

the last of lands, the emptiest ¹

by Robbo Bennetts

first published, here, 10 July 2025

plunging into the unknown

In the remote past, one or more bands of modern humans embarked on a most audacious adventure. They had guessed, we assume, that land lay beyond the horizon, before plunging into waist-deep water and launching their watercraft into the open sea. This dangerous crossing to Sahul² was, reputedly, the first long-distance sea voyage by members of our species. How could they have guessed that there was land out of sight but somehow within reach? Had they observed the flight paths of migratory birds? Had they seen distant plumes of smoke triggered by lightning strikes? Had some brave souls amongst them made an exploratory or accidental journey to the new world and returned to tell their tale? Did they realise how momentous was their exploit? Had they any notion of the endless vastness of the planet's oceans? It is unknown whether their watercraft were carefully and laboriously constructed using skills acquired through long experience crossing river deltas and narrower sea channels in southern and south-eastern Asia. Or whether they were of a crude design, hurriedly lashed together, perhaps little more than tangles of buoyant plant matter that had washed out of a river mouth in flood? How and why this crossing was made will probably remain one of the great mysteries of the human story.

first impressions+

What these adventurers saw when they first set foot on our shores was an assemblage of flora and fauna that had evolved over millions of **years** in almost total isolation from the rest of the world. The super-continent Gondwana began to break up about 150 million years ago. By the time modern humans had emerged as a separate species, Sahul had been geographically isolated from the other continents for something like 50 million years. Consequently, much of our wildlife — especially creatures that couldn't fly, swim or float long distances — evolved in unique ways. Some would have been familiar to the newcomers. A range of plants, insects, reptiles, birds and fish, or their close relatives — such as saltwater crocodiles, pythons, turtles and barramundi — were found on both sides of the Wallace Line.³ Goannas, frill-necked lizards, flying foxes, hopping mice and kookaburras all originated in Asia. But many other creatures — macropods like kangaroos and the world's only egg-laying mammals (platypus and echidna) — would surely have seemed just as bizarre to the first Australians as they did to the first Europeans to come to these shores. Apart from bats and rodents which also came from Asia, there were no land-based placental mammals here until dingoes arrived a few thousand years ago.

Fauna that had not previously encountered humans is inferred to have been “naive”, meaning having no natural fear of us and therefore no fight or flight response upon our approach. Darwin observed such naivety in the doves and pigeons of the Galapagos Islands which were not familiar with humans.⁴ Presumably, early Australian hunters could walk up to their prey and deal death blows at close quarters without too much bother. Given that some herbivorous megafauna like diprotodons were also heavy and slow-moving, calories must have come very cheaply in those “honeymoon” years.

Unlike other inhabited continents, there were few wild animals here that might have posed an existential threat to the new arrivals. There were many animals that could bite or scratch, but as far as we know, Australia had no terrestrial mammals with hoofs, horns, antlers or tusks. There seem to have been no or virtually no animals capable of deadly clawing⁵, charging or trampling, and none we know of before dingoes arrived that hunted in packs like wolves or lions. Apart from saltwater crocodiles, sharks and possibly

¹ From A D Hope's poem “Australia”

² I.e. mainland Australia, Tasmania and New Guinea before they were separated by rising sea levels

³ The Wallace Line is an imaginary line that represents a barrier or border between fauna that evolved in Asia and fauna that evolved in Sahul.

⁴ Flannery, *The Future Eaters*, Reed New Holland, Sydney, 1994 (this edition 2002), pp189-90

⁵ Kangaroos have been known to disembowel dogs with their rear feet.

marsupial lions, few if any predators were likely to have preyed on humans. Even if they had, modern humans had long been apex hunters. Our ancestors had learned to hunt cooperatively, to master fire and to kill at a distance. The first Australians, therefore, would probably have had little or nothing to fear from other species they found here. Whether they had anything to fear from other humans who may have arrived earlier is an open question.⁶ Amongst the most dangerous known creatures in this continent, and the waters surrounding it, it seems, were venomous reptiles, insects and marine creatures. There were also poisonous plants like the Western Australian peas which contain sodium fluoroacetate (the same compound found in the rabbit poison 1080) and gympie gympie, a Queensland rainforest shrub with stinging hairs which are known to cause excruciating, recurring pain on contact. Apart from dangerous creatures, of course, there were, and still are, creatures such as various kinds of flies (including mosquitoes) and wasps (such as hornets) that could make life seriously unpleasant.

There were few physical barriers to movement around Australia like high altitude mountains or deep snow. The main barrier was probably the tyranny of distance, but after good rain almost anywhere on the mainland could be reached easily enough by foot. While the art of building watercraft persisted in many coastal and wetland areas, in places the need for watercraft disappeared altogether.⁷

Kaurna knowledge-holders James Charles and elder Uncle Lewis O'Brien argue that all the natural threats encountered by the first Australians made their establishment here "the harshest time in human history" These threats included:

fluctuating temperatures, ice ages, fluctuating CO2 levels, extremely high dust levels, high ice volume, high winds, large scale bush fires, glacial movement, low rain fall, extreme arid conditions, limited plant growth, evaporation of fresh water lakes, and dramatic sea level fluctuations.⁸

Some of these threats will be explored below.

a dry and ancient land

"A dry and ancient land" was the title of a conference that I co-convened in 2002. Geologist Jim Bowler and biologist Tim Low were keynote speakers. Bowler has devoted much of his working life to comprehensively tracing the cyclical pattern of the natural history of a series of basins in western NSW, a journey which led him to discover "Mungo Man" and other fascinating secrets of our deep past. In 2002 Tim Low had only recently published *Feral Future* which details the ways in which our fragile ecosystems have been and continue to be devastated by the introduction of invasive species.

The history of Australia is written in our dirt. The depth, fertility and moisture of soil are key indicators of the degree to which plant and animal life, and concomitantly human society are able to flourish. As Josephine Flood noted, "Australia is drier and flatter, with generally shallower soil and less biomass than any other inhabited continent, with the world's most unpredictable climate".⁹ Our comparatively low average rainfall can be gauged by the volume of our rivers. The Murray-Darling basin occupies one seventh of Australia's land mass. At 2,508 kilometres in length, the Murray is one of the longest rivers in the world. Yet neither the Murray nor any other Australian river appear in the top 100 rivers of the world ranked by discharge. While we do experience severe flooding, there is not enough consistently heavy rainfall, run-off or snowmelt in our major watersheds to support high-volume rivers or great fertile river deltas like those found in other parts of the world. Our mountains were once Himalayan in scale but have been worn down over millions of years. Now our highest mountain, Kosciuszko, is the only one of the "Seven Summits"¹⁰ that can be accessed by a four-hour return walk from the nearest carpark. The geological stability of the Australian continent has meant that there has been little or no recent tectonic uplifting or volcanic or glacial activity, meaning that there has been relatively little generation of new soil. After Sahul split away from the rest of Gondwana it inched northwards towards warmer and drier climes. Now our arid interior is situated in a zone dominated by subsiding dry air masses and high pressure systems. It is too far south to fully benefit from tropical rain depressions and too far north to fully benefit from the moisture-laden westerly winds. The coastal fringes in the east and south-west benefit from rainfall produced by orographic lifting over their respective mountain

⁶ Historian Murray Johnson raises a series of tantalising possibilities relating to earlier occupation by other hominids who had arrived in south-eastern Asia well before us: Murray Johnson, *Australia's Ancient Aboriginal Past*, Australian Scholarly Publishing, Melbourne, 2020, pp55-108

⁷ I recall no mention in the literature of watercraft along the South Australian coast and most Western Australian coastal regions.

⁸ James A Charles & Lewis O'Brien, "The Survival of Aboriginal Australians through the Harshest Time in Human History: Community-Strength", *International Journal of Indigenous Health*, Vol 15, 2020, p 6, published online by ResearchGate

⁹ Josephine Flood, *The Original Australians*, Allen & Unwin, Sydney, 2019, p26

¹⁰ The highest mountain on each of the seven continents.

ranges but that same process tends to create rain shadows further inland. The unpredictability of our rainfall — even in normally wetter parts of the continent — is largely the result of the influence of the El Niño Southern Oscillation Index.¹¹ Archaeologist Brian Fagan explains:

[W]hen atmospheric pressure was high in the Pacific Ocean it tended to be low in the Indian Ocean, from Africa to Australia, and vice versa. This “Southern Oscillation” seesawed back and forth, changing rainfall patterns and wind directions over both the tropical Pacific and the Indian oceans.¹²

Not only are most Australian soils poor, thin, fragile and hydrophobic but, as mooted above, they are no longer replenished by glaciation or volcanic activity. In many parts of Australia they are also saline or sodic. Less than one percent of Australia has been glaciated in the past million years, compared to almost 50 percent of North America.¹³ The last volcanic eruptions occurred here several thousand years ago but then only in a small corner of south-eastern Australia. Our landscapes have been so weathered for so long that alluvial deposits of eroded material contain few plant nutrients and thus also lack fertility.¹⁴ Nor is there much significant recycling of plant matter by herbivores. Consequently, many of our ground-cover plants are shallow-rooted and prone to disturbance by fire, human and animal traffic, and earthworks. Soil not held together by the roots of plants is more readily washed or blown away.

The role of fire in Australia’s ecosystems has long been the subject of debate within the scientific community. As early as 1994 Flannery argued that “fire has made Australia — originally the most resource-poor land — an even poorer one. Fire saw the fat of the land slowly flushed onto the floodplains and into the estuaries, where today it supports swamp and mangrove”.¹⁵ Researchers at Northern Arizona University concluded that soil depletion is more severe during high-intensity fires than it is during low-intensity fires such as mosaic burns, stating that “the relationship between fire and soil nutrients is complex ... fire intensity is usually the most critical factor affecting post-fire nutrient dynamics, with greater nutrient losses occurring with higher fire intensity”.¹⁶ Sclerophyll¹⁷ plants such as eucalypts seem to have been the major beneficiaries of altered fire regimes with the arrival of humans here. Australia’s 800 or so eucalyptus species are able to dominate our landscapes because most are favoured by fire (other than the most intense fires) and they have a competitive advantage in extracting moisture in environments with depleted soil and low or variable rainfall.

Nutrient-poor soil produces nutrient-poor dust, which tends to be low in phosphorus and nitrogen”.¹⁸ This reduces the benefits of deposition downwind and downstream. In Jared Diamond’s view, the lack fertility of suspended solids that wash into the waterways and out to sea means that Australian rivers and coastal waters are also relatively unproductive.¹⁹ Flannery colourfully suggests that “Australia’s oceans are a watery mirror of its land—for both are largely infertile deserts”.²⁰ This may explain why none of our fishing grounds are rated among the world’s top wild catch fisheries.²¹ Thin dry soil also produces less living biomass and therefore less moisture retention. Our continent has for the most part been unable to sustain the lush vegetation and super-abundance of wildlife found in more favoured regions. There appears to be no record here of the vast herds of herbivores seen in Africa and the northern hemisphere such as zebra, wildebeest and bison. Nor has this continent been able to support human population levels anywhere near as high as found in other parts of the world.²²

yet, when humans first arrived here, Australia was “a land of plenty”

Since primordial times the world’s climate has cycled between warmer, more humid periods and cooler drier periods. Fifty thousand years ago our climate was warm and humid. Geoscientist Tristan Salles and his

¹¹ Flannery, p83; Jared Diamond, *Collapse, How societies choose to fail or survive*, Penguin, Melbourne, 2005, p384

¹² Brian Fagan, *Floods, Famines and Emperors*, Basic Books, New York, 2009, p39

¹³ Diamond, pp380-81

¹⁴ Colin Pain et al., “Old, flat and red-Australia’s distinctive landscape” in *Shaping a Nation: A Geology of Australia*, Geoscience Australia-ANU, Canberra, 2012, p253, published online by ANU

¹⁵ Flannery, p233.

¹⁶ “Fire Effect on Soil”, *Northern Arizona University*, published online

¹⁷ hard-leaved

¹⁸ Tristan Salles et al., “Physiography, foraging mobility, and the first peopling of Sahul”, *Nature Communications*, 2024, Vol 15, No 3430

¹⁹ Diamond, p382

²⁰ Flannery, pp78-79

²¹ Andrew Broadley et al., A Global Review of the Critical Link between River Flows and Productivity in Marine Fisheries, *Reviews in Fish Biology and Fisheries*, Vol 32, 2022, p817, republished online by ResearchGate

²² Our comparatively low population levels explain, among many other things, vulnerability to foreign invasion and (in post-colonial times) our dependence on “Big Brothers” like Britain and the US.

colleagues argue that back then, “Sahul geography would have included a mosaic of environments from rainforests, savannas, deserts, alpine regions, grasslands and temperate forests”.²³ As mooted above, benign weather patterns, ample potable surface water and relatively flat terrain no doubt made it relatively easy for the first Australians to explore and populate the whole continent. Archaeologist Mike Smith believes that the small bands which roamed the interior before it dried would have seen

a striking picture of a rich savannah environment with a mosaic of habitats, including riparian woodland, seasonally inundated floodplains, deep permanent waterholes and back-swamps, as well as significant dryland areas with an open vegetation of chenopods, grassland, daisies and *Callitris* pine woodlands [references removed for readability]. The Katapiri fauna [found in central Australia] includes macropods such as short-faced kangaroos. Other large herbivores include *Diprotodon optatum* (>1500 kg) and the giant wombat. Medium-sized arboreal species, such as possums and koalas are present as well as smaller taxa characteristic of arid zone faunas, such as bandicoots, rat kangaroos and hare wallabies. Large flightless birds include the emu, and the much larger *Genyornis* (about 275 kg). This fauna supported a range of carnivores and scavengers including a large varanid lizard, the marsupial lion (*Thylacoleo carnifex*), thylacines and a large freshwater crocodile. The channels and waterholes also supported a range of fish, freshwater mussels and chelid turtles. The large fish vertebrae in these assemblages indicate that some individual fish weighed as much as 36–50 kg.²⁴ [Most Latin names have been removed here for readability.]

At this time a complex system of megalakes graced inland Australia. When the Kati Thanda-Lake Eyre lake system was first seen by human eyes, for example, it

[spanned] hundreds of kilometres of teeming estuaries and rivers. Lake Eyre itself stood 25 m deep and with a volume of some 380 cubic kilometres (roughly 700 Sydney Harbours).

These inland mega-lakes were fed by big rivers such as Cooper Creek and the Diamantina River, which pumped large volumes of water into the continental interior every year to fill the lakes to the levels shown by the position of their ancient beaches. Mega-Lake Eyre held roughly ten times the water volume achievable under today's wettest climate, and if present now would rank among the ten largest lakes (in area) on Earth.²⁵

Like other megalakes it would have provided everything that the vibrant semi-sedentary communities which were scattered along its shores needed in order to prosper: fresh water, abundance and variety of game, edible and medicinal plants, shade, and natural materials needed for fires and construction of shelters and equipment. The Lake Eyre basin is similar in area to the Murray-Darling basin. At about 1.2 million square kilometres, it occupies an eighth of Australia's land mass, making it the world's largest inland drainage system. Kati Thanda-Lake Eyre filled at a time when there was much higher local rainfall and much more run-off from monsoonal rains which coursed down what were then more regular waterways like Cooper Creek and the Diamantina River.²⁶ Run-off that regularly flowed into the lake system was significantly greater than run-off from the most serious floods in the catchment since records began.²⁷

Not long after humans arrived, however, much of Australia — the inland especially — began to dry out. The drying out intensified from about 40 to 45,000 years ago to the present.²⁸ Runoff and surface water significantly diminished. The great lakes slowly shrank. Species like flamingos and most fish that depended on permanent water became locally extinct. The desiccation²⁹ of the landscape and salinisation of the dry lake beds made survival much more challenging for both man and beast. In 1964 Donald Campbell broke the world land speed record reaching a speed of 403mph in his *Bluebird CN7* on the horizonless salt flats at Lake Eyre. By then surface water appeared only as a mirage, except on those relatively rare occasions when the creeks flowed again and everything magically sprang back to life. Kati Thanda-Lake Eyre had once been one of the great natural wonders of the world. At the turn of the twentieth century, having set up camp overlooking the salt flats, Baldwin Spencer and Francis Gillen remarked:

[We] thought of the strong contrast between the silence and sterility of the scene, as we looked down upon it now, and the fertility and exuberance of life which must have characterised it in bygone ages when it was a great sheet of fresh water, surrounded, doubtless, by a rich and varied forest growth amongst which browsed huge *Diprotodons* and birds as large as the New Zealand moa.³⁰

²³ Salles et al.

²⁴ M A Smith, “The historiography of kardimarkara: Reading a desert tradition as cultural memory of the remote past”, *Journal of Social Anthropology*, 26 December 2018, published online. Most terrestrial megafauna were doomed to extinction

²⁵ Tim Cohen et al. (2015b), “Drying inland seas probably helped kill Australia's megafauna”, *The Conversation*, 26 February 2015, published online

²⁶ Pain et al., p244

²⁷ Researcher Gerald Nanson quoted in Carl Holm, “Great drying reveals clues to big wet”, *ABC*, 1 February 2011, published online

²⁸ Tim Cohen et al. (2015a) “Hydrological transformation coincided with megafaunal extinction in central Australia”, *Geology*, Vol 43, No 3, 22 February 2015, republished online by ResearchGate

²⁹ Drying out

³⁰ Baldwin Spencer & Francis Gillen, *Across Australia*, MacMillan & Co, London, 1912, Vol 1, p109, republished online by Internet Archive

Indeed, when humans first arrived at its shores, as Cohen et al. commented, it “truly was the inland sea that proved so elusive to Charles Sturt and other 19th-century colonial explorers.”³¹

the ice age

In the past 50,000 years Australia’s climate experienced continental-scale aridification and cooling ahead of and during the Last Glacial Maximum [LGM], warming in the early Holocene and intensification of the El Niño/Southern Oscillation during the mid-to-late Holocene.³² When the continent cooled, the air held less moisture and less rain fell. Inland, a combination of significant reduction of surface water, low humidity, low CO₂ in the atmosphere and fierce dust storms rendered most previously occupied areas uninhabitable. Recent research has attributed the lowered levels of CO₂ during the LGM to the fact that cold seawater absorbs significantly *more* carbon from the atmosphere than does warm seawater.³³ Having evolved in a carbon-heavy planet, plants are said to “love CO₂”,³⁴ and many do not flourish when CO₂ levels are low. Gerhart and Ward hypothesised that the effects of low CO₂ on plants may have reduced tropical forest cover by 44–69% during the LGM, replaing forests with wet-and-dry tropical grasslands.³⁵ Consequently, humans abandoned as much as 80 per cent of the continent.³⁶ There was a general exodus to the coast and certain inland refuges which had permanent water such as the Murray-Darling Basin and the central highlands of Tasmania. Archaeologist Alan Williams and his associates graphically capture the way in which the Last Glacial Maximum radically altered the landscape:

The LGM is the most significant climatic event to face modern humans since their arrival in Australia. Recent studies have demonstrated that the LGM in Australia was a period of significant cooling and increased aridity beginning ~30ka and peaking between ~23 and 18ka. [Citations deleted for readability.] This period saw a decline in annual temperatures by as much as 10 C compared with the present day, glaciation of uplands in the Snowy Mountains and Tasmania, a reduction in rainfall by 60% or more, especially in the interior through a weakening of the summer monsoon and poleward displacement of winter westerlies, and, linked to the latter, markedly lower lake-levels. The LGM also resulted in changes in vegetation structure to generally more steppe-like and grassland-dominated environments, increased dune activity and dust transport, and an expansion of the arid zone into semi-arid and mesic [i.e. moister] environments.³⁷

rising sea levels

When much more than present of the planet’s water was locked up in the poles and glaciers during the LGM, sea levels dropped dramatically. Continental shelves were exposed, creating bridges between land masses that were previously separated by water. Two million square kilometres of our continental shelf were exposed around the perimeter of the continent, increasing our area by a third.³⁸ When the planet began to rewarm about 17,000 years ago, sea levels began to rise, though not at a steady rate. A collaborative study led by geochemist Stephen E Lewis from James Cook University found that “The key records of post-glacial sea-level rise from the Australian sites ... as well as from Barbados and Tahiti show remarkable agreement ... Sea level rose about 16 m in only 300 years between 14,300 to 14,600 years BP”.³⁹ That is incomparably faster than the projected sea level rise for the rest of this century. Another period of cooling took place in the southern hemisphere during the Antarctic Cold Reversal about 14,700 to 13,000 years ago, and soon after in the northern hemisphere during the Younger Dryas.

³¹ Cohen et al. (2015b)

³² Ray Tobler et al., “Aboriginal mitogenomes reveal 50,000 years of regionalism in Australia”, *Nature*, Vol 544, 2017, p180, published online by JSTOR

³³ Samar Khattiwala et al., “Air-sea disequilibrium enhances ocean carbon storage during glacial periods”, *Science Advances*, Vol 5, No 6, 12 June 2019, published online by science.org

³⁴ Andrew Moseman, “Don’t plants do better in environments with very high CO₂?”, *Climate Portal*, 8 January 2024, published online

³⁵ Laci Gerhart & Joy Ward, “Plant responses to low CO₂ of the past”, *New Phytologist*, Vol 188, No 3, 14 September 2010, p689, published online by NPH online library. Fire was possibly at least as significant a factor.

³⁶ Wes Judd, “Ice Age struck indigenous Australians hard”, *Australian Geographic*, 27 September 2013, published online

³⁷ Alan Williams et al., “Human refugia in Australia during the Last Glacial Maximum and Terminal Pleistocene: a geospatial analysis of the 25–12ka Australian archaeological record”, *Journal of Archaeological Science*, December 2013, Vol 40, Issue 12, p4612, published online by Elsevier. The total inhabited area of the continent was again reduced, this time by nearly 50%, during the Antarctic Cold Reversal, a temporary cooling that occurred between 14,500 and 13,000 ago.

³⁸ Johnathon Benjamin et al., “Aboriginal artefacts on the continental shelf reveal ancient drowned cultural landscapes in northwest Australia”, *PLoS One*, 1 July 2020, introduction, published online

³⁹ Stephen E Lewis et al., “Post-glacial sea-level changes around the Australian margin: a review”, *Quaternary Science Reviews*, 2017, Vol 74, p25, published online by Research Online: the open access institutional repository for the University of Wollongong

Low-lying coastal strips had supported established populations and were important corridors for human movement. In 2017 divers located hundreds of submerged artefacts at two different cultural sites in the Dampier Archipelago (Murujuga) in north-west Australia.⁴⁰ If the sea rose slowly coastal peoples would have had more time to plan, but even so, any decision to abandon ancestral land must have been made with great reluctance. More elevated, neighbouring areas were likely to have been optimally populated and there may have been little or no capacity or inclination to absorb an influx of extra mouths. Blainey asserted that tribes which were compelled to move inland “entered territory to which few of its members normally had right of access... The slow exodus of refugees, the sorting out of peoples and the struggle for territories probably led to many deaths as well as new alliances”.⁴¹

In Aboriginal Australia and around the world, rising sea levels must have been the most discussed issue around campfires for many centuries, even well away from the coast. It comes as no surprise therefore, as Charles and O'Brien suggested, to find “many Aboriginal oral Dreaming stories which record that sea levels were much lower than they are today”, adding, “it is incredible that this Aboriginal oral history has been shared down approximately 320 generations accurately for at least 8,000 years”.⁴² One such story saw inundation as punishment for wrong-doing:

Bund-jel was very angry with the black people, because they had done evil and wicked things; and *Bund-jel* [created the ocean, causing a flood for] many days on the earth, and all the black people were drowned, except such as *Bund-jel* favored, and these were caught up by him and fixed in the sky as stars. One Kaolin and one Baggarook — one man and one woman — who had climbed a high tree on a mountain, escaped the flood which *Bund-jel* had made, and they lived; and all the people now existing are descended from these two.⁴³

the mid-holocene warm period

In 1921 ruins of what became known as the Indus civilisation were discovered in Harappa in modern-day Pakistan's Punjab province. This civilisation disappeared for reasons that remained a mystery. Archaeologists who were focused on south-eastern Asia were similarly “puzzled by what they call ‘the missing millennia,’ a period from roughly 6000 to 4000 years ago with little evidence of human settlements”.⁴⁴ In 2020, field researchers achieved a break-through after analysing stalagmites rising up from a cave floor in northern Laos. Like ice core and sand core samples, stalagmites can provide an accurate record of ancient weather patterns. The researchers concluded that:

A megadrought that lasted more than 1000 years may have plagued Southeast Asia 5000 years ago, setting up dramatic shifts in regional civilizations⁴⁵ ... The researchers believe the drought began when the drying of the distant Sahara Desert disrupted monsoon rains and triggered droughts throughout the rest of Asia and Africa.⁴⁶

Fifteen years earlier, back in Australia, researchers had analysed core sediment from Black Springs in the Kimberley and concluded that there had been

a mid-Holocene ENSO [El Niño Southern Oscillation] forced⁴⁷ collapse of the Australian summer monsoon and ensuing mega-drought spanning approximately 1500 yrs ... The severity of the drought [they believed] was enhanced through positive feedbacks triggered by change in land surface condition and increased aerosol loading of the atmosphere⁴⁸ leading to a weakening or failure of monsoon rains. This confirms that pre-historic aboriginal cultures experienced catastrophic upheaval⁴⁹ due to rapid natural climate variability ...⁵⁰

Were these megadroughts connected? The answer seems to be found in the sands of the Sahara Desert. Between 20,000 and 10,000 years ago, the Sahara was largely uninhabited desert as it is today. Then, it

⁴⁰ Ibid. These sites have been submerged for at least 7,000 years.

⁴¹ Geoffrey Blainey, *Triumph of the Nomads*, Macmillan, South Melbourne, 1982, p91

⁴² Charles & O'Brien, p8

⁴³ R Brough Smyth, *The Aborigines of Victoria*, Government Printer J Ferres, Melbourne, vol 1, 1878, p429, republished online by Internet Archive

⁴⁴ Charles Choi, “Ancient megadrought may explain civilization's ‘missing millennia’ in Southeast Asia”, *Science Magazine*, 22 August 2020, published online

⁴⁵ Notably the Indus River (or Harappan) civilisation

⁴⁶ Choi, op cit.

⁴⁷ “Forced” weather events were caused by external factors.

⁴⁸ I.e. dust and other minute airborne particles

⁴⁹ By inference, this upheaval included the demise of the broad stroke Wandjina rock art painters.

⁵⁰ Hamish McGowan et al., “Evidence of ENSO mega-drought triggered collapse of prehistory Aboriginal society in northwest Australia”, *Geophysical Research Letters*, Wiley Online Library, 2012, abstract, published online

seems, the monsoonal summer rains returned transforming it into lush verdant landscape with permanent rivers and lakes.⁵¹ The promise of unlimited pasture drew Nile Valley pastoralists and their livestock into the region about 8,000 years ago. Within few thousand years, however, everything had reverted. **Once again, the monsoons failed.** The desert re-emerged and the pastoralists and their livestock retreated to the Nile Valley.⁵² Environmental archaeologist David Wright explains that:

as humans spread west from the Nile river 8,000 years ago, they brought with them sheep, cows, and goats that gobbled up, mowed down, and trampled over native vegetation. This transformed the landscape and altered the local climate... [Consequently] overgrazing led to drought. Drought stunted the growth vegetation, which further transformed the landscape, which worsened the drought, in a feedback loop that eventually produced a hot, dry, dusty desert roughly the size of the United States.⁵³

Trampled, churned-up soil soon eroded. Dust storms and mega-dust-plumes followed. Incalculable quantities of dust were deposited in all points of the compass: the Caribbean Sea, southern Europe and across Asia. While rain droplets form around “cloud seeds” which consist of dust and other airborne particles, air that is saturated with dust produces little or no rain. Dust-laden air drifting eastwards from north Africa over hundreds of years seems to have triggered the megadrought in south and south-eastern Asia.⁵⁴ But how were megadroughts in south-eastern Asia and Australia linked? Fagan argues that “persistent droughts in Australia often coincide with monsoon failure in India and have a close connection to the seesaw movements of the Southern Oscillation”.⁵⁵ Our weather patterns are connected to those of India and other Indian Ocean basin countries by the Indian Ocean Dipole (IOD). Typically, during a positive IOD, warmer surface temperatures in the west Indian Ocean mean less rainfall in central and southern Australia.

All this implies that anthropogenic climate change not only took place long before the Industrial Revolution but that our climate was affected by the actions of humans on the other side of the planet. It may have impacted here in another way as well. If a megadrought in south Asia brought about civilisational collapse over there, it can be reasonably inferred that whole populations were displaced. In 2010, genetic research conducted by the Max Planck Institute concluded that a group of Dravidian speakers made their way to Australia’s Kimberley coast about 4,000 years ago and stayed.⁵⁶ Nitin Saxena, a geneticist at the University of Sydney, asserted that the DNA evidence from “a slew of studies” supports this conclusion.⁵⁷ That of course is debatable, but what is beyond debate is that, during the mid-Holocene, for well over a thousand years, much of the Australian continent was at least as warm as it is today.⁵⁸

the medieval warm period

Mandy Freund and her collaborators tell us that recent droughts like the Federation Drought (1895-1903), the World War II Drought (1939-45), and the Millennium Drought (1997-2009) “may have been the worst in 800 years”.⁵⁹ Put differently, in the twelfth century there were droughts that were far worse in this country than any others we have seen since records began. Researcher Daryl Lam maintains that “the 2000-2007 South East Queensland drought has almost certainly been exceeded in duration numerous times in the last thousand years”.⁶⁰ The period of almost uninterrupted droughts here in the twelfth century is known as the Medieval Warm Period (MWP). As was the case with the mid-Holocene Warm Period, temperatures in many parts of the world were also comparable to those today. In 2011 American geologist Don Easterbrook stated that “Oxygen isotope studies in Greenland, Ireland, Germany, Switzerland, Tibet, China, New Zealand, and elsewhere, plus tree-ring data from many sites around the world all confirm the presence of a global Medieval Warm Period”.⁶¹ The Climate Extremes research group identified eight megadroughts in Australia during the MWP, “including a 39-year drought (1174–1212 CE), which occurred during an unprecedented

⁵¹ This also applied to the Arabian Peninsula. (Abdulla S Zaki et al., “Monsoonal imprint on late Quaternary landscapes of the Rub’ al Khali Desert”, *Nature*, 2025, Vol 6, No 255, published online)

⁵² Bjorn Carey, “Sahara Desert Was Once Lush and Populated”, *LiveScience*, 21 July 2006, published online

⁵³ Quoted in Jeremy Deaton, “Solving the Mystery of the Sahara”, *Nexus Media News*, 20 March 2017, published online

⁵⁴ Daniel Rosenfeld et al., “Desert dust suppressing precipitation: A possible desertification feedback loop”, *Proceedings of the National Academy of Science*, 15 May 2001, Vol 98, No 11, published online

⁵⁵ Fagan, p60

⁵⁶ See Frederick Delfin et al., “Genome-wide data substantiate Holocene gene flow from India to Australia”, *Proceedings of the National Academy of Sciences*, Vol 110, No 5, 14 January 2013, published online. This topic will be further explored at a later date.

⁵⁷ Quoted in Kumud Merani, *The Story Untold*, Part 1, (podcast), SBS, 21 March 2014, published online

⁵⁸ Patrick De Deckker, “The Holocene hypsithermal in the Australian region”, *Quaternary Science Advances*, vol 7, July 2022, abstract, republished online by Science Direct. De Dekker specifically mentions the possible influence on decreased rainfall in southern Australia as a result of a negative Southern Annular Mode when rain-bearing westerlies retreated further south of the continent.

⁵⁹ Mandy Freund et al., “Recent Australian droughts may be the worst in 800 years”, *The Conversation*, 2 May 2018, published online

⁶⁰ Daryl Lam, “Unprecedented? Unlikely.”, *Proceedings of the 11th Australian Stream Management Conference*, Victor Harbor, SA, 11-14 August 2024, republished online by River Basin Management Society

century of aridity (1102–1212 CE).⁶² We can well imagine the impact on humans and wildlife of such a drought. In the worst affected areas, as with the MWP, most surface water would have evaporated. Most creeks and rivers would have stopped flowing. Game would have become scarce. Again, there would have been catastrophic upheaval.

More ephemeral weather patterns could also wreak havoc. Fagan argues that:

The most dramatic shifts [worldwide] have been on an even shorter compass—the decadal flips of the North Atlantic Oscillation [NAO], the constant seesaws of ENSO [El Niño Southern Oscillation] in the Pacific. These shifts bring violent, unpredictable weather and threaten catastrophe, especially for societies living at the edge of survival, in marginal lands, or at high densities in exceptionally fertile environments. For the past five thousand years, ENSO and NAO have killed millions of people, caused civilisations to collapse, and taxed human ingenuity to the limit.⁶³

Port Phillip's chief protector of Aborigines G A Robinson's visit to Lake Boloke in Victoria's western district in the 1840s provides us with a glimpse of how unpredictable, short-term fluctuations in weather patterns might have affected communities. From the first days of his journey, Inga Clendinnen told us, Robinson:

makes frequent reference [in his journal] to a place called Boloke. There is a lake there and an abundance of fish and fowl which still draws natives from all over the region. So rich is the abundance that this is a traditional meeting-place for the ceremonial resolution of conflict, a place of feasting and of celebration. Through the slow drudge of days Boloke shimmers on the edge of awareness as a vision of peace and plenty. Then he goes there—to find desolation. The lake waters have been sucked up by drought. There are signs of many natives: 'a vast number' of old shelters, abandoned tools, and everywhere on the beach their tracks, 'thick as sheep tracks'. On this day he sees not one. Instead there are dead eels, on the sand, on the banks, strewn along the beach. At the deserted camps 'dead eels lay in mounds; thousands of dead eels, and very large ones too'. Crows are feasting upon them.⁶⁴

Fortunes changed dramatically as the eels went from being "rich in their abundance" to being "strewn along the beach". Anywhere food resources dramatically shrank, communities would have come under pressure to move outside their domain which may well have triggered conflict over dwindling resources. A W Howitt described a more recent pattern of interactions that may well provide a window into the deep past:

There is a large extent of country, without any permanent surface water, between the Darling, Murray, and Murrumbidgee Rivers. This was occupied by the Berriait tribe ... At times of drought they were forced to go to the rivers for water, and as these were occupied by other tribes such as the Barkinji and the Wonghibon, they had to fight their way in strong parties.⁶⁵

If pitched battles did take place, the outcome could well have been dire for the losers and perhaps for all involved. Asymmetric access to food resources could explain why explorers like Sturt and Mitchell one day encountered kinship groups whose members were "clean-limbed" and "well-conditioned"⁶⁶ and a day or two later encountered others who were starving and in a pitiable state.⁶⁷ Certainly, seasonality was a major factor as well. In 1865 English naturalist Augustus Oldfield remarked:

During the summer season, the black man riots abundance, but during the rest of the year, when vegetation is dormant, when some kinds of game have retired to winter quarters, and others, through frequent hunting, have become shy, and consequently difficult to capture, and when the fish, having performed their mission, have deserted the rivers, the struggle for existence becomes very severe.⁶⁸

wildfires

It is commonly asserted that devastating wildfires have only occurred *since* Europeans arrived. Conventional wisdom has it that the early settlers so disrupted Aboriginal fire management systems that fuel loads built up to a point where frequent, devastating wildfires became inevitable. There is no doubt some truth in that view, but it does not seem to adequately take into account fuel reduction that resulted from intensive grazing by

⁶¹ Don J. Easterbrook, "Geologic Evidence of Recurring Climate Cycles and Their Implications for the Cause of Global Climate Changes—The Past is the Key to the Future", in *Evidence-Based Climate Science*, 2011, section 5.1.1.6, published online

⁶² Nerilie Abram, "Insights into drought from palaeoclimate data", *Australian Research Council Centre of Excellence for Climate Extremes*, 2018, published online. This century included a 39-year drought which was three times longer than the longest drought we have experienced since 1788.

⁶³ Fagan, p109

⁶⁴ Inga Clendinnen, *Tiger's Eye*, Text Publishing, Melbourne, 2000, pp216-17

⁶⁵ Alfred William Howitt, *The Native Tribes of South-eastern Australia*, Macmillan, London, 1904, p51, published online by Internet Archive

⁶⁶ Charles Sturt, *Two Expeditions into the Interior of Southern Australia*, Smith, Elder, London, 1833, p108, republished online by Australian Digital Collections (University of Sydney)

⁶⁷ Sturt, p112

⁶⁸ Augustus Oldfield, "On the Aborigines of Australia", in *Transactions of the Ethnological Society of London*, Vol 3, Royal Anthropological Institute of Great Britain and Ireland, London, 1865, pp269-70, published online by JSTOR

introduced herbivores or the clearing of forests; nor does it take into account the inherent physical and logistical limitations on the area of land that could be regularly burnt by relatively sparse populations, especially in relation to difficult-to-access land and land that people may have had little or no reason to visit. In Aboriginal Australia, select areas (such as around encampments, along songlines and across grasslands) were burned most regularly while fuel loads were likely to build up elsewhere. We know, also from the journals of early explorers, that there were many large tracts of forest and scrub — some of which explorers found impenetrable — that showed little or no evidence of having been recently burnt. That may have been due to damp fuel, poor accessibility and/or the limitations mooted above on manpower imposed by low populations. Victoria's Otways Ranges — which were ravaged by the Ash Wednesday fires in 2003 — boasted all three of these factors in the early nineteenth century. Much of this mountain range is steep and covered in dense, virtually impenetrable bush; it has high rainfall and was sparsely populated. There is some evidence that Aboriginal people tended to avoid the Otways and rainforests in general. Environmental researcher Lawrence Niewójt states that, according to calculations based on chance encounters, only 26 Gadubanud individuals lived in the Otways at the time of first contact, "a remarkably tiny group size for a vast territory stretching from Painkalac Creek (near Aireys Inlet) in the east to the Gellibrand River that flows west of the mountains".⁶⁹ Even if this figure was an underestimate, it is unlikely that the risk of severe wildfires was ever eliminated by means of cultural burning. Nor ought we automatically assume that populations occupying any tracts of land were always stable enough to indefinitely maintain an effective land management regime. G A Robinson, having pushed his way through dense scrub in Gippsland, noted that, due to communal warfare, when a "once powerful" tribe became defunct, their "country in consequence [was] unburnt having no native inhabitants".⁷⁰

It would be surprising if devastating fires had not occurred before colonisation. Researchers Neal Enright and Ian Thomas hold that while climatic changes during the Holocene drove both the drying and increasing fire-proneness of Australian landscapes, the situation may have been exacerbated by Aboriginal land practices.⁷¹ Fire ecologists Manu Black and Scott Mooney agree. They suggest that the high fire activity during the mid-Holocene "seems likely [to have been] a complex nexus between climate and human society".⁷²

As noted above, Charles and O'Brien list large-scale bushfires as one of the hazards that made the original peopling of Australia "the harshest time in human history". The difficulty, it seems, is in proving it. In the words of science writer Amber Dance, "Evidence of fire is ephemeral: Its traces, in the form of ashes or baked soils, are usually eroded away by wind or water".⁷³ As well as being the flattest and driest of the habitable continents, Australia has also been described as the most flammable.⁷⁴ Sclerophyll forests, most particularly, are structured to burn.⁷⁵ Wildfires are generally more frequent and more intense when El Niños follow La Ninas. Bliege Bird et al. noted that "greater climatic variability tends to increase wildfire size [across diverse ecosystems], particularly in Australia, where alternating wet-dry cycles increase vegetation growth, only to leave a dry overgrown landscape highly susceptible to fire spread".⁷⁶ The likelihood and intensity of wildfires is determined by a combination of fuel load, humidity, wind and ignition. Ignition was constant because lit on a daily basis, all-year-round, across Australia, even on days that would now be declared total fire ban days. People depended on fire for cooking, warmth, hunting and shaping tools and equipment. They were even used as a weapon of war, as recounted by runaway William Buckley.⁷⁷ Even though the first Australians were masters of fire, accidents were possible,⁷⁸ just as they are today. In 2005, despite modern

⁶⁹ Lawrence Niewójt, "Gadubanud society in the Otway Ranges, Victoria: an environmental history", *Aboriginal History*, vol 33, 2009, p179, republished online by JSTOR. Niewójt hastens to add that a range of *other* evidence suggests that a more accurate number was in the hundreds. Nevertheless, it is unlikely that even hundreds of people could have effectively managed the potential fire risk of such an extensive and often difficult-to-access mountain range has been known for its terrible post-contact wildfires.

⁷⁰ Marie Hanson Fels, 'I succeeded once': The Aboriginal Protectorate on the Mornington Peninsula, 1839-1840, *ANU E PRESS*, 2011, p255, published online by library.open.org

⁷¹ Neal J Enright & Ian Thomas, "Pre-European Fire Regimes in Australian Ecosystems", *Geography Compass*, June 2008, Vol 2, No 4, republished online by Wiley

⁷² Manu P. Black & Scott D. Mooney, "Holocene fire history from the Greater Blue Mountains World Heritage Area, New South Wales, Australia: the climate, humans and fire nexus", *Regional Environmental Change*, March 2006, p48, published online

⁷³ Amber Dance, "Uncovering Ancient Clues to Humanity's First Fires", *Sapiens Anthropology Magazine*, 14 June 2017, published online

Establishing that such megafires occurred over a large area would require sampling many sites, which appears to be an area of research that does not attract adequate funding.

⁷⁴ Christopher M. Wurster et al., "Indigenous impacts on north Australian savanna fire regimes over the Holocene", *Scientific Reports*, Vol 11, 2021, published online by nature.com

⁷⁵ This will be examined elsewhere in greater detail.

⁷⁶ Rebecca Bliege Bird et al., "Aboriginal hunting buffers climate-driven fire-size variability in Australia's spinifex grasslands", 2012, *Proceedings of the National Academy of Sciences*, June 2012, republished online by ResearchGate

⁷⁷ William Buckley, *The Life and Adventures of William Buckley*, Text Publishing, Melbourne, 2009 (1842), pp131-32

⁷⁸ Sylvia Hallam, *Fire and Hearth*, Australian Institute of Aboriginal Studies, Canberra, 1975, p44. One of the more common accidents was rolling onto a camp fire at night while asleep.

fire management systems and modern technology, a fuel reduction burn escaped in Wilsons Promontory National Park and much of the park was incinerated. Nineteenth century Victorian pastoralist Edward Curr observed that Aboriginal people, who were then still living traditionally, were “constantly setting fire to the grass and trees, both accidentally, and systematically for hunting purposes.”⁷⁹ Anticipating Rhys Jones by nearly 100 years⁸⁰, he wrote:

Living principally on wild roots and animals, *he tilled his land and cultivated his pastures with fire*; and we shall not, perhaps, be far from the truth if we conclude that almost every part of New Holland was swept over by a fierce fire, on an average, once in every five years. That such constant and extensive conflagrations could have occurred without something more than temporary consequences seems impossible, and I am disposed to attribute to them many important features of Nature here; for instance, the baked, calcined, indurated condition of the ground so common to many parts of the continent, the remarkable absence of mould which should have resulted from the accumulation of decayed vegetation, the comparative unproductiveness of our soils, the character of our vegetation and its scantiness, the retention within bounds of insect life (notably of the locust, grasshopper, caterpillar, ant and moth), a most important function, and the comparative scarcity of insectivorous birds and birds of prey. They must also have had an influence on the thermometrical range, and probably affected the rainfall and atmospheric and electrical conditions.⁸¹ [My emphasis]

In July 1935, anthropologist Donald Thomson and his Aboriginal guides travelled on foot through rough terrain in eastern Arnhem Land in order to meet Yolngu elder Wonggu. He wrote:

On the fringe of Arnhem Bay we descended upon a great grass flat, thousands of acres in extent, covered by a dense growth of blady grass six or seven feet in height... with the dual object of clearing the way and attracting the attention of any people who might be in the neighbourhood, we fired those grass flats. The result was the biggest fire I have ever seen. It swept after us rapidly with an ominous roar and we had to halt and burn breaks to clear the ground ahead of us to ensure our own safety. Flames shot hundreds of feet into the air and dense clouds of smoke rose to the sky, obscuring the sun, so that for hours it shed only a pale yellowish light over the country... To me the destruction was appalling, but the people were accustomed to these great fires for they burn the grass regularly each season to enable them to travel freely about the country and to assist them in hunting game.⁸²

There are Dreamtime stories of conflagrations such as the following story relayed by historian James Bonwick:

[Many] years ago, ... where there was abundance of gum trees, opossums, and fresh water; ... the sorcerers of the land of Toolcoon, a neighbouring country, set the bush on fire, the flames of which spread in all directions, driving the natives before it, and destroyed many tribes. Coma, the progenitor of the Murray tribes, was on the point of perishing, with his family, when the Murray burst from a cleft in the ground and extinguished the flames around them. It flowed on, till it came to the sea, and has, ever since, formed a barrier to the fire extending across the continent, as it did once in ancient times. Whether this story has any foundation in the facts of former ages, it would be vain to attempt to determine ...⁸³

A wildfire on the scale of, say, Ash Wednesday would undoubtedly have impacted very differently on Aboriginal Australia compared to contemporary society. Firstly, families did not own thousands of material goods (as we do) that could be destroyed by fire. Secondly, apart from anyone who was very old or otherwise very infirm, kin groups and families were highly mobile and knew where there was safe shelter. The main on-going risk during a wildfire, therefore, may have been to hunting grounds and food security. That could have been very serious if there were local extinctions of staple prey. We can borrow a horrific example from North America where the fire regime was remarkably similar to that of Aboriginal Australia. In 2023, building on more than a century of earlier research in and around the La Brea tar pits, researchers uncovered a trove of evidence pointing to human-lit wildfires which ravaged southern California 12-13,000 years ago. Following a centuries-long megadrought, these fires triggered a chain of mass extinctions of megafauna.⁸⁴ We do not seem to have hard evidence of events of that kind happening here.

flooding rains

⁷⁹ Edward Curr, *Recollections of Squatting in Victoria*, George Robertson, Melbourne, 1883, p191, published online by the Australian Legal Information Institute

⁸⁰ See italicised passage.

⁸¹ Ibid. Curr was very articulate for a man who seems not to have been educated beyond his time in Ushaw College, a Roman Catholic seminary.

⁸² Donald Thomson, *Donald Thomson in Arnhem Land*, The Miegunya Press, Melbourne, 2010, p88

⁸³ James Bonwick, *The Wild White Man and his Port Phillip Friends*, Geo. Nicholls, Melbourne, 1856, p55, republished online by AITSIS

⁸⁴ F Robin O'Keefe et al., “Pre-Younger Dryas megafaunal extirpation at Rancho La Brea linked to fire-driven state shift”, *Science*, vol 381, issue 6659, 18 Aug 2023, published online

Australia's flatness means that floodwater spreads widely and drains slowly. The floods that engulfed Queensland in Autumn 2025 were "bigger than Texas" but, after the initial downpours, few who were in the path of the floodwater were taken by surprise.⁸⁵ As extreme as recent floods have been, past flooding, however, seems to have been significantly worse. According to Lam, "evidence of extreme floods from the past has been found throughout Australia' [many of them being] of greater magnitude than in the records".⁸⁶ Jonathan Nott and his collaborators agree, arguing that

plunge-pool sedimentary sequences ... [which] provide a record of extreme floods for the last 30,000 years ... identify the early to mid-Holocene and the period immediately prior to the Last Glacial Maximum as the two periods of greatest flood magnitudes of the late Quaternary. Flood discharges at these times were up to five times greater than any floods experienced over the last 4,000 years.⁸⁷

One of the main sources of flooding is tropical rain depressions that develop as cyclones track inland. Climate modellers Johnathan Koh and Chris Brierley argue that the global frequency of tropical cyclone formation has been relatively constant over the range of past climates.⁸⁸ The ancestor of the first Australians of course had already encountered cyclones in south-east Asia long before they arrived here. No doubt they had time-proven strategies to keep themselves safe, such early detection and retreating to secure shelters. Past and present indigenous Mornington Islanders have been able read various warnings of severe storms and cyclones, such as when birds known as "manowar" are observed flying over Mornington.⁸⁹ A persistent (if contested) story has circulated ever since Cyclone Tracey hit Darwin on Christmas Eve 1974 to the effect that Aboriginal residents had already deserted the town.⁹⁰ Aboriginal Australians have also long had ready strategies to deal with floods. Unlike settlers they did not build permanent dwellings on the edge of waterways. They could decamp at a moment's notice without experiencing terrible property loss. Moreover, many historical accounts suggest that they were excellent swimmers.

tsunamis

To Charles and O'Brien's list of natural hazards we can add tsunamis and comet strikes. Researchers have found ample physical evidence of megatsunamis pounding settled areas along the Australian coastline. Possible triggers include volcanic eruptions, earthquakes, submarine landslips and, indeed, comet strikes. Bryant and Knott describe the sheer power of these megatsunamis:

The largest palaeo-tsunami waves in Australia swept sediment across the continental shelf and obtained flow depths of 15–20 m at the coastline with velocities in excess of 10 m s⁻¹ [i.e. 10 metres per second]. In New South Wales, along the cliffs of Jervis Bay, waves reached elevations of more than 80 m above sea-level with evidence of flow depths in excess of 10 m. These waves swept 10 km inland over the Shoalhaven delta. In northern Queensland, boulders more than 6 m in diameter and weighing 286 tonnes were tossed alongshore above cyclone storm wave limits inside the Great Barrier Reef. In Western Australia waves overrode and breached 60 m high hills up to 5 km inland. Shell debris and cobbles can be found within deposits mapped as dunes, 30 km inland. The array of signatures provide directional information about the origin of the tsunami and, when combined with radiocarbon dating, indicate that at least one and maybe two catastrophic events have occurred during the last 1000 years along these three coasts.⁹¹

One of the most catastrophic series of tsunamis in recorded history was triggered by the eruption of Krakatoa in Indonesia in 1883. Seismic sea waves were

recorded as far away as South America and Hawaii. The greatest wave, which reached a height of 120 feet (37 metres) and took some 36,000 lives in nearby coastal towns of Java and Sumatra, occurred just after the climactic explosion.⁹²

⁸⁵ "Flood", *Geoscience Australia*, page last updated: 14 May 2025, published online

⁸⁶ Lam, op cit.

⁸⁷ Jonathan F Nott, David M Price & Edward A Bryant, "A 30,000 year record of extreme floods in tropical Australia from relict plunge-pool deposits", *Geophysical Research Letters*, Vol 23, Issue 4, 15 February 1996, pp 379-382, republished online by ACU Publications. Since settlement, catching water in dams and reservoirs, and pumping it from waterways for irrigation and town water, no doubt affected environmental flow in drier times, but also may have mitigated moderate flooding to some degree.

⁸⁸ J H Koh & C M Brierley, "Tropical Cyclone Genesis across Palaeoclimates", *Climate of the Past Discussions*, Copernicus Publications, London, 2015, Vol 11, p200, published online

⁸⁹ Eddie McLachlan, "Seagulls on the Airstrip: Indigenous Perspectives on Cyclone Vulnerability Awareness and Mitigation Strategies for Remote Communities in the Gulf of Carpentaria", *Australian Disaster Resilience*, (undated, possibly 2 January 2018), published online. These would be man-o-war or lesser frigate birds.

⁹⁰ Gail Liston & Xavier La Canna, "Cyclone Tracey: Aboriginal people foresaw 'bad event' in Darwin, *ABC website*, Thursday 25 December 2014

⁹¹ Edward Bryant and Johnathon Knott, "Geological Indicators of Large Tsunami in Australia", *Natural Hazards*, Kluwer Academic Publishers, Holland, 2001, abstract

⁹² "Krakatoa", *Encyclopaedia Britannica*, 16 January 2020, accessed 1 September 2021

According to the *Australian Geographic*:

Its force was four times more powerful than the largest bomb ever detonated, with resulting concussive air waves that travelled seven times around the globe... The eruption ... was heard some 3500km away in Perth, ... global temperatures fell by as much as 1.2°C in Krakatoa's aftermath, and, says Dr Kelsie Dadd from Macquarie University, sunlight reflected from suspended dust particles resulted in spectacular sunsets throughout the world for months afterwards.⁹³

In north-western Australia, one tsunami tossed about a boulder weighing 286 tonnes, while another generated an 80-metre wave that swept inland for ten kilometres.⁹⁴ The most destructive of all known tsunamis, though

occurred around the seventeenth century [and] can now be traced along 1500 km of coastline [of the Kimberley] ... Aboriginal legends [associated with the Wandjina paintings] concentrate on the three main elements of a comet impact in the ocean: the comet itself, tsunami and flooding rains ... The Wandjina event generated the biggest and most widespread mega-tsunami yet found in the Australian region. The wave reached a maximum of 35 km inland in the Great Sandy Desert, deposited sands up to 40 m deep on the lee side of headlands and laid down bedded gravels on the landward side of 40 m hills situated over 5 km inland (Bryant & Nott 2001; Nott & Bryant 2003). These aspects are an order of magnitude greater than that produced by any historic volcanic or earthquake generated tsunami originating from Indonesia (Nott & Bryant 2003). The spectacular nature of this cosmic phenomenon has dominated Aboriginal mythology for the past four centuries.⁹⁵

We can only imagine how giant waves might have impacted on unsuspecting coast-dwellers when such events seemed to occur both sporadically and unpredictably, sometimes centuries apart. Did coastal communities register what they were seeing, let alone have ready survival strategies?⁹⁶ Bryant captures the suddenness of an impending onslaught:

Aborigines at [such] locations initially would have heard, but not seen, the tsunami approaching. Their first indication of disaster would have been when they looked up and saw the ocean dropping on them from the sky as the tsunami wave surged over headlands.⁹⁷

comets

Oral traditions seem often to have been designed more to regulate behaviour than anything else. In 1904, for example, anthropologist **AW Howitt** recounted the legend of the sea rushing over the land and drowning nearly all mankind because secrets had been betrayed to women.⁹⁸ Nevertheless, oral traditions can provide valuable and unique insights into past events. Bryant et al. argue that "Aboriginal legends about comets and tsunami are ubiquitous throughout Australia".⁹⁹ In a 2013 research paper, Duane Hamacher analysed 11 oral traditions and historical records and established that at least some of them were "plausible instances of Aboriginal oral traditions leading to (or coinciding with) colonial identification of the meteorites". Hamacher identifies a possible meteorite site on the north-east outskirts of Melbourne which has been since demolished by a quarrying company:

An account of a cosmic impact event in Victoria is found in the traditions of the Wurundjeri people of the Melbourne region [Hamacher tells us]. According to Smyth (1878) a deep cavern at Cave Hill in Lilydale, 35 km east of Melbourne, is described in local oral traditions as a place where a star fell from the sky. The cavern is called *Bukkertillibe* in the Wurundjeri language, which roughly translates to "bottomless pit." According to the oral tradition, it was formed when the sky-deity *Pundjel* (more commonly known as *Bunjil*) became angry when the people did things that displeased him. In a rage, he caused a star to fall from the sky and strike the earth, creating the hole and killing many people. The story served to explain the origin of the cavern, which was unique in the region. The oral tradition served as a strict warning to follow laws and traditions.¹⁰⁰

⁹³ Julian Swallow, "On this day: Krakatau's massive eruption", *Australian Geographic*, 7 November 2013, published online. Some of us will well remember the beautiful mauve sunsets that appeared in the sky after Pinatubo erupted in 1991.

⁹⁴ 80 metres is the equivalent height of a 26 story skyscraper.

⁹⁵ Bryant et al., p213

⁹⁶ In Phuket in southern Thailand on 26 December 2004 thousands of people drowned after being struck by a tsunami. Many who died had ventured well away from the normal shoreline after the approaching tsunami sucked out seawater. They were were attracted by the water-filled depressions dotted about the exposed seafloor and the promise of entrapped fish. In this case they seem to have been the victims of their own natural curiosity.

⁹⁷ Edward Bryant, "Cosmogenic mega-tsunami in the Australia region: are they supported by Aboriginal and Maori legends?", University of Wollongong Research Online, 2007, p205

⁹⁸ Alfred William Howitt, *The Native Tribes of South-eastern Australia*, Macmillan, London, 1904, p494, published online by Internet Archive

⁹⁹ Bryant et al., p205

¹⁰⁰ Duane W. Hamacher, "Recorded Accounts of Meteoritic Events in the Oral Traditions of Indigenous Australians", *Archaeoastronomy*, Vol 25, Sydney, 2013, p8, published online

volcanic eruptions

As noted above, a relatively small pocket of Australia — comprising western Victoria and south-eastern South Australia — experienced volcanic eruptions before humans arrived until a few thousand years ago. The impact on those living near active volcanoes or in the path of lava flows would certainly have ranged from dislocating to devastating. It may have meant loss of their hunting grounds, disruption of water courses and/or the need to relocate wholly or partly outside traditional estates, but may have also created economic opportunities such as those associated with the Budj Bim eel traps. The time-frozen figures of Pompeii dramatically remind us of how people can be caught out by such natural disasters. There are, unsurprisingly, dreamtime stories about eruptions that took place, including a tradition among the aborigines of the western district of Victoria that fire came out of a hill near Mortlake, and of "stones which their fathers told them had been thrown out of the hill by the action of fire."¹⁰¹ Volcanoes, like tornadoes and earthquakes, were relatively local and would not have impacted human occupation in Australia anywhere near the same degree as the continent-wide megadisasters.

conclusion

Those of our ancestors who settled in the fertile valleys of the Rhine or Danube Rivers and the great river deltas of Asia found abundance but remained geographically connected with the rest of the known world to the degree that they could benefit from the **transformative** discoveries and inventions elsewhere. They could not have predicted that their descendants would eventually create wealthy, populous and powerful societies which had access to.

A vanguard of modern humans walked to the south-eastern edge of the world. Some of their descendants later sailed or drifted across a sea channel to an unknown destination. They too set foot on what presented as a land of plenty but was essentially a fragile, weathered land comprising unique biomes and biota that had evolved in isolation for tens of millions of years. As soon as they arrived the first Australians themselves became almost entirely isolated from the rest of humanity for hundreds of generations.¹⁰² After a relatively brief period that seems to have been idyllic, fortunes changed. First there were the mass extinctions of most of our megafauna (millennia before almost all similar extinctions elsewhere).¹⁰³ Then there was a drawn-out cycle of climate-based existential crises, including the desiccation of much of the continent, the chilling of the continent and the inundation of much of our coastline. While it is most likely that there was a series of population collapses in the past twenty thousand, the best-adapted (and luckiest) human lineages survived at least five continental-scale climate-based mega-disasters and an untold number of regional and local catastrophes.

Isolation from the rest of the world had for an eternity protected Australian ecosystems from external threats. Similarly, as long as the first Australians were isolated from other humans, they remained free from exotic diseases, foreign influences and foreign invasion. If Australia had been easily accessible from mainland Asia, the first Australians may have been subjugated or displaced in the same way that most of their hunter-gatherer cousins in the Indonesian archipelago were when farmers arrived from the north about 4,000 years ago. Instead, Aboriginal Australians exercised sovereignty over their own land and developed their own unique cultures, as far as we know, without foreign interference for many millennia. They did not have to endure the terrible cost of "progress" that accompanied the transformation of societies overseas and brought about the class system, slavery, prisons, plagues, wars and inquisitions. It is unlikely that serfs in medieval Europe were better off than most foragers in Australia. After all, who would choose a life of drudgery, servitude and conscription ahead of roaming freely through unspoiled vistas, living by one's wits and physical prowess, working according to need, equitably sharing the produce of labour, and fully participating in a rich spiritual life, **always with a sense of place and a sense of purpose?**

According to one estimate, a billion descendants of the first tiny band/s of adventurers who successfully made their way from south-eastern Asia have drawn breath here.¹⁰⁴ While we would expect that populations ebbed and flowed over time, how a critical mass of humans were able, not only survive so many existential crises but occupy every corner of such a disparate continent is a more complex question than it might first

¹⁰¹ Reginald Murray, *Geology and Physical Geography of Victoria*, Government Printer, Melbourne, 1887, p129, republished online by Internet Archive

¹⁰² There were some examples of hardware introduced from New Guinea, such as Bougainvillean outrigger canoes used in eastern Cape York and dugout canoes traded from Macassans, though these exchanges were probably both very recent.

¹⁰³ The extinction of most of the megafauna can properly be regarded as a major disaster which forced populations throughout Sahul to reorganise the ways that they procured food.

¹⁰⁴ Billy Griffiths, *Deep Time Dreaming*, Black Inc, Melbourne, 2019, p1

appear. Isolation was critical but only one of many factors. I think that of equal importance were the ingenuity and resilience of the first Australians, their mobility and adaptability, their low population densities, small-group autonomy, cosmologies which promoted social cohesion and personal toughness *and*, as suggested above, a good measure of luck. Whatever the reasons for the successful peopling of Australia, it was a truly remarkable achievement.

In the words of archaeologist Harry Allen:

In colonising this continent 50,000 years ago, Aboriginal people opened the chapter of human history in Australia. In tending the light of human culture in Australia and creatively responding to the difficult times that followed, they fulfilled all the requirements we could ask of any people.¹⁰⁵

¹⁰⁵ Harry Allen, "The past in the present? Archaeological Narratives and Aboriginal History" in *Long History, Deep Time*, ANU, Canberra, 2016, republished online by JSTOR