[61] Words prefixed with *ak-* indicate 'in water' or 'in liquid'. Muskogee words also represented a river's characteristics and can give a town its name. For example, *Wawautumcau* refers to the 'rumbling waters' along the Coosa River. European colonisers called this section of the river the shoals of the Coosa. Such traditions continued throughout the 18th century and beyond. The Creek town of Okmulgi, located along the Ocmulgee River, highlights how Native Southerners used rivers and water stories to characterise their towns and navigate their homeland. Okmulgi, for instance, translates as 'bubbling or boiling water'.[62]

One of the Cherokees other neighbors, the Catawbas, also nurtured water stories and looked to rivers to define their collective identity. The Catawbas became a prosperous Indigenous community in the Piedmont region of North Carolina and South Carolina during the 17th and 18th centuries. The rivers of the Piedmont determined where Catawbas constructed their villages, located their council houses, and planted their crops. Catawbas, like Cherokees, paid close attention to seasonal cycles and

[57] Kehoe (2017: 13).

[58] Swanton (1922: 215–82); Jenkins (2009: 236); Ethridge (2003: 28); Oatis (2004: 56); Aftandilian (2011: 194).

[59] Early English colonisers referred to Muscogee people 'living on Ochese Creek', a tributary of the Ocmulgee River, near modern-day Macon, as the Ochese Creek. The English later shortened this to simply 'Creek'. See Hahn (2004: 6). Note also that the English did not identify the Ochese people as living *with* the land and water, but 'on' it. This is a colonial worldview that ultimately justified the dispossession of Native Southerners.

[60] Saunt (1999); Hahn (2004).

[61] Gatschet (1884, I: 60); Martin & McKane Mauldin (2000: 57).

[62] Ethridge (2003: 33).

Figure 4. A rare archaeological find, a canoe unearthed in Cherokee country and housed at the Tennessee Division of Archaeology, Nashville, Tennessee. Photograph by author.

watched and listened to the flow of the rivers. Reflecting the centrality of water in Catawba worldviews, they referred to themselves as *Ye Iswa*: the 'river people'.[63]

Native Southerners looked upon rivers as gateways not only to other worlds but to neighboring polities. Indeed, waterways connected communities in trade, diplomacy, and cultural exchange. While water was shared, it sometimes became a source of disagreement and even warfare. Using the rivers in these different ways required a reliable means of transportation: pirogues and canoes.

pirogues and canoes served a variety of functions. In the 1540s, Spanish conquistadors observed the painted and canopied pirogues that transported chiefs and Elders along the Southeast's rivers.[64] Among the Cherokees, skilled craftspeople hollowed out the trunks of large poplar trees to fashion canoes that transported people to hunting grounds and diplomats to council houses. Cherokee fishermen also used canoes. Before taking their canoe to water, fishermen would pray to *Yun'wi Ama'yine'hi,* or the 'water-dwelling people', to ensure a good catch.[65]

For Cherokees and their Indigenous neighbors, rivers were more than transportation thoroughfares; rivers told stories. The water that flowed through rivers sustained, cleansed, and renewed life. However, like human life, the life of a river needed to be cared for. Cherokees needed to read the river to ensure that the watershed homes of their kin remained in balance and harmony with the local ecosystem. Signs of disharmony needed to be guarded against, a principle that the story about the four cords Mooney learned about in the 1890s reminded Cherokees of. Those cords represented the cardinal directions – north, south, east, and west – and lifted the mountain peaks toward *Galunlati*. Cherokees elaborated on their geo-environmental philosophies by telling stories that also included the directions of up, down, and centre, thereby creating a narrative reminder of the sacredness of the number seven, and, importantly, the fragile tapestry of earth's geological and climactic life.[66]

Water also helped Cherokees map southern Appalachia. Just as the sound and flow of a river acted as an auditory compass for traveling Cherokees, so flowing rivers carried deep cultural meaning. Rivers were alive, they were precious, and they had personalities. The anthropomorphic qualities associated with waterways is clearest in the way Cherokees traditionally referred to rivers as *yvwiya gunahita*, the 'long person'.[67] This nomenclature reflects a central pillar of water stories and ecological knowledge in Cherokee culture: rivers have wisdom, they have consciousness, and if

[63] Speck (1939: 404–17); Brown (1968); Savage Jr. (1956: Chapter 3).
[64] Shipp, ed. (1881: 354–55).
[65] Mails (1992: 39); Mooney (1992: 496, 547); Camuto (1997: 180).
[66] Duncan (2008: 11).
[67] Duncan (2008: 5).

humans are silent and listen, rivers teach people important lessons about the health of a river and the ecosystems they irrigate.

Cherokees water stories explain the origins, health, and ecological importance of rivers. One of the most important of these living histories is that of *Kanane'ski Amai'yehi* (the Water Spider) and 'The First Fire'.[68] This story emphasises the importance of cooperation and the roles that fire and water play in cleansing and renewing life.

There are a number of versions of *Kanane'ski Amai'yehi* and 'The First Fire', but the moral is essentially the same. In a scene resembling earth's last major ice age, the story begins at a time when there is no fire. Everyone, and everything, was frozen. The animals, birds, and insects all tried to find a way to bring warmth to their world. Then, *Ani-Hyuntikwalaski* (the Thunderers), a powerful clan of storm spirits that take on human form and inhabit the Darkening Lands in the west, sent lightening to the bottom of a hollow sycamore tree at the centre of a mythical island.[69] The glowing fire and billowing smoke alert the animals – raven, the screech owl, the horned owl, the hooting owl, little blacksnake, the great blacksnake, and others – that *Ani-Hyuntikwalaski* has ignited fire. The Wolf suggests that this fire, 'as warm as the sun', might bring warmth and light to their land. A council is called, and the decision is made to bring fire back from the island. The animals, however, all fail in their efforts to acquire fire.

Downcast, but still determined, a new council is convened. Out of this meeting, Water Spider weaves a bowl out of her own thread and volunteers to go to the island to retrieve a coal of fire. *Kanane'ski Amai'yehi* crosses the waters to the centre of the island, obtains a single piece of coal, and successfully returns to share fire with the other animals. This story taught the Cherokees the value of cooperation and consensus; it also reminded them of the impact that they could have on their physical environment and the sacrifices needed to balance the ecological wellbeing of a community. Every Cherokee council house had a hearth at its centre, and those who reenacted *Kanane'ski Amai'yehi's* sacrifice by reignited the sacred fires within the council house performed what Cherokees considered a sacred duty.[70]

Fire brought warmth and light to the world, a technological breakthrough that required the animals to cross a body of water. This was not an uncommon motif in Cherokee water stories. Heroic migration narratives and tales of beings – or what anthropologist A. Irving Hallowell referred to as 'other than human persons' – plunging into the earth through caves or diving into the Underworld via whirlpools, remain

[68] Isaacs (2019: 46, 246).
[69] This 'island' might be read as 'Appalachia', the land between the Atlantic Ocean and the inland sea.
[70] Mooney (1992: 240–2).

part of Cherokee oral traditions today.[71] During the 18th and 19th centuries, Cherokees viewed flowing waterways as gateways to the underworld and the domain of Triassic-like creatures such as the horned-serpent Uktena, whose blood, if spilled, had the power to flow down-stream, darken the water, and sicken those who drank from it.[72] Alternatively, flowing waterways possessed the power to cleanse. However, the story of Uktena served as a reminder that Cherokees lived in a delicately balanced, interconnected world; any disruption to that balance risked the world becoming unhealthy (or unbalanced). People needed humility, altruism, and they always needed to remember their obligations to community. The story of the Aní-Kutánî underscores this communal ethos.

Cherokee oral traditions tell of the Aní-Kutánî traveling a great distance before reaching southern Appalachia.[73] Sometimes referred to as the eighth Cherokee clan, the Aní-Kutánî comprised an ancient priesthood who are said to have migrated from an island once located at the centre of the Atlantic Ocean.[74] The Aní-Kutánî were also thought to possess great power due to their knowledge of sacred medicine. These medicines relied on an intimate knowledge of different plants and herbs. The Aní-Kutánî, however, misused their power. They became selfish, self-indulgent, and abducted Cherokee wives. A Cherokee civil war ensued, eventually resulting in the defeat and banishment of the Aní-Kutánî, but not before the ancient priesthood cursed the Cherokees by unleashing a powerful form of witchcraft among them.[75]

Water flows through the retelling of the Aní-Kutánî narrative – from the legend of their migration to the use of water in preparing sacred medicines – just as it exists in scores of other oral traditions. In Cherokee ecological knowledge, water is part of an oral, spiritual, and performative library that archives knowledge and connects spiritual places to local ecosystems. Generation after generation of Cherokees view water as medicine, the responsibilities they have toward it being renewed through stories and practical engagements with the riverine environment. In the early 19th century Cherokees such as Thomas Nutsawi (Deer in the Water), Thomas Smith (Shield Eater), and Thomas Pridget taught Christian missionaries their creation stories, migration narratives, and understanding of history.[76] Nutsawi, one of those knowledge keepers, gave the missionary Daniel Butrick an overview of Cherokee ecological

[71] Hallowell's (1960: 19–52) use of the phrase 'other than human persons' referred to Ojibwe oral traditions. However, his use of this phrase is applicable to Cherokee traditions. Quote is at 43.
[72] Mooney (1992: 253; Isaacs (2019: 78).
[73] Fogelson (1984: 261); Minges (2003: 74–5). See also Marriot & Rachlin (1972: 45, 179); Leeds (1996: 1–3); Lauter (2004: 60).
[74] It should be noted that other Southeastern tribes shared with the Cherokee a belief in ancient migrations, often occurring over vast and treacherous stretches of water. See DeRosier Jr. (1970: 7); Brescia Jr. (1985: 6–7); Folsom (2004: 71–2).
[75] Fogelson (1984: 255–63); Teuton (2010: 3–6).
[76] Starr (1917: 38); Abram (2015: 12).

knowledge. Nutsawi told Butrick that Cherokees saw the different spheres of the cosmos as interconnected. Cherokee historical knowledge, or *agoliye*, guided the Cherokees' adherence to the principle of *gudugi,* or the concept of working together, so that communities followed the 'right path of walking or living' (or *duyvkta*).[77]

At a time when slaveholding interests began pushing American politicians to pass laws to facilitate the dispossession and removal of Native Southerners, Cherokee knowledge keepers worried about the disharmony that settler colonial expansion caused to the ecosystems they had long nurtured.[78] The settler ideal of individual landownership and private water rights represented direct attacks on the principle of *gudagi*, and the ethos of *tohi* and *osi*.[79] Pausing to reflect on the Cherokees long-held commitment to being good stewards of the environment, Nutsawi explained, 'Not long after the creation God directed men to build high places, on which to erect houses of worship, where they might offer sacrifices, assemble for religious instruction and perform their dances'.[80] He was referring to the earthen mounds upon which Cherokees constructed council houses that overlooked their watershed towns throughout *Shaconage*. These elevated places of worship were purified by water brought from the river below. Such acts, Nutsawi implied, connected the sacred mountains with the ebb and flow of rivers on the 'low ground'.[81]

Cherokees adapted their water stories and innovated their ecological practices to meet the challenges posed by 18th- and 19th-century settler colonialism. The continual loss of land and access to navigable rivers, especially after the American Revolution, meant the survival of Cherokee communities demanded innovation. And yet, Cherokees continued to locate their council houses, towns, and farms adjacent to flowing rivers – living water. At Red Clay, the last capital of the Cherokee Nation in the Southeast prior to the Trail of Tears, Blue Hole Spring reminded Cherokees of their links to an interconnected spiritual and physical world. The Spring's perfectly blue waters flowed into a stream adjacent to the Cherokee council house. Cherokees dipped their gourds into the flowing stream to collect drinking water. Elders did the same, while also mediating the immense powers associated with Blue Hole Spring. Cherokees believed that medicine people equipped with the appropriate spiritual training could access the underworld gateway that lay beneath the crystal blue waters of the spring.[82]

[77] Isaacs (2019: 26).

[78] On the political and legal history of Native American removal see Green (1982); Garrison (2002); Saunt (2020).

[79] On the environmental impacts of private water rights see Barlow and Clarke (2005).

[80] Anderson *et al.* (2010: III, 2).

[81] Anderson *et al.* (2010: III, 49).

[82] Cherokees nurtured similar stories about other underwater gateways, such as the 'haunted whirlpool' known as 'The Suck'. See Mooney (1992: 347).

Figure 5. Blue Hole Spring, a gateway to the Underworld. Photograph by author.

Red Clay provides an example of how Cherokees shared water stories not only by recalling oral traditions but through the locations at which they retold those stories, by drinking from nearby waterways, and incorporating local rivers and streams into ceremonies.[83] Ceremonial traditions, and the watershed locations of sacred places, continued to connect Cherokee people living on the 'low ground' to the sacred mountains long after the tragic era of removal.[84]

Cherokees could not avoid water stories. People even dreamed about the stuff. When dreams included visions of fish, people became alarmed. Cherokees viewed fish as liminal beings and worried that when fish appeared in a dream it foretold of bad things in the future.[85] In most instances, however, visions of water and rivers brought people together. Rivers reminded women about the importance of 'coming to water', the daily routine of walking to the local riverbank to collect sufficient water to meet the community's needs. On other occasions, water stories combined the sacred with the mundane. For example, not far from where Shooting Creek meets the Hiwassee River, the members of a Cherokee town once prayed and fasted. At the end of their cleansing ceremony, the town's people went down to the river. As they walked by the river's edge, it was said that people who listened attentively and had good hearing could hear people talking under water.[86]

Stories of this nature reminded Cherokees of their connection to a living world. The philosophy of ecological interrelatedness is clearest in the tradition of 'going to water'. Europeans reported seeing Cherokees engaged in 'going to water' ceremonies as early as the 17th and 18th centuries. 'Going to water' served a range of ceremonial functions. It involved Elders leading community members to the cane breaks at the banks of a river (the most sacred section of a river) to cleanse body and soul.[87] 'Going to water' could also involve Beloved Women guiding postpartum or post-menstrual women through cleansing ceremonies, or medicine people might try to identify the cause of a person's illness and promote their healing by immersing the patient in the cool flowing waters of a local river. Most importantly, 'going to water' underscored the concept of interconnectedness in Cherokee epistemologies. Cherokee townspeople

[83] Watson (1990: 35). Cordell (1989); Jackson, (1995); D'Arcy (2006). For non-Indigenous perspectives on water, culture, and history, see Klein, (2004); Steinberg (2001); Langston (2003); Linton (2010). The Cherokee marked the yearly recurrence of the seasons with six festivals: the Great New Moon Feast, the Cementation and Propitiation Festival, the Exalting Bush, the Festival of the First New Moon of Spring, the New Green Corn Feast, and the Ripe Green Corn Feast. Mooney (1992: 232); Mails (1992: 164); Bruchac (2003: 75); Mails (2003: 37); Jastrzembski (2006: 289); Zogry (2010: 107).

[84] Anderson *et al.* (2010: III, 2, 49).

[85] Altman (2006: 70–1).

[86] Arneach (2008).

[87] Anderson *et al.* (2010: II, 99).

manifest this aspect of their ecological knowledge by gathering together in the river to bathe and to pray for a healthy and a long life.[88]

Cherokee folklorist, Barbara Duncan, writes that Cherokees continue to view water as a sacred, cleansing agent. More than a molecule – H_2O – water possesses powerful cultural and spiritual qualities. Duncan writes, when the sun rose over a Cherokee town each morning, people gathered to sing and pray, to 'wash away any bad thoughts or feelings. They believed water had power to cleanse the body and the spirit'.[89]

Learning from Cherokee water stories

Environmental scientists like to remind us that mountains with healthy ecosystems are the worlds 'water towers'.[90] Over 50 per cent of the world's fresh water comes from snow melt and runoff from mountains. Mistreat or misuse them, and we run the risk of exacerbating freshwater shortages and stripping mountain ecosystems of their biodiversity and their ability to act as 'carbon sinks'.[91]

The Cherokee people's unbroken connection to the deep history of the southern Appalachian Mountains means they understand the importance of mountain watersheds in regional ecologies. Water stories remind Cherokees that water is finite. Indeed, Cherokee ecological knowledge highlights not only the intricate interconnections in the ecosystems of southern Appalachia, but the nourishment that mountain watersheds provide to people's spiritual health and physical wellbeing. As Cherokee beloved man Jerry Wolfe explained in 2015, *yvwiya gunahita* 'was called upon for strength, for cleansing, for washing away sadness, for ailments.'[92]

Ensuring health and wellbeing is a constant challenge. The Cherokee story of 'The Rabbit and the Image', a popular folktale, reminds people of the need for vigilance and cooperation because fresh water is not infinite. Rabbit is part of a trickster tradition that Native people from diverse language groups have nurtured for centuries.[93] In the Cherokee version, 'The Maneaters' respond to an extended period of drought by digging a well to collect water. Rabbit sees the well being constructed and asks, 'What are all of you doing?' The Maneaters, cat-like creatures who also appear in Muskogean-language narratives, invite Rabbit to help them. Rabbit declines, claiming he can get

[88] Adair (1775: 153–54, 164); Mooney (1900: 1–10); Duncan (1993: 94–99).
[89] Duncan (2008: 11). See also Lefler (2015: 159–78).
[90] Viviroli *et al.* (2007).
[91] Viviroli *et al.* (2003: 32–40).
[92] Kays (2015).
[93] Haag (2016: xxvii).

water from the dew. The Maneaters accept Rabbit's response but warn him not to take any of their water. The Maneaters feared that Rabbit would return to steal their water under the cover of darkness. Those suspicions became reality when Rabbit started stealing the well water. A trap is set up to catch Rabbit and stop his theft. Rabbit is eventually apprehended but remained defiant. He mocks The Maneaters, who in turn threaten Rabbit with additional punishments.[94]

Rabbit, ever the trickster, escapes, but the moral of the story remains clear: water is finite and must be shared equitably among kin and non-kin alike. Lies and theft risk warfare over access to resources which in turn magnifies disharmony in the spirit worlds and destabilises human relations. Indeed, Rabbit's defiance stands as a reminder that there are always beings unwilling to engage in cooperative and reciprocal relationships; such beings threaten the sustainability and resilience of finite resources such as water.

Other Cherokee water stories highlight similar lessons about the importance of reciprocity and sustainability. These narratives reflect the living traditions contained in Cherokee storytelling and how narrators renew a story's didactic significance by incorporating newer insights. Remember Nutsawi? In the early 19th century, he reportedly told missionaries of a time when the world became 'full of people who were very wicked. They disregarded all good instructions, and would not listen to any thing [sic] good that was said to them'.[95] Nutsawi's thinly veiled swipe at European colonisers echoed the biblical story of Noah's Ark, suggesting that he, like other Native storytellers, engaged in cultural syncretism to produce water stories that were meaningful to both Cherokees and European colonisers. Such syncretism was important if two groups of people with culturally distinct backgrounds were going to co-govern the environments of North America's mountain South. Water provided Nutsawi with a motif to reach across cultural divides. Nutsawi reportedly claimed that an old man was instructed by 'a certain dog' to place 'all kinds of animals' into a vessel. The old man obeyed, and shortly after closing the door on his vessel 'rain commenced, and continued forty days and forty nights, while the water at the same time gushed out of the ground, so that as much water came up, as fell down from the clouds. The wicked people could swim but little before they would sink and drown'.[96]

Nutsawi's syncretic rendering of a great deluge incorporated elements of biblical narratives gleaned from missionaries and incorporated them into a Cherokee-centric story about human cooperation and ecological stewardship. As Nutsawi concludes the story, 'the family saved in the ark were red'. He added, 'the Red people … are the

[94] Dalala (2016: 175–76).
[95] Anderson *et al.* (2010: III, 6).
[96] Anderson *et al.* (2010: III, 6).

real people, as their name *yv wi ya*, indicates'.[97] Nutsawi's Cherokee forebears were a chosen people because they eschewed selfishness. Unlike the European colonisers whom Cherokees saw as *ugasalesgi* ('greedy') people, Cherokees remained true to reciprocal relationships with other humans and their more-than-human kin. This ethos empowered Cherokees to survive a grave environmental threat to their existence, something 'God' acknowledged. As Nutsawi explained: 'Long ago God made himself known to the Indians, chose them for his people, and told them they should be the father of all other nations. He also talked with some of them, and told them things to come and thus made them prophets'.[98]

Nutsawi's story, like the origin narratives that Mooney learned about in the 1890s, remain alive today. Cherokee knowledge keepers connect water stories to a holistic understanding of the world, renewing their commitment to long-held ecological knowledge and guiding the environmental policies and practices of the Eastern Band of Cherokee Indians. Of course, not every Cherokee can be a 'prophet', but Cherokees remain cognizant of their responsibility to live in balance and harmony with the land and waterways of *Shaconage*.

In the early 2000s, half-a-century after Western scientists identified the 'great acceleration' in human-induced climate change, Cherokee Elder Freeman Owle told folklorist Barbara Duncan that 'the Cherokee people still believe the earth has a lot to give'. Owle suggested that the earth was not yet ready to 'sink down into the ocean', insisting that the Cherokees:

> still believed that it's important to take care of the waters,
> to preserve the air,
> to preserve the forest,
> to preserve the life of people themselves.[99]

Still living *with* the land and listening to the waterways of *Shaconage*, Cherokee people like Freeman Owle remain convinced that the old stories can guide us all to a resilient climate future.

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[97] Anderson *et al.* (2010: III, 10).
[98] Anderson *et al.* (2010: III, 10).
[99] Duncan (2008: 55).

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Vanda Station, Antarctica: a biography of the Anthropocene

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Abstract: This article uses the history of New Zealand's Vanda Station in Antarctica as a case study of the inseparability of human history and environmental change in the age of the Anthropocene. Vanda Station was built in the late 1960s to promote New Zealand's sovereignty claims to Antarctica and to promote scientific research in the predominantly ice-free McMurdo Dry Valleys region. Over the course of the 1970s and 1980s, the levels of the nearby Lake Vanda rose dramatically, and in the early 1990s the decision was taken to close the station. Rather than seeing the closure of Vanda simply as a consequence of the rising lake levels, this article suggests instead that it was the result of a number of interconnected social, political, scientific, and environmental factors. Although the concept of the Anthropocene is not unproblematic, a biographical approach to the history of Vanda Station can add depth and nuance to our understanding of the geological age of humans. In the McMurdo Dry Valleys, the 'birth', 'life' and 'death' of Vanda Station helps to demonstrate how the political status quo maintained itself through a partial adaptation to the new realities of the Anthropocene. This political adaptation, however, relies on maintaining human-nature dichotomies and resisting the full implications of viewing the region as an eco-social system.

Keywords: Antarctica, McMurdo Dry Valleys, Anthropocene, New Zealand, United States, Japan, history of science, environmental history, geopolitics, climate change, critical physical geography.

Notes on the authors: see end of article.

Introduction

In the early 1990s, the government of New Zealand took the decision to close and remove Vanda Station, its main scientific research station in the predominantly ice-free McMurdo Dry Valleys region of Antarctica. Although classified as a cold desert as a result of its relative lack of precipitation, this isolated region contains a number of ice-covered lakes fed by summertime meltwater streams from nearby alpine glaciers. The level of the nearby Lake Vanda had risen by around ten metres since Vanda Station first opened in the 1968–1969 season and the lake waters were threatening to inundate the entire site.[1] On the face of it, the closure of Vanda Station after 25 years of operation was a purely technical decision. Scientists could predict with a good degree of confidence the future rate of lake level rise based on climate trends, topography, and knowledge of the glaciers, and environmental planners within the New Zealand Antarctic Programme responded to this information by removing the station and cleaning up the area. A small hut was built on higher ground close to the lake, but this was not intended as a direct replacement and would not be permanently staffed. Today, the site where the original field camp once stood is almost completely submerged by the lake.

The closure of Vanda Station has been presented as a warning parable for the consequences of anthropogenic climate warming on a global scale. Reflecting on the rising levels of Lake Vanda, for example, the environmental historian Tom Griffiths writes:

> Are we pushing the maintenance systems of the Earth too far, in Antarctica and elsewhere? Vanda station, operated by New Zealand since 1968, once stood on high rugged ground overlooking the lake. But the lake has been rising about a metre a year for 30 years, and the station was destined to be flooded. It was dismantled in the early summer of 1992. When water flows in Antarctica, the world now watches with concern.[2]

Although the extent of the lake level rise was not quite the 30 metres implied by Griffiths, his wider concerns are very much in keeping with recent scholarship on the Anthropocene, the proposed geological epoch in which humanity has been an agent of massive global change.[3] In this context, the predominantly ice-free environment of the McMurdo Dry Valleys offers a haunting premonition of what an ice-free Antarctica might look like, and the rising lake levels might be seen as a foreshadowing of rapidly rising sea levels throughout the world.

[1] Hawes *et al.* (2013); Castendyk *et al.* (2016).
[2] Griffiths (2007: 325–326).
[3] See, for example, McNeill & Engelke (2016); Bonneuil & Fressoz (2017); Stine & Kress (2017).

While rising lake levels certainly contributed to the closure of Vanda Station, the story is not a straightforward case study of the consequences of recent anthropogenic climate warming. From a scientific perspective, although rising lake levels are certainly linked to a changing climate, in this part of Antarctica it is difficult to attribute direct causation to recent anthropogenic warming.[4] From a more human-focused perspective, political and cultural factors also contributed to the closure of Vanda Station. Since 1923, New Zealand has claimed ownership of the McMurdo Dry Valleys as part of its wider sovereignty claim to the Ross Dependency.[5] The 1959 Antarctic Treaty suspended political claims to the continent, but did little in practice to stop claimant countries promoting existing claims.[6] In the McMurdo Dry Valleys, New Zealand's claims to sovereignty are not recognised by either the United States or Japan, the other two countries that have had the most active presence in the region.[7] In a strategy that might be labelled an assertion of 'environmental authority', Vanda Station was constructed with the goal of demonstrating New Zealand's Antarctic claims through the performance of science and the production of useful knowledge.[8] For several years following its opening in the late 1960s, Vanda Station served this purpose, and New Zealand was able to demonstrate its commitment to scientific internationalism by inviting scientists from the United States, Japan and other countries to stay at the station and use its facilities.

By the mid–1980s, however, Vanda's effectiveness in supporting New Zealand's political position in Antarctica was becoming less clear. In terms of scientific productivity, there were fewer New Zealand publications on the McMurdo Dry Valleys in the 1980s than in the 1970s.[9] Rather than having a strong scientific reputation, the station had become better known for its hospitality, its hard-drinking culture, and for naked swims in Lake Vanda. 'Vanda's important contribution to Antarctic science', writes the New Zealand Antarctic historian David Harrowfield, 'was greatly overshadowed by the more light-hearted antics of its sometime occupants, which became the folklore of the station.'[10] At a time when the racial and gender politics of Antarctic science were starting to change,[11] Vanda had become a bastion of a particular form of

[4] Bomblies *et al.* (2001); Doran *et al.* (2002).
[5] Precis of Memorandum on British Policy in the Antarctic, EA 11 11 (Item Reference 27): Imperial Conference 1926, New Zealand National Archives (Wellington). For a useful summary of New Zealand Antarctic policy see Templeton (2000; 2018).
[6] Dodds (2019).
[7] Joyner (1997).
[8] Howkins (2017).
[9] Results of Bibliometric analysis conducted on McMurdo Dry Valley publications. Results available upon request.
[10] Harrowfield (1999: 3).
[11] Seag (2017).

Figure 1. Vanda Station in early 1980s. Copyright Haruta Murayama.

'traditional' Antarctic culture. Female scientists in particular did not always feel comfortable visiting the station, and by discouraging talented scientists, the culture of Vanda in some ways became an obstacle to doing state of the art science.

Rather than seeing the environmental causes of the closure of Vanda as being distinct from the cultural and political causes, a central argument of this article is that they were in fact very closely connected. The rising lake levels helped to highlight the value of environmental knowledge within a political system that already privileged science; the emphasis on science shone a spotlight on the problematic aspects of the culture of Vanda Station that were impeding the scientific – and hence political – value of the station. In other parts of the McMurdo Dry Valleys, policy makers and environmental managers have responded to the rise of lake levels by moving field camps further from the shoreline, and a similar decision could have been taken at Vanda Station.[12] However, rather than moving the station and attempting a radical change to its culture, it was easier to close Vanda and start again. The small camp that took the place of Vanda was not intended as a direct replacement and would not be

[12] This has been done by the US Antarctic Program at its Lake Bonney and Lake Fryxell Camps.

permanently occupied, even during the summer research season. Seen in this context, the rising lake levels provided a convenient justification for the closure of Vanda Station, as the political status quo sought to adapt to the implications of the changing environment.

A biography of the Anthropocene

In making an argument for the interconnectedness of the environmental, cultural, and political aspects of Vanda's history, this article adopts a biographical approach and argues that the history of Vanda Station can be viewed as a 'biography of the Anthropocene'.[13] On a global scale, many proponents of the Anthropocene argue that humans are not only having a massive environmental impact, but also that these environmental impacts have major consequences for human life on the planet.[14] A biographical approach to the history of Vanda Station helps to focus attention on these eco-social interactions at a much smaller scale and to explore what they have meant for the people and environments involved.

The Anthropocene is a fiercely debated concept, and many significant objections have been raised from different academic perspectives. Scientifically, at the time of writing the Anthropocene remains an entirely unofficial geological age. There seems to be a good degree of support for making a formal declaration that the Earth has shifted from the Holocene epoch to the Anthropocene epoch among members of the Anthropocene Working Group of the Quaternary Sub-commission of the International Commission on Stratigraphy, the scientific body tasked with making an initial recommendation for the establishment of a new geological epoch.[15] But a proposal from this working group would only be the start of a broader approval process, which would need to culminate in a favourable vote by the executive committee of the International Union of Geological Sciences. Despite near universal recognition of the massive extent of anthropogenic environmental changes, many scientific questions remain. There is a long-running debate, for example, about when this proposed epoch began, and evidence is still being gathered to demonstrate a global anthropogenic signal in rock stratigraphy.

[13] For other examples of biographical approaches to environmental history see, for example, Coates (1996); Cioc (2006); Cohn (2017); Corton (2018).
[14] See, for example, McNeill & Engelke (2016).
[15] Subramanian (2019)

In the social sciences and the humanities, the concept of the Anthropocene has been extensively discussed, but also extensively criticised. Scholars have highlighted the hubris of a term that gives humans geological agency on a planetary scale, and have attacked proponents of a 'good Anthropocene' who see it as giving them license to continue efforts to geoengineer the world out of the problems we cause.[16] Other scholars have pointed to the unfairness of lumping all of humanity together as geological agents, when in reality it has been a small minority of the global population who have caused almost all of the problems and reaped almost all of the rewards.[17] Others see the term Anthropocene as hiding the true causes of the massive environmental changes the world is currently experiencing and prefer terms such as Capitalocene, Plantationocene, or Anthropo-obScene.[18] A number of scholars have pointed out that there are many problems associated with the planetary scale at which much of the analysis of the Anthropocene takes place.[19] Not only can this easily seem quite abstract, but it also privileges certain forms of knowledge over others, and the views of certain people over others, with significant political implications.

Despite the problems associated with the concept of the Anthropocene, it remains a useful way of thinking about the inseparability of human history and environmental change. Framing the history of Vanda Station as a biography of the Anthropocene draws upon insights from a variety of academic fields that examine the intersection of humans and non-human nature.[20] There are clear resonances, for example, with post-human approaches to the environmental humanities, which give some degree of agency to non-human nature.[21] In seeking to combine the human history of Vanda Station with a close understanding of its changing biophysical environment, this article engages in particular with the emerging field of critical physical geography. Critical physical geographers argue that Anthropocene environments are as much the products of social forces and histories as they are of biophysical processes: 'structural power relations incorporate and draw on the materiality of nature, creating inextricably eco-social systems'.[22] In this approach, histories of science and environmental change cannot be abstracted from political and cultural histories, but require symmetrical analyses that refuse to collapse the social into the material (and vice versa).[23]

[16] Lecain (2015)
[17] Merchant (2020)
[18] See Haraway (2015); Swyngedouw & Ernstson (2018)
[19] Heise (2008)
[20] See, for example, Emmett & Nye (2017); Martens (1999); Cox (2014); Sinclair *et al.* (2015); Robbins, (2004); Sismondo (2010); Lave *et al.* (2018).
[21] Bennett (2010)
[22] Lave *et al.* (2018:5).
[23] King & Tadaki (2018).

While stopping short of attributing anthropomorphic characteristics to Vanda Station, a biographical approach informed by critical physical geography highlights the difficulty of delineating where the human ends and the non-human begins. The closure of Vanda Station, for example, was obviously not a 'death' in a biological sense, but the grief and loss felt by many of the people who had worked there was real, and its removal led to tangible environmental changes. The materiality of Vanda Station and the surrounding environment was shaped by both the political context and by the race, class and gender relations that characterised life at the station, at the same time as the environmental conditions fundamentally influenced the culture that developed there. The 'othering' of Japanese and female scientists, for example, mirrored an approach that saw the material environment of the McMurdo Dry Valleys as an object of study and conquest by white, male scientists and support staff. Change occurred not by challenging the subject-object dichotomy in the way the environment was to be viewed and studied, but by selectively allowing new groups such as female scientists and support staff into the club, while continuing to exclude others such as Japanese scientists.

As a case study from a continent that is often seen as being at the front line of climate warming and rising global sea levels, a biography of Vanda Station offers a particularly relevant example of the human-nature geo-assemblages that characterise the geological age of humans.[24] Even one of the most remote locations in the world can be viewed as an eco-social system. Embedded in the history of Vanda Station are competing visions of Antarctica, and the tension between a particular, national vision of the continent based on a local manifestation of culture, and a universal, international vision of the continent based on commonly accepted understandings of what constitutes legitimate Antarctic science. This contest was not straightforward: over the course of the history of Vanda Station, for example, the New Zealand Antarctic Programme found itself on both sides of this contest, sometimes at the same time. Somewhat paradoxically, given that it generally sees anthropogenic change as a bad thing, the scientific vision draws much of its strength from its engagement with material changes such as the rising levels of Lake Vanda. The political status quo has proved remarkably resilient by adapting itself to the new conditions of the Anthropocene. But this political resilience relies on maintaining a separation between culture and nature and not following through with all the implications of the Anthropocene in relation to the blurring of categories.

A biography of Vanda Station also helps to demonstrate that histories of the Anthropocene require both generality and specificity. While it was a prominent station with a well-documented history, many of the broad trends in the history of Vanda

[24] Leane & McGee (2019).

Station can be seen at other Antarctic stations and in other national programmes during the same period, as well as in New Zealand, American, and Japanese society more generally. The political use of scientific research stations, for example, was common across the continent, and many countries have struggled to integrate female scientists and promote racial diversity.[25] Within the McMurdo Dry Valleys themselves, the US field camps had much in common with Vanda, and the New Zealand Antarctic Programme should in no way be singled out for criticism. At the same time, the specificity of Vanda's history is important. This is primarily a New Zealand story, and the history of Vanda reflects that. If Vanda Station had been built as a genuinely international station, as was originally proposed, then its history would almost certainly have been different, and the rising lake levels may not have led to its closure.

The 'birth' of Vanda Station

Scientific research had begun in the McMurdo Dry Valleys during the so-called 'heroic era' of Antarctic exploration in the early 20th century, although this was confined to the single valley that would later be known as Taylor Valley. Britain's Captain Scott visited the ice-free region towards the end of his first Antarctic expedition, and famously wrote: 'It is certainly a valley of the dead; even the great glacier which once pushed through it has withered away'.[26] For reasons unknown, he measured the width of the narrow channel separating the two lobes of Lake Bonney, which would become an important baseline measurement to estimate lake level rise over the next 100 years.[27] Raymond Priestley made a brief visit to the Dry Valleys during Shackleton's *Nimrod* expedition, and the young Australian geologist Griffith Taylor led a scientific party which spent a week exploring the region during Scott's second and ultimately tragic expedition.[28] The history of Taylor's Western Sledge Party is particularly interesting, not least because Taylor would go on to become one of the most prominent environmental determinist thinkers of the first half of the 20th century, and these nascent ideas both shaped and were shaped by the way he understood the Antarctic environment.[29]

Following the end of the 'heroic era' of exploration, activity in Antarctica largely ceased. It would be almost fifty years before scientists next visited the McMurdo Dry Valleys. The International Geophysical Year (IGY) of 1957–58 instigated a massive

[25] Hemmings (2011); Seag (2017).
[26] Scott (2001: 567).
[27] Howkins (2016).
[28] Howkins (2016).
[29] Bashford & Strange (2008); Yusoff (2018)

scientific research programme across the Antarctic continent.[30] The ice-free landscape of the McMurdo Dry Valleys offered a variety of research opportunities, and scientific activity expanded beyond Taylor Valley to the other ice-free valleys of the region, including Wright Valley, where Vanda would be constructed. IGY work in the region was carried out by scientists from New Zealand and the United States, the two countries with logistics hubs at nearby Ross Island.[31] For geologists and geomorphologists, this ice-free landscape was one of a few places on the continent where the bedrock was exposed and where geomorphic features provided clues to previous ice ages. For ecologists, the lakes, streams, and soils of the McMurdo Dry Valleys contained microscopic ecosystems that could be used to understand adaptations to life in an extreme environment. Throughout the IGY, scientific activity was confined to the summer months of October to March, when sunlight was available and when the climate was relatively benign.

Summer research in the McMurdo Dry Valleys continued into the 1960s. During this decade Japanese scientists joined scientists from New Zealand and the United States working in the region. A major motivation for Japanese involvement in Antarctica during the IGY was a reengagement with the global community after the horrors of the second world war.[32] In the McMurdo Dry Valleys, Japan's involvement was driven by the fascinating figure of Tetsuya Torii, a wealthy geochemist who developed a long-standing interest in the region. Torii had got his start in Antarctic research at Japan's Showa Station on the opposite side of the continent, but after being introduced to the McMurdo Dry Valleys on a short trip to Antarctica following the 1961 SCAR meeting in Wellington, Torii realised the tremendous potential for geochemistry research in the predominantly ice-free region. In the 1963–64 and 1964–65 seasons, Torii went to the Dry Valleys as guest of the US Antarctic Programme and worked in and around Don Juan Pond, one of the most saline bodies of water on the planet. It was here that he identified Antarcticite, the first new mineral to be described in Antarctica.[33] Unlike the state-funded United States and New Zealand programmes, Torii's wealth and connections allowed him to raise private funds for much of his work.[34]

From a purely scientific point of view, the construction of a research station on the shores of Lake Vanda in the late 1960s made a lot of sense. The McMurdo Dry Valleys were within helicopter range of the US and New Zealand logistical hubs of McMurdo Station and Scott Base on Ross Island, and could also be reached for much of the year

[30] Launius *et al.* (2010).
[31] Bull & Barwick (2009).
[32] Tonami (2017).
[33] Torii & Ossaka (1965).
[34] https://kyokuchi.or.jp/?page_id=176 (accessed 1 Feb 2021, using Google Translate).

by tracked vehicles across the sea-ice of McMurdo Sound. The growth in the science of limnology provided a clear motivation for building a field camp next to the largest lake in Wright Valley. Lake Vanda was interesting for a number of reasons: unusually, for example, its heat increased with depth.[35] The longest river in Antarctica, the Onyx River, flows into Lake Vanda, and it was relatively close to the scientific curiosity of Don Juan Pond, where Torii and others had been working. The growing scientific activity in the Dry Valleys, and particularly in Wright Valley created an incentive for having an outlying logistical hub. A permanent field camp in the McMurdo Dry Valleys also held out the possibility of extending research into the winter for the first time, which was seen at the time as important for making progress in a number of fields.[36]

The construction of Vanda Station, however, was not the result of purely scientific motivations. In the mid–1960s, the US National Science Foundation put forward unofficial proposals to construct a Dry Valley Station 'under the joint auspices of the United States, New Zealand and Japan'.[37] In January 1966, T.O. Jones at the US Office of Polar Programs sent similar letters to New Zealand and Japan. Unsurprisingly, the justification of the establishment of a new station focused on science, not politics, and in particular on the opportunities for conducting research in the McMurdo Dry Valleys through the winter:

> The primary interest in a wintering over operation in the dry valleys is to observe rates of change in the environment and to determine the underlying causes of these changes. Included in such observations might be measurements of glacier and soil movements, snow accumulation and transfer, lake characteristics, and erosion rates, as well as the collection of routine meteorological and micrometeorological data. These and other measurements would form valuable base lines for the analysis of existing conditions in the dry valley areas. Although the annual changes may be small, it is quite likely that the largest measurable departure from average conditions on the Antarctic Continent occur within these dry valleys.[38]

[35] For a review of the physical limnology research in the McMurdo Dry Valleys see Spigel and Priscu (1998).

[36] R.B. Thompson, Dry Valley Station. Undated Planning Document. CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

[37] R.E. Willett, Ross Dependency Research Committee Visit to Scott Base 10 Dec 1965, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

[38] T.O. Jones to R.B. Thomson, 10 January 1966, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch). Similar correspondence took place with Japan. See for example T.O. Jones to Kiyoshi Sugie, 26 April 1966, Box 94 Antarctic Headquarters, Ministry of Education, Culture, Sports, Science, and Technology – Japan, Exchange Scientists, 1966–1970, Archive of the Japanese National Institute of Polar Research, Tokyo.

In the letter to New Zealand, Jones added 'Because of the work which has been carried out in the ice free valleys by scientists from NZ, we are considering an international cooperative program of work at this small wintering station'[39]. If not quite a fully international endeavour, the American plan still differed considerably from the traditional pattern of building national scientific stations in Antarctica.[40] This was in line with the US policy of furthering its own political interests through promoting international research in Antarctica.[41]

There was some initial support for the US proposal from New Zealand and Japanese scientists. Following a visit to Scott Base that included a flight through Taylor and Wright Valleys, R.E. Willett, for example, recommended that the Ross Dependency Research Committee (RDRC) should 'give most favourable consideration to any such proposal'.[42] Bob Thompson replied to Jones that 'The proposal as a whole is a good one and most interesting, particularly to a number of our people who have spent many summers during the past years in this area.'[43] As a result of lack of funding, however, US officials did not follow through with their plan to initiate the programme in February 1967. This gave time for political objections to be raised by members of the RDRC early in 1967:

> Many members of the RDRC expressed their fears that if New Zealand does not establish a station in the Dry Valleys this coming year, the United States may well do so and in a way which could be detrimental to the area and seriously affect all New Zealand's past, present, and future work in this area. Also a great loss of NZ prestige in Antarctica generally.[44]

In addition to their concerns about American intentions, New Zealanders also worried about Japan. In a letter to Bob Thompson, the head of the New Zealand Antarctic Programme, Mike Prebble, a research student at the Scott Polar Research Institute in Cambridge noted: 'Harry Francis [from the NSF] in a word of warning said be careful of the Japanese. They are liable to hone in on the scientific programme in the Dry Valleys and then it becomes very difficult to move them. Apparently USARP is still

[39] T.O. Jones to R.B. Thomson, 10 January 1966, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).
[40] Hemmings (2011).
[41] Joyner (1997).
[42] R.E. Willett, Ross Dependency Research Committee Visit to Scott Base 10 Dec 1965, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).
[43] R.B. Thompson to T.O. Jones, 17 March 1966, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).
[44] R.B. Thompson, Dry Valley Station [undated, unsigned memo], c.1967, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

being pestered about the dry valley station by the Japs despite the withdrawal of funds for this project.'[45] Wartime suspicion and language was still very much in evidence.

Instead of moving forward as part of an international collaboration, the New Zealand government decided to build its own national station in the McMurdo Dry Valleys. Not only would the initiative highlight New Zealand's scientific credentials and offer a variety of new research opportunities, but it would also offer an opportunity to invite scientists from United States, Japan and other countries to use the station, thereby demonstrating at least some degree of benign scientific internationalism. Rather than being an international station with multiple national flags, Vanda was a New Zealand station with a New Zealand flag. While perhaps not exactly the outcome that US Antarctic policy-makers had initially wanted, they were happy to offer logistical and emergency support to the New Zealand plan, and take advantage of opportunities for collaboration;[46] Japanese scientists were happy to have a base they could use for research.

A site for the new station was identified by Thompson and J. Holmes Miller in the 1966–67 season. Following approval for the project from the RDRC in March 1967,[47] construction of Vanda Station began in the 1967–68 season, but due to financial constraints it would not be completed until the following summer. Most materials were airdropped to the site,[48] while others were transported across the sea-ice of McMurdo Sound, over the Wilson Piedmont Glacier and up Wright Valley (on a track that is still visible from the air alongside the Onyx River, as a consequence of the disturbance of the desert pavement). Two tractor accidents involving crevasses in October 1968 highlighted the difficulty of this work.[49] The station was opened by the Governor-General of New Zealand, Sir Arthur Porritt, on 9 January 1969.

The five-man party that wintered-over at Vanda in 1969 were the first humans to experience the polar night in the McMurdo Dry Valleys. In a reflection of the geopolitical concerns that had led to the construction of Vanda as a national station, the first winter-over party included an American meteorologist, but no Japanese scientists. The original Vanda Station consisted of one living quarters hut and one

[45] M. Prebble to R.B. Thomson, 23 May 1967 [handwritten] CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969.

[46] R.B. Thompson, Dry Valley Station. Undated Planning Document, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

[47] Report on Vanda Station, undated, [*c.* Jan 1968], CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

[48] Report on Vanda Station, undated, [*c.* Jan 1968], CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

[49] B. Lucy to R.B. Thomson, Superintendent, Antarctic Division, 11 Dec 1968, CAHU CH370 Box 13 2/21 Policy and Programmes – Dry Valley Station, 1966–1969, New Zealand National Archives (Christchurch).

laboratory hut. Bill Lucy, the leader of the first over-wintering party was critical of the 'slip shod' work put into the living quarters, and he complained that 'The major fault in the mess construction was the lack of any rubber sealing strips between the panels and this fact alone accounted for most of the icing that occurred during the winter.'[50] A decision was taken not to install a generator so as not to interfere with geomagnetic measurements. Instead, electricity would be obtained from a wind turbine that powered batteries.

From the start, a lack of knowledge of climatic conditions along with logistical challenges hampered the functioning of the over-wintering station. 'Contrary to most prophecies,' wrote Lucy in relation to the decision to rely on wind power for electricity, 'there was very little wind during the winter months and calm periods of up to 3 weeks were not uncommon.'[51] Temperatures dropped steadily during these calms only to rise sharply when the wind eventually arrived. Winter temperatures ranged from a few degrees below freezing during wind periods to approximately –57 °C during a prolonged calm spell.' This necessitated a September re-supply of fuel and a new generator from Scott Base. Despite problems, the first winter at Vanda was broadly considered a success by those involved, and the New Zealand government could take credit for showing that it was possible to occupy this harsh region during the difficult winter conditions. 'If we have not found the answers to all the problems encountered,' wrote Lucy, 'we have, at least, found most of the problems.'[52]

The 'life' of Vanda Station

The second winter at Vanda did not go as well as the first. A number of medical items were freeze broken over the course of 1969 and a number of 'do not freeze' drugs had frozen.[53] On top of this, Vanda's wintering parties did not include a trained doctor. A fatal helicopter accident that happened nearby in November 1969 caused a great deal of concern, and there was worry about the lack of adequate heating and cramped conditions. Citing these concerns, and several others, the original members of the

[50] B. Lucy, Winter 1969 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).
[51] B. Lucy, Winter 1969 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).
[52] B. Lucy, Winter 1969 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).
[53] D. Lowe, Summer Season 1969/70 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).

1970 overwintering party refused to stay at Vanda.[54] Instead of abandoning plans for a second over-winter, the New Zealand government hastily assembled a second team from its staff at Scott Base. The second season encountered many more difficulties and achieved fewer successes than the first season. Somewhat ironically – given the installation of a new generator to replace the wind turbine – 1970 proved a much windier winter than 1969 making travel around the valleys more difficult.[55]

Following the challenges of the 1970 winter, Vanda switched for the next three years to being a summer-only station. The costs of over-wintering were high and the scientific benefits less than anticipated. In 1974, an international big science project known as the Dry Valley Drilling Project coincided with the New Zealand Government's decision to reopen Vanda Station for a winter season, in part so that a bore hole in Lake Vanda could be monitored year-round.[56] But once again, the practical challenges of living through the winter darkness in the McMurdo Dry Valleys proved to be significant. A major problem of this winter season was the failure of the cold storage in the (relatively) warm month of February, meaning that much of the food supplied for the winter thawed and became rotten.[57] These difficulties led to an impromptu late winter evacuation of the over-wintering party back to Scott Base. This would be the final attempt to maintain Vanda as a year-round station: despite occasional suggestions to try another winter from this point onwards, it would only be occupied during the austral summer, with station personnel usually arriving in late October and leaving in late February.

The difficulties faced by the early residents of Vanda, especially the members of the over-winter parties, help to explain why the station developed such a distinctive culture and quickly became for many the emblematic field camp of the McMurdo Dry Valleys. While summer conditions could sometimes be quite pleasant, cold temperatures and raging winds were never far away. Although certainly not as uncomfortable as camps in the 'deep field' interior of the continent, life at Vanda was not without its discomforts and dangers. The residents who made a success of living at Vanda tended to respond to the harsh environment through outward demonstrations of bravado and hardiness.

[54] D. Lowe, Summer Season 1969/70 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).
[55] H.P. Lowe, Winter 1970 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).
[56] A.M. Bromley, Winter 1974 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).
[57] A.M. Bromley, Winter 1974 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

One of the most famous rituals of Vanda Station was the Royal Lake Vanda Swim Club. Early in the life of the station, residents began to skinny dip in the melted margins of the ice-covered lake.[58] Over time, the activity became ritualised as the Vanda Swim Club with an elaborate set of rules, which included '1) No togs allowed' '4) Complete immersion must be achieved' and '10) A fig leaf may be worn, but must be a genuine fig leaf, and must be naturally green without artificial aid.'[59] Participants received a shot of Drambuie liqueur and a freshly made scone as reward for braving the icy waters of the lake. By the late 1970s joining the Lake Vanda Swim Club had become one of the principal highlights of a visit to the McMurdo Dry Valleys. 'Initially I had regarded the swim club as a bit of a joke,' wrote G.H. Lewis, the station leader in 1979–80, 'but soon realized that it plays an important part in morale and international relations. All our visitors and VIPs thought the swim club was marvellous'.[60] A description from the Vanda Station leader's report of 1988 captured something of the spirit of the Swim Club:

> 1988 ended with a splash in a big way with three of the personnel going down to the lake, cracking the ice and going into the water together. Minor injuries were sustained by two of the swimmers but weren't noticed until later. This was probably due to the temperatures of the water, BUT the fact that three bottles of Drambuie had been disposed of might also have had some bearing on this.[61]

Given the harsh environmental conditions and the element of danger this implied, it is perhaps unsurprising that Vanda's traditions bore considerable similarity to those of the military. The macho bravado of these local rituals might be seen as replicating the broader-scale geopolitics of 'conquering nature' across Antarctica.[62]

While the traditions of Vanda Station certainly created a sense of hierarchy (swimmers vs. non-swimmers, for example[63]), the overall consequence was to foster a

[58] There is a mention of the Vanda Swim Club in the 1975/76 leader's report, but by that stage it was already clearly established. H.P. Lowe, H.P., Summer Season 1975/76 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

[59] CAYP CH805 2803 Box 168, Antarctica social club records – The Royal Vanda Swimming Club Log Book, 1979–1994. New Zealand National Archives, Christchurch. Rule numbers have been crossed out and changed over time. These are the original numbers.

[60] G.H. Lewis, Summer Season 1979/80 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

[61] R.D. Corlett, R.D., Summer Season 1988/89 – Vanda Leader Reports, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch).

[62] Howkins (2016).

[63] R.D. Corlett, R.D., Summer Season 1988/89 – Vanda Leader Reports, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch). The station leader at one point referred to 'five swimmers and two wimps'.

broadly egalitarian ethos that reflected something of the way New Zealand's national culture was frequently imagined.[64] 'All of Vanda staff and duties are interchangeable,' wrote the station leader Harold Lowe in the 1975–76 season, 'therefore, clothing and equipment issue should be the same for everyone. Everyone does everything.'[65]. Traditional notions of social class based on economics and social background were certainly not absent from the history of Vanda Station – leaders were picked for their character and background – but these class differences tended to be flattened by the station's egalitarian ethos. Frequent 'DV' (Distinguished Visitor) visits to Vanda Station from Scott Base and McMurdo Station also served to flatten hierarchies by introducing residents of Vanda to celebrities, politicians and high-ranking military officers in a situation where residents were the ones with local knowledge and a sense of familiarity.

As well as challenging traditional social hierarchies based on class, the culture of Vanda Station also challenged scientific hierarchies. It was not uncommon, for example, for complaints to be made that having a good time got in the way of doing science. The station leader in the 1979–80 season, for example, complained that a helicopter 'jolly flight' for personnel from Scott Base was being given priority over the need to service remote meteorological screens. When this led to an additional flight being made he added 'I feel this extravagant move illustrates the way in which the so called "jolly" syndrome has got out of control in the last few years.'[66] The leader the following season wrote that 'the resources of Vanda appear to be squandered in that only two programmes were centred on the Station,' adding, 'I am sure a more profitable use of the Station facilities for scientific investigations is both possible and desirable'.[67] Such complaints do not mean that no science was done at Vanda, or that programme officers had no influence. But it does mean that the scientists who thrived in this system tended to be the ones who adapted to and enjoyed this culture. Reputation at Vanda was determined less by scientific productivity and more by past experience, practical skills and the ability to fit in with the culture of the station.

Another characteristic of the culture of Vanda Station was epitomised by a rivalry between two groups known as the 'Asgard Rangers' and the 'Vanda Vandals'. The Asgard Rangers were the glaciologists and hydrologists who roamed the valleys surveying glaciers and measuring streams. The Vanda Vandals were those whose work

[64] See, for example, King (1999).

[65] H.P. Lowe, H.P., Summer Season 1975/76 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

[66] G.H. Lewis, Summer Season 1979/80 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

[67] P. Johnstone, Summer Season 1980/81 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

kept them around Vanda Station. These two groupings formed the basis of an ongoing rivalry based around practical jokes and good-humoured banter. 'A good sense of humour,' reported one station leader, 'is so important at a place like Vanda that it has almost become one of our programmes this year (not to be taken seriously).'[68] The Viking helmet symbol of the Asgard Rangers, for example, was painted onto the roof of Vanda Station, to mark a conquest of rival territory. While such antics might appear quite juvenile to outsiders, they functioned as another response to living in a difficult environment. The existence of the Asgard Rangers and the Vanda Vandals also highlights the close overlaps of work and leisure, which not only characterised the culture of Vanda Station but also Antarctic research more generally.

Like in much of Antarctica, during the early years of Vanda Station, environmental protection received relatively little attention. Greywater (and worse) was simply poured onto the ground, wheeled vehicles were driven across the fragile soils, and on one occasion in the early 1980s the surface of Lake Vanda was set on fire to burn fuel spilled by a failed airdrop.[69] These somewhat lax attitudes towards good environmental practice reflected the norms of the times, and retrospective criticism is largely unfair, especially since it was fairly common for station leaders to express concern about environmental negligence. But it is not difficult to make connections between a lack of environmental awareness and the broader 'conquest of nature' mentality that reflected the culture of Vanda Station.

As planned, Vanda Station hosted a number of international exchange scientists. The summer season of 1970–71, for example, saw visits of varying lengths by scientists from Japan, Russia, the United States, and Germany.[70] Japanese scientists would be the most frequent foreign visitors, and their presence added an explicit racial dimension and complicated the initial whiteness of the station. The opening of Vanda saw the Japanese programme in the region shift from relying primarily on US support to relying primarily on New Zealand support. The Japanese scientists got along well with their New Zealand hosts, evidenced by the sharing of national cuisines and beverages during holiday celebrations, which were often high-points for the year ('We are now experts in chopsticks, thanks to Dr. Torii' wrote one station leader in his

[68] G.H. Lewis, Summer Season 1979/80 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).

[69] J. Alexander, Summer Season 1984/85 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch). For a retrospective analysis, see for example, D.S. Sheppard to M. MacFarlane, 5 August 1993 , CAYP CH805 2802 Box 4 18/3 Vanda Station: Vanda Station Removal, 1992–1994, New Zealand National Archives (Christchurch).

[70] P.F. Dyer, Summer Season 1970/71 – Vanda Leader Report, CAYP CH805 2802 Box 33 13/3/1 Reports: Leader: Vanda Station, 1969–1973, New Zealand National Archives (Christchurch).

annual report[71]). Led by Tetsuya Torii, the Japanese clearly enjoyed being at Vanda Station and sharing in certain elements of its culture.

With memories of the Second World War still fresh, however, there were also instances of racial prejudice. A letter from a New Zealand camp manager, dated April 1984, for example, noted:

> The Japanese party in particular put a great deal of pressure on us. Individually they were very nice people, but at 0655 on the dot, 5 red jacketed nippons all in a line coming for breakfast and then sitting politely behind the table waiting for it to appear was not my favourite view… Doc Torii in particular seemed to radiate the opinion that Vanda Station ran entirely for his benefit.[72]

More generally, for much of the time they spent at the station there was relatively little day-to-day interaction between New Zealand and Japanese personnel, and in the early years in particular, the Japanese tended to remain physically distant in their own campsite. The Japanese scientists faced a number of difficulties working in a predominantly English-language environment.[73] Dry Valley place names, for example, were almost exclusively English, and the Japanese researchers don't seem to have made any attempt to provide Japanese names. When Torii made his discovery of Antarcticite in 1965, he originally wanted to call the new mineral Don Juanite, after the name of the site, but he was dissuaded by the US Geological Survey, owing to its womanising connotations of which he was likely unaware.[74] Taken together with their own preferences, the attitudes encountered by the Japanese scientists and the challenges they faced likely served as obstacles to the levels of scientific collaboration that might have been expected to develop through sustained research over such an extended period of time.

While the presence of Japanese scientists at Vanda Station serves as the most obvious focal point for observing the role of race in the history of the McMurdo Dry Valleys, racial factors were not limited to relations among the different national programmes. In both the New Zealand and the US Antarctic programmes, minorities were conspicuous by their absence (as they were in the Japanese programme). Almost all the New Zealand scientists and support staff were of *Pākehā* (white settler) heritage; very few, if any came from Māori or Polynesian backgrounds. The role of the military – which was something of a racially integrated institution – meant that there was a little more diversity in the US programme. But even at the American field camps

[71] G.H. Lewis, Summer Season 1979/80 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).
[72] 'Bunty to Garth, Norm, and Bob', 27 April 1984. CAYP CH805 2802 Box 41 13/2/2 Reports: Scientific Vanda, Dec 1968-June 1990. New Zealand National Archives (Christchurch).
[73] B. Doughty, Summer Season 1978/79 – Vanda Leader Report, CAYP CH805 2802 Box 34 13/3/1 Reports: Leader, Vanda Station, 1973–1985, New Zealand National Archives (Christchurch).
[74] Harrowfield (1999: 45).

almost none of the scientists or the people working in the Dry Valleys came from minority backgrounds. With the notable exception of the Japanese scientists staying at the station, Vanda remained a predominantly white space throughout its existence.

In addition to the racial tensions highlighted by the presence of Japanese scientists, Vanda Station was also the site of tensions around gender. Like virtually everywhere else in Antarctica up to the early 1990s, men dominated the history of Vanda Station. None of the over-wintering parties included women, Vanda never had a female station leader, and women were always in the minority at the station during summers. It would not be until the 1986–87 season that Joanne Cowan became the first female station worker.[75] In the relative absence of women, the culture of Vanda Station developed in a way that was at the same time hyper-masculine and curiously boyish, and for many of its residents this culture appears to have been a big part of the attraction of working there. From close to the beginning of its existence, however, Vanda's masculine world was threatened by efforts to increase female participation in Antarctic activities. Both the US programme and the New Zealand programme made increasing efforts to integrate female scientists and support staff during the 1970s and 1980s, and an increasing number of women lived, worked, and visited the station during the summer months.[76]

While men often liked to think that they were in control of 'allowing' women to play more of a role in Antarctic science, the reality was very much a bottom-up process. The integration of women into Dry Valleys research might be seen as a series of ongoing efforts by individuals and small groups to make women working in the Dry Valleys a reality. Difficulties and obstacles were very much part of this story, and the experiences were not universally positive. The challenges of sustaining a scientific career in Antarctica with pressures of family were experienced by both men and women, but social expectations often made these more difficult for women. There were pin up calendars in the labs, crude and sexualised humour, and a culture characterised by acts of physical prowess and endurance, and by hard drinking. Some women seem to have relished the challenge of proving themselves in a 'man's world', and for them (like many of the men), such a working environment was part of the attraction of Vanda Station. For others, however, it was an added hurdle to overcome to allow for the science to be done. During the 1969–1970 season, for example, Lois Jones led the first US female scientific team to work in Antarctica to the Dry Valleys, where they spent Christmas at Vanda Station. Jones had recently completed a PhD at Ohio State University on the geochemistry of the McMurdo Dry Valleys using samples collected

[75] Harrowfield (1999: 36). There had been a woman (Christina Troup) on the Asgard Rangers 1980/81.
[76] Seag (2017).

for her by male colleagues. She was only allowed to work in the region on the condition that it was an all-female team and although her results were reported in a number of respected scientific journals, Jones would never return to work in Antarctica.[77]

The hostile environment facing female scientists at Vanda Station was exemplified by the Lake Vanda Swim Club. According to rule number five of the club, not only did participants have to swim naked in the lake, but they also had to consent to having their photos taken while doing so. Rule seven added 'all photographs are property of photographer and may be published at his (or her) discretion' and rule eleven gave residents of Vanda permission to 'leer, peer, peep, spy, photograph, make advances, rude suggestions or invitations and compliments as seen fit'.[78] The perceived need to prove oneself in this way was experienced by women and men alike, and not all men enjoyed participating in the Vanda Swim Club. But comments in the Vanda Station leader's reports hint at the pressure that women in particular were put under to take their clothes off and be photographed going for a swim. After noting that a member of the US VXE–6 helicopter squadron had become the first female swimmer of 1988 ('duly witnessed by all the staff at Vanda. Photographic proof is available on request'), the Vanda Station leader's report lamented that 'NZ girls slow starters'.[79] The same report summarised the swim numbers for December: 'The swimming club is going well with 54 brave people entering the water but only two of these being females of the opposite sex!!! And to make matters worse they were both Americans, maybe our base staff are too shy!!! Come on girls we would like to see more of you, in the water.' Even members of visiting New Zealand Youth Groups were encouraged to take a swim: one of the comments in the logbook was 'child pornography,' while another swimmer was keen to point out that she was 18 years old.[80]

The pressures faced by female researchers were not only an important part of the social history of Vanda Station, but also had an impact on the history of science. Regardless of the place of their research or their scientific discipline, many female scientists building their careers during the 1970s and 1980s in the United States, New Zealand, Japan and elsewhere, were subject to prejudice and discrimination. But the pressures facing female scientists at Vanda Station were particularly intense. These

[77] For a recent celebration of Lois Jones' work in Antarctica, see https://byrd.osu.edu/symposia/celebrate-women/videos (accessed 1 February 2021). Also see https://www.thearcticinstitute.org/women-polar-research-brief-history/ (accessed 1 February 2021).

[78] CAYP CH805 2803 Box 168. Antarctica social club records – The Royal Vanda Swimming Club Log Book, 1979–1994. New Zealand National Archives, Christchurch. Rule numbers have been crossed out and changed over time. These are the original numbers.

[79] R.D. Corlett, Summer Season 1988/89 – Vanda Leader Report, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch).

[80] CAYP CH805 2803 Box 168. Antarctica social club records – The Royal Vanda Swimming Club Log Book, 1979–1994. New Zealand National Archives (Christchurch).

pressures put up an additional barrier to the integration of female scientists and support staff. While it certainly reflected broader trends in science, it is perhaps no coincidence that the number of women working in the McMurdo Dry Valleys would increase dramatically from the mid–1990s onwards, following the closure of Vanda Station and the prohibition of swimming in the lakes.

The 'death' of Vanda Station

For the residents of Vanda Station who returned in consecutive years, it was not difficult to observe the rising levels of Lake Vanda. As they broke lake ice for drinking water and to go for a swim, it was obvious that the edge of the lake was moving progressively closer to the station. By the mid–1980s, the annual station leader reports were beginning to express concern. Reporting on the 1985–86 season Peter Foster, the station leader, wrote:

> From 1970 to 1986 the lake has risen 5.2m. The new Dunlite tower and the freezer at the 91m level which at present is 3.83m above the lake while the new lab is 6.83m above the lake. As rises of over 2m have been recorded, Vanda would have to be shifted about the time water reaches the freezer. Since 1981 the average lake rise has been 0.52 m/year and possibly increasing. Should the current rate of rise continue then the lake would reach the freezer and Dunlite tower base in 1993 which is only seven years away. Unless the Antarctic climate starts cooling in the near future then flooding is inevitable.[81]

Lake level measurements at the station quantified the anecdotal observations of the residents. In closed basin lakes like Lake Vanda, no outflow exists and levels are the simple difference between streamflow and precipitation directly to the lake minus water lost to evaporation or, in the case of Lake Vanda, through sublimation (ice evaporation) from its ice cover. Notably, the soil surrounding the lake including the lake bottom is underlain by permafrost – soil perennially below freezing precluding any subsurface losses to groundwater. The rising lake level clearly showed that stream input from the Onyx River, the only significant water supply to the lake, was greater than losses to sublimation. Based on the measurements of streamflow, the sublimation losses estimated from lake level rise and the knowledge of how lake volume increases with lake level elevation (determined by early survey work prior to station construction), it was easy to predict the rate of future lake level rise, assuming constant conditions. It was clear the station had to be moved.

[81] P. Foster, Summer Season 1985/86 – Vanda Leader Report, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch).

As the level of Lake Vanda continued to rise through the 1980s, the scientific productivity of scientists working from Vanda Station began to decline. Some good science continued to be done in the McMurdo Dry Valleys at this time. An important international conference on Dry Valleys science, for example, was hosted by Mike Selby at the University of Waikato in May 1985, which functioned to showcase New Zealand scientific research.[82] Around this time, there were some calls for another winter season to be tried at Vanda Station. But these calls went unanswered, and, in general, the 1980s was not a strong decade for New Zealand Dry Valleys science. Although a somewhat crude measure, the number of New Zealand publications on the McMurdo Dry Valleys fell decade by decade from the 1970s to the 1990s, before rising again in the 2000s after Vanda had closed.[83]

If never quite a liability to New Zealand's sovereignty claims, the early sense of scientific optimism and prestige generated by Vanda Station had significantly dissipated by the mid–1980s. It was becoming less clear whether Vanda was fulfilling its original goal of promoting New Zealand's Antarctic sovereignty through the performance of Antarctic science. Other factors accompanied this loss of scientific prestige and no single cause resulted in the decision to close Vanda Station. The priorities of Antarctic science were changing, and fields that had been cutting edge in the late 1960s were no longer cutting edge in the late 1980s, in part because most of the work had been done and questions had been answered (for example by the Dry Valley Drilling Project).[84] Discussions over a Mineral Protocol for Antarctica were raising questions about environmental protection across the continent, and good 'stewardship' was becoming closely connected to the politics of sovereignty.[85] Under these circumstances, it was no longer clear that maintaining a central research station in a place like the McMurdo Dry Valleys was the best approach to protecting the environment and supporting New Zealand sovereignty. At the same time, funding for Antarctic science was tight and Vanda Station was expensive to run. With New Zealand's main logistical hub of Scott Base on Ross Island performing the presence and administration required to demonstrate effective occupation under international law, the return on investment of a costly station in the McMurdo Dry Valleys was uncertain.

On a visit to Tokyo in 1986, Bob Thompson informed Tetsuya Torii that New Zealand would no longer provide logistical support for Japanese researchers at Vanda

[82] R.B. Thompson to M. Selby, 9 April 1985, CAYP CH805 2802 Box 46, 14/4/4 Meetings and Conferences: 1985 Dry Valley Conference – RDRC, 1984–86, New Zealand National Archives (Christchurch).
[83] Data obtained from bibliometric analysis and available on request.
[84] Barker (1977).
[85] Antonello (2019).

Station.[86] Without this support, Japanese research became unsustainable, and the decision brought an abrupt end to over 20 years of Japanese Dry Valleys science. The 1986–87 season was the final year of Japanese research at Vanda, and the station report hints a slightly strained relationship, despite one last memorable Christmas party: 'I am confident that Vanda played its part in the life of the Ross Dependency for the season and flew the PR flag regardless of any political clouds that may have been lurking on or just beyond the horizon'.[87] The fact that there was virtually no continued Japanese research in the McMurdo Dry Valleys after this season, including no international collaborative efforts, highlights the tight-knit and isolated character of the Japanese research group.

Following the end of support for the Japanese presence at the station, Vanda continued for several years as a New Zealand-only summer station. But there was a growing sense that the end was near. With the waters of Lake Vanda threatening to inundate the site, there was a real danger that 25-years of accumulated environmental contamination around the station would find its way into the lake, with potentially damaging consequences for future limnological research. A decision was taken to remove the station and replace it with two smaller huts on the opposite side of the lake. Under some pressure from Greenpeace and from the terms of the newly signed Environmental Protocol to the Antarctic Treaty, the removal of Vanda Station was accompanied by a substantial environmental clean-up operation of the contaminated site.[88]

The clean-up operation served as a public confession of the environmental damage Vanda Station had caused, but also offered New Zealand an opportunity to demonstrate its commitment to good environmental management. The soil scientists Ian Campbell and Graham Claridge conducted an environmental survey of Vanda Station during the 1992–93 season and reported their findings to Gillian Wratt, the Director of the New Zealand Antarctic Programme.[89] Soil samples from around Vanda Station were analysed by D.S. Sheppard from the Nuclear Sciences Group.[90] The results indicated 'measurable contamination relative to the baseline samples, of heavy metals including silver, total carbon, nitrate, and phosphate.' A particular focus of concern

[86] Y. Yoshida, Chronological List of Activities of Fieldwork in McMurdo Dry Valleys by Japanese Parties, obtained at Archive of the Japanese National Institute of Polar Research, Tokyo.
[87] C. Lynch, Summer Season 1986/87 – Vanda Leader Report, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch).
[88] M. Bourke, Summer Season 1990/91 – Vanda Leader Report, CAYP CH805 2802 Box 34 Reports: Leader, Vanda Station, 1985–1991, New Zealand National Archives (Christchurch).
[89] I.B. Campbell to G.S. Wratt, Jan 16 1993, CAYP CH805 2802 Box 41 13/2/2 Reports: Scientific Vanda, Dec 1968-June 1990, New Zealand National Archives (Christchurch).
[90] D.S. Sheppard to M. MacFarlane, 5 August 1993 , CAYP CH805 2802 Box 4 18/3 Vanda Station: Vanda Station Removal, 1992–1994, New Zealand National Archives (Christchurch).

was 'Greywater Gulley' where wastewaters had been tipped: '…it must be concluded that the contaminants in the soils at this site are being leached into the lake waters, and are accessible to the algae, as attested to by the bloom.' The fact that work on clean-up began during the 1993–94 season before the circulation of an Initial Environmental Evaluation caused some unease among environmentalists, but with the removal of the remaining Vanda Station structures in the 1994–95 season, a difficult project was successfully completed.

The removal of Vanda Station in the 1994–95 season coincided with the relocation of two small huts from other parts of the Dry Valleys (Lake Fryxell and Lake Miers) to a site on the opposite side of Lake Vanda. The construction of this new structure again caused concerns among environmentalists that work was being done before environmental assessments had been completed, but this was not too serious an issue.[91] Importantly, the new huts were not intended as a direct replacement for Vanda Station. They would not be permanently staffed meaning that there would be no replication of the culture of the original station. The closure of Vanda coincided not only with the signing of the Environmental Protocol to the Antarctic Treaty in 1991, but also with transformation of the New Zealand Antarctic Programme into Antarctica New Zealand and a new, lighter touch approach being taken to scientific research in the Dry Valleys. Rather than working from fixed camps, in recent years New Zealand scientists have tended to rely instead on temporary campsites that are thought to have less of an environmental impact. There would be a small increase in the number of New Zealand Dry Valley publications in the first decade of the 2000s and much of this research was closely connected to environmental protection and management. In much the same way that the establishment of Vanda Station had the goal of promoting New Zealand sovereignty through science, the removal of the station and the increased emphasis on environmental protection this precipitated can be viewed as an effort to promote New Zealand sovereignty through sound environmental practice.[92]

Conclusion: adapting to the Anthropocene

For anyone who visited the McMurdo Dry Valleys during the 1970s and 1980s, Vanda Station is likely to evoke powerful memories. The station gained something of a legendary status, not so much for the science that was done there, but for its culture. Constructed and run by the New Zealand Antarctic Programme, Vanda Station was

[91] A. Hemmings to L. Sparrer, 15 Nov 1994, CAYP CH805 2802 Box 4 18/3 Vanda Station: Vanda Station Removal, 1992–1994, New Zealand National Archives (Christchurch).
[92] Taylor *et al.* (2016).

quite obviously a 'Kiwi' facility. In reference to the rustic cabins owned by many New Zealanders, Vanda Station was often thought of as the 'bach' (pronounced 'batch') of Scott Base: a place to escape to for rest and recreation. But Vanda Station was also an international space: scientists and helicopter pilots from the United States were frequent visitors, Japanese geochemists used the station as their base for much of its life, and it was a popular stopping point for 'Distinguished Visitor' tours of the Dry Valleys. While most Antarctic field camps and research stations have their own distinct identities, in relation to its relatively small size and relatively short existence, Vanda arguably made a disproportionate contribution to developing a distinctive and influential Antarctic culture. Over the life of Vanda Station, however, this culture became an impediment to the conduct of high-profile scientific research. By the time of its closure in the early–1990s, it was no longer clear that the station was fulfilling its original purpose of promoting New Zealand's Antarctic sovereignty claim through facilitating scientific research. In this context, rising lake levels offered a neat justification for closing the station and starting again, yet there was nothing inevitable or pre-determined about this decision.

A biographical approach to the history of Vanda Station helps to highlight the interconnectedness of its scientific, political, cultural and environmental histories. Vanda Station can be studied as an eco-social system that both shaped and was shaped by the material environment of the McMurdo Dry Valleys. Building on a recognition of this interconnectedness, a biographical approach also helps to put the history of Vanda Station into the broader context of the Anthropocene epoch. The 'birth', 'life' and 'death' of Vanda Station were all shaped fundamentally by the cultural and material conditions that on a global scale are coming to be recognised as 'the age of humans'. Framing the history of this New Zealand Antarctic Station as *a* biography of the Anthropocene can make an important contribution to understanding these wider trends. It becomes possible to see how the political status quo in the McMurdo Dry Valleys has been maintained through a partial adaptation to the new realities of a human-influenced biophysical world. The closure of Vanda Station represented an implicit acknowledgement on the part of the New Zealand government that its nationalistic and hyper masculine approach to asserting Antarctic sovereignty was no longer viable. In the face of rising lake levels, it became politically expedient to close the station and focus on integrating sound environmental management into their performance of science.

In line with some of the more critical humanities literature on the Anthropocene,[93] a biography of Vanda Station reveals that the history of the 'age of humans' is rarely as straightforward as it may appear. The rising lake levels certainly played an important

[93] See, for example, Lecain (2015).

role in the closure of Vanda Station, but the encroaching water was not the only cause. Rather than approaching the study of the Anthropocene as a renewed form of environmental determinism, where humanity will inevitably suffer, the history of Vanda Station presented in this article suggests that more complex eco-social interactions lie just beneath the surface of the dominant narrative (and now the water of Lake Vanda). Environmental historians and other scholars might argue with strong justification that human history has always been inseparable from the history of the environment. But in an age where even a supposedly 'pristine' environment like the McMurdo Dry Valleys has been deeply impacted by human actions, this interconnectedness is arguably more profound, more reciprocal and more pervasive than ever.[94]

While the implications of the Anthropocene are difficult to comprehend at a global scale, smaller scale microhistories can help make sense of our current age. The blurring of nature and culture revealed by a biography of Vanda Station makes it difficult to sustain the idea of 'the environment' as something 'out there' to be investigated as an object of study. Seen in this way, the current climate emergency cannot just be treated as an external threat to the well-being of humanity, but something much deeper that affects what we do and who we are. The totalising vision of the Anthropocene promoted by science creates a comprehensive framing for the way the world is understood that goes beyond science into geopolitics, race and gender relations, and class structures. Even the way we tell stories and think about history is being shaped by the eco-social relations of the Anthropocene. On one level, a biography of Vanda Station might just be one relatively small part of the history of an uncharacteristic region of a peripheral continent. But on another level, it is a story that has much to tell us about the challenges facing humanity in the 21st century.

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