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Integrating long-lived traditions and scientific knowledge to improve understanding of volcanic history and hazards: examples from Australasia and the Pacific Islands

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Abstract

Traditional knowledge and oral accounts of natural phenomena provide valuable insights into natural hazards, including volcanic eruptions. Indigenous societies with oral traditions have often developed culturally grounded strategies for mitigating volcanic hazards. However, the integration of cultural knowledge and scientific understanding remains underexplored in modern volcanic hazard mitigation. This study takes a qualitative approach, using examples from Australasia and the Pacific Islands, to examine how the integration of long-standing cultural knowledge and volcanological research can enhance our understanding of precursory activity, eruption chronologies, and the relative timing of past volcanic events. Additionally, it offers detailed accounts of the hazards experienced and their impacts on people and the environment. We also propose directions for future research. Whilst differing world views in the causation of volcanic activity will remain, incorporating all available

knowledge on past volcanic events will help local communities in volcanically active regions become better prepared and more resilient to future volcanic activity.

1. Introduction

In recent years, several studies have shown that culturally grounded traditions (often labelled 'myths' and 'legends') about natural phenomena are plausibly based on eyewitness accounts of these events, often made millennia prior (Piccardi & Masse, 2007; Németh & Cronin, 2009; Liritzis et al., 2019). Among the most memorable and widespread traditions are those recalling volcanic phenomena which are found in almost every regularly active volcanic zone in the world (Blong, 1982; Buckland et al., 1997; Deur, 2002; Swanson, 2008; Nunn et al., 2019; Nordvig, 2021; Lancini et al., 2023).

While some have argued that the memorability of volcanic phenomena was sufficient to have them feature in enduring oral traditions, recent research (e.g., Fepuleai et al., 2017; Nunn et al., 2019; Németh and Gravis, 2022; Holmberg, 2023) shows that such traditions likely served multiple roles, including forms of situational applicability. For by recalling what had happened in the past, specifically the range and expression of particular manifestations of volcanism (such as gas emissions, ash fall, lava flows, volcano and caldera formation) and the hazards they posed to people in particular places (such as toxic-gas emission, times of darkness, pollution of water sources, smothering of food resources), these traditions can play roles comparable to those in modern risk planning. This point has been demonstrated in Pacific Island contexts, particularly within the cultural regions of Melanesia and Polynesia (Petterson et al., 2003; Cashman & Cronin, 2008), in Papua New Guinea and the Philippines (Blong, 1982; Rodolfo & Umbal, 2008), in China (Haiquan et al., 2002), in the Cascade Range of the western USA and Canada (Deur, 2002; Nunn, 2018) and along northern Mediterranean coasts (De Benedetti et al., 2008). Furthermore, it has been discussed that enduring (oral) traditions preserve information on past volcanic activity that enable a more in-depth study of volcano history, including aspects beyond the reach of modern scientific enquiry. These traditions might also contain details that allow the mechanics and (proximate) causes of volcanism at particular places to be identified (Viramonte & Incer-Barquero, 2008; Nunn, 2014; Fepuleai et al., 2017).

This study employs a qualitative research approach to explore the long-standing traditions of volcanism in Australasia and the Pacific Islands. Using a case study design, we aim to explore how these traditions inform and potentially enhance modern interpretations of volcanic activity and its impacts in the region. Our methodology integrates traditional knowledge (and its interpretation) from the existing literature, along with cultural perspective and insights held by traditional knowledge holders within the project team, alongside published scientific data. Our research builds on and broadens earlier discussions of this topic (especially Cashman & Cronin, 2008; Cronin & Cashman, 2008) and extends insights from well-studied locations to lesser-known ones to guide future research. We acknowledge that there are limitations to approaches that selectively interpret traditional stories through external frameworks. When non-local or non-traditional researchers isolate and extract elements they deem relevant to their research aims, especially across culturally and geographically diverse contexts, there is a risk of misrepresenting or distorting the stories' original meanings or intended significance (Gill et al., 2021). Additionally, use of written records, often of colonial (non-traditional) origin, to investigate oral histories and traditions of another culture introduces inherent challenges, including biases and misinterpretations (Cashman and Cronin, 2008; Swanson, 2008; Kouritzin & Nakagawa, 2018). Throughout this paper, we use the term *understanding* broadly to refer to the ability to comprehend, interpret, or make sense of phenomena. We acknowledge that in scientific discourse, *understanding* typically implies causal explanation based on empirical evidence. However, we also use *understanding* in a cultural or interpretive sense, referring to how individuals or communities make meaning of experiences, including spiritual or non-empirical domains.

The next section gives context to this paper, explaining the nature of traditional knowledge of volcanism, its cultural filters, and its often multi-millennial longevity. Section 3 discusses how such traditions can improve knowledge of volcanic history, hazards and impacts, while Section 4 examines the role of such traditions in volcanic risk management, past and future. Section 5 asks whether contemporary understandings of the nature of volcanism in representative localities might be enhanced by the examination of details in traditional knowledge, and Section 6 sets out a future research agenda.

2. Traditional knowledge of volcanism in Australasia and the Pacific Islands

The geotectonic diversity of Australasia (Australia, New Zealand and Papua New Guinea) and the Pacific Islands helps account for the unevenness of stories about volcanism across this vast region. Mainland Australia itself, largely a continental fragment within the Indo-Australian Plate and having no active margins, has experienced little recent volcanism since human occupation 50,000 years ago or longer (Clarkson et al., 2017; Tobler et al., 2017), the exceptions being the Newer Volcanics Province (NVP) in southeast Australia, with most recent eruptions around 5000 years ago, and in northeastern Queensland, with activity as recently as 7000 years ago (Whitehead et al., 2007; Cas et al., 2017; Cohen et al., 2017). Based on the present scientific dating of eruptions (Whitehead et al., 2007; Cohen et al., 2017; Matchan et al., 2018), approximately 15 volcanoes are likely to have been active since human arrival to Australia. In contrast, New Zealand (Aotearoa), where people first arrived only about 800 years ago (Hogg et al., 2003; Anderson, 2015), and much of Papua New Guinea, probably settled about the same time as Australia (Summerhayes et al., 2010), straddle convergent plate boundaries along which young volcanism has been comparatively frequent (Hill & Hall, 2003; Stirling et al., 2017). The situation in the Pacific Islands, where people arrived first about 3500 years ago (Carson, 2018), ranges widely from convergent plate-boundary situations where volcanism is common, to other plate-boundary and intraplate situations where it is rare; the most common exceptions in the latter are at hotspots where relatively fixed mantle plumes are crossed by moving lithospheric plates, giving rise to linear chains of islands (Nunn, 1994; Nunn, 1999b; Neall & Trewick, 2008). There is evidence that ancestral Pacific Islanders, who had crossed the entire Pacific from west to east before European arrival, witnessed shallow-water ocean volcanism and incorporated this into oral traditions (Nunn, 2003).

2.1. Cultural filtering of observations of ancient volcanism

Stories among Indigenous Australian (Aboriginal) cultures have endured for millennia (Hamacher & Norris, 2009; Nunn & Reid, 2016; Nunn, 2018; Nunn et al., 2019; Wilkie et al., 2020). This is attributable to the harshness of the climate and/or land, the challenges of survival, and the consequent imperative to pass knowledge across generations as completely and as clearly as possible (Ross, 1986). This knowledge includes stories of volcanism and other hazardous or livelihood-disrupting phenomena about which each successive generation should learn in case such phenomena might reoccur (e.g., Hamacher & Norris, 2009; Nunn & Reid, 2016). For example, when “some of the volcanic bombs found among the scoriæ at the foot of Mount Leura” in the Newer Volcanic Province were shown to a local Aboriginal man in the 1880s “he said they were like stones which their forefathers told them had been thrown out of the hill by the action of fire” (Dawson, 1881, p. 102). Stories about giant serpents, which abound in Aboriginal Australian traditions, may have arisen from observations of “lava flows winding their way along watercourses and valleys… after solidifying and cooling, some of these lava flows revealed tunnels through their interiors” which may have led to the intentional avoidance of such places in Aboriginal traditions (Bindon & Raynal, 1998, p.4).

In Papua New Guinea, where volcanism is more widespread and occurs more frequently than in mainland Australia, less has been formally recorded about volcano stories and traditions, although these are almost certainly ubiquitous (Blong, 1982; Johnson, 2013). For example, in the New Guinea highlands, stories about the “times of darkness” (or *Yuu Kuia*), which occurred in the aftermath of major eruption events when volcanic ash blocked out sunlight and fell from the skies, are regarded by the Enga people as *atome pii* (historical events) not *tindi pii* (myths) (Mai, 1981).

In New Zealand and the Pacific Islands, stories about volcanism are common. As with explanations for catastrophe in many traditional (oral knowledge-based) societies, human behaviour is commonly ‘blamed’ for their occurrence (Purzycki et al., 2016). For example, the perverse actions of one group are ultimately held responsible for the island-destroying eruption of Kuwae (Vanuatu) in 1453 Common

Era (CE) (Ballard, 2020). In addition, the ~2500-year-old dome-forming eruption at Nabukelevu (Fiji) was locally interpreted to result from divine actions, and its subsequent impacts as a result of conflicts between gods (Cronin et al., 2004a; Nunn, 2018). Furthermore, there is evidence that Pacific Islander peoples deliberately avoided places where eruptions had once occurred. Examples include the *tapu* (taboos) used this way in New Zealand. For example, on the active volcanic mountain of Taranaki (North Island), "the designation of the upper slopes as a sacred area (*wahi tapu*), perhaps after initially being declared out of bounds (*rahui*), was a deliberate societal response to reduce the [human] impacts of future eruptions" (Lowe et al., 2002, p. 138). Observations of shallow-water volcanism by cross-ocean voyaging Pacific Islander peoples, likely informed pan-Pacific stories of the demigod Maui "fishing up" islands (Nunn, 2003; Nunn, 2021a). Collectively, these culturally embedded stories provide insight into the enduring nature of traditions associated with volcanic activity.

2.2. The longevity of volcanic traditions and their implications

Many memories of eruptions from Australasia and the Pacific Islands have been passed on within oral traditions for thousands of years, requiring inter-generational transference with a high degree of replication fidelity for often hundreds of generations. In the Pacific Islands, there are several well-dated eruptions that feature in (largely oral) traditions, including the already mentioned Kuwae eruption in Vanuatu (1453 CE) and the Nabukelevu eruption in Fiji (around 2500 years ago) (Cronin et al., 2004a; Witter & Self, 2007). Others come from Hawaii where the prolonged 15th-century eruption of Kīlauea is recalled in oral traditions (Swanson, 2008) and from New Zealand, where the ~500-550 years BP eruption of Rangitoto Island (Needham et al., 2011) is likely remembered in local Māori traditions (Nichol, 1992). Traditions of similar longevity are known from Papua New Guinea (Blong, 1982) but the situation here, as in other places where volcanism is comparatively frequent, often makes it challenging to link specific stories and volcanic events.

In contrast, volcanism in mainland Australia has been comparatively infrequent and largely confined to two parts of the country. Volcanism in northern Queensland 5000-9500 years ago features in oral traditions. Examples include the ~7000 (±2000) BP eruption at Kinrara (*Banganbara*) volcano (Cohen et al., 2017; Gertz, 2022) and the >9130 BP maar-forming eruptions at Lake Eacham (*Yidyam/Bana Wiingina/Wiinggina*) volcano (Dixon, 1991; Whitehead et al., 2007; Nunn et al., 2019). In the southeast, NVP eruptions around 5000 years ago are likely remembered in Boandik oral traditions (e.g., Smith, 1880, pp. 14-15). Oral traditions about feuding mountains hurling rocks at each other and hills throwing out fire and stones are associated with several volcanoes in the NVP (e.g., The Argus, 1897; Howitt, 1904). A possible ~37-ka BP eruption memory at Budj Bim refers to "the land and trees dancing" (Gunditjmara People & Wettenhall, 2010; Matchan et al., 2020).

Memories of volcanic eruptions have been kept alive by several oral traditional societies in Australasia and the Pacific Islands for thousands of years. This raises several questions for volcanologists and related specialists. The first, considered in Section 3 below, is how our understanding of the history of volcanism can be improved through the integration of long-lived traditions and modern volcanology. The second, discussed in Section 4, is whether contemporary volcanic risk management strategies can be enhanced by information obtained from such traditions. The third, reviewed in Section 5, is whether there is any detail in traditional knowledge that can provide deeper volcanological insight into volcanic processes in particular places, such as magma ascent and the evolution of eruptions.

3. Improved insight into past volcanic events, hazards and impacts through traditional knowledge

In several parts of the world, geological reconstructions of the history and distribution of volcanic eruptions have utilised historical data without always explicitly acknowledging that they come from non-scientific sources (Cashman & Giordano, 2008). In fact, several geoscientists have concluded from specific studies of volcanic history that the earlier side-lining of culturally grounded oral traditions resulted in a less comprehensive account of volcanic history. An example comes from the Hawaiian Islands where traditional stories pointed geologists to multiple eruptive episodes, the evidence for which had not been identified from scientific surveys (e.g., Kauahikaua et al., 2002; Swanson, 2008). A similar story from Fiji (see Section 5.1) pointed to an eruption of Nabukelevu Volcano within the period of these islands' human occupation, something geologists had not hitherto suspected (Nunn, 1999a; Cronin et al., 2004a).

In several instances, modern science has 're-discovered' eruptions, the existence of which had been encoded in traditional knowledge far earlier. In such cases, it was simply a case of knowing where to look for information – oral traditions have commonly been labelled 'myths and legends' and dismissed as potential sources of empirical data by conventionally-trained scientists. Yet in most cases claims of 'discovery' of ancient volcanic eruptions by retrodictive geoscientific methods are often no more valid than claims that 18th-century European explorers 'discovered' places where people were already living. A good example is the 1453 CE eruption of Kuwae (Vanuatu) which, when first 'discovered' by French geologists in the 1990s was labelled *l'éruption volcanique oubliée* – the forgotten eruption – yet stories recalling this catastrophe, one of the largest eruptions within the past 10,000 years, abounded among the people of neighbouring islands (Eissen et al., 1994; Ballard, 2020).

Traditional knowledge not only records past volcanic events but also provides details on the hazards they produced and their impacts at the time on local communities. Oral traditions describe precursors, the unfolding of eruptions, and the consequences for people and the environment, offering insights that complement geological evidence and enrich our understanding of both natural processes and past human responses.

3.1. Case study: Observed volcanism in Northeast Queensland (Australia)

The most recent volcanic eruptions in mainland Australia took place thousands of years ago within the basaltic volcanic fields in the northeast and southeast. These fields could potentially erupt again, producing lava flows or explosive (phreatomagmatic) explosions in nature, dependent largely on the presence or absence of the explosive interaction of magma with external water, such as shallow aquifers. To date, approaches in understanding the nature of past eruptions have largely used physical volcanology with little consideration on what the impacts were on the people and the environment at the time. Aboriginal cultural knowledge of young volcanism in Australia provides an opportunity to examine the lived experiences and volcanic processes through accounts that have survived via oral knowledge.

A long-standing Aboriginal oral tradition details the formation of Lake Eacham (*Yidyam/Bana Wiingina/Wiinggina*) maar volcano in the Atherton Volcanics Province of northeast Queensland, resulting from an eruption at least 9,000 years BP (Whitehead et al., 2007). The eruption is attributed to the actions of newly initiated men, who broke important taboos and angered the rainbow serpent, who then caused the eruption (Dixon, 1991, Govor, 2000). The story recalls how the sky turned yellow, a wind blew, and all the animals ran away, in part blown by the wind. The story also states that the people camped at the eruption site were lost. The protagonist of the story is an old man who threw fire and cut and hit the ground around the camp, making deep cuts in the ground.

The observations provided in the stories marry well with volcanological knowledge of the style of eruption associated with phreatomagmatic, maar-forming volcanism: multiple explosions producing ash blocking out the sun, causing earthquakes (inferred from the hitting and breaking of the ground), and powering base surges (a type of pyroclastic density current) that may appear as forceful wet winds. What is apparent from the oral tradition is the limited warning that was recognised. The stories detail that the animals ran away only after the explosive ash-producing eruptions began and that people also were caught off guard with little time to respond or flee the danger, many losing their lives (Dixon, 1991). The oral tradition provides important information about the rapid unfolding of events and hazards and short eruption warning. Despite likely being a short-lived (monogenetic) volcanic event, it was seemingly significant enough to locals at the time to embed the event into oral traditions and, to reduce future risk of disaster by making it taboo to camp at the maar lake at night or bathe or fish in its waters (e.g., Mysterious Lakes, 1939).

Oral accounts of the Lake Eacham eruption indicate that it took place in an open bare area in the scrub (Dixon, 1991; Govor, 2000). The emphasised reference to bare ground may provide, in hindsight, a precursor of an impending eruption; diffuse gas emissions possibly sufficient to inhibit plant growth but not visible or detectable to the people who came to camp there at the time.

Other young volcanoes in northeastern Australia also have associated oral traditions. Kinrara (*Banganbara*) volcano, which erupted ~7000 (±2000) BP in the nearby McBride Volcanic Province, is mentioned in Gugu Badhun traditions (Gertz, 2022). One tradition tells of how fire melted the rocks and explains the lava in the valley. Another tradition recounts how a witch doctor made a pit in the ground (assumed to be Kinara crater) and created a lot of dust in the air which caused people to get lost with fatal consequences (Hoolihan & Sutton, 1970; James, 2009).

3.2. Case study: Catastrophe by inference on New Britain Island (Papua New Guinea)

There are many examples of people abandoning places after a catastrophe. Some of the clearest examples are associated with volcanism and include the sustained abandonment of the Crater Lake (Oregon, USA) area by the Klamath people following the terminal eruption of Mount Mazama 7600 BP (Deur, 2002) and the regional depopulation of western El Salvador (Central America) for decades following the massive Ilopango Volcano eruption ~430 CE (Smith et al., 2020).

Traditions of place abandonment and place avoidance can often be interpreted as analogues for environmental destruction and/or loss of life and livelihood following a volcanic eruption. Within our region of study, examples of abandonment or avoidance of volcanic regions are noted from New Zealand (Lowe et al., 2002), Papua New Guinea (Johnson, 2013) and Australia (Lake Eacham; Mysterious Lakes, 1939).

In some comparatively constrained small island contexts, however, it seems clear that long-term abandonment was not possible in the way it was elsewhere. A good example is provided by the western part of New Britain Island (Papua New Guinea), part of the Bismarck Volcanic Arc and one of the region's most volcanically active areas (Neall et al., 2008). First occupied around 40,000 years ago, the archaeological and volcanological evidence for discontinuous occupation is overwhelming, with periods of abandonment interpreted after major eruptions, and periods of re-occupation typically a few generations later (Torrence et al., 2000). Considering the linkages that local people make between volcanic activity and cosmology, their observations of repeated volcanism may underpin a rich cultural awareness of its causes. For example, many local Mengen communities consider Ulawun Volcano to be the abode of dead souls who periodically fight each other and start fires causing eruptions (Wood et al., 2020). Yet eruptions are also causes for celebration as the ash was said to improve the growth of crops. This kind of 'domestication of hazard' appears typical of peoples who have lived for considerable time in active volcanic contexts, such as West New Britain and the islands of Vanuatu and around Dieng and Merapi volcanoes on the Indonesian island of Java (Galipaud, 2002; Dove, 2008; Lavigne et al., 2008; Ballard et al., 2020). Such situations almost certainly underlie oral traditions that involve recollections of eruptive history. This connection between cultural narratives and environmental adaptation highlights the role of traditional knowledge in shaping effective risk management strategies.

4. Risk management

Like modern approaches to risk planning, traditional societies developed responses to volcanic activity grounded in their perceived understandings of its causes – responses that may have helped mitigate risk while also carrying cultural significance (Vansina, 1985; Lilomaiava-Doktor, 2020; Nunn, 2021b). The purpose of relating stories about natural catastrophe in oral societies was and continues to be informative for each new generation, explaining how their ancestors experienced, and survived, and to teach them about how to recognise the precursors of catastrophe and respond appropriately to it – similar to contemporary geoscience-informed explanations of volcanism that guide people's behaviours. Such reasoning explains contemporary examples of ritual volcano worship in non-Western cultural contexts (Nimmo, 1986; Donovan et al., 2012), as well as the multi-millennial endurance of the memories of specific eruptions (see above).

The identification of precursors to eruption was and remains a key element of Indigenous risk management in many contexts. For example, residents of Baliau on active Manam Island Volcano (Papua New Guinea) note "that the presence of a blue smoke ring around the volcano in approximately April time means that a volcanic eruption around July is likely. If the eruption does not take place by the end of July, then the community can rest easy as things have returned to normal within the volcano" (Mercer & Kelman, 2010, p. 417). The same study suggests that risk mitigation at Baliau extends to the use of renewable materials for housebuilding, the routine and anticipatory preservation of key foods, and the sustaining of social (inter-community) support networks.

Recognition of both the innate efficacy and the desirability of using Indigenous knowledges for management of volcanic (catastrophic) risk is explicit in the adoption of the 2015-30 Sendai Framework for Disaster Risk Reduction (UN Office for Disaster Risk Reduction, 2015). Incorporating local Indigenous knowledge into early warning systems and community education aligns with the framework's goals of enhancing preparedness and reducing risk through inclusive approaches.

Former culturally grounded responses to the proximity of active volcanoes likely morph into responses underpinned by contemporary (global) religions (Chester & Duncan, 2008). A good example comes from the Italian volcano Etna. where religious perceptions and behaviours underpin a "parallel practice" in response to volcanic threat (Chester et al., 2008, p. 225). A similar plural understanding of volcanism in highland Java (Indonesia) underpins the responses of local residents (Griffin & Barney, 2021). People living close to the active Dieng Volcanic Complex in Java have had their traditional cultural attitudes to volcanism entrenched by their adoption of Hinduism or Islam that provide faith-informed reasons for remaining on the land in times of heightened volcanic activity (Lavigne et al., 2008).

4.1. Case study: Risk management through precursor recognition, Savo Island (Solomon Islands)

Located within the Solomon Islands Arc, between the Pacific and Indo-Australian lithospheric plates, Savo Island is the emergent part of an ocean-floor stratovolcano with a history of regular eruptions (Petterson et al., 2003). Most of its inhabitants live in coastal villages, probably for much of the past 3000 years (Sheppard and Walter, 2006), accumulating a long evidence-based appreciation of the island's eruptive history. The collection of oral traditions from Savo (Toba, 1993) allows insights into the ways in pre-contact times that the islanders accepted and responded to two major volcanic events, especially the use of precursors to anticipate eruption.

The earlier event (Toghavitu) was preceded by "the filling of the crater with water, and then a period of increasingly violent earthquakes and tsunamis" (Petterson et al., 2003, p. 168) and forced the survivors to take refuge on Guadalcanal Island 35 km away. The second eruption, possibly in the 1830-40 period, was also preceded by water filling the summit crater but did not affect the entire island. Probably for both events, and certainly for more minor eruptions within the past millennium, the cultural identification of precursors through the intergenerational oral communication of *kastom* (customary) stories was sufficient to allow pre-event evacuation of Savo (Cronin et al., 2000).

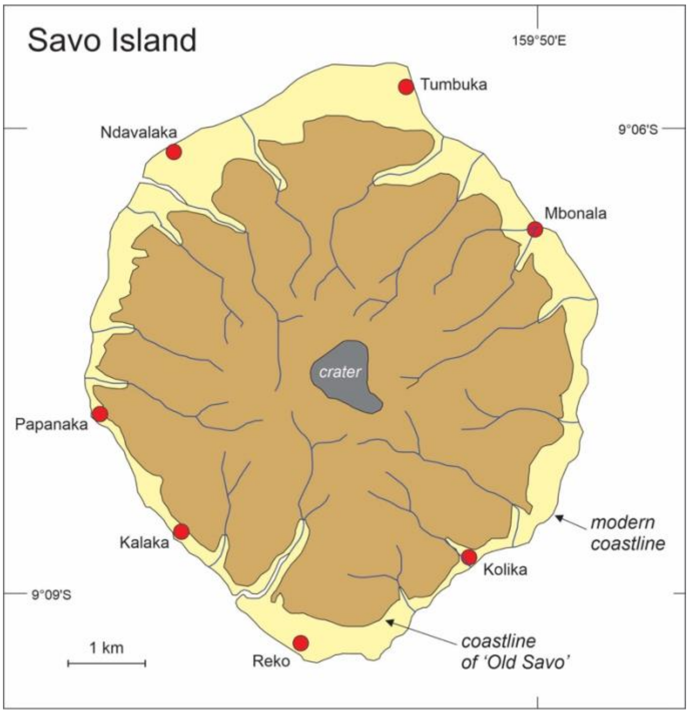

Figure 1. Savo Island (Solomon Islands) is an active volcano on which people have probably been living for about 3000 years. During this time, they have developed knowledge of eruption precursors that include cycles of coastal progradation (post-eruption) and recession. It is said that when the coastline reaches that of 'Old Savo', the next eruption is imminent, a story told in the villages of both Reko (for Kalaka-Kolika) and Ndavalaka (for Papanaka-Tumbuka), as reported in Cronin et al. (2004c).

An important culturally grounded (*kastom*) eruption precursor, identified from community surveys by Cronin et al. (2004c), refers to the erosion of the coastal lowlands formed during the last eruption. Communities in the Reko and Ndavalaka areas, for example, consider that an eruption is imminent when the island approaches the size of 'Old Savo' (Figure 1). These communities consider this to be a sign that "evil forces" (Cronin et al. 2004c, p. 126) are massing on Savo and that their leaders should then advise people when and where to move.

This "unique empirical chronometer for eruption recurrence" (Nunn, 2018, p. 58) may afford a glimpse of once widespread and sophisticated eruption precursors on islands with active volcanoes in the southwest Pacific (Gaillard and Le Masson, 2007; Fepuleai et al., 2017).

4.2. Case study: Including Indigenous Knowledge in hybrid volcanic risk management (Vanuatu)

In globalised Indigenous contexts, where communities that employ culturally grounded approaches to understanding and responding to risk coexist alongside those that favour Western scientific interpretations, several recent studies have sought to identify more inclusive approaches to risk management (Mercer et al., 2010; Mercer et al., 2012; Hiwasaki et al., 2014; Macnight Ngwese et al., 2018). Most people in Vanuatu continue to draw on traditional, culturally grounded ways of understanding volcanic risk (Galipaud, 2002; Calandra, 2020). However, in recent decades Western-informed approaches of characterising, anticipating and managing disasters have gained influence, largely due to "the sustained influence of foreign agencies and NGOs through the development of disaster risk reduction institutions, frameworks, and training of national actors" (Jackson, 2021, p. 10). Given the number of active volcanoes in the country and the almost constant risk they pose, the most effective way of future volcano risk planning is to combine traditional (*kastom*) and Western approaches (Cronin et al., 2004b).

The best documented example of this in Vanuatu is that of Ambae Island, where several eruptions have occurred in the past few decades. Using a Participatory Rural Appraisal (PRA) approach, scientists and risk planners sought information from local residents about their knowledge of volcanism, its causes and manifestations, and their favoured responses. This information was then compared with its Western equivalents and "participatory community level volcanic risk management strategies and emergency management plans" were developed (Cronin et al., 2004b, p. 653). More concord was achieved on actions to be taken to save lives and livelihoods after the onset of a volcanic event, but much less agreement was obtained around the causes or precursors of eruption. In particular, there was no agreement about who should decide when a warning of an eruption was needed, the default plan simply saying this would be issued through a government outlet.

As in comparable contexts, integrating of *kastom* (traditional) and Western approaches to risk planning and management in Vanuatu has not been without its challenges. A study of tsunami preparedness on Pentecost Island demonstrated that traditional stories – and the guidance they convey regarding appropriate responses – had a greater influence than science-based messaging (Walshe & Nunn, 2012). Similarly, on Ambae Island in 1995, when volcanic activity indicated a potential eruption, external authorities attempted to enforce an evacuation that many residents resisted. The absence of a significant eruption subsequently reinforced local distrust toward scientific knowledge (Cronin et al., 2004b).

5. Integrating traditional knowledge to enhance scientific understanding of volcanism

Given that eyewitness accounts of memorable volcanic events affecting traditional societies have been encoded in their enduring oral traditions, we can ask whether the detail in these accounts can inform contemporary issues of interest to volcanologists, such as the sequencing of eruptive events, their nature and extent, and even the source of volcanic materials.

This is explored through three case studies (below), each of which focuses on a different aspect of eruptive expression. The first looks at the likely succession of eruptive phenomena, deduced from recently collected oral traditions in Fiji, of the c2500-year old eruption of Nabukelevu on Kadavu Island. The next section explores traditional Hawaiian stories from the island of Hawai'i demonstrating that its pre-European inhabitants were attentive observers of both the timing and location of lava flows and caldera formation – insights that inform later understanding of the island's volcanic history. Finally, we examine a detailed, culturally grounded narrative from southern Australia that throws light on the sequence of volcanism, the succession of events at key locations and the various expressions of volcanism at each site.

5.1. Case study: Nabukelevu Volcano, Fiji

At the western extremity of Kadavu Island in southern Fiji stands the andesitic Plio-Pleistocene volcano named Nabukelevu (or Mount Washington) that is considered to have erupted three times within the c3000-year human occupation of the Fiji archipelago (Cronin et al., 2004a). Its most spectacular eruption within this period occurred around 2500 years ago (>2420 ± 90 years BP) and is inferred, from geological observations, to have involved formation of the present summit dome and a flank collapse marked by a debris avalanche.

Stories collected from numerous Kadavu communities in 2019 plausibly contain observations of these three events (Lancini et al., 2023). Most stories involve the antics of two ancestral beings (*Vu*), one of whom, named Tanovo, lives on Ono Island, the other, named Tautaumolau, on Nabukelevu itself (Figure 2). In most narratives, including some published (reviewed by Nunn, 1999a; Lancini et al., 2023), Tanovo daily enjoyed watching the sunset WSW of Ono until the day when his view became obscured by the growth of a high mountain (Nabukelevu), interpreted as a memory of the growth of the conspicuous summit dome. Angered, Tanovo 'flew' to Nabukelevu where he started digging material from the top of the mountain (probably to form the vent crater) until discovered by Tautaumolau, who then chased his rival around the island. Tanovo dropped 'soil' (likely indicting tephra fall) from his baskets while being chased which created islands. In some of the oral accounts, after lightening his load, Tanovo then becomes the pursuer, not the pursued, causing Tautaumolau to hide under the sea. Tanovo then drank the water to expose him, which could be interpreted as a memory of ocean withdrawal preceding a tsunami possibly caused by a flank collapse of Nabukelevu.

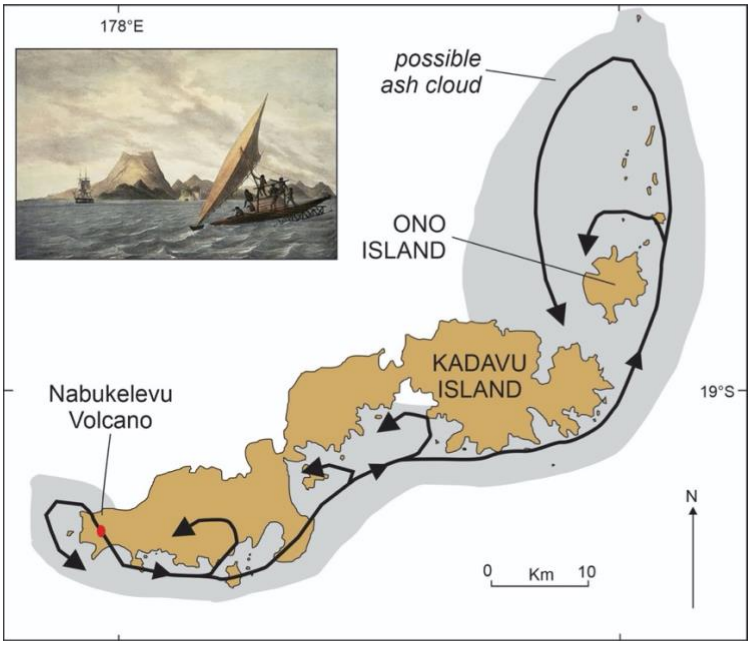

Figure 2. The Kadavu Island group (Fiji) is dominated by Nabukelevu Volcano that rises from its westernmost extremity and is known to have erupted dramatically about 2500 years ago (Cronin et al., 2004a), perhaps a few hundred years after these islands were occupied by people. Thirteen groups of stories collected recently from Kadavu informants contain details that allow the probable route of the ash cloud (indicated by the black arrows) to be reconstructed (Lancini et al., 2023). Inset shows the earliest-known representation of Nabukelevu, an 1833 hand-coloured lithograph (Vue de l'Ile Kandabon) by Jacques Arago based on a sketch by Louis de Sainson, artist aboard the Astrolabe that sailed past Kadavu in 1827.

Information about this eruption that has not been reported by volcanologists can be inferred from other details in these traditional stories. Principal is the route of the 'chase' of Tanovo by Tautaumolau along the southern edge of the main island and into the smaller islands off its eastern end, which could be interpreted as the direction in which the main ash cloud moved (shown in Figure 2). Additionally, all narratives agree that the direction of the 'chase' reversed in these islands, moving south instead of north, a plausible recollection of changes in eruption dynamics.

Details about Tanovo's view of the sunset becoming blocked suggest, according to local informant Petero Uluinaceva (Nawaisomo, Ono), that the dome-building eruption at Nabukelevu took place in November/December when the sunsets on Ono are most spectacular. Finally, an association between the Tanovo/Tautaumolau stories and other land-changing events, including landslips on Ono and the eastern part of Kadavu itself, suggest that the dome-forming eruption and its aftermath produced earthquakes that affected the entire area rather than that in the immediate vicinity of the volcano.

5.2. Case study: Hawai'i Island (Big Island), Hawai'i group, USA

People have lived in the Hawaiian Islands for approximately 800-1100 years (Wilmshurst et al., 2011), during which time they likely witnessed numerous eruptions from both Mauna Loa, the largest volcano on Hawai'i Island (the Big Island), and Kīlauea, located in the southeastern part of the island.

One of the earliest traditional Hawaiian accounts of volcanic activity recorded by a European visitor, the Rev. William Ellis, describes a shift in volcanic behaviour at Kīlauea:

> … it [Kīlauea] had been burning from time immemorial … and had overflowed some part of the country during the reign of every king that had governed Hawaii: that in earlier ages it use to boil up, overflow its banks, and inundate the adjacent country; but that, for many kings' reigns past, it had kept below the level of the surrounding plain, continually extending its surface and increasing its depth, and occasionally throwing up, with violent explosion, huge rocks or red-hot stones (Ellis, 1826, p. 217).

Swanson (2008) interprets the prolonged effusive activity described in these "earlier ages" as a series of shield-building lava eruptions, which based on ^{14}C dating, occurred between approximately 1000 and 1400 CE. In Hawaiian oral tradition, the eruptive phase is associated with the deity 'Ailā'au, eater of forests, who presided over Kīlauea during a time of widespread lava flows that destroyed much land and vegetation (Westervelt, 1916). Pele, another fire deity, is said to have later displaced 'Ailā'au and ultimately assumed control of Kīlauea. Pele is thought to have arrived after the first Polynesian settlers, possibly in the 1300s. A substantial lava flow once named 'Ailā'au (Holcomb, 1987) has since been renamed the Kualoloa flow field, in part because it was likely emplaced after 'Ailā'au's departure from Kīlauea. The Kualoloa flow erupted over a 60-year period ending in about 1480 CE (Clague et al., 1999).

The tradition recorded by Ellis suggests that for a long period afterward, lava remained contained below the level of the surrounding land surface, with occasional explosive eruptions of rock and lava. This is interpreted as evidence for the presence of a summit caldera over an extended period. Swanson (2008) estimated that if "many king's reigns" equated to 10–15 kings each ruling for 20–25 years, then a summit caldera had been present since around 1440-1600 CE – much earlier than 1790, as had been previously believed (e.g. Decker and Christiansen, 1984; Holcomb, 1987). Radiocarbon ages now estimate the caldera formed in about 1480-1510 CE (Swanson et al., 2012).

The formation of the caldera is also inferred from traditional stories (Swanson, 2008). According to oral tradition, Pele's sister Hi'iaka dug furiously to recover her lover's body creating the modern Kīlauea Caldera in the process. The scientific discovery that the caldera is older than 1790 and close in time to the end of the Kualoloa eruption emerged only recently (Swanson et al., 2012). As Swanson reflected:

> Had we looked for geologic evidence to test the traditions, rather than ignoring them, we probably would have realized much sooner that formation of the caldera closely followed the eruption of the ʻAilāʻau flow [Kualoloa flow field] and that both took place centuries before 1790. There is a lesson here, plain to see (Swanson, 2008, p. 430).

Insights from Hawaiian oral traditions underscore the value of integrating Indigenous knowledge systems into scientific inquiry, particularly in reconstructing the eruptive history of complex volcanic systems such as Kīlauea.

5.3. Case Study: Mount Gambier Sub-Province, Newer Volcanics Province, Australia

There are many Indigenous Australian (Aboriginal) stories recalling volcanism in the Newer Volcanics Province (NVP) of southeastern Australia. Several of which were recorded by early European colonists and commentators (e.g., Smyth, 1878; Smith, 1880; Dawson, 1881; Howitt, 1904). For example, one of the earliest geologists to study the region noted that "the Aborigines point to some of the recently extinct volcanoes, and say that fire came from them once" (Smyth, 1878, p. 406).

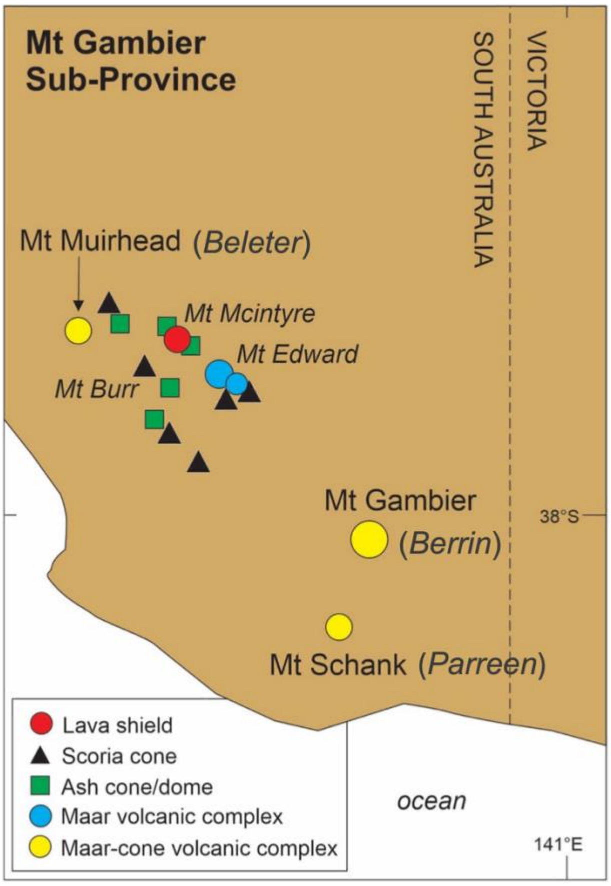

Figure 3. The western part of the Newer Volcanics Province known as the Mount Gambier sub-province. The most recent volcanic eruptions took place at Mount Gambier (Berrin) and Mount Schank (Parreen) around 5000 years ago and these volcanoes feature within Aboriginal oral traditions of the Boandik People.

This case study focuses on a group of volcanoes in the western NVP (Figure 3) about which one group of Aboriginal stories can be interpreted to throw light on the sequencing and relative timing of volcanism, To date, these aspects of the volcanic activity have eluded volcanologists on account of the array of contrasting dates and eruption ages obtained via different dating techniques on different materials.

The volcanoes featured within the oral tradition: Mount Muirhead (*Beleter*), Mount Schank (*Parreen)*, and Mount Gambier (*Berrin*), which form part of the Mt Gambier sub-province (van Otterloo et al., 2013), are the subjects of a sequential narrative told by the Boandik people recorded in the late 19th century (Smith, 1880) and that continues to be told today by Boandik Elders (Jacquelin-Furr, 2020; 2024). The story involves a giant named Craitbul, who with his family settled for 'a considerable time' (Smith, 1880, p. 14) atop Mount Muirhead and were accustomed to cooking their food there. Then one night when the oven was full, they were awakened by the piercing shriek of the *Bullin* (a bird) and fled in fear of an evil spirit called *Tennateona* or *Woor*. They moved to Mount Schank, set up camp and made their ovens but the same thing happened, and one night when the oven was empty the *Bullin* was heard again, forcing them to flee further inland and away from the sea to Mount Gambier where they thought they would be safe from the evil spirit. There they lived for a long time and made an oven to cook their food until one day water rose from below, dousing their oven's fire; so they made another but the same thing happened. They made two more ovens but each time the water came up until they had four ovens. Their last home was said to be in a cave on the side of the peak. The story states that if anyone "disbelieves this story they may dig at the top of Mount Muirhead, and there they will find evidence to prove its truth. Mt Muirhead was the oven" (Smith, 1880, p. 14).

The inference of the mountains as ovens suggests that the soil was warm enough to cook food, at least near possible fumaroles. The status of an open or closed oven when the family fled likely reflects the present-day geomorphology of the volcanoes: the dome like appearance of the 'closed' oven at Mount Muirhead and the 'open' oven appearance due to the large tuff cone in the crater of Mt Schank. The *Bullin*'s shriek could be interpreted as the sound of gas escaping from ground cracks opening under magmatic pressure, or early interactions between rising magma and underground aquifer, heralding an imminent eruption. The sequence of eruptions, with Mount Muirhead erupting prior to Mount Schank and Mount Gambier and the succession of maar-lake formation at Mount Gambier are consistent with available geological evidence (van Otterloo et al., 2013; Nunn, 2018; Nunn et al., 2019). While no radiometric ages are available for Mount Muirhead, the eroded nature of the volcano and overlying sediment cover indicates that its formation clearly predates that of Mount Schank and Mount Gambier, both of which are estimated to have erupted around 5000 years ago (Blackburn et al., 1982; Smith and Prescott, 1987). Palaeomagnetic dating of volcanic rocks from Mount Schank and Mount Gambier suggests that the two volcanoes erupted around 300 years or more apart but was unable to determine the eruption order (Barbetti and Sheard, 1981). The Boandik tradition, however, informs that Mount Schank was active before Mount Gambier. The presence of ostracods in maar-lake sediments of Blue Lake / Warwar at Mount Gambier that are a similar age to that of inferred crater development suggest that water filled the craters soon after they formed (Gouramanis et al., 2010) and that episodes of maar formation and water filling occurred, just as the Craitbul narrative states, in succession (van Otterloo et al., 2013).

6. Conclusions and future research directions

This study shows that in many situations across Australasia and the Pacific Islands, some culturally grounded oral traditions are likely to have originated with observations of diverse volcanic phenomena. In traditional societal contexts, the codification of these observations within non-Western worldviews, and their subsequent exaggeration and embellishment to make their re-telling memorable, have led many people to dismiss them as myths and legends. We argue that not only is this position often unjustified but also that these traditions sometimes contain information about ancient volcanism that would be difficult to obtain by conventional scientific enquiry. The important role that long-lived traditions have in disaster risk reduction and in illuminating the nature, occurrence and recurrence of volcanism is often undervalued. Interdisciplinary and bicultural collaboration remains critical to understanding the complex interplay between cultural, environmental, historical and other factors that shape perceptions of volcanic risk. Developing partnerships among local knowledge holders, geoscientists, decision makers, emergency practitioners and other citizenry can foster holistic approaches to volcanic risk reduction, bridging diverse worldviews and knowledge systems.

However, as societies evolve, the transmission of traditional knowledge may be disrupted. Future research should explore how social, economic and cultural changes influence the use and preservation of traditional knowledge in volcanic regions. Understanding these dynamics is essential to ensure that traditional knowledge remains, and expands, as a valued component of volcanic risk management. Ethical documentation and conservation of this knowledge can safeguard against marginalisation and loss of knowledge caused by socio-cultural and environmental changes. This approach also presents challenges in preventing the appropriation and misuse of knowledge by others (Oguamanam, 2009; Kilemba and Mafongoya, 2017). Collaborative and holistic efforts between volcanologists and local communities in mapping and understanding volcanic hazards, utilising shared knowledge bases and local cultural protocols for knowledge sharing, represents one approach to preservation. Such documentation also provides the foundation for understanding the principles behind local practices within their unique contexts, making them more accessible and comprehensible to others.

Future research should also focus on refining theoretical frameworks and best practices that integrate traditional and scientific volcanic knowledge, emphasising two-way knowledge sharing (Ermine, 2007; Geia et al., 2013; Ford et al., 2020). Participatory research models should actively engage traditional communities as co-researchers, ensuring their perspectives inform the design and implementation of volcanic risk reduction strategies (Cronin et al., 2004b). Co-established research protocols can protect traditional knowledge from misinterpretation or misuse, fostering equity and mutual respect in these collaborations. Developing systematic research approaches to interpret traditional knowledge and practices, address uncertainties, and establish consensus of interpretation with the knowledge holders themselves (e.g., Ali et al., 2021), can reduce misunderstandings when these practices are considered outside their cultural and place-based contexts. Case studies that examine successful integration frameworks beyond local contexts could offer insights into the adaptability of these approaches elsewhere.

In the last few decades, there has been a growing awareness of the role local and traditional knowledge can play in disaster risk reduction (UNIDNDR, 1994; Dekens, 2007; Mercer et al., 2010; 2012). However, its application remains less common in practice (Cronin et al., 2004b; Gaillard et al., 2012). Addressing disaster risk through a more holistic and systemic approach requires understanding the complex socio-natural systems involved. Integrating traditional and local knowledge with Western scientific approaches has often yielded a richer and more nuanced understanding of volcanic processes and their impacts on communities. Nevertheless, this holistic approach must address challenges such as preserving the cultural authenticity of traditional knowledge, ensuring ethical collaboration, and overcoming biases that have historically privileged scientific knowledge over traditional and local perspectives.

Future research should further explore how traditional knowledge can be authentically and ethically embedded into volcanic early warning systems and volcanic disaster preparedness programs. Citizen science initiatives could be co-developed by traditional knowledge holders and non-local geoscientists to engage communities in reporting traditional knowledge-based early warning indicators, fostering cultural awareness of the value of traditional knowledge within the broader community. This is particularly relevant in colonised countries where Western knowledge systems often dominate disaster risk reduction (Gaillard et al., 2012; Bertoli et al., 2024. Inclusion of traditional knowledge into hazard assessments and the use of remote sensing tools to support and expand traditional observations in inaccessible regions are promising directions for future exploration.

By valuing and integrating traditional knowledge with scientific data, future research can contribute to more inclusive, culturally sensitive, and effective volcanic hazard management strategies. These efforts will ultimately foster safer and more resilient communities. The lessons of such research have implications not only for the regions studied but also for global practices in disaster preparedness and mitigation.

Author contributions

HH: Conceptualisation, Methodology, Investigation, Writing- Original Draft and Reviewing and Editing, Visualisation. MJ-F: Writing- Reviewing and Editing, Traditional Knowledge. PN: Conceptualisation, Methodology, Investigation, Writing- Original Draft and Reviewing and Editing, Visualisation. KT: Writing- Reviewing and Editing, Traditional Knowledge. KN: Conceptualisation, Methodology, Investigation, Writing- Original Draft and Reviewing and Editing. LF: Writing- Reviewing and Editing. AM: Writing- Reviewing and Editing. TU: Writing- Reviewing and Editing.

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Data availability

All data and sources of data are provided within the paper.

References

Ali, T., Buergelt, P. T., Paton, D., Smith, J. A., Maypilama, E. L., Yuŋgirrŋa, D., Dhamarrandji, S., & Gundjarranbuy, R. (2021). Facilitating Sustainable Disaster Risk Reduction in Indigenous Communities: Reviving Indigenous Worldviews, Knowledge and Practices through Two-Way Partnering. *International Journal of Environmental Research and Public Health*, *18*(3), 855. https://doi.org/10.3390/ijerph18030855

Anderson, A.J. (2015) Speaking of migration AD 1150–1450. In: Anderson A, Harris A, Williams B (eds) *Tangata Whenua – An Illustrated History*. Auckland: Bridget Williams Books, pp. 42–69. ISBN**:** 9781927131411

Ballard, C. (2020). The Lizard in the Volcano: narratives of the Kuwae eruption. *The Contemporary Pacific*, 32(1): 98–123. http://hdl.handle.net/10125/75673

Ballard, C., McDonnell, S. and Calandra, M. (2020). Confronting the naturalness of disaster in the Pacific. *Anthropological Forum*, 30(1-2): 1–14. https://doi.org/10.1080/00664677.2020.1729698

Barbetti, M. and Sheard, M. J. (1981). Palaeomagnetic results from Mounts Gambier and Schank, South Australia. *Journal of the Geological Society of Australia*, *28*(3–4), 385–394. https://doi.org/10.1080/00167618108729177

Bertoli, A., Ng'asike, J. T., Amici, S., Madjar, A., & Tesar, M. (2024). Decolonizing western science education and knowledge in early childhood: Rethinking natural hazards and disasters framework through indigenous 'ecology of knowledges' in Kenya. *Global Studies of Childhood*, *14*(2), 197–213. https://doi.org/10.1177/20436106231199773

Bindon, P. and Raynal, J.P. (1998). Humans and volcanoes in Australia and New Guinea. *Quaternaire*, 9(1): 71–75. halshs-00004118

Blackburn, G., Allison, G.B. and Leaney, F.W.J. (1982). Further evidence on the age of the tuff at Mt Gambier, South Australia. *Transactions of the Royal Society of South Australia*, 106: 163–167.

Blong, R. (1982). The Time of Darkness: Local Legends and Volcanic Reality in Papua New Guinea. Australian National University Press, Canberra. http://hdl.handle.net/1885/114749

Buckland, P.C., Dugmore, A.J. and Edwards, K.J. (1997). Bronze Age myths? Volcanic activity and human response in the Mediterranean and North Atlantic regions. *Antiquity*, 71(273): 581–593. https://doi.org/10.1017/S0003598X00085343

Calandra, M. (2020). *Disasta*: Rethinking the Notion of Disaster in the Wake of Cyclone Pam. *Anthropological Forum*, 30(1-2): 42–54. https://doi.org/10.1080/00664677.2019.1647826

Carson, M.T. (2018). Archaeology of Pacific Oceania: Inhabiting a Sea of Islands. Routledge, London. ISBN: 9781138097179

Cas, R., Van Otterloo, J., Blaikie, T. and Van Den Hove, J. (2017). The dynamics of a very large intra-plate continental basaltic volcanic province, the Newer Volcanics Province, SE Australia, and implications for other provinces. In: Monogenetic Volcanism. *Geological Society, London, Special Publications*, 446, 123–172. https://doi.org/10.1144/SP446

Cashman, K.V. and Cronin, S.J. (2008). Welcoming a monster to the world: myths, oral tradition, and modern societal response to volcanic disasters. *Journal of Volcanology and Geothermal Research*, 176(3): 407–418. https://doi.org/10.1016/j.jvolgeores.2008.01.040

Cashman, K.V. and Giordano, G. (2008). Volcanoes and human history. *Journal of Volcanology and Geothermal Research*, 176(3): 325–329. https://doi.org/10.1016/j.jvolgeores.2008.01.036

Chester, D.K. and Duncan, A.M. (2008). Geomythology, theodicy and the continuing relevance of religious worldviews on responses to volcanic eruptions. In: J. Grattan and R. Torrence (Editors), *Living Under the Shadow: Cultural Impacts of Volcanic Eruptions*. Left Coast Press, Walnut Creek, California, pp. 203–224. https://doi.org/10.4324/9781315425177

Chester, D.K., Duncan, A.M. and Dibben, C.J. (2008). The importance of religion in shaping volcanic risk perception in Italy, with special reference to Vesuvius and Etna. *Journal of Volcanology and Geothermal Research*, 172(3): 216–228. https://doi.org/10.1016/j.jvolgeores.2007.12.009

Clague, D.A., Hagstrum, J.T., Champion, D.E. and Beeson, M.H. (1999). Kīlauea summit overflows: their ages and distribution in the Puna District, Hawai'i. *Bulletin of Volcanology*, 61(6): 363–381. https://doi.org/10.1007/s004450050279

Clarkson, C., Jacobs, Z., Marwick, B., Fullagar, R., Wallis, L., Smith, M., Roberts, R.G., Hayes, E., Lowe, K., Carah, X., Florin, S.A., McNel, J., Cox, D., Arnold, L.J., Hua, Q., Huntley, J., Brand, H.E.A., Manne, T., Fairbairn, A., ¼ Pardoe, C. (2017). Human occupation of northern Australia by 65,000 years ago. *Nature*, 547, 306–310. https://doi.org/10.1038/nature22968

Cohen, B.E., Mark, D.F., Fallon, S.J. and Stephenson, P.J. (2017). Holocene-Neogene volcanism in northeastern Australia: chronology and eruption history. *Quaternary Geochronology*, 39: 79–91. https://doi.org/10.1016/j.quageo.2017.01.003

Cronin, S.J. and Cashman, K.V. (2008). Volcanic oral traditions in hazard assessment and mitigation. In: J. Gratton and R. Torrence (Editors), *Living under the Shadow: Cultural Impacts of Volcanic Eruption*. Left Coast Press, Oakland, California, pp. 175–202. https://doi.org/10.4324/9781315425177

Cronin, S.J., Ferland, M.A. and Terry, J.P. (2004a). Nabukelevu volcano (Mt. Washington), Kadavu – a source of hitherto unknown volcanic hazard in Fiji. *Journal of Volcanology and Geothermal Research*, 131(3): 371–396. https://doi.org/10.1016/S0377-0273(03)00414-1

Cronin, S.J., Gaylord, D.R., Charley, D., Alloway, B.V., Wallez, S. and Esau, J.W. (2004b). Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu. *Bulletin of Volcanology*, 66(7): 652–668. https://doi.org/10.1007/s00445-004-0347-9

Cronin, S.J., Petterson, M.G., Taylor, P. and Planitz, A. (2000). Report on the workshop on volcanic hazards, operational support planning and awareness programs for Savo Volcano, Solomon Islands, SOPAC (Miscellaneous Report 373), Suva.

Cronin, S.J., Petterson, M.G., Taylor, P.W. and Biliki, R. (2004c). Maximising multi-stakeholder participation in government and community volcanic hazard management programs; A case study from Savo, Solomon Islands. *Natural Hazards,* 33(1): 105–136. https://doi.org/10.1023/B:NHAZ.0000035021.09838.27

Dawson, J. (1881). *Australian Aborigines: The Languages and Customs of Several Tribes of Aborigines in the Western District of Victoria, Australia*. George Robertson, Melbourne. ISBN: 9780855751180.

De Benedetti, A., Funiciello, R., Giordano, G., Diano, G., Caprilli, E. and Paterne, M. (2008). Volcanology, history and myths of the Lake Albano maar (Colli Albani volcano, Italy). *Journal of Volcanology and Geothermal Research*, 176(3): 387–406. https://doi.org/10.1016/j.jvolgeores.2008.01.035

Decker, R.W., Christiansen, R.L., 1984. Explosive eruptions of Kilauea Volcano, Hawaii. National Research Council. National Academy Press, Washington DC, pp. 122–132.

Dekens, J. (2007) *Local Knowledge for Disaster Preparedness: A Literature Review*. Kathmandu, Nepal: International Centre for Integrated Mountain Development (ICIMOD).

Deur, D. (2002). A most sacred place: the significance of Crater Lake among the Indians of Southern Oregon. *Oregon Historical Quarterly*, 103(1): 18–49. http://www.jstor.org/stable/20615207

Dixon, R.M.W. (1991) *Words of our country: stories, place names, and vocabulary in Yidiny, the Aboriginal language of the Cairns-Yarrabah region*; compiled and edited by R.M.W. Dixon; with flora identification and interpretation by Tony Irvine. St. Lucia, Australia. University of Queensland Press, 312 p. ISBN : 0702223603.

Donovan, K., Suryanto, A. and Utami, P. (2012). Mapping cultural vulnerability in volcanic regions: The practical application of social volcanology at Mt Merapi, Indonesia. *Environmental Hazards-Human and Policy Dimensions*, 11(4): 303–323. https://doi.org/10.1080/17477891.2012.689252

Dove, M.R. (2008). Perception of volcanic eruption as agent of change on Merapi volcano, Central Java. *Journal of Volcanology and Geothermal Research*, 172(3): 329–337. https://doi.org/10.1016/j.jvolgeores.2007.12.037

Eissen, J.P., Monzier, M. and Robin, C. (1994). Kuwae, l'éruption volcanique oubliée. *La Recherche*, 270: 1200–1202. http://www.documentation.ird.fr/hor/fdi:41480

Ellis, W. (1826). *Narrative of a Tour through Hawaii, or Owhyhee; with remarks on the history, traditions, manners, customs, and language of the inhabitants of the Sandwich Islands*. Fisher and Jackson, London. https://doi.org/10.5962/bhl.title.163283

Ermine, W. (2007). The ethical space of engagement. *Indigenous Law Journal*, 6(1), 193–203. https://jps.library.utoronto.ca/index.php/ilj/article/view/27669/20400

Fepuleai, A., Weber, E., Nemeth, K., Muliaina, T. and Iese, V. (2017). Eruption Styles of Samoan Volcanoes Represented in Tattooing, Language and Cultural Activities of the Indigenous People. *Geoheritage*, 9(3): 395–411. https://doi.org/10.1007/s12371-016-0204-1

Ford, L., Woodward, E., Hill, R., Tengö, M., & Harkness, P. L. (2020). Actions towards best practice: To support our knowledge our way. In E. Woodward, R. Hill, P. Harkness, & R. Archer (Eds.), Our knowledge, our way in caring for country: Indigenous-led approaches to strengthening and sharing our knowledge for land and sea management. Best Practice Guidelines from Australian experiences (1 ed., pp. 105–117). CSIRO. https://www.csiro.au/en/Research/LWF/Areas/Pathways/Sustainable-Indigenous/Our-Knowledge-Our-Way/OKOW-resources

Gaillard, J.C. and Le Masson, V. (2007). Traditional societies' response to volcanic hazards in the Philippines - Implications for community-based disaster recovery. *Mountain Research and Development*, 27(4): 313–317. https://doi.org/10.1659/mrd.0949

Galipaud, J.-C. (2002). Under the volcano: Ni-Vanuatu and their environment. In: R. Torrence and J. Grattan (Editors), *Natural Disasters and Cultural Change*. Routledge, London, pp. 162–171. https://doi.org/10.4324/9780203165102

Geia, L. K., Hayes, B., & Usher, K. (2013). Yarning/Aboriginal storytelling: Towards an understanding of an Indigenous perspective and its implications for research practice. *Contemporary Nurse*, *46*(1), 13–17. https://doi.org/10.5172/conu.2013.46.1.13

Gertz, J. (2022). *Gugu Badhun Sovereignty, Self-Determination, and Nationhood.* PhD thesis, James Cook University. https://doi.org/10.25903/abhm-4m07

Gouramanis, C., Wilkins, D. and De Deckker, P. (2010). 6000 years of environmental changes recorded in Blue Lake, South Australia, based on ostracod ecology and valve chemistry. *Paleogeogr. Paleoclimatol. Paleoecol.*, 297(1): 223–237. https://doi.org/10.1016/j.palaeo.2010.08.005

Gill, J.C., Taylor, F.E., Duncan, M.J., Mohadjer, S., Budimir, M., Mdala, H. and Bukachi, V. (2021). Invited perspectives: Building sustainable and resilient communities – recommended actions for natural hazard scientists, *Nat. Hazards Earth Syst. Sci.*, 21, 187–202, https://doi.org/10.5194/nhess-21-187-2021

Govor, E. (2000). *My Dark Brother. The story of the Illins: A Russian-Aboriginal family*. University of NSW Press. IBSN 0868405949.

Griffin, C. and Barney, K. (2021). Local disaster knowledge: Towards a plural understanding of volcanic disasters in Central Java's highlands, Indonesia. *The Geographical Journal*, 187(1): 2–15. https://doi.org/10.1111/geoj.12364

Gunditjmara People with Wettenhall., G. (2010). The people of Budj Bim: Engineers of aquaculture, builders of stone house settlements and warriors defending country. ISBN 978-0-9757778-4-8

Haiquan, W., Taniguchi, H. and Ruoxin, L. (2002). Chinese myths and legends for Tianchi Volcano eruptions. *Northeast Asian Studies*, 6: 191–200.

Hamacher, D.W. and Norris, R.P. (2009). Australian Aboriginal geomythology: eyewitness accounts of cosmic impacts? *Archaeoastronomy*, 22: 60–93.

Hill, K.C. and Hall, R. (2003). Mesozoic-Cainozoic evolution of Australia's New Guinea margin in a west Pacific context. In: R. Hillis and R.D. Müller (Editors), Defining Australia: The Australian Plate as part of Planet Earth. *Geological Society of America*, Boulder, pp. 265–290. https://doi.org/10.1130/0-8137-2372-8.265

Hiwasaki, L., Luna, E., Syamsidik and Shaw, R. (2014). Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. *International Journal of Disaster Risk Reduction*, 10: 15–27. https://doi.org/10.1016/j.ijdrr.2014.07.007

Hogg, A.G., Higham, T.F.G., Lowe, D.J., Palmer, J.G., Reimer, P.J. and Newnham, R.M. (2003). A wiggle-match date for Polynesian settlement of New Zealand. *Antiquity*, 77(295): 116–125. https://hdl.handle.net/10289/5248

Holcomb, R.T., 1987. Eruptive history and long-term behavior of Kilauea Volcano. In: Decker, R.W., Wright, T.L., Stauffer, P.H. (Eds.), Volcanism in Hawaii. Professional Paper, vol. 1350. U.S. Geological Survey, pp. 261–350.

Holmberg, K. (2023). Merapi and its dynamic 'Disaster Culture'. In: Gertisser, R., Troll, V.R., Walter, T.R., Nandaka, I.G.M.A., Ratdomopurbo, A. (eds) *Merapi Volcano. Active Volcanoes of the World*. Springer, Cham. pp 67–87. https://doi.org/10.1007/978-3-031-15040-1_3

Hoolihan, D. and Sutton, P. (1970). AIATSIS Library Reference MS379 P91, Field Tape 70/2 (Sutton_P08_001800B) and Tape 70/10 (Sutton_P08_001804B).

Howitt, A.W. (1904). *The native tribes of South-East Australia*, Macmillan and Co. Ltd, London.

Jackson, G. (2021). Perceptions of disaster temporalities in two Indigenous societies from the Southwest Pacific. *International Journal of Disaster Risk Reduction*, 57: 102221. https://doi.org/10.1016/j.ijdrr.2021.102221

Jacquelin-Furr, M. (2020, April 28). *Craitbul Story by Aunty Michelle* [video]. YouTube https://youtu.be/lVAv6lFWXC4?si=pUjDeRg0dNzm0t4D

Jacquelin-Furr, M. (2024, July 28). *Craitbul - A journey across Boandik Country* [video]. YouTube https://youtu.be/4CcpOm74iuw?si=IpSKzR1JMaQU3lDT

James, R.A. (2009). A modern history of the Gugu Badhun people and their country. Masters Thesis, James Cook University. http://eprints.jcu.edu.au/9487

Johnson, R.W. (2013). Fire Mountains of the Islands: A History of Volcanic Eruptions and Disaster Management in Papua New Guinea and the Solomon Islands. ANU E Press, Canberra. https://www.jstor.org/stable/j.ctt5hgz8j

Kauahikaua, J., Cashman, K., Clague, D., Champion, D. and Hagstrum, J. (2002). Emplacement of the most recent lava flows on Hualālai Volcano, Hawai‘i. *Bulletin of Volcanology*, 64(3–4): 229–253. https://doi.org/10.1007/s00445-001-0196-8

Kilemba, L.M. & Mafongoya P.L. (2017). The challenges of documentation and conservation of indigenous knowledge for natural resources, p. 139-158. In Mafongoya, P.L. and Ajayi, O.C. (Eds), *Indigenous Knowledge Systems and Climate Change Management in Africa*, CTA, Wageningen, The Netherlands, 316 pp ISBN 978-92-9081-619-5.

Kouritzin, S., & Nakagawa, S. (2018). Toward a non-extractive research ethics for transcultural, translingual research: perspectives from the coloniser and the colonised. *Journal of Multilingual and Multicultural Development*, *39*(8), 675–687. https://doi.org/10.1080/01434632.2018.1427755

Lancini, L., Nunn, P., Nanuku, M., Tavola, K., Bolea, T., Geraghty, P., Compatangelo-Soussignan, R. (2023). Driva Qele / Stealing Earth: Oral Accounts of the Volcanic Eruption of Nabukelevu (Mt. Washington), Kadavu Island (Fiji), ~2,500 Years Ago. *Oral Tradition*, 36/1, 63–90. https://oraltradition.org/driva-qele-stealing-earth-oral-accounts-of-the-volcanic-eruption-of-nabukelevu-mt-washington-kadavu-island-fiji-2500-years-ago

Lavigne, F., De Coster, B., Juvin, N., Flohic, F., Gaillard, J.-C., Texier, P., Morin, J. and Sartohadi, (2008). People's behaviour in the face of volcanic hazards: Perspectives from Javanese communities, Indonesia. *Journal of Volcanology and Geothermal Research*, 172(3): 273–287. https://doi.org/10.1016/j.jvolgeores.2007.12.013

Lilomaiava-Doktor, S. (2020). Oral Traditions, Cultural Significance of Storytelling, and Samoan Understandings of Place or Fanua. *Nais-Native American and Indigenous Studies Association*, 7(1): 121–151. https://doi.org/10.5749/natiindistudj.7.1.0121

Liritzis, I., Westra, A. and Miao, C. (2019). Disaster Geoarchaeology and Natural Cataclysms in World Cultural Evolution: An Overview. *Journal of Coastal Research*, 35(6): 1307–1330. https://doi.org/10.2112/JCOASTRES-D-19-00035.1

Lowe, D.J., Newnham, R.M. and McCraw, J.D. (2002). Volcanism and early Maori society in New Zealand. In: R. Torrence and J. Grattan (Editors), *Natural Disasters and Cultural Change*. Routledge, London, pp. 126–161. https://doi.org/10.4324/9780203165102

Macnight Ngwese, N., Saito, O., Sato, A., Agyeman Boafo, Y. and Jasaw, G. (2018). Traditional and Local Knowledge Practices for Disaster Risk Reduction in Northern Ghana. *Sustainability*, 10(3): 825. https://doi.org/10.3390/su10030825

Mai, P. (1981). The 'Time of Darkness' or Yuu Kuia. In: D. Denoon and R. Lacey (Editors), *Oral Tradition in Melanesia*. University of Papua New Guinea, Port Moresby, pp. 125–140.

Matchan, E.L., Phillips, D., Traine, E. and Zhu, D. (2018). $^{40}Ar/^{39}Ar$ ages of alkali feldspar xenocrysts constrain the timing of intraplate basaltic volcanism. *Quat. Geochronol.* 47, 14–28. https://doi.org/10.1016/j.quageo.2018.04.009

Matchan, E.L., Phillips, D., Jourdan, F. and Oostingh, K. (2020). Early human occupation of southeastern Australia: New insights from 40Ar/39Ar dating of young volcanoes. *Geology*, 48(4): 390–394. https://doi.org/10.1130/G47166.1

Mercer, J. and Kelman, I. (2010). Living alongside a volcano in Baliau, Papua New Guinea. *Disaster Prevention and Management: An International Journal*, 19(4): 412–422. https://doi.org/10.1108/09653561011070349

Mercer, J., Kelman, I., Taranis, L. and Suchet-Pearson, S. (2010). Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters*, 34(1): 214–239. https://doi.org/10.1111/j.1467-7717.2009.01126.x

Mercer, J., Gaillard, J., Crowley, K., Shannon, R., Alexander, B., Day, S. and Becker, J. (2012). Culture and disaster risk reduction: Lessons and opportunities. *Environmental Hazards*, 11(2): 74–95. https://doi.org/10.1080/17477891.2011.609876

Mysterious Lakes (1939, April 19). *King Island News (Currie, King Island: 1912–1986*, p. 2. Retrieved January 22, 2025, from http://nla.gov.au/nla.news-article212308822

Neall, V.E. and Trewick, S.A. (2008). The age and origin of the Pacific islands: a geological overview. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1508): 3293–3308. https://doi.org/10.1098/rstb.2008.0119

Neall, V.E., Wallace, R.C. and Torrence, R. (2008). The volcanic environment for 40,000 years of human occupation on the Willaumez Isthmus, West New Britain, Papua New Guinea. *Journal of Volcanology and Geothermal Research*, 176(3): 330–343. https://doi.org/10.1016/j.jvolgeores.2008.01.037

Needham, A.J., Lindsay, J.M., Smith, I.E.M., Augustinus, P., Shane, P.A. (2011). Sequential eruption of alkaline and sub-alkaline magmas from a small monogenetic volcano in the Auckland Volcanic Field, New Zealand. *Journal of Volcanology and Geothermal Research*. 201(1–4):126–142. https://doi.org/10.1016/j.jvolgeores.2010.07.017

Németh, K. and Cronin, S.J. (2009). Volcanic structures and oral traditions of volcanism of Western Samoa (SW Pacific) and their implications for hazard education. *Journal of Volcanology and Geothermal Research*, 186(3-4): 223-237. https://doi.org/10.1016/j.jvolgeores.2009.06.010

Németh, K., Gravis, I., 2022. Geoheritage and geodiversity elements of the SW Pacific: A conceptual framework. *International Journal of Geoheritage and Parks* 10(4): 523–545. https://doi.org/10.1016/j.ijgeop.2022.09.001

Nichol, R. (1992). The eruption history of Rangitoto: reappraisal of a small New Zealand myth. *Journal of the Royal Society of New Zealand*, 22(3): 159–180. https://doi.org/10.1080/03036758.1992.10426554

Nimmo, H.A. (1986). Pele, ancient goddess of contemporary Hawaii. *Pacific Studies*, 9(2): 121–179.

Nordvig, M. (2021). Volcanoes in Old Norse Mythology: Myth and Environment in Early Iceland. Arc Humanities Press, Leeds. https://doi.org/10.2307/j.ctv1k76ht8

Nunn, P.D. (1994). *Oceanic Islands*. Blackwell, Oxford. ISBN 10: 0631178112

Nunn, P.D. (1999a). Early human settlement and the possibility of contemporaneous volcanism, western Kadavu, Fiji. Domodomo, *Scholarly Journal of the Fiji Museum*, 12: 36–49.

Nunn, P.D. (1999b). *Environmental Change in the Pacific Basin: Chronologies, Causes, Consequences*. Wiley, New York. ISBN 0471949450.

Nunn, P.D. (2003). Fished up or thrown down: the geography of Pacific Island origin myths. *Annals of the Association of American Geographers*, 93(2): 350–364. https://doi.org/10.1111/1467-8306.9302006

Nunn, P.D. (2014). Lashed by sharks, pelted by demons, drowned for apostasy: the value of myths that explain geohazards in the Asia-Pacific region. *Asian Geographer*, 31(1): 59–82. https://doi.org/10.1080/10225706.2013.870080

Nunn, P.D. (2018). *The Edge of Memory: Ancient Stories, Oral Tradition and the Post-Glacial World*. Bloomsbury, London. ISBN-13 978-1472943286.

Nunn, P.D. (2021a). O cei na vulavula? Insights and regrets of a foreign geoscientist in the Pacific Islands. *Geosciences*, 11: #182. https://doi.org/10.3390/geosciences11050182

Nunn, P.D. (2021b). *Worlds in Shadow: Submerged Lands in Science, Memory and Myth*. Bloomsbury, London. ISBN 9781472983497.

Nunn, P.D., Lancini, L., Franks, L., Compatangelo-Soussignan, R. and McCallum, A. (2019). Maar stories: how oral traditions aid understanding of maar volcanism and associated phenomena during pre-literate times. *Annals of the American Association of Geographers*, 109(5): 1618–1631. https://doi.org/10.1080/24694452.2019.1574550

Nunn, P.D. and Reid, N.J. (2016). Aboriginal memories of inundation of the Australian coast dating from more than 7000 years ago. *Australian Geographer*, 47(1): 11–47. https://doi.org/10.1080/00049182.2015.1077539

Oguamanam, Chidi, Documentation and Digitization of Traditional Knowledge and Intangible Cultural Knowledge: Challenges and Prospects (2009). In Toshiyuki Kono, ed., Intangible Cultural Heritage and Intellectual Property: Cultural Diversity and Sustainable Development (Antwerp: Intersentia, 2009) 357–383, Available at SSRN: https://ssrn.com/abstract=2296199

Petterson, M., Cronin, S., Taylor, P., Tolia, D., Papabatu, A., Toba, T. and Qopoto, C. (2003). The eruptive history and volcanic hazards of Savo, Solomon Islands. *Bulletin of Volcanology*, 65(2–3): 165–181. https://doi.org/10.1007/s00445-002-0251-0

Piccardi, L. and Masse, W.B. (Editors) (2007). Myth and Geology. *Geological Society of London*, London, 350 pp. ISBN 978-1-86239-216-8

Purzycki, B.G., Apicella, C., Atkinson, Q.D., Cohen, E., McNamara, R.A., Willard, A.K., Xygalatas, D., Norenzayan, A. and Henrich, J. (2016). Moralistic gods, supernatural punishment and the expansion of human sociality. *Nature*, 530(7590): 327–330. https://doi.org/10.1038/nature16980

Rodolfo, K.S. and Umbal, J.V. (2008). A prehistoric lahar-dammed lake and eruption of Mount Pinatubo described in a Philippine aborigine legend. *Journal of Volcanology and Geothermal Research*, 176(3): 432–437. https://doi.org/10.1016/j.jvolgeores.2008.01.030

Ross, M.C. (1986). Australian Aboriginal oral traditions. *Oral Tradition*, 1(2): 231–271. https://core.ac.uk/download/pdf/159354575.pdf

Sheppard, P.J. and Walter, R. (2006). A revised model of Solomon Islands culture history. *The Journal of the Polynesian Society*, 115(1): 47–76. https://www.jstor.org/stable/20707321

Smith, B.W. and Prescott, J.R. (1987). Thermoluminescence dating of the eruption at Mt Schank, South Australia. *Australian Journal of Earth Sciences*, 34(3): 335–342. https://doi.org/10.1080/08120098708729415

Smith, J. (1880). *Booandik tribe of South Australian Aborigines: a sketch of their habits, customs, legends and language*. Government Printer, Adelaide. ISBN-13 978-1015572904.

Smith, V.C., Csta, A., Aguirre-Diaz, G., Gutierrez, E. (2020). The magnitude and impact of the 431 CE Tierra Blanca Joven eruption of Ilopango, El Salvador. *PNAS*, 117(42), 26061–26068. https://doi.org/10.1073/pnas.2003008117

Smyth, R.B. (1878). *The Aborigines of Victoria: with Notes relating to the Habits of the Natives of Other Parts of Australia and Tasmania*. John Ferres, London.

Stirling, M., Bebbington, M., Brenna, M., Cronin, S., Christophersen, A., Deligne, N., Hurst, T., Jolly, A., Jolly, G., Kennedy, B., Kereszturi, G., Lindsay, J., Neall, V., Procter, J., Rhoades, D., Scott, B., Shane, P., Smith, I., Smith, R., Wang, T., White, J.D.L., Wilson, C.J.N. and Wilson, T. (2017). Conceptual Development of a National Volcanic Hazard Model for New Zealand. *Frontiers in Earth Science* 5:51. https://doi.org/10.3389/feart.2017.00051

Summerhayes, G.R., Leavesley, M., Fairbairn, A., Mandui, H., Field, J., Ford, A. and Fullagar, R. (2010). Human adaptation and plant use in highland new Guinea 49,000 to 44,000 years ago. *Science* 330 (6000), 78–81. https://doi.org/10.1126/science.1193130

Swanson, D.A. (2008). Hawaiian oral tradition describes 400 years of volcanic activity at Kīlauea. *Journal of Volcanology and Geothermal Research*, 176(3): 427–431. https://doi.org/10.1016/j.jvolgeores.2008.01.033

Swanson, D.A., Rose, T.R., Fiske, R.S. and McGeehin, J.P. (2012). Keanakākoʻi Tephra produced by 300 years of explosive eruptions following collapse of Kīlauea's caldera in about 1500CE. *Journal of Volcanology and Geothermal Research* 215–216: 8–25. https://doi.org/10.1016/j.jvolgeores.2011.11.009

The Argus, (1897, October 12) TUESDAY, OCTOBER 12, 1897. *The Argus (Melbourne, Vic.: 1848–1957)*, p. 4. Retrieved April 4, 2022, from http://nla.gov.au/nla.news-article9774721

Toba, T. (1993). Analysis of Savo custom stories on the eruption of Savo Volcano, Ministry of Energy, Water and Mineral Resources (Seismology Unit, Technical Report TR6/95), Honiara.

Tobler, R., Rohrlach, A., Soubrier, J., Bover, P., Llamas, B., Tuke, J., Bean, N., Abdullah-Highfold, A., Agius, S., O'Donoghue, A., O'Loughlin, I., Sutton, P., Zilio, F., Walshe, K., Williams, A.N., Turney, C.S.M., Williams, M., Richards, S.M., Mitchell, R.J., ¼ Cooper, A. (2017). Aboriginal mitogenomes reveal 50,000 years of regionalism in Australia. *Nature* 544**,** 180–184. https://doi.org/10.1038/nature21416

Torrence, R., Pavlides, C., Jackson, P. and Webb, J. (2000). Volcanic disasters and cultural discontinuities in the Holocene of West New Britain, Papua New Guinea. In: W.J. McGuire, D. Griffiths and I.S. Stewart (Editors), The Archaeology of Geological Catastrophes. *Geological Society of London* (Special Publication 171), London, pp. 225–244. http://dx.doi.org/10.1144/GSL.SP.2000.171.01.18

United Nations International Decade for Natural Disaster Reduction (UNIDNDR) (1994) Yokohama strategy and plan of action for a safer world: Guidelines for natural disaster prevention, preparedness and mitigation. Geneva: UNIDNDR.

UN Office for Disaster Risk Reduction (2015). Sendai Framework for Disaster Risk Reduction 2015-30, United Nations, New York. https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030 van Otterloo, J., Cas, R.A.F. and Sheard, M.J. (2013). Eruption processes and deposit characteristics at the monogenetic Mt. Gambier Volcanic Complex, SE Australia: implications for alternating magmatic and phreatomagmatic activity. *Bulletin of Volcanology*, 75(8): 737. https://doi.org/10.1007/s00445-013-0737-y

Vansina, J. (1985). Oral Traditions as History. University of Wisconsin Press, Madison.

Viramonte, J.G. and Incer-Barquero, J. (2008). Masaya, the "Mouth of Hell", Nicaragua: Volcanological interpretation of the myths, legends and anecdotes. *Journal of Volcanology and Geothermal Research*, 176(3): 419–426. https://doi.org/10.1016/j.jvolgeores.2008.01.038

Walshe, R.A. and Nunn, P.D. (2012). Integration of indigenous knowledge and disaster risk reduction: a case study from Baie Martelli, Pentecost Island, Vanuatu. *International Journal of Disaster Risk Science*, 3(4): 185–194. https://doi.org/10.1007/s13753-012-0019-x

Westervelt, W.D. (1916). Hawaiian Legends of Volcanoes. Tuttle, Honolulu.

Whitehead, P.W., Stephenson, P.J., McDougall, I., Hopkins, M.S., Grahams, A.W., Collerson, K.D. and Johnson, D.P. (2007). Temporal development of the Atherton Basalt Province, north Queensland. *Australian Journal of Earth Sciences*, 54(5): 691–709. https://doi.org/10.1080/08120090701305236

Wilkie, B., Cahir, F. and Clark, I.D. (2020). Volcanism in Aboriginal Australian oral traditions: Ethnographic evidence from the Newer Volcanics Province. *Journal of Volcanology and Geothermal Research*, 403: 106999. https://doi.org/10.1016/j.jvolgeores.2020.106999

Wilmshurst, J.M., Hunt, T.L., Lipo, C.P. and Anderson, A.J. (2011). High-precision radiocarbon dating shows recent and rapid initial human colonization of East Polynesia, *Proc. Natl. Acad. Sci.* U.S.A. 108 (5) 1815–1820, https://doi.org/10.1073/pnas.1015876108

Witter, J.B. and Self, S. (2007). The Kuwae (Vanuatu) eruption of AD 1452: potential magnitude and volatile release. *Bulletin of Volcanology*, 69(3): 301–318. https://doi.org/10.1007/s00445-006-0075-4

Wood, M., Foale, S. and Gabriel, J. (2020). Anticipating Ulawun Volcano in New Britain, Papua New Guinea. *Anthropological Forum*, 30(1-2): 30–41. https://doi.org/10.1080/00664677.2019.1647831