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RESEARCH

Apex Liminality: Comprehending Lord Howe Island's Cloud Forest and Related Island Ecosystems

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Elevated isolated habitats that occur on mountain peaks and ridges are commonly referred to as *sky islands*. Sky islands are islands in a biogeographical sense but can also occur *on* islands. In these contexts, habitat islanding is effectively doubled, leading to highly distinct ecosystems. One subset of sky islands occurs in areas frequently covered by water vapour. These are commonly referred to as *cloud forests* but might be better characterised as *elevated cloudy ecosystems* in recognition of their nature as dynamic assemblages of vaporous, material and animate elements. The limited extent of these areas and their reliance on cloaking vapour to maintain their habitats make them particularly vulnerable to a range of Anthropocene pressures.

Following a discussion of the limitations of analogous naming practices for such ecosystems, the article provides a general characterisation of elevated cloudy habitats and explores notions of atmospheres and of visibility with particular regard to Lord Howe Island and human perceptions of and experiences within its cloud forest zone. Moving to more comparative analyses, the article refers to various interventions that have either undermined or attempted to maintain similar island ecosytems and the prospects for these at a time of increasing global climate change. In considering such aspects, the article identifies the manner in which the elevated cloudy ecosystems of some islands are as integrated with and dependent on water vapour as they are on the islands' surrounding seas and merit recognition as a distinct phenomenon in this regard.

Keywords: sky islands; cloud forests; elevated cloudy ecosystems; Lord Howe Island

Introduction

Elevated habitats that show distinct characteristics from surrounding low(er) lands have often been characterised as *sky islands*, reflecting their status as distinct, isolated areas within broader landscapes. This term is attributed to Natt Noyes Dodge, a naturalist who worked for the US National Parks Service in the 1930s–1950s, when he referred to the Chiricahua Mountains massif in south-eastern Arizona as a 'mountain island in a desert sea' (1943: 25). His use of the term precedes the development of the field of island biogeography by Robert McArthur and E. O. Wilson in the early 1960s (which was consolidated in their 1967 book *The Theory of Island Biogeography*) but evinces a similar perception of biogeographical isolation. The term *sky island* subsequently gained traction, with a group of around 63 elevated areas in the US Southwest now being commonly referred to as the Madrean Sky Island region (e.g., Wild Sonora n.d.). In recent decades, the term *sky island* has also been applied to similar environments outside of North America, for example, to areas of southwestern China (He & Jiang 2014) and to the Indian Western Ghats (Robin, Vishnudas, Gupta et al. 2017). A related term, *island ranges*, referring to aggregates of such habitats, such as those occurring in the Crazy Mountains of Montana, has not become widely adopted and has more of a regional relevance.

While the analogous term used to refer to these habitat isolates can be understood biogeographically, it is worth reflecting on the inflection that habitual use of such analogies brings to perceptions of the environmental character of such locales. Traditionally, islands have been understood as areas of terrain located in seas, lakes or rivers whose flora and terrestrial fauna are largely isolated by virtue of their inability to survive (let alone flourish) in the aquatic environments that surround them. There are, of course, exceptions to this with regard to amphibious reptiles, birds and mammals (such as crocodiles, penguins or otters, respectively) and with regard to humans who can develop aquapelagic livelihoods in particular environments (with or without the aid of relevant technologies). Birds and flying insects are partially exempt from such isolation due to their ability to fly over waters to other terrestrial areas (although this exemption is constrained, for most species, by the distances of some remote islands from other terrestrial isolates or mainlands). As both Charles Darwin (1859) and more recent island biogeographers

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have established, species isolated on islands for extended durations show several developmental characteristics, most notably, speciation—the evolution of distinct species due to particular localised conditions (Chen & He 2009).

In contrast to water-hemmed islands, the islandish/archipelagic aspect of sky islands is determined by climate—higher areas being cooler than lower ones and with rainfall levels reflecting the standard meteorological pattern of moist air cooling as it rises over high land with resultant precipitation. In the case of cloud forests, it is not just rainfall but also (annually or seasonally variable) concentrations of low cloud that create distinct habitats. As Reinhardt, Emanuel and Johnson (2013) have identified,

> Mountain cloud forest (MCF) ecosystems are characterized by a high frequency of cloud fog, with vegetation enshrouded in fog. The altitudinal boundaries of cloud-fog zones co-occur with conspicuous, sharp vegetation ecotones between MCF- and non-MCF-vegetation [that] suggests linkages between cloud-fog and vegetation physiology and ecosystem functioning.

The characteristic fog also has a key role in determining the nature of the light falling on flora, which differs from the spectral band ratios and cumulative daily radiation patterns typical of sea-level light fall, delivering a different quality of photosynthetic light in cloud forests that affects plant growth patterns (Reinhardt, Smith & Carter 2010).

The distinct flora and fauna that occur on sky islands and in/as cloud forests reflect two climatic/environmental factors: (1) changes that have led to various species being 'warmed out' of low-lying areas and persisting as remnants in higher, cooler ones and (2) the aforementioned speciation, whereby genetic developments occur to allow species to cope with and thrive in specific environments (see, for example, Favé 2012). Elevated moist habitats are thereby distinct as a general category and are also often significantly distinct from each other, even when proximous, such as within massif systems. Mobility of species between sky island/cloud forest locales is easier than on and off archetypal islands but is, nevertheless, restricted. These aspects can lead to cloud forests on islands being effectively regarded as islets within islands. But while apposite to considering such environments through the lenses of either island biogeography or island studies, such analogisation is only partially successful, since sky island/cloud forest environments fluctuate far more—over both seasons and centuries—than archetypally monolithic islands (such as Lord Howe Island itself). Indeed, echoing the rationale behind Grant McCall's call for the establishment of island studies as a distinct field of research,[1] elevated cloud forests merit understanding in their own right. This is less obviously achieved through comparison to the fixed materiality of islands than it is to the assemblage of liquid, material and animate elements that have been understood to constitute *aquapelagos* around islands (see *Shima* 2022). These assemblages are dynamic, in that they have historically waxed and waned as climate patterns have altered and, more recently, as Anthropocene factors have impacted upon them (2012: 7). In recognition of the uniqueness of assemblages defined by the interaction of water vapour with animate and inanimate elements in elevated locales, it is more productive to regard and refer to them as *elevated cloudy ecosystems* (henceforth ECEs) than metaphoric islands.

Having addressed issues concerning nomenclature, this article considers the ways in which residents, tourists and naturalists have perceived and engaged with the ECEs that occupy two areas of the northern part of Lord Howe Island. In order to formulate an approach to this topic, I returned to a prescient article published in 1992 in which John Urry identifies four main ways in which societies have intersected with physical environments: *stewardship* (aimed at preserving aspects for posterity); *exploitation* ('for maximum instrumental appropriation'); *scientization* (such as the creation of natural reserves): and *visual consumption* (through constructing, regarding and representing 'the physical environment as a "landscape" … embellished for aesthetic appropriation') (1992: 2–3). Urry's framework is particularly pertinent since all four tendencies have been manifest on Lord Howe Island, with *exploitation* being managed and constrained by the *stewardship* of islanders and island bodies and with the *scientization* of its natural assets intermingling with their *visual consumption* as landscape under the umbrella of the island's UNESCO World Heritage listing (discussed further below). I have tried to retain awareness of this quadripartite framework throughout and to think with and through the island—and, most particularly, its distinct ECEs—as emblematic of Anthropocene pressures.

ECEs have a distinct character with regard to what Urry refers to as their '"aesthetic consumption"' and managed 'exploitation'. As previously outlined, cloud forest environments are marked by their innate vaporousness and wetness, qualities that blur materiality and immateriality. These aspects delineate the very delicacy of such environments. In contrast to Urry's emphasis on *visual* consumption, sight is only one of the perceptual faculties involved in human interactions and aesthetic engagements with such environments, with their atmospheres being more broadly tangible. This tangibility involves a bodily awareness of humidity that relies on subtleties of perception. As Filingeri (2015) has identified, 'humans have been shown to sense humidity despite the absence of specific skin hygroreceptors: the sensory integration of cutaneous thermal (i.e., evaporative cooling) and tactile (i.e., mechanical pressure and friction) sensory inputs has been shown to be used as a hygrosensation strategy to detect skin wetness and humidity.' In cloud forests, sight (including impaired sight), hygrosensation, hearing, physical/mental awareness of altitude and more complex mental expectations and perceptions of place informed by the former construct the (figurative) atmosphere of the place as experienced by human visitors.[2] This perceptive/aesthetic experience of the atmosphere of a physical environment is one that Böhme has recognised in his call for a 'social-natural science' that introduces the 'aesthetic experience into the science of ecology', since 'what affects human beings in their

environment are not only just natural factors but also aesthetic ones' (2017: 1). As he asserts, the 'elements of the environment are not only causal factors which affect human beings as organisms but they produce an impression on their feeling' (2017: 1), effectively creating 'tuned spaces' (2017: 2). The atmospheres of these spaces are what he terms 'quasi-objective' in that they *are* 'out there' (in an objective sense), but they are also not like 'beings or things' in that 'they are nothing without a subject feeling them' (2017: 2).

While ecologists and water resource researchers have studied aspects of cloud environments on islands in the 2000s (see Dias et al. 2007 and Figueira, Prada & Sequeria 2006, for example), island studies scholars have shown less interest in issues concerning (various forms of) water vapour and humidity, their relationship to island environments and the nature of human perception and aesthetic experience of them. This is somewhat paradoxical, as the issue is effectively 'hidden in plain sight' in a famous example of indigenous place-naming, New Zealand being referred to by its Maori ancestral population as Aotearoa ('land of the long white cloud'), in reference to the clouds visible on the horizon that signalled the presence of land underneath them. Of the handful of island studies articles in which scholars have pursued integrated social-natural science perspectives on clouds and islands, two stand out: Vale (2017), on perceptions of the Azores and, more recently, Hodges (2022), with regard to a broader consideration of perceptions and representations of water vapour and mirages in the South China Sea.

Vale's work is notable for moving from a discussion of the (conceptual) 'territorial legibility' of the Azores (2018: 79) to consider 'a process of co-visibility, of seeing and being seen … and of the island as a *terraquée* space' in which components 'intersect in a more-than-geographical manner' (2018: 80). The integration she proposes and, indeed, the human perceptions she identifies as engendering the 'legibility' of the *terraquée* space in question (*terra:* land, *aquée*: water) (Hayward, 2012) are closely similar to the concept of the aquapelago and, in particular, to Suwa's (2012, 2018) readings of the aquapelago as an extended *shima* (cultural neighbourhood) generated by human experience in and perceptions of landscapes and associated waterscapes.[3] Vale's work contributes significantly to the development of aquapelagic models by stressing haze, mist and cloud as defining aspects of the apprehension and experience of the island aggregate of the Azores and can also be understood to converge with the concept of the ECE that I advance in this paper, particularly in her discussion of visitors' perceptions of Azorean landscapes. Here, Vale contends that 'one's first impressions are unmistakably atmospheric, heavy with water and shadow', leading to 'bodily apprehension-immersion' that involves embracing and 'interpreting the enveloping atmosphere' (2018: 84, 86). As she goes on to identify the 'characteristic elements' of the island territory, profiles 'emerge from a mixture of indistinct humid matter intrinsically connected with nature' (2018: 92) in a locale that Brandão identifies as being 'drenched with humidity' (2009: 86). Interpreting literary accounts of encounters with the Azores in which mists, mistiness and obstructed vision play a significant role, Vale asserts that

> images form beyond history and are created as part of the seeing/gazing process, in which the subject recurrently and continually receives impressions. That which can be read in the territory thus interferes with the user's apprehension of space. For this reason, the time/space union becomes a referential, content-heavy marker. (2018: 92)

These reflections are complemented by Hodges's imaginative and wide-ranging discussion of water vapour, mirages and maritime mythology in the South China Sea. Reflecting on the 'atmospheric turn' in anthropology and geography (after Griffero 2019) that has influenced his study, Hodges parallels Vale in asserting that 'The prevalence of atmospheres and affects in such new scholarship is related to the fact that both are encountered spatially. They are things in the air, that we feel as we have a physical experience in a place not just in an interior subjectivity' (2022: 118). As he goes on to identify,

> Thinking atmospherically also blurs the boundary of the island. It softens the distinction between physical and imaginary borders…. Islands, like atmospheres, are more than just isolated destinations, material resources or idyllic representations. They are ecosystems, spheres of influence and sites of collision between competing systems: of the colonial and indigenous, the geologic and oceanic, the gaseous and the liquid. (2022 121, 122)

This line of argument is particularly apposite for cloud forests, which comprise homeostatic systems scattered in isolated locations. The forests' existence, defined by the cloudiness of their assemblages, involves the emission of the unsaturated gaseous hydrocarbons isoprene and terpene by trees, and, hence, the density of condensation nuclei (aka 'cloud seeds') present in the vicinity (Zhao, Buchholz, Tillmann et al. 2017). Put simply, there is a feedback loop in operation—the more trees, the more the 'seeding' hydrocarbons and the more the cloud cover and, conversely, the less trees, the less the 'seeds' and the less the cloud cover, in an accelerating dynamic pattern. While the isoprene and terpene emissions cannot be seen—and are not, thereby, a visible phenomenon—their presence simultaneously catalyses visible vapour and impairs visual access to that which the vapour supports and cloaks. Similarly, diminution of the gases is apparent through the greater visibility of trees and peaks in increasingly cloudless forest areas and in an increased sense of dryness in such locales.

Hodges's assertions also raise notable issues about human experience on and perceptions and imagination of islands that complement Vale's discussions of the vaporous swathes and filaments that can cloak island surfaces. Discussing atmospheres in their broadest sense, Hodges asserts the following:

> Atmospheres also bring with them a question of time. There is the geological time frame of the Anthropocene and all the other epochs that have come before us. There is also a speculative time frame of what things might be on the horizon in the future. Atmospheres work across both, they are visible in the material record of the Earth and they exist in this future time of what may come. Seen on the horizon, they can draw us forward or push us back in retreat. And like a ship's log, it can feel like our only recourse is to just jot down the changes in the weather, all while attempting cautiously to plot the safest course forward…. To think atmospheres and the deep sea is much like the contemplation of a mirage. It involves pursuit of a place that might never be reached but that, nonetheless, motivates very real desires and fears. (2022: 122)

These characterisations are pertinent for the present and future of Lord Howe and other islands, and their ECEs, as the Anthropocene gains pace. In the discussions that follow, I draw on perceptions of space, time and, in particular, Anthropocene transformation informed by sensory experience and my desires and fears for unique environments.

Lord Howe Island

While most cloud forests occur on continental mountain ranges, there are also a small number located on islands, most notably Yakushima (southern Japan), La Gomera (Canary Islands), Santa Rosa (California) and in various parts of Oceania, including Savaii (Samoa) and Lord Howe Island (henceforth LHI). In what follows, I focus on the latter before comparing the condition of its ECEs and conservation efforts to those of the aforementioned islands.

The group of islands that LHI forms the central and largest component of is located in the south-western Pacific around 31°33'40.7"S, 159°05'38.1"E, 600 kilometres east of the Australian continental mainland (**Figure 1**). The islands have an aggregated land area of 1,540 hectares and a reef and marine area of over 145,000 hectares and are administered as part of the Australian state of New South Wales (NSW). There is no evidence of human inhabitation (or even visitation) of the islands prior to Western mariners encountering the area in the 1780s (Anderson 2016). The main (and only inhabited) island was first settled in the 1830s and currently has a permanent population of c385. The most recent census figures show 79.6% of the population indicating Australian ancestry[4] and the largest other groups being of New Zealander (3.9%), English (2%) or US descent (1.7%) (Australian Bureau of Statistics 2016). Tourists are demographically similar. Destination NSW (2017) visitor survey data indicates that 88% of visitors are Australian, with the majority of the remainder comprising travellers from England and the United States.[5]

Since initial settlement, human inhabitation and exploitation of the island has been relatively light in terms of land clearance (aside from the low mid-north section) and has not resulted in extractivist, industrial and/or military disruption and/or alienation of lands of the type that has happened on other Australian outliers,

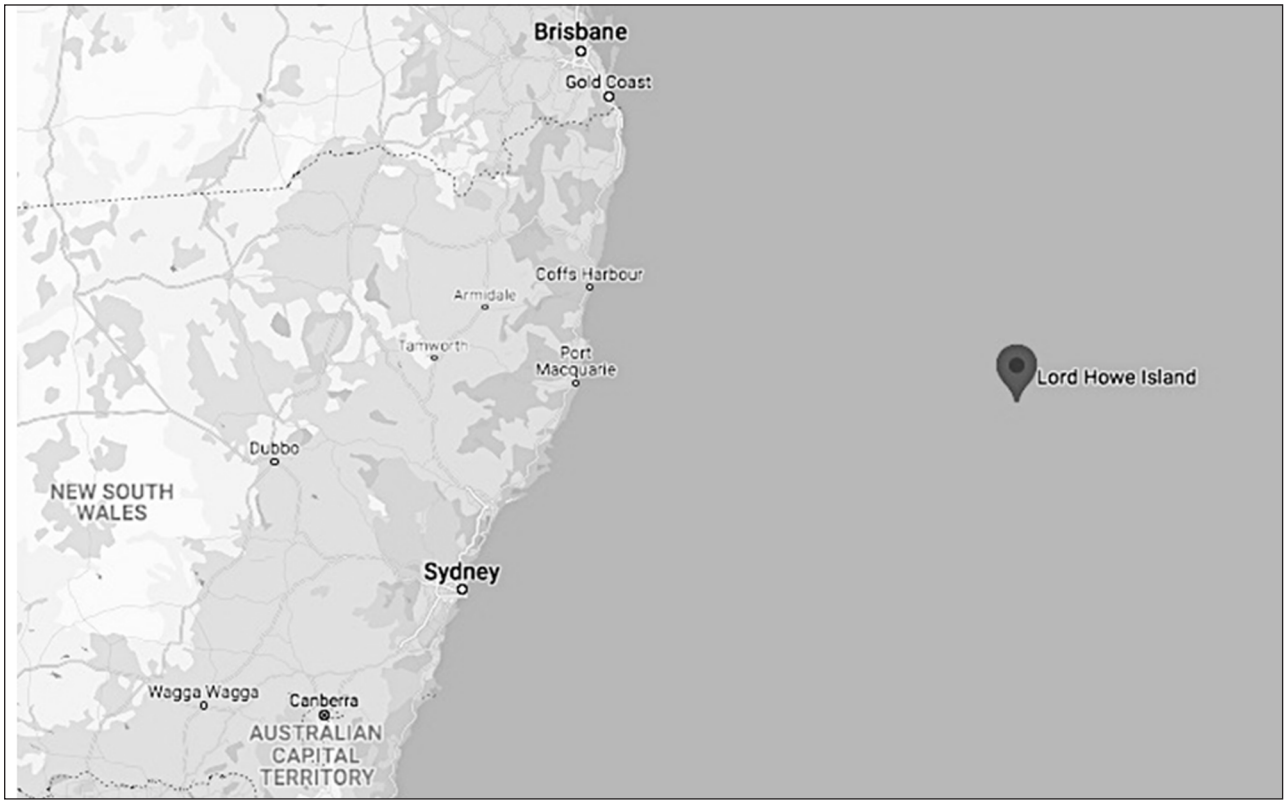

Figure 1: Map of Lord Howe Island in relation to the mid-east coast of Australia. Google Maps 2021.

such as Christmas Island (see Hayward 2021). LHI has a somewhat unique administration in which an appointed board exercises primary authority over island matters (Reis and Hayward, 2013). Unlike Australia's lamentable national record in failing to protect the Great Barrier Reef (Flannery 2016; Gunia 2021), the management of LHI's natural assets has been prudently conducted by the board in cooperation with Parks and Wildlife NSW. One key aspect of this has been strict regulation of visitor numbers and, thus, the scale of the local tourism industry, with a restricted maximum of 400 tourists being permitted at any one time. This restriction results from LHI's 1982 UNESCO World Heritage listing as a site of 'outstanding universal value' with regard to two qualifying categories: '(vii) contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance' and '(x) contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation' (UNESCO n.d.).

Despite its undoubted appeal, LHI is a complex space in terms of access to and visibility of its major environmental and touristic assets. While the coral reef that graces the main island's central north-western shore is easily visible and visitable, its two other major attractions are less accessible and more elusive. In addition to LHI's elevated southern section, discussed in detail below, the thin and vertiginous (560 metre high) Ball's Pyramid (the world's tallest sea stack), located 20 kilometres south-east of LHI, is a remarkable formation.[6] Due to its position, it is only visible from high and difficult to access vantage points on LHI's south-eastern coast. It can also elude the gaze. On my third research visit to LHI, for instance, I recorded the following field note:

> Climbed the steep, slippery path up to the Goat House Cave on the western side of the island, concerned about the changing weather conditions that saw clouds building (and worried about my lack of suitable all-weather gear). Clambered around to the flat area adjacent to the shallow cave and glimpsed Balls Pyramid, standing thin and dark against the sea and sky. After resting and draining my water bottle I rummaged in my bag and pulled out my phone to take a photo but in the interim the vertical stack had disappeared. Disconcerted, I peered into the distance and realised that grey smudges of rainy mist had cut out the view and I became concerned to head back down in case the rain hit the main island. Turning back as I rounded the corner to descend, I thought that I could see a small black vertical oval floating in the mist like a suspended mirage, the top or a mid section of the Pyramid temporarily exposed by a gap in the mist and by my precise perspective point, perhaps? As I soon as (I thought) that I had glimpsed it, it disappeared and I descended as dense 'mizzle' settled on the slopes.

The main island comprises a small hilly area at the northern end; a flat isthmus in the central area, around which the island's main settlement, small tourism industry and single airstrip are based; and an elevated area that looms dramatically at the southern end, supporting the island's ECEs. The highest point, Mount Gower, rises to 875 metres and has cloaking cloud cover on its upper reaches for much of spring through to autumn. This micro-climate nurtures what is officially termed a 'gnarled mossy cloud forest' by New South Wales Department of Planning, Industry and Environment (DPIE) (2011), covering a 27-hectare area, with a smaller fragment on the summit ridge of the adjacent peak, Mount Lidgbird (777 metres high). Anecdotal evidence gleaned from my research visits to the island over the last 15 years suggest that high-season tourists find the vista from the flatter residential area (**Figure 2**) both fascinating, for the mystery of its hidden summit, and frustrating, if they are after a clear shot of it. For many, this vista is all they experience of the island's cloud forest. The cloud forest is thereby a cloaked asset for the island—there, but mostly unattainable and unknowable.

In terms of Hodges's previously cited characterisation, the peak has its own literal and figurative atmosphere that plays a role in the broader affective atmosphere of the island, for which it is a misty 'crowning glory'. The moist and humid environment on the peak nurtures a variety of flora, including trees that range from two to eight metres in height, with the primitive angiosperm *Zygogynum howeanum* and the *Ericaceae* tree *Dracophyllum fitzgeraldii* as dominant species, and with tree ferns, ferns and mosses prominent as understorey. The distinct environment constitutes a biodiversity 'hotspot' on the island, particularly for invertebrates (NSW DPIE 2011). The winter months—when the peak is often clear—are cool enough to allow the distinctive vegetation to survive through the drier period.

Tourists wishing to visit the ECEs have to undertake a protracted hike along a coastal path on the west of the island and then an 850-metre ascent up an uneven and often wet track that has guide ropes secured at its steepest points. Considerable fitness and fortitude are needed to complete the 8-to-10-hour return route. The dramatic terrain traversed has led to the Mount Gower trail being listed as one of the top ten 'Great Walks of Australia' on the eponymous website. While the trek may be attempted individually, local publicity stresses the importance of travelling with one of the two licenced local guides (for both safety reasons and so that visitor behaviour en route and at the peak can be monitored). Weather conditions also often cause planned ascents to be postponed. The low number of tourists permitted on the island and the physically arduous nature of the trail has served to limit visitation to the ECEs and, thereby, to limit disruption of their cloud forest environment. At present, with two qualified guides operating for around nine months of the year, an estimated 800 tourists access the summit annually (with a further 50–100 making part of the ascent) (Ian Hutton, personal communication, October 8, 2021, and Tripadvisor data).

Figure 2: Elevated southern section of Lord Howe Island viewed from the central lowland. Photo: Bree-anna Brunjes, 2021; reproduced with permission of the photographer.

Given the short duration of human inhabitation of LHI, the low population (numbering less than 50 for much of the 19th century), the difficulty of accessing its peak areas until routes and ropes were established in the 1980s and the lack of pressing reasons to attempt ascent, there has been no development of socio-cultural traditions of sensory awareness and perception in the cloud forest of the type that Steven Feld (1991, 1996), for instance, documented with regard to the long-established population of the Mount Bosavi region in Papua New Guinea.[7] Feld has described these awarenesses and perceptions in terms of 'the shaping forces of a sensuous world, of how the tactility, proxemics, kinetics, and so forth shape and orient relations between materials, non-humans, and humans' and, in response to my research, has asked, how these might create 'conditions for understanding anthropogenic transformation' relevant to Anthropocene changes on LHI (personal communication, February 22, 2022). The answer is relatively simple in that there is a distinct under-development of subtle perceptions and understandings of LHI's cloud forest compared to indigenous experiences of similar areas (due to the factors outlined above). As outlined below, the vast majority of humans experiencing LHI's ECEs are recent, infrequent (and often singular) visitors whose impressions (understandably) appear to be less developed and subtle than those Feld noted amongst the Bosavi.

The majority of the 234 visitor reports on the Mount Gower trek featured on the Tripadvisor website (as of October 8, 2021) emphasise the demanding nature of the climb as a key aspect of the experience (with a significant number expressing disappointment or frustration at its difficulty and/or their inability to complete the full stretch). Walkers' appreciative comments on the cloud forest environment describe it as being a 'misty mossy wonderland' (Concam, March 2016); 'so primeval' (RogerK, November 2018); a 'magical forest with an indescribable amalgam of moss carpeted floor, ferns and palms' (Kayelle100, October 2019); a 'magical, fantastical, Tolkienesque environment' (Robynrad, May 2018); and 'a magical Shangrila' (Peter J, May 2013). These comments draw on a number of cultural referents to try and convey visitors' perceptions of an unfamiliar ('indescribable') place and environment whose flora and enveloping atmosphere (using the latter term in a Böhmean sense) are most readily comprehended in terms of an assumed/allusive primitiveness and/or through reference to elaborate fantasy locales such as those created by J. R. R. Tolkien in his fiction or the Tibetan mountain paradise described in James Hilton's novel *Lost Horizon* (1933) and the eponymous film adaptations (1937 and 1973). The cloud forest is objectively 'there' (**Figure 3**), but the locale perceived and represented by visitors is a co-creation of place, human physical experience of place and cultural referents deployed by visitors to convey their sense of the place's atmosphere.

While no Tripadvisor reports refer to the fragility of the cloud forest environment (and/or show any awareness of

Figure 3: Lord Howe Island cloud forest. Photo: Ian Hutton, n.d. reproduced by permission of the photographer.

visitors' potential to disrupt it), the forest has been listed as a 'critically endangered ecological community' since 2011 under the NSW Threatened Species Conservation Act (1995). One of the best-known threats to LHI's distinct flora and fauna has been the proliferation of *Rattus rattus*, commonly known as the black rat or ship rat, which has been present on LHI since 1918. By the early 2000s, the island's rat population, estimated at over 100,000, was observed to have had a severe impact on local flora by eating seeds and, thereby, affecting the reproduction of species such as the *Hedyscepe* and *Lepidorrhachis* palms endemic to the cloud forest (Baker & Hutton 2006). Following a widely publicised poisoned baiting initiative in 2019–2020, the rodents appear to have been eradicated, and there is evidence of significant regeneration of endemic cloud forest species (Siossian & Marshall 2021)—although the identification of what are assumed to have been new rat arrivals on the island in 2021 (Kurmelovs 2021) is a reminder that rat prevention policies and mechanisms need to be an ongoing project if the ecological balance and species diversity of the island at time of initial Western encounter is to be maintained.[8] It should also be acknowledged that while there has been careful management and limitation of numbers of tourists ascending to the ECEs, there has also been some erosion and foliage damage along approach trails, and there is concern over the incidence of invasive species such as African love grass (*Eragrostis curvula*) and broad-leaved paspalum (*Paspalum mandiocanum*) being introduced via seeds carried from lower areas on hikers' boots (Hutton, personal communication, October 8, 2021).

In addition to tourism visitation, rodent pressures and related disruptors, such as invasive weeds or pathogens, the most pressing concern for the peak areas and, indeed, the whole World Heritage site, is one of the Anthropocene's signature elements—climate change.[9] The first clear local impact of this global phenomenon was perceived not on LHI's high, moist peaks but on the main island's coastal fringe in the form of a coral bleaching event that was observed and documented in summer 2018/2019 (Moriaty, Leggat, Eakin et al. 2019). While submerged thermometers and/or remote-sensing technologies can pick up changes in ocean temperatures, these are often most apparent from their biological impacts. Coral reefs have commonly been perceived as key indicators of spikes in ocean temperatures and, hence, as 'canaries in the coalmine' of global climate change (Sweet, Burian & Bulling 2021). One of the clearest indicators of sudden rises in ocean temperature in tropical and subtropical latitudes is the visible bleaching (i.e., whitening) of coral that has died off as a result of being over-heated and the related reduction in the number of fish species that feed on and around coral reefs. The prospect of continued ocean warming and often repeated bleaching events remains a major concern for islanders, naturalists and tourism agencies alike.

Just as global warming imperils coral reefs, it also endangers the viability of cloud forests (Bubb, May, Miles et al. 2004). As the NSW DPIE recognised in 2012, the cloud forests that occupy the upper peaks of LHI have nowhere cooler to retreat to if local temperatures increase. Similarly, the DPIE report noted that increased volatility or other seasonal shifts in rainfall patterns, storm frequency

or intensity could also damage, deplete or eradicate the assemblage of water vapour, moisture, terrain, flora and fauna that constitute the island's ECEs. Drone surveys conducted by local naturalist Ian Hutton after a number of exceptionally dry years in the last decade reveal a significant reduction in tree canopy around the peak. This imperils the epiphytes that rely on moist air to sustain themselves on tree trunks and creates favourable light conditions for invasive plants to thrive. As causes and signs of ecological degradation, the reduction in cloud cover and opening up of the cloud forest canopy go hand in hand, signalling peril and future ecological erasure in a manner that recalls Vale's characterisation that 'images form beyond history and are created as part of the seeing/gazing process, in which the subject recurrently and continually receives impressions' that affect the visitor/viewer's 'apprehension of space' (2018: 92). Similarly, the implications of changes in cloud cover, humidity and light invite us—after Hodges—to 'think atmospherically' in a way that also 'blurs the boundary of the island', softening ' the distinction between physical and imaginary borders' in a manner that emphasises how islands are 'more than just isolated destinations' or 'idyllic representations' (as in tourism promotion materials) but are, rather, 'ecosystems, spheres of influence and sites of collision between competing systems' (2022: 122). As he also asserts, the study of 'these environs involves thinking about their relationship to wider networks and assemblages, both real and imagined' (2022: 122). In this context, there is no wider network than the aggregated industrial/extractivist combine that has driven the Anthropocene, a force that flows across state boundaries, state protected areas, UNESCO World Heritage sites and ECEs alike, transforming all it encounters.

Comparative Experiences of ECEs

The profile of LHI's cloud forest ecosystem presented above contributes to understandings of the perception and present-day conditions of cloud forests and sky islands within the enfolding phenomenon of the Anthropocene and merits consideration against the current state of other island ECEs. Globally, a number of significant cloud forests are under threat (e.g., Panama's Cerro Chucantí (Rainforest Trust 2017) and Cameroon's Bali Ngemba (Onana 2018)), and many island cloud forests have been destroyed, transformed or otherwise depleted by clearance, climate changes and/or invasives over the last 200 years. Even those that have continued to exist in remote areas without severe depletion, such as the tropical montane zones of Savaii in Samoa (Conservation International 2010) or areas of the high islands and islets of French Polynesia (Meyer 2011), are now under threat from global warming.

One of the most marked destructions of cloud forest habitat has occurred on Santa Rosa Island, located 42 kilometres south of Santa Barbara, on the Californian mainland, where the island's central, cloud-shrouded, high ridge-supported clusters of tall oak and pine trees growing out of lower evergreen shrubs and bushes at the time of initial European colonisation in the early 1800s has disappeared. The settlers' introduction of grazing animals (principally goats, pigs, sheep and deer) led to the cloud forest's ground cover, and the many fallen acorns dispersed across it, being massively depleted, undermining new growth and leading to erosion, a reduction in moist air retention and a collapse of the ecosystem. Now regarded as a lost natural asset, there are schemes underway to try to recreate the environment through laborious interventions that have yet to show significant success (US National Park Service 2016; Bernard, McEachern & Niessen 2016). The cloud forest is now absent and only lingers, dissipated, as a memory referred to in signage, pamphlets and papers and in aspirational projects seeking to return it to a much-changed island.

By contrast, a different kind of Anthropocene transformation has affected areas of Hawai'i, where a variety of invasives have established themselves and flourished in ECEs, out-competing native species in many cases. While the invasive trees have contributed to the maintenance of the cloud forest system by emitting isoprene and terpene, they now form part of an integrated community of endemic Hawaiian species and thriving introduced trees. Cloud forest systems thereby persist but in a much-changed form, and visitors to tourist attractions such as the Kona Cloud Forest Sanctuary encounter a range of exotic species (leading to questions about quite what the 'sanctuary' is providing a refuge for). Other islands have had greater degrees of success in combatting disruption of cloud forests and safeguarding indigenous bio-assets, Yakushima, in southern Japan, being a case in point.

Yakushima is a mountainous island of 540 square kilometres that rises to a central peak of 1,936 metres. Its population of c14,000 mostly live around its small coastal fringe, and many are employed in tourism or tourism-related occupations. The major tourism draw of the island is its charismatic mega-flora, in the form of the stands of huge *Cryptomeria japonica* trees, known locally as *yakusugi*, many of which are estimated to be over 1,000 years old. These trees grow on the island's mid-upper slopes as a result of the island's mild and wet climate and create the canopy cover for the cloud forest environment in a similar manner to the large acorn trees that once proliferated on Santa Barbara. As Hayward and Kuwahara (2013) have detailed, while Yakushima's largest trees were revered by the island's early inhabitants, pressures of poverty resulted in *yakusugi* being harvested for export to main island Japan from the mid-1600s on for use in building and boat construction. This extractivist operation continued intermittently through to the 1970s, resulting in the removal of most *yakusugi* stock from the island's ECE, except for those growing in a small number of designated protection areas.

In the absence of data on the scale and composition of the cloud forest areas prior to logging, it is difficult to ascertain the impact of the latter activity, but the growth of younger cryptomeria trees in the centre of the island adjacent to surviving ancient trees (**Figure 4**) since cessation of logging in the late 20th century appears to have stabilised the existing pockets of cloud forest (Takashima,

Figure 4: Lower trunk and surface root system of giant *Cryptomeria japonica* tree, mosses and shrubs on the peak area of Yakushima (with humans included for scale purposes). Photo: Henry Johnson, 2017, reproduced by permission of the photographer.

Kume, Yoshida, et al. 2017). This stabilisation has been accompanied by a return to reverence for the *yakusugi* and the island's ECE that is manifest in the ecotourism that has flourished since Yakushima's successful World Heritage listing in 1992. Many tourists arrive specifically to visit the cloud forest, which is accessible by a relatively short walk from a car park on the upper-mid section of the island, and/or via a trek to the vicinity of the island's most famous and celebrated tree, the *Jōmon Sugi*, which has been dated at around 2,000 years old (Gymnosperm database 2007).

In a similar manner to the variable visibility of Lord Howe Island's natural assets, one of the ironies of the *Jōmon Sugi's* prominence as a tourist attraction is that many of those who complete the three-to-four-hour trek up to a viewing platform 15 metres away from the tree to gaze across at it are unable to see it due to the dense mist that often fills the space in-between. In this context, local guides emphasise the effort of the walk, the travellers' proximity to the tree and their sense of the atmosphere around it as the essential experience. The reputation of the tree thereby precedes tourists' experience of its vicinity and imbues the misty, moist atmosphere of the locale with a culturally dense and expectant Böhmean atmosphere that is not purely reliant on and/or gratified by the tourist gaze alone. Those thwarted in their efforts to *see* the precious tree are provided with ample audio-visual documentation in the island's ecotourism centres.

Yakushima and Lord Howe Island are home to unique habitats that occur where meteorological and biological factors combine to create cloud reliant/seeding ecosystems. As has been detailed, these are often hidden from the gaze of locals and tourists by their inaccessibility and/or the enveloping water vapour present for protracted periods that gives the locales their name. Given these factors, and the danger of tourist-related damage to fragile environments, it is pertinent to consider the role representational technologies might play in allowing both tourists visiting LHI and a broader global public to experience LHI's ECEs and other cloud forests in a mediated form. Factors such as the increased dissemination of high-quality, lightweight audio-visual technologies; the development and increasingly low-cost availability of drones; the development of various internet platforms; and the increased quality and affordability of VR (virtual reality) technologies are all significant. The audio-visual representation of tourist attractions has led to the development of 'virtual tourism', whereby sites are enjoyed vicariously through high-quality pre-recorded or live-streamed material that often provides perspectives and vistas that the average tourist cannot access. Tourism Australia's website makes this clear by featuring 'virtual tours of top Australian cultural experiences' that, the

website asserts, will allow you to 'experience the iconic Australian outback through a lens' (Fraser 2021) that constructs 'the physical environment as a "landscape" … embellished for aesthetic appropriation' (Urry 1992: 3).

To date, while LHI has been well served by local videographers' and photographers' websites,[10] there has been little investment in online or VR tourism or facilities as well equipped and ambitious as those housed at Yakushima's Environmental and Cultural Village Center. The need for high-quality immersive representations of cloud forests is all the more urgent and poignant given the lack of decisive interventions to reduce carbon emissions sufficiently to put a break on global warming. Research and modelling such as that undertaken by Helmer, Gerson, Scott Baggett et al. (2019) on páramo alpine ecosystems suggest that if global warming continues along current levels, within 25–45 years 70%–86% of these systems will dry, as cloud immersion declines, and be subject to colonisation of trees from lower slopes. Detailed modelling of this type has not yet been undertaken for LHI but would be likely to produce similar projections. In such contexts, LHI's cloud forests would progressively dwindle and be transformed by the incursion of species migrating from lower areas. The contemporary documentation of LHI's ECEs would thereby be their memorial, one in a series of markers of the Anthropocene's profound impact on global ecosystems.

But audio-visual systems and texts can only convey an impression of such locales through two sensory systems. The hygrosensation experienced while being enveloped in the misty blanket of a cloud forest—together with the enhanced roles that other perceptions play in perceiving such locations—can only be imagined. In such mediated contexts, the 'time/space union' created by experiencing an atmosphere of the type described by Böhme (2017) is absent, and the affective 'referential content-heavy marker' (Vale 2018: 92) of such locales would be massively weakened. If, as Böhme contends, 'the atmosphere of a certain environment is responsible for the way we feel about ourselves in that environment' (2017: 1), how and what will we feel about that environment and/or ourselves if all that is left is single-sensory representation of a locale that has changed beyond recognition? Such realisations are vivid reminders of the tsunami of loss engendered by the Anthropocene, not just of flora, fauna and ecosystems—precious and irreplaceable as these are—but also the quality of our potential experience of such locales and the deep value of our interaction with planetary ecosystems.

Conclusion

ECEs are generated by the interaction of flora and aggregated water vapour in homeostatic systems. These systems, in turn, facilitate particular experiences for humans encountering them. The nebulous aspects of such locales invite characterisation in terms of the expanded senses of atmospherics of place explored by Vale (2017) and others. In this sense, LHI's and Yakushima's cloud forests can be understood as much as *experiential* assemblages as they can *experienced* places. In seasonal terms, such environments have, so far, been 'stably fluctuable', subject to and able to survive changes in air moisture and intensity of light and temperature over short durations, but they are being challenged by global warming and the related climate variations occurring within the Anthropocene. Depending on the eco-political and eco-aesthetic sensibilities of visitors and researchers, elevated vaporous isolates can be characterised as both fragile and precious. While they may have sustained for millennia, they now appear ephemeral as Anthropocene challenges loom.

For all that it may be a highly impressionable aspect of encountering such environments, the hygrosensation experienced by visitors as a signature element of the environment is distinctly unrecordable (compared to the ease with which audio-visual impressions may be gathered) and difficult to describe and relate (in the English language at least), rendering experience of such locales as an elusive, fleeting phenomenon. As Vale (2018) has asserted, the experience of the temporal and spatial aspects of a location under particular atmospheric conditions—such as cloud cover and various degrees of vaporous suspension or precipitation—is a defining aspect of (some) islands that stresses variable historicity rather than (presumptions of) timeless essences and related expectations of unchanging reliability. ECEs are thereby both (always) in flux and (currently) endangered.

The nature of ECEs, understood as multifaceted, performative iterations of terrain, flora and atmospheres that create the habitat for particular insects, birds and animals to thrive in and for particular types of human visitors to encounter them, is striking. It is a reminder of the richness of biogeographical phenomena that have developed over aeons and that cannot be regenerated in anything but the palest approximation by any rewilding enterprise that might by mounted either now (as on Santa Rosa) or in a future where Anthropocene-generated climate change and a range of other factors (such as increased radiation, microplastic dispersals, etc.) have more radically transformed the intricate workings of the entire planetary system. In this manner, the retreat of cloud forests to the peaks of islands and mountains where—with no place higher to go—existing ECEs will, in all likelihood, evaporate as their cloud cover dissipates, provides a haunting motif for more general environmental loss. While individual species may be maintained outside of their original environments and, on occasion, may be successfully reintroduced to locales, whole ecosystems are so complex that they cannot be regenerated in anything like their original entireties. What is lost stays lost.

Notes

[1] Here I am consciously echoing the fundamental tenant of island studies, as originally conceived by Grant McCall as the discipline of 'nissology', specified by him as 'the study of islands on their own terms' (1994: 93).

[2] No individuals or communities reside in the elevated vaporous isolates discussed in this article.

[3] Also see *Shima*'s 2022 online anthology of articles on aquapelagos.

[4] With 0.8% specifying Aboriginal/Torres Strait Islander descent.

[5] The proportions indicated in the 2017 survey are in line with local residents' perceptions of the demographics of visitors over the last three decades, as these have been communicated to me in personal correspondence.

[6] Ball's Pyramid can only be visited and scaled by experienced climbers who have obtained permits and secured passage to it.

[7] LHI resident Ned King is believed to have been the first individual to have climbed Mount Gower, sometime in the 1850s, but there is no indication that ascents were frequent until the mid to late 1900s (Ian Hutton, personal communication, February 10, 2022).

[8] There has been considerable debate about the eco-politics involved in attempting to either conceive of recently introduced species as 'invasive' and/or remove such invasive species from areas and restore previous ecosystems (see, for instance, Brown & Sax 2004, with particular regard to Australia). My representation of environmental issues on LHI in this article accords with the dominant tendency on the island and in Australian environmental circles to see removal of LHI's rat population as beneficial to local biodiversity and to the continuation of the area's World Heritage status as a biodiversity hotspot.

[9] There is some debate as to what the most distinctive signature of the Anthropocene is. Along with human-induced climate change, nuclear weapons fallout has been identified by some researchers as the signature element (e.g., Waters, Syvitski, Galuszka et. al. 2015), while others have cited the human engineering of 'a large and extensive suite of novel, albeit not formally recognized minerals' (Zalasiewicz, Kryza & Williams 2014) as the most obvious.

[10] See, for instance, Lord Howe Island Tours' and Kenny Lees's websites.

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Competing Interests

The author has no competing interests to declare.

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