

My island home: place-based integration of conservation and public health in Oceania

THEMATIC SECTION
Humans and Island
Environments

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SUMMARY

Oceania can be characterized by a richness of culture, biodiversity and natural resources and a particular future that the changing climate will bring to islands, livelihoods and ecosystems. We reviewed literature detailing the limitations of siloed approaches to public health and conservation action for regional sustainability, highlighting opportunities for regional integration as place-based, through activities that are locally relevant, innovative engagement across a broader variety of sectors and working with indigenous peoples' knowledges. We present three case studies that extend and redefine the boundaries of the fields of public health and conservation, enabling collaborators to better respond to complex issues impacting biodiversity and human health. These case studies make explicit the links between nutrition, catchment management, water resources, fisheries, marine protected areas and communicable and non-communicable diseases. Public health and conservation are more meaningfully connected in place-based, reciprocal and compassionate activities, using common language to draw on the well-developed instruments of both sectors. These will include health impact assessments and combine health and ecological economics, which together will contribute to responding to an emergent set of challenges, namely human population increase, urbanization, overfishing and more severe aspects of climate change.

Keywords: biodiversity, infectious diseases, non-communicable diseases, catchment management, integrated island management, health impact assessment, ecosystem services, traditional knowledge

INTRODUCTION

Oceania is a vast region, consisting of the four sub-regions of Australasia, Melanesia, Micronesia and Polynesia.

Unsurprisingly, oceans are the major influence on the sustainable livelihoods of the more than 41 million people (World Population Review 2017) who call this region home. Often referred to as the 'liquid continent', Oceania is inhabited by an unfathomable number of species, covering 155.557 million km², including an estimated 157 000 km of coastline (Kingsley *et al.* 2015). Consequently, islanders have learned to privilege water more than terrestrial domains, as they recognize oceans not as void but as a dynamic realm – the 'Great Source' – for all of humanity and all species on Earth (Feary 2012). As oceans are the primary drivers of Earth's climatic system, Oceania also provides an appropriate context for new perspectives on human health and species conservation that place people as part of nature, rather than as a controlling influence over it (Feary 2012).

It is no longer disputed by mainstream science that we are experiencing human-induced climate change (McMichael *et al.* 2017). Although Oceania has a richness and variety of cultures, biodiversity and natural resources, human population increase and the changing climate pose significant threats to islander ways of life and limit the capacity of governments, organizations and individuals to address key issues of sustainability. Furthermore, Oceania is at a stage of development whereby the policy decisions taken will significantly affect the environmental and social wellbeing of the entire planet (Kubiszewski *et al.* 2016). These 'wicked problems' highlight the need for innovative approaches to the theory and practices underpinning both public health and conservation work and to align with the experiences and aspirations of islanders for their future health and wellbeing (Brown *et al.* 2010).

Scenario planning is a structured process of assessing alternative futures for the Oceania region, the goal of which is to present potential futures based on policy decisions around influential and uncertain drivers (O'Brien 2000). Unlike forecasting, projection and predictions, scenario planning explores plausible rather than probable futures (Peterson *et al.* 2003). Of four archetypal scenarios (see Raskin 2016), we have adopted the 'Great Transition Initiative' scenario, which focuses on exploring visionary solutions to the sustainability challenge, including new socioeconomic arrangements and fundamental changes in societal values, to frame our work.

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The ‘Great Transition Initiative’ scenario depicts a transition to a society that preserves natural systems, provides high levels of welfare through material sufficiency and equitable distribution and enjoys a strong sense of local solidarity (Kubiszewski *et al.* 2017). It requires approaches that integrate across disciplines and with local knowledge to generate more creative and innovative programmes, drawing on the past and generating novel solutions for public health and conservation work. This future scenario acknowledges the threats of rising seas to islanders and to the biodiversity of the region, coupled with human population increase, growing urbanization and communicable and non-communicable disease, and harnesses the widespread interest in climate change as a catalyst for ‘grass roots regionalism’ (Titifanue *et al.* 2017). As the ancestors of Oceania’s peoples used meticulous observations of the oceanic elements, trial and error, commitment, determination and innovation to design vessels that could journey out into the unknown, we now also need deep vision and courage to visualize new ways to connect us with and beyond our current horizons and to support solutions from place-based integration of regional concerns.

This paper uses the concept of place to respond appropriately to complex relationships between people, species, home and health. Place is both a location and a meaning (Brown & Weber 2013), and a ‘sense of place’ encompasses ‘place attachment, dependence, identity, meaning and character’, all of which shape human interactions with nature and contribute to wellbeing (Masterson *et al.* 2017). Place-based approaches acknowledge unique needs specific to a geographic area, engage multiple stakeholders, seize opportunities (particularly local skills and resources) and adapt to new learning and stakeholder interests. Public health and conservation experts working together can, through place-based collaborations, redefine disciplinary and organizational borders and adapt human interests to maximize the health and wellbeing of all lives, livelihoods and ecosystems. In the first section of this paper, we provide reasons and examples of why efforts in the environment and human health and wellbeing sectors should be considered together. We then offer initial guidance on how to create meaningful links between these sectors.

PLACE AS A FOCAL POINT FOR HEALTH AND WELLBEING

On a waning moon, after the storm, men, women and children speak and laugh excitedly, ambling along the beach towards the river mouth, carrying fine-mesh scoop nets and dry firewood. It is that time again. Smoke rises and dissipates in the moist, salty morning breeze. Many are there already, busily tending fires on the riverbank and wading eagerly with their nets to where freshwater mixes with sea. Looking into the shimmering, clear water, they see thousands of tiny eyes surging upstream, as shoals of almost transparent post-larval fishes begin following the freshwater plume upstream into the island interior. It is the keenly anticipated season of

the whitebait run. White gold. A noisy flock of terns dive urgently among scooping nets, silver trevally glint and charge at the hordes of tiny fish running the gauntlet, hugging the river’s emerald edge, hiding under overhanging vegetation and among the flotsam. Many years later, as adults, some are caught upstream, filling inland pots and bellies. Some grow into iridescent stream dwellers, living to reproduce, with their own larvae meandering back to the warm ocean once again. Those who grace the scoop nets today are carried ashore and packed carefully into bamboo segments. A few segments find the fire, a subtle, smoky fishy flavour to be savoured, but most are bound for market, where the seasonal delicacy will fetch the highest prices of the year.

This vignette of island life could be located almost anywhere, post-human settlement, within the high islands of Oceania. It reflects islanders’ understandings of the connections between oceans, rivers, land, culture, economy and human wellbeing on islands, and of the hope, happiness and resilience gained from their traditional knowledge of natural pattern and process. Also highlighted are the specialized co-evolution of the life histories of island inhabitants, the delicate and unique nature of island systems, species and cultures and the sense of place and of home rooted in geography, geology, the diversity of life, cultural history and an ecologically literate life. People’s health and wellbeing is tied to the health of ecosystems that define their lived experience, a relationship that guides place-based approaches to island governance and to understanding islanders’ public health and conservation imperatives.

PUBLIC HEALTH IMPERATIVES AND APPROACHES IN OCEANIA

Primary health concerns in Oceania are linked to rapidly changing social and ecological settings and are composed of infectious diseases, particularly respiratory illness related to overcrowding, and enteric diseases linked to water pollution, poor sanitation and poor health and hygiene practices, as well as vector-borne diseases (Global Health Data Exchange 2015). The transition of many communities to a more urbanized way of living is also central to the burden of non-communicable disease, with obesity and diabetes rising disproportionately faster in the Pacific region over the past three decades than in the rest of the world (Hawley & McGarvey 2015). These health threats are amplified by high levels of dependence on natural resources for subsistence and concentrated populations along low-lying floodplains and coastal margins (Jenkins & Jupiter 2015).

A ‘healthy islands’ vision within the Yanuca Island Declaration on Health in Pacific Island Countries and Territories has been reaffirmed by regular meetings of Pacific Health Ministers (most recently WHO 2015a). It continues to reflect a commitment to the above matters by embodying indigenous principles of social, emotional, cultural and physical wellbeing that are enriched through respectful engagement with life-enhancing environments, education

practices and leisure activities. Government health ministers have also advised each individual nation to conduct studies and develop action plans, particularly with respect to the impacts of climate change, natural hazards and ecosystem disruptions (e.g. Fiji Ministry of Health and Medical Services 2016). For this to happen, it seems obvious that each nation's public health institutions and environmental management agencies need to be able to work together, and to work directly with the people for whom these issues have the most impact. Large-scale defences are hardly implementable in isolated island regions.

Thus, a significant challenge involves how to overcome minimal financial and physical resources and infrastructure that can be unsustainable without demoralizing local people. Local approaches are often thought about and resourced in order to overcome the helplessness of people, the fragility of ecosystems and the threats to habitat (Warrick *et al.* 2017), rather than focusing on hopefulness, resilience and strengths. A primary imperative is overcoming the negative consequences of the long-term use of deficit discourses in mitigating the impacts of climate change and promoting the holistic vision of healthy islands.

BIODIVERSITY CONSERVATION APPROACHES AND LINKS TO HEALTH IN OCEANIA

Biodiversity conservation is also a well-defined priority in the region, particularly in the Pacific Island countries and territories (PICTs), where diverse and functioning ecosystems underpin subsistence economies, wellbeing and culture (SPREP 2012). A plethora of regional and national policy frameworks support biodiversity conservation, although PICTs are often acting with limited central governance capacity and high environmental exposure. Added to this are intergovernmental aid and the associated (and unrealistic) encumbrance of national and international biodiversity reporting commitments (Jupiter *et al.* 2014). Although common approaches in islands – such as ecosystem-based management, community-based adaptive management, integrated coastal management or integrated water resource management – customarily have biodiversity conservation as a clear objective, limited attempts are being made to measurably link these biodiversity conservation objectives, via the ecosystem services that are most valued by local people (such as food and water security), to human health and wellbeing outcomes.

From a broad policy perspective, PICTs are signatories to the Convention on Biological Diversity (CBD) and, under its auspices, develop National Biodiversity Strategy and Action Plans. It is a short step, then, to link these to a joint work programme of the CBD–World Health Organization (WHO), namely using Aichi Biodiversity Targets for public health objectives, to better institutionalize health and biodiversity co-benefits. Conceivably, this framework would enable biodiversity conservation approaches to engage with specific, localized and community-derived priority public health

questions from the outset of programme design, to proactively integrate management across closely linked ecosystems (e.g. land and sea realms) and to emphasize the socio-cultural dynamics effecting these places.

At a regional policy level, this is happening. The Secretariat of the Pacific Regional Environment Programme (SPREP) and the United Nations Environment Programme (UNEP) published the principles for Pacific integrated island management, which emphasize the cost-effectiveness of addressing the common goals of conserving biodiversity, maintaining ecosystem services and securing human health and wellbeing through coordinated networks of institutions and communities (Jupiter *et al.* 2013).

The International Union for Conservation of Nature (IUCN), in its Oceania regional plan for 2017–2020, states a regional goal of ‘valuing the benefits from nature for human health and well-being,’ with a primary strategy to give priority to building new knowledge, partnerships and practical projects with the regional health sector (IUCN 2017). With the task of meeting rising demand and funding pricier healthcare systems, a case for innovative conservation-based healthcare strategies is now becoming more compelling to regional and global leaders, although clear pathways for policy decision-making and action are not yet available.

BUILDING ROBUST EVIDENCE FOR LINKING CONSERVATION AND HUMAN WELLBEING

A recent systematic review by McKinnon *et al.* (2016) of 1043 studies from the developing world revealed that most link resource management interventions on forestry and fisheries to economic and material outcomes, with around a quarter of these specifically examining protected area effects on economic wellbeing. Less than 9% used any quantitative approaches to evaluate the causal effect of conservation interventions and less than 2% evaluated health outcomes.

In general, there are few studies that show benefits of linking social and ecological outcomes (Bowler *et al.* 2012) or evaluate non-economic aspects of wellbeing such as culture and spirituality, freedom of choice and action (McKinnon *et al.* 2016). Here, we present a review of where we think the evidence lies, starting with three case studies from the Oceania region that illustrate ways in which conservation and public health studies and interventions can work synergistically. Beyond this, we present a more broadly based argument for the contributions that biodiversity conservation can make to public health.

Case study A: marine protected areas, fisheries and nutrition in Oceania

Marine protected areas (MPAs), particularly locally managed marine areas, are widely recommended as a way of achieving conservation and fisheries management in the region (Jupiter *et al.* 2017). Their contribution to nutritional delivery is likely to increase, with fish populations globally predicted to decline

over the coming decades, leading to more than 10% of the world's population possibly facing nutritional deficiencies, particularly in Oceania (Golden *et al.* 2016). Pacific Island populations consume up to six times the average global consumption of *c.* 18 kg person⁻¹ year⁻¹, and fish provide 50–90% of dietary animal protein in rural areas across a wide range of Pacific Island countries (Bell *et al.* 2015). At the heart of fisheries management initiatives involving MPAs has been an overwhelming focus on mitigating the loss of biodiversity and of income (Jupiter *et al.* 2014), yet a much stronger emphasis should be placed on human health outcomes – with nutrition as an obvious and important focus.

Although the importance of fish to food security and livelihoods in the region is undisputed, studies on the impact of MPAs on levels of fish consumption are rare (e.g. Aswani & Furusawa 2007). There is also a general paucity of information regarding the contribution of fish consumption to overall nutritional adequacy and health status in PICT populations, particularly as they contend with the ongoing nutrition transition and growing rates of non-communicable disease (Charlton *et al.* 2016). In addition, despite fish being a vital and highly bio-available source of micronutrients, most previous studies of the decline in fisheries have considered only how people will be affected by a loss of protein, while micronutrient deficiency is often not considered at all (Golden *et al.* 2016).

Aswani and Furusawa (2007) provide a rare and relevant example from the Roviana Lagoon in the Solomon Islands, where they assessed whether MPAs influenced local perceptions of governance, environmental change, livelihood strategies and actual human nutrition and health. They conducted cross-comparisons of villages with MPAs and a village without an MPA and calculated energy (MJ), protein (g) and fat (g) intake using participants' daily food consumption records and calculating the amount of marine resources protein (reef and pelagic fishes, crustaceans and molluscs) consumed. Items regularly eaten by villagers were measured directly to estimate the average food consumed. The study demonstrated that villages with effective MPAs and positive cultural attitudes regarding ocean governance had higher levels of dietary energy and nutrient intakes than the villages without or with ineffective MPAs. Inhabitants of these latter villages, in fact, had the highest proportion of fat in their diets from imported foodstuffs and the lowest proportion of fish protein.

Specific improvements in marine conservation in the Pacific and beyond have the potential to enhance nutritional delivery for these peoples, although this needs careful evaluation within each specific socio-ecological and management context (Golden *et al.* 2016). Gjertsen (2005), for example, demonstrated positive outcomes for reef health, but poor outcomes for child nutritional status (increased proportion of underweight children) in those Philippine MPAs that had higher fines for infringements and expensive boundary demarcations. The economic burden to the communities managing the MPAs resulted in a localized decrease in the

disposable incomes available to locals to provide for the nutritional requirements of their families.

Case study B: care for country

The UN Sustainable Development Goals reflect concerns for biodiversity, conservation, land and sea management, forest management and human health and wellbeing. Some of these goals, when combined with the rights enshrined in the UN Declaration on the Rights of Indigenous Peoples (2007), demonstrate widespread acknowledgment of participatory approaches combined with biological and cultural diversity through land care and cultural practices referred to as 'caring for country' (Weir *et al.* 2011). Large multidisciplinary teams of indigenous peoples, ecologists, social scientists, medical practitioners and policy analysts have demonstrated both health benefits for indigenous Australians such as increased physical activity, improved nutrition and mental health, a reduction in the use of alcohol and other drugs, a reduction in the experience of family violence and improved landscape health from 'caring for country' (Burgess & Johnston 2007, Garnett & Sithole 2007). They also yield net annual health savings (Burgess *et al.* 2005).

Australian Aboriginal and Torres Strait Islander people, along with other indigenous peoples and government employees in the region, are heavily involved in the provision of a wide range of environmental services, including border protection, quarantine, wildfire abatement, carbon sequestration and trading, weed control, feral animal control, biodiversity conservation, restoration of wetlands, water resource management and sustainable commercial enterprises such as eco-tourism (Hunt *et al.* 2009, Berry *et al.* 2010). The diverse environmental activities to which indigenous people contribute have positive outcomes for climate change mitigation, biodiversity monitoring, protection of endangered species, landscape health and more (Hunt *et al.* 2009, Pollard *et al.* 2014). As part of their multidisciplinary research into health and country, Garnett and Sithole (2007) examined the ecological benefits of caring for country activities and found positive outcomes for habitat, biodiversity and landscape health where people worked with traditional practices, such as patchwork burning to control wildfires. As Morrison (2007) writes: 'In terms of environmental research, caring for country reflects a growing global trend towards intercultural approaches that combine Western scientific and Indigenous knowledges.'

Conservation initiatives have also benefited from working with indigenous people and utilizing their knowledge of landscape and species in surveying wildlife populations (Wilson *et al.* 2010). On the Anangu Pitjantjatjara Yankunytjatjara lands in Central Australia, for example, the Kuka Kanyini wildlife management project was designed in response to indigenous knowledge traditions and practices, and matches indigenous knowledge with scientific knowledge as part of wildlife surveys and identifying and improving habitats for threatened species (Wilson & Woodrow

2009). Other successful intercultural landscape management programmes include the Anangu Pitjantjatjara cyber tracker programme for threatened species and the Itjaritjari Project to collect information on the critically endangered Southern marsupial mole (Brown *et al.* 2006).

These projects, which were supported by the Aboriginal Lands Integrated Natural Resources Management Plan and Investment Strategy (2004–2007) (Brown *et al.* 2006), and other case studies show how traditional Aboriginal ecological knowledge often applied constraints upon where species could be harvested and by whom (e.g. Corey *et al.* 2017). Such practices are thought to have ensured the continued survival of plant and animal species and promoted biodiversity and human health through heterogeneous land use practices (Altman & Whitehead 2003, Wilson *et al.* 2010). These holistic approaches to health and wellbeing, conservation work and care for country are founded in philosophies that encompasses environmental, socio-cultural and economic aspects of indigenous land management (Morrison 2007), and they work because they are owned and directed by indigenous people. Land care and cultural practices are found throughout Oceania, although they are expressed in different languages (see Pollard *et al.* 2015). Environmental conservation and cultural practices are themselves intimately linked and thereby are material in the health and wellbeing of indigenous peoples.

Case study C: managing small-island river basins for aquatic biodiversity, water-borne disease prevention and psychosocial wellbeing

In Fiji, it has been demonstrated that many of the upstream drivers of freshwater biodiversity loss not only facilitate an increased incidence of water-borne disease such as typhoid fever, but also contribute to the potential physical and psychosocial impacts of nutritional and cultural deficit. Jenkins *et al.* (2010) demonstrated the notable absence from degraded river basins of suites of fishes that traditionally formed the staple diets of inland communities. Conspicuously absent species in heavily modified catchments include the many migratory species that form important commercial and cultural fisheries for Pacific islanders (such as whitebait). These effects are largely seasonal and magnified in degraded catchments, with pronounced negative impacts on food-provisioning services and biodiversity during heavy rainfall and severe storms (Jenkins & Jupiter 2011).

Community bans on harvesting and clearing within riparian buffer zones can be effective at maintaining fish diversity, even in basins where forests have previously been extensively cleared (Jenkins *et al.* 2010). However, these benefits are rapidly removed once the ban has been lifted and food fish from rivers again become scarce (Jenkins & Jupiter 2011). For many Fijian inland communities, freshwater fishes not only comprise a major part of their diet, but also have important cultural totemic values. The loss of freshwater fish biodiversity therefore has potentially important implications for physical

and cultural wellbeing. However, like many studies, while biodiversity loss can be clearly demonstrated, the precise nature of its impact on physical health or psychosocial wellbeing through nutritional or cultural deficit has not been investigated.

Fiji has also shown how many of the same river basin-scale anthropogenic alterations of land cover and hydrology that are causing aquatic biodiversity loss – particularly deforestation and fragmentation of riparian forest and connections between road and river networks – also facilitate the transmission of typhoid fever through processes of increased erosion and flooding (Jenkins *et al.* 2016). Similar environmental drivers affect leptospirosis in Fiji, including high-density livestock farming near rivers and increased susceptibility to flooding (Lau *et al.* 2016). But even though poor river basin management has been proven to compromise bio-cultural diversity and food and water security, the response by public health, conservation and humanitarian agencies has been piecemeal and reactive (Kumar 2010, Jenkins *et al.* 2016, Nolet 2016). Little attention is being given either to basin-scale preventative measures or attempts to evaluate the compounded downstream impacts on ecosystem services such as disease regulation, food provision or psychosocial impacts.

Instead, the focus has largely been one-dimensional, end-of-the-line strategies such as post-outbreak vaccination, post-flood river dredging or post-collapse fisheries closures (Jupiter *et al.* 2014, Daigneault *et al.* 2016, Scobie *et al.* 2016), further underscoring the missed opportunity for addressing upstream risk factors and achieving multiple dividends. Managing small-island river basins to ensure the protection of ecosystem services provided by limited freshwater resources and their highly threatened aquatic biodiversity is both a critical sustainable development challenge and a major intersection point at which to study the relationships between river basin condition, aquatic biodiversity and public health and wellbeing.

Broader relationships between biodiversity conservation and human health

There are several recent examples of where the multifarious and complex relationship between biodiversity conservation and human health has been reviewed more broadly (e.g. McKinnon *et al.* 2016, Kilpatrick *et al.* 2017), but a comprehensive review can be found in WHO (2015b), which highlights how biodiversity loss, ecosystem degradation and ill health often share common threats and point towards mutually supportive solutions.

Where bushland and wetlands (including near-shore marine areas) are protected as reserves or maintained as locally managed areas, they contribute to settings for human health. Urban bushland ranges from a bush park of native trees to wetlands or any native vegetation like woodlands and forests that are characteristic of the local region. With undisturbed soils and associated wildlife, they are more diverse than other types of green spaces, such as parklands, and significantly add

to neighbourhood biodiversity. The more unfragmented or unaltered the bushland, the more likely it will be to retain biological diversity, similarly with more contiguous wetland habitat, from the lower parts of rivers to estuaries, mangrove areas, areas of seagrass and near-shore reefs.

Thus, hills, watercourses, gullies, a mixed forest and connected land–sea habitats have greater biological diversity than flat land, a plantation of trees or a series of aquaculture ponds. The diversity of land and waterscape and habitat features and the ecosystem services in general that such ‘undeveloped’ green and blue infrastructure can provide, as contributors to human health, are virtually never accounted for in land and water development processes, nor are these arguments made as part of the reasoning for protecting or conserving biodiversity assets.

Interestingly, much of the evidence for health benefits comes from passive and active exposure to biodiversity and diverse green spaces (WHO 2015b). Specifically, the therapeutic benefits include the ability of plants to clean urban air by absorbing carbon dioxide, to purify water by filtering and to moderate extreme temperatures (shade in hotter times and less exposure in cool or colder times). Access to green spaces contributes to stress reduction and attention restoration (Tyrväinen *et al.* 2014), while a view over trees or vegetation conveys a mental health benefit and has been used for rehabilitation and restoring health following illness or injury (Ulrich *et al.* 1991). Exposure to the diversity of life forms (such as the difference between a plantation of trees and a mixed forest or bushland) adds to the restorative health effect (Honold *et al.* 2016), as may daily and seasonal changes and landscape features.

Changes to mood, in particular improved energy and tranquillity and decreased anger and fatigue (Bowler *et al.* 2010), can be demonstrated during and after exposure to nature. There is an improved cognitive function associated with being more contemplative and mindful of our surroundings. A prominent example of these effects is the Japanese concept of *shinrin yoku* (forest bathing). Lee *et al.* (2011) demonstrated increased positive and decreased negative feelings experienced by young males in a forest environment, along with improved physiological responses, such as significantly increased parasympathetic and suppressed sympathetic nervous activity, and markedly decreased salivary cortisol levels and pulse rates. Statistically, it has been shown that coronary heart disease and overall mortality – and even asthma, diabetes and mental health in general – are lower where people are living with more green space in a type of dose–response relationship (Shanahan *et al.* 2015): so the more ‘nature’, the better the outcome.

Current thinking is that the quality and diversity of the habitat also play a role. For example, views of diverse vegetation more effectively lower stress as measured by cortisol levels (Honold *et al.* 2016), and exposure to microbes through the skin and the gut, particularly early in life, primes the immune system. Immune functioning is enhanced and expanded by biodiversity (Haahtela *et al.* 2013) from the

landscape, soils, vegetation, wildlife and associated microbes in the air, water and soil – the sort retained in reserved and protected bushland and wetlands. As a result, it has been proposed as a central pathway (Kuo 2015) for achieving a host of health benefits.

While most studies have focused on the health benefits of green spaces, fewer have studied the health impacts of outdoor blue spaces (spaces that prominently feature water – either natural or manmade – and are accessible to humans) such as rivers, streams, lakes and oceans. A recent systematic review by Gascon *et al.* (2017) found that people living close to blue spaces report higher levels of physical activity and that interaction with blue spaces often has a positive effect on mental health – particularly in terms of stress reduction and perceived wellbeing. This is an emerging topic (most studies in this area have been conducted in last 5 years) of particular relevance to the Oceania region.

It is important to consider the ways in which these health benefits are gained. When people spend leisure time, recreate or exercise in settings where biodiversity and landscape diversity play a stronger role than urban infrastructure, their health outcomes are improved. Similarly, social engagement around the caring for green spaces or in conservation groups mediates many of these benefits (Moore *et al.* 2006).

The exact role of biodiversity in people’s health can be difficult to demonstrate (Hough 2014), with most studies of the physiological health benefits of interacting with nature correlative and purely descriptive, with little or no evidence as to how these benefits are delivered. Part of the difficulty with studies examining this relationship is that nature is not clearly defined, biodiversity is not being explicitly measured and there is clearly a lack of research from rural, developing countries of equatorial latitudes. Nevertheless, reviews have argued repeatedly that the weight of evidence shows a causal relationship between biodiversity and a myriad of health benefits (see Sandifer *et al.* 2015).

TOOLS OF ENGAGEMENT

Reciprocity, compassion and the removal of institutional ‘silos’

We highlight the relationships between biodiversity conservation and human health and wellbeing because the sectors that serve these fields of endeavour have, to an extent, been guilty of inward-looking, centralizing tendencies that have identified their own problems as being the most urgent, and sought to solve their own problems with less reference to broader societal drivers or agendas.

The sustainability discourse identifies these societal compartments as ‘silos’, and problematizes their independence and promotes an emphasis on their interdependence instead. Breaking down the boundaries of these ‘silos’ is a challenge to the status quo. In this case, those involved in biodiversity conservation must now change its internal priorities and learn to speak the language of health and act as advocates for

health. Public health practitioners, in a broader context, must elevate in priority the environmental determinants of health. These are reciprocal requirements for interventions that must involve both sectors.

The health sector has much to pass on. Health promotion is already in this space, arguing that health needs to be in all policy processes in society (WHO 2011). Particular instruments will be valuable in facilitating cross-sectoral dialogue; for example, health impact assessment (HIA) and burden of disease metrics like disability-adjusted life-year measures, which quantify the burden of disease from mortality and morbidity, are both transferrable.

Conservationists, if their training has been in the ecological sciences, can also lend their understandings of ecosystem processes and ecosystem services to cross-sectoral activities. In particular, the use of ecosystem services allows for the quantification of costs or benefits of a particular proposal and can be readily linked to HIA (Horwitz & Parkes 2016). Particularly fruitful ‘spaces’ for cross-sectoral activities could come from bringing together health economics (burden of disease) and ecological economics (ecosystem services), since they both balance the economic costs of disease and the health benefits derived from the environment. In doing so, they allow us to make better judgements – we are no longer forced to see an environment as a source of ill health – and we can see where we are making trade-offs unreasonably.

Decisions that involve these types of trade-offs need to be place-based and negotiated locally by and with the people whose lives they will affect. Representation of marginalized stakeholders, increased transparency of information and engaging with the core pursuits of other sectors will be key components of negotiations. These approaches open the door to localized, place-based considerations that engage people in hopeful, warm-hearted, compassionate discourse, meaningfully drawing upon a suite of knowledges.

Using the knowledges framework of Brown *et al.* (2010), biodiversity and health can draw upon individual knowledge and the lived experiences of people as meaningful articulations of the relationship. Local knowledge, understood and shared by neighbours and communities, is often built on and transferred over generations, and is also well represented as traditional ecological knowledge (e.g. Pollard *et al.* 2014, 2015). For cross-sectoral purposes, individual and local knowledges are as valuable as the specialized knowledges of each discipline and provide as much evidentiary basis for decision-making. A further type of knowledge – strategic knowledge – is constructed by the organizations and institutions that represent the sectors themselves, and they often dominate along with that which is specialized. And beyond these is the knowledge expressed by the metaphorical narratives, the art and the story-telling, depicting a holistic impression of the relationship that we cannot possibly hope to express in other ways. Together, these knowledges broaden our vision of traditional health and ecological wisdom.

CROSS-SECTORAL APPROACHES

Health impact assessments

As stated above, HIAs provide an opportunity to attend structurally to the health benefits of biodiversity conservation actions. HIA has its roots in at least three strands: where the environment influences human health (the domain of ‘environmental health’); addressing health inequalities; and the consideration of social determinants of health and the need for interventions to address or promote health equity through planning (Harris-Roxas *et al.* 2012). Alone or combined, the capacity to produce a powerful analysis of health consequences can be envisaged. HIA identifies the health impacts of any proposal, whether it be a project, programme, plan or policy (Uttinger *et al.* 2005), and is thereby relevant for a proactive and systematic evaluation of the health consequences of a biodiversity conservation initiative. HIA is particularly well suited where the engagement by the public health sector is required in non-health sector activities (Harris-Roxas *et al.* 2012, Harris-Roxas & Harris 2013). It can identify both the negative health effects (and how to minimize them) and the positive health effects (and how to enhance them) (Winkler *et al.* 2010).

Integrated island management

Important learning opportunities exist within some local approaches to islands management, which are collated in a handbook of good practice, *Pacific Integrated Island Management* (Jupiter *et al.* 2013). Integrated island management is an approach that calls for the ‘sustainable and adaptive management of natural resources through coordinated networks of institutions and communities that bridge ecosystems and stakeholders with the common goals of maintaining ecosystem services and securing human health and wellbeing’ (Jupiter *et al.* 2013).

Five of its ten guiding principles are particularly relevant for those seeking to integrate island conservation and public health systems:

- Adopt a long-term integrated approach to ecosystem management.
- Maintain and restore connectivity between complex social and ecological systems.
- Incorporate stakeholders through participatory governance with collective choice arrangements, taking into consideration gender and social equity outcomes.
- Recognize uncertainty and plan for adaptive management through regular monitoring, evaluation and review, leading to evidence-based decision-making.
- Organize management systems in nested layers across sectors, social systems and habitats.

These approaches might apply, for example, to the technical divisions of the Pacific Community, charged with supporting the 22 Pacific Islands and Territories, where each division (Economic Development, Public Health, Geoscience, Statistics for Development, Land Resources and Fisheries,

Aquaculture and Marine Ecosystems) is necessarily engaged in sectoral pursuits. Any division might perform a HIA or facilitate and support a country performing one. Adopting each guiding principle from integrated island management, each division will have an approach to assist other divisions to achieve their objectives and contribute to broader societal objectives that do not reside in one sector alone. For example, it will help support countries to achieve policy coherence in planning and financing decisions. This applies to instances where health and conservation linkages exist and to the increasingly recognized mandates around climate change and health linkages (Hoy *et al.* 2014, McKiver *et al.* 2016), particularly with regards to economic and food security issues in fisheries and agriculture (see Bell *et al.* 2013, Taylor *et al.* 2016).

HORIZON SCANNING

Scanning the dotted islands on the horizon and glancing in society's collective wake, the need for linking conservation and human health is glaringly apparent. There must be a vision of the future where robust and informed conservation of the environment acts as preventative medicine.

Human population increase and urbanization

Increases in both human population and urbanization are facilitating increased ecosystem transformation, biodiversity loss and the incidence of a variety of poverty-related diseases. Overall annual population growth in the Pacific Islands is relatively high at 2.1% compared to global growth of 1.1%, while economic growth remains slow and little progress is being made in raising per capita incomes (World Bank 2016). Melanesia has the highest national population growth rates, particularly Papua New Guinea and Solomon Islands at 2.8%, and Vanuatu at 2.5% (Pacific Community 2016).

Some of the smallest nations in the Pacific Islands region have the highest rates of urbanization, such as Kiribati, one of the most sparsely populated countries on earth, with one of the most densely populated capitals, South Tarawa.

The urban population in the Pacific Islands is set to double within the next 25 years (Jones 2012). Melanesia, in particular, is experiencing a rapid growth of sprawling, largely underserved settlements, compounding environmental, social, health and economic adversities. The majority of studies where associations between biodiversity and health can be inferred have been conducted in urban Western settings from northern latitudes. Examining the relationship of health to biodiversity conservation within urban, equatorial and developing world settings is extremely limited, and further research in this area is required, particularly for rapidly urbanizing Melanesia. From a policy perspective, the settings-based health promotion approach of Healthy Cities (de Leeuw *et al.* 2017), embedded within the Healthy Islands vision, will benefit from greater co-engagement by conservation ecologists in providing evidence of the contribution of biodiversity to healthy urbanization.

Climate change and natural disasters

Species and nations in Oceania are being exposed to climate changes at a pace and to an extent they have seldom experienced, which has led to direct and indirect impacts on ecosystem function and environmental provisioning services and heightened susceptibility to public health impacts (Kingsford & Watson 2011, McIver *et al.* 2016). Eight of the 20 countries with the highest average losses (scaled by gross domestic product) due to climate-related natural disasters are in the Pacific Islands, and these disasters are expected to increase in number and scale, especially in relation to El Niño/La Niña cycles (Pelesikoti & Suwamaru 2017). The extent to which specific conservation approaches can facilitate disaster mitigation and recovery is poorly studied. Building greater understanding at the interface of conservation ecology and disaster-related epidemiology will strengthen existing models both of disaster risk management and of conservation (Jenkins & Jupiter 2015). Health surveillance systems can incorporate aspects of biodiversity and habitat surveillance in the context of key provisioning services (e.g. food and water), alongside routine disease surveillance, and continue to collect this information in the weeks, months and years following a disaster. This will give policy-makers and managers the tools needed to monitor and evaluate the longer-acting health consequences of conservation interventions in various disaster settings.

Water and sanitation

Access to safe water and adequate sanitation is failing to keep pace with human population growth, urbanization and ecosystem transformation, with two-thirds of the population in the Pacific Islands continuing to rely on unprotected sources of water and unsanitary means of excreta disposal (WHO/UNICEF 2016). By 2015, it had fallen behind both Asia and sub-Saharan Africa to become the region with the least access to improved drinking water. For a region in which a large proportion of the population obtains drinking water from untreated surface sources, the role of environmental conservation has obvious synergies with the water, sanitation and hygiene (WASH) sector in terms of the management of water catchments for the provision of potable water and flood mitigation. Specific collective engagement around drinking water safety planning processes, employing cross-habitat 'ridge-to-reef' approaches, enabling small, isolated and informal communities and building cooperative networks across the region are all vital to strengthening and maintaining the resilience of Pacific communities. Seeking to understand the cross-sectoral synergies for policy and action will strengthen not only the conservation and health sectors in the region, but also the multiple sectors engaged in WASH development.

Fisheries and nutrition

Malnutrition is the single largest contributor to the global burden of disease. With limited opportunities for agriculture

and animal husbandry, fisheries are of direct importance to the people of the Pacific and contribute up to 90% of dietary protein in some island states (Bell *et al.* 2009). Pacific peoples often have diets in which many calories come from a staple root crop, rich in carbohydrates but poor in many key nutrients. Both marine and freshwater fishes help provide the critical vitamins, minerals and macronutrients to supplement these starchy staple crops (see Case Study A above). As malnutrition is a preeminent public health concern and many Pacific Islander diets are linked directly to the state of the near-shore marine and other wetland environments, investigation into the dietary impacts of changes to the fish communities of coral reefs and other wetland ecosystems via conservation action is fertile ground for providing solid, empirical evidence linking the health of the ecosystem with human health.

Post-truth insularity

We recognize that many of the possible response options to human health and ecosystem change lie primarily outside the direct control of the two sectors responsible for each. Options are embedded as attitudes and perceptions in areas such as sanitation and water supply, education, agriculture, trade, tourism, transport, development and housing. Integrated solutions need nurturing within our education systems and institutions, realizing that they need to transform as well (Wooltorton *et al.* 2015) by moving away from siloed behaviours, with incentives and rewards to learn and teach across the disciplines and by removing barriers to cross-disciplinary cooperation. This could be achieved by orientating around specific thematic areas (e.g. water) and by being inclusive of voices and participation from a fuller breadth of plural society, endeavouring not simply to collect disciplinary experts to bring their own viewpoints, but also to view the issue collectively from an integrated perspective that promotes humanitarian values of compassion, understanding and welfare in the broadest sense.

Several key obstacles to informed integration are apparent: emotionality versus objectivity in political decision-making, growing suspicion of public institutions, lack of public support for the sciences, perceived elitism or bias of experts and increasing insularity (Alders & Stellmach 2017). This concept of insularity, particularly in relation to islands, is prescient as it highlights an excessive preoccupation with self, homeland and nationhood that acts in direct opposition to the outward, expansive and collective engagement that is needed to demonstrate the intimate interdependence of all human and natural systems. As educators and practitioners of environmental conservation and public health, society has a growing responsibility to foster a science of sustainability underpinned by humanitarian values (Alders & Stellmach 2017).

As the Dalai Lama recently tweeted (20 July 2017), 'Education today needs not only to develop our intelligence, but also to support basic human values of warm heartedness and compassion.' Only these basic qualities can foster acceptance

and understanding of the biological, cultural, political, social, economic and spiritual diversity that must be understood in order to tackle the sustainability challenges ahead.

CONCLUDING RECOMMENDATIONS

The contemporary context of an unprecedented rate of human population growth, ecological degradation, endangered species and rapid shifts in climate has presented new priorities and challenges to people living in Oceania. Herein, we are advocating for place-based integration approaches to transcend artificial boundaries of discipline, institution, government, race, religion and natural systems. Place-based integration approaches need the support of government and other land and sea management practice, and those engaged in collaborations need to work with and embrace all forms of diversity and knowledge.

The case studies in this paper demonstrate place-based approaches to public health and conservation practice that display not only environmental, but also health, wellbeing, cultural, socio-political, economic and other benefits aligned with the aspirations of Oceania islanders. While place-based conservation and public health is still developing, the literature reveals how interlinked these fields are and the potential for benefits to be multiplied through mutually reinforcing positive connections. Where researchers have drawn on indigenous peoples' holistic expressions of wellbeing, this wellbeing involves more than just setting health within a social determinants of health framework – it involves the larger context of place and includes the health and wellbeing of ecosystems, place and those who reside in it.

Place-based approaches to health and wellbeing are receiving greater recognition in collaboration with government, community and private initiatives. A commitment to promoting integrated thinking in educational and governing institutions around the topics in which the health and wellbeing of all people, entities and systems are considered is pivotal to achieving the benefits identified for wellbeing. This integration needs to be supported by the development of tools that support collective engagement, such as HIA tools where public health can consider conservation as a form of preventative medicine and where conservation uses precise indicators of health. Through these place-based partnerships, we might also be able to transform the current language of crisis, loss and vulnerability into a constructive discourse founded on a language of reciprocity, compassion and equity, and to play our role in the great transition scenario – the one that holds the promise for our future generations on Earth.

CONFLICT OF INTEREST

None.

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None.

ETHICAL STANDARDS

None.

References

- Alders, R. & Stellmach, D. (2017) The role of humanitarian academics in a post-truth world. *DevPolicyBlog*. URL <http://devpolicy.org/role-humanitarian-academics-post-truth-world-20170724/>
- Altman, J. & Whitehead, P. J. (2003) *Caring for Country and Sustainable Indigenous Development: Opportunities, Constraints and Innovation, CAEPR Working Paper No. 20/2003*, Canberra, Australia: Centre for Aboriginal Economic Policy Research, Australian National University.
- Aswani, S. & Furusawa, T. (2007) Do marine protected areas affect human nutrition and health? A comparison between villages in Roviana, Solomon Islands. *Coastal Management* 35(5): 545–565.
- Bell, J. D., Kronen, M., Vunisea, A., Nash, W. J., Keeble, G., Demmke, A. & Andréfouët, S. (2009) Planning the use of fish for food security in the Pacific. *Marine Policy* 33(1): 64–76.
- Bell, J. D., Allain, V., Allison, E. H., Andréfouët, S., Andrew, N. L., Batty, M. J., Blanc, M., Dambacher, J. M., Hampton, J., Hanich, Q. & Harley, S. (2015) Diversifying the use of tuna to improve food security and public health in Pacific Island countries and territories. *Marine Policy* 51: 584–591.
- Bell, J. D., Ganachaud, A., Gehrke, P. C., Griffiths, S. P., Hobday, A. J., Hoegh-Guldberg, O., Johnson, J. E., Le Borgne, R., Lohodey, P., Lough, J. M. & Matear, R. J. (2013) Mixed responses of tropical Pacific fisheries and aquaculture to climate change. *Nature Climate Change* 3(6): 591–599.
- Berry, H., Butler, J., Burgess, C. P., King, U., Tsey, K., Cadet-James, Y. L., Rigby, C. W. & Raphael, B. (2010) Mind, body, spirit: co-benefits for mental health from climate change adaptation and caring for country in remote Aboriginal Australian communities. *NSW Public Health Bulletin* 21(5–6): 139–145.
- Bowler, D. E., Buyung-Ali, L. M., Healey, J. R., Jones, J. P., Knight, T. M. & Pullin, A. S. (2012) Does community forest management provide global environmental benefits and improve local welfare? *Frontiers in Ecology and the Environment* 10(1): 29–36.
- Bowler, D. E., Buyung-Ali, L. M., Knight, T. M. & Pullin, A. S. (2010) A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health* 10(1): 456.
- Brown, G. & Weber, D. (2013) A place-based approach to conservation management using public participation GIS (PPGIS). *Journal of Environmental Planning and Management* 56(4): 455–473.
- Brown, R., Creaser, P., Kerins, S., Lennon, J. & Liddy, M., eds (2006) *Indigenous Involvement in Environmental and Heritage Management, Case Studies Prepared for the 2006 Australian State of the Environment Committee*. Canberra, Australia: Department of the Environment and Heritage.
- Brown, V. A., Harris, J. A. & Russell, J. Y. (2010) *Tackling Wicked Problems through the Transdisciplinary Imagination*. London, UK: Earthscan.
- Burgess, P. & Johnston, F. H. (2007) *Healthy Country: Healthy People: Indigenous Natural and Cultural Resource Management and Health*. Darwin, Australia: Menzies School of Health Research.
- Burgess, P., Johnston, F. H., Bowman, D. J. M. S. & Whitehead, P. J. (2005) Healthy country: healthy people? Exploring the health benefits of indigenous natural resource management. *Australian and New Zealand Journal of Public Health* 29(2): 117.
- Charlton, K. E., Russell, J., Gorman, E., Hanich, Q., Delisle, A., Campbell, B. & Bell, J. (2016) Fish, food security and health in Pacific Island countries and territories: a systematic literature review. *BMC Public Health* 16(1): 285.
- Corey, B., Webb, G. J., Manolis, S. C., Fordham, A., Austin, B. J., Fukuda, Y., Nicholls, D. & Saalfeld, K. (2017) Commercial harvests of saltwater crocodile *Crocodylus porosus* eggs by Indigenous people in northern Australia: lessons for long-term viability and management. *Oryx* June: 1–2.
- Daigneault, A., Brown, P. & Gawith, D. (2016) Dredging versus hedging: comparing hard infrastructure to ecosystem-based adaptation to flooding. *Ecological Economics* 122: 25–35.
- de Leeuw, E., Stevenson, A., Jolley, G., McCarthy, S. & Martin, E. (2017) Healthy cities, urbanisation, and healthy islands: Oceania. In: *Healthy Cities: The Theory, Policy, and Practice of Value-Based Urban Planning*, eds R. de Leeuw, J. Simos, pp. 315–337. New York, NY, USA: Springer.
- Feary, S. (2012) From Kauri to Kumara: forests and people of the Pacific Islands. In: *Australia's Ever-changing Forests VI: Proceedings of the Eighth National Conference on Australian Forest History*, ed. B. J. Stubbs et al., pp. 202–207. St Lucia, Australia: Australian Forest History Society, Inc., in association with Tankard Books.
- Fiji Ministry of Health Medical Services (2016) *Climate Change and Health Strategic Action Plan 2016–2020*. Suva, Fiji: Government of Fiji
- Garnett, S. & Sithole, B. (2007) *Sustainable Northern Landscapes and the Nexus with Indigenous Health: Healthy Country, Healthy People*. Canberra, Australia: Land and Water Australia, CSIRO.
- Gascon, M., Zijlema, W., Vert, C., White, M. P. & Nieuwenhuijsen, M. J. (2017) Outdoor blue spaces, human health and well-being: a systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health* 220: 1207–1221.
- Gjertsen, H. (2005) Can habitat protection lead to improvements in human well-being? Evidence from marine protected areas in the Philippines. *World Development* 33(2): 199–217.
- Global Health Data Exchange (2015) *Global Burden of Disease Study 2015 Data Resources*. Seattle, WA, USA: Global Health Data Exchange. URL ghdx.healthdata.org
- Golden, C. D., Allison, E. H., Cheung, W. W., Dey, M. M., Halpern, B. S., McCauley, D. J., Smith, M., Vaitla, B., Zeller, D. & Myers, S. S. (2016) Fall in fish catch threatens human health. *Nature* 534(7607): 317–320.
- Haahtela, T., Holgate, S., Pawankar, R., Akdis, C. A., Benjaponpitak, S., Caraballo, L., Demain, J., Portnoy, J. & von Hertzen, L. (2013) The biodiversity hypothesis and allergic disease: world allergy organization position statement. *World Allergy Organization Journal* 6(1): 3.
- Harris-Roxas, B., Viliani, F., Bond, A., Cave, B., Divall, M., Furu, P., Harris, P., Soeberg, M., Wernham, A. & Winkler, M. (2012) Health impact assessment: the state of the art. *Impact Assessment and Project Appraisal* 30(1): 43–52.
- Harris-Roxas, B. & Harris, E. (2013) The impact and effectiveness of health impact assessment: a conceptual framework. *Environmental Impact Assessment Review* 42: 51–59.
- Hawley, N. L. & McGarvey, S. T. (2015) Obesity and diabetes in Pacific Islanders: the current burden and the need for urgent action. *Current Diabetes Reports* 15(5): 29.

- Honold, J., Lakes, T., Beyer, R. & van der Meer, E. (2016) Restoration in urban spaces: nature views from home, greenways, and public parks. *Environment and Behavior* 48(6): 796–825.
- Horwitz, P. & Parkes, M. W. (2016) Scoping health impact assessment: ecosystem services as a framing device. In: *Handbook on Biodiversity and Ecosystem Services in Impact Assessment*, ed. D. Geneletti, pp. 62–85. Cheltenham, UK: Edward Elgar Publishing.
- Hough, R. L. (2014) Biodiversity and human health: evidence for causality? *Biodiversity and Conservation* 23(2): 267–288.
- Hoy, D., Roth, A., Lepers, C., Durham, J., Bell, J., Durand, A., Lal, P. N. & Soares, Y. (2014) Adapting to the health impacts of climate change in a sustainable manner. *Globalization and Health* 10(1): 82.
- Hunt, J., Altman, J. C. & May, K. (2009) *Social Benefits of Aboriginal Engagement in Natural Resource Management, CAEPR Working Paper No. 60/2009*, Canberra, Australia: Centre for Aboriginal Economic Policy Research, Australian National University.
- IUCN (2017) Oceania regional plan for 2017–2020. URL <https://www.iucn.org/regions/oceania/about/iucn-oceania-regional-plan-2017-2020>
- Jenkins, A. P., Jupiter, S. D., Qauqau, I. & Atherton, J. (2010) The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: a case study from Fiji. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20(2): 224–238.
- Jenkins, A. P. & Jupiter, S. D. (2011) Spatial and seasonal patterns in freshwater ichthyofaunal communities of a tropical high island in Fiji. *Environmental Biology of Fishes* 91(3): 261–274.
- Jenkins, A. P. & Jupiter, S. D. (2015) Natural disasters, health and wetlands: a Pacific small island developing state perspective. In: *Wetlands and Human Health*, eds M. Finlayson, P. Horwitz, P. Weinstein, pp. 169–191. New York, NY, USA: Springer.
- Jenkins, A. P., Jupiter, S. D., Mueller, U., Jenney, A., Vosaki, G., Rosa, V., Naucukidi, A., Mulholland, K., Strugnell, R., Kama, M. & Horwitz, P. (2016) Health at the sub-catchment scale: typhoid and its environmental determinants in Central Division, Fiji. *EcoHealth* 13(4): 633–651.
- Jones, P. (2012) *Managing Urbanisation in Papua New Guinea: Planning for Planning's Sake? Working Papers Series Two, No. 33*. Geelong, Australia: Alfred Deakin Research Institute.
- Jupiter, S. D., Cohen, P. J., Weeks, R., Tawake, A. & Govan, H. (2014) Locally-managed marine areas: multiple objectives and diverse strategies. *Pacific Conservation Biology* 20(2): 165–179.
- Jupiter, S. D., Epstein, G., Ban, N. C., Mangubhai, S., Fox, M. & Cox, M. (2017) A social–ecological systems approach to assessing conservation and fisheries outcomes in Fijian locally managed marine areas. *Society & Natural Resources* 30: 1096–1111.
- Jupiter, S., Jenkins, A., Long, W. L., Maxwell, S., Watson, J., Hodge, K., Govan, H. & Carruthers, T. (2013) *Pacific Integrated Island Management: Principles, Case Studies and Lessons Learned*. Montreal, Canada: Secretariat of the Pacific Regional Environment Programme (SPREP) and Geneva: United Nations Environment Programme (UNEP).
- Jupiter, S., Mangubhai, S. & Kingsford, R. T. (2014) Conservation of biodiversity in the Pacific Islands of Oceania: challenges and opportunities. *Pacific Conservation Biology* 20(2): 206–220.
- Kilpatrick, A. M., Salkeld, D. J., Titcomb, G. & Hahn, M. B. (2017) Conservation of biodiversity as a strategy for improving human health and well-being. *Philosophical Transactions of the Royal Society B* 372(1722): 20160131.
- Kingsford, R. T. & Watson, J. E. (2011) Climate change in Oceania – a synthesis of biodiversity impacts and adaptations. *Pacific Conservation Biology* 17(3): 270–284.
- Kingsley, J., Patrick, R., Horwitz, P., Parkes, M., Jenkins, A., Massy, C., Henderson-Wilson, C. & Arabena, K. (2015) Exploring ecosystems and health by shifting to a regional focus: perspectives from the Oceania EcoHealth Chapter. *International Journal of Environmental Research and Public Health* 12(10): 12706–12722.
- Kubiszewski, I., Anderson, S., Costanza, R. & Sutton, P. C. (2016) The future of ecosystem services in Asia and the Pacific. *Asia & the Pacific Policy Studies* 3: 389–404.
- Kubiszewski, I., Costanza, R., Anderson, S. & Sutton, P. (2017) The future value of ecosystem services: global scenarios and national implications. *Ecosystem Services* 26: 289–301.
- Kumar, V. (2010) Water management in Fiji. *International Journal of Water Resources Development* 26(1): 81–96.
- Kuo, M. (2015) How might contact with nature promote human health? Promising mechanisms and a possible central pathway. *Frontiers in Psychology* 6: 1093.
- Lau, C. L., Watson, C. H., Lowry, J. H., David, M. C., Craig, S. B., Wynwood, S. J., Kama, M. & Nilles, E. J. (2016) Human leptospirosis infection in Fiji: an eco-epidemiological approach to identifying risk factors and environmental drivers for transmission. *PLoS Neglected Tropical Diseases* 10(1): e0004405.
- Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T. & Miyazaki, Y. (2011) Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health* 125(2): 93–100.
- Masterson, V., Stedman, R., Enqvist, J., Tengö, M., Giusti, M., Wahl, D. & Svedin, U. (2017) The contribution of sense of place to social–ecological systems research: a review and research agenda. *Ecology and Society* 22(1): 49.
- McIver, L., Kim, R., Woodward, A., Hales, S., Spickett, J., Katscherian, D., Hashizume, M., Honda, Y., Kim, H., Iddings, S. & Naicker, J. (2016) Health impacts of climate change in Pacific Island countries: a regional assessment of vulnerabilities and adaptation priorities. *Environmental Health Perspectives* 124(11): 1707–1714.
- McKinnon, M. C., Cheng, S. H., Dupre, S., Edmond, J., Garside, R., Glew, L., Holland, M. B., Levine, E., Masuda, Y. J., Miller, D. C. & Oliveira, I. (2016) What are the effects of nature conservation on human well-being? A systematic map of empirical evidence from developing countries. *Environmental Evidence* 5(1): 8.
- McMichael, A., Woodward, A. & Muir, C. (2017) *Climate Change and the Health of Nations: Famines, Fevers, and the Fate of Populations*. Oxford, UK: Oxford University Press.
- Moore, M., Townsend, M. & Oldroyd, J. (2006) Linking human and ecosystem health: the benefits of community involvement in conservation groups. *EcoHealth* 3: 255–261.
- Morrison, J. (2007) Caring for country. In: *Coercive Reconciliation: Stabilise, Normalise, Exit Aboriginal Australia*, eds J. Altman, M. Hinkson, pp. 249–262. Melbourne, Australia: Arena Publications.
- Nolet, E. (2016) ‘Are you prepared?’ Representations and management of floods in Lomanikoro, Rewa (Fiji). *Disasters* 40(4): 720–739.
- O’Brien, P. (2000) *Scenario Planning: A Strategic Tool*. Canberra, Australia: Bureau of Rural Sciences.

- Pacific Community (2016) Pacific Island populations – estimates and projections of demographic indicators for selected years. URL <https://prism.spc.int/regional-data-and-tools/population-statistics>
- Pelesikoti, N. & Suwamaru, J. K. (2017) ICTs in Pacific Islands' climate change and disaster risk reduction policy and programs. In: *Achieving Sustainable E-Government in Pacific Island States, Public Administration and Information Technology*, vol. 27, eds R. Cullen, G. Hassall, pp. 269–303. South Yarra, Australia: Springer Nature.
- Peterson, G., Cumming, G. & Carpenter, S. (2003) Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17(2): 358–366.
- Pollard, E., Brodie, G., Thaman, R. & Morrison, C. (2014). The use of herpetofauna and cultural values to identify priority conservation forests on Malaita, Solomon Islands. *Pacific Conservation Biology* 20(4): 354–362.
- Pollard, E. M., Thaman, R., Brodie, G. & Morrison, C. (2015) Threatened biodiversity and traditional ecological knowledge: associated beliefs, customs, and uses of herpetofauna among the 'Are' Are on Malaita Island, Solomon Islands. *Ethnobiology Letters* 6(1): 99–110.
- Raskin, P. (2016) *Journey to Earthland: The Great Transition to Planetary Civilization*. Boston, MA, USA: Tellus Institute.
- Sandifer, P. A., Sutton-Grier, A. E. & Ward, B. P. (2015) Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: opportunities to enhance health and biodiversity conservation. *Ecosystem Services* 12: 1–15.
- Scobie, H. M., Nilles, E., Kama, M., Kool, J. L., Mintz, E., Wannemuehler, K. A., Hyde, T. B., Dawainavesi, A., Singh, S., Korovou, S. & Jenkins, K. (2014) Impact of a targeted typhoid vaccination campaign following cyclone Tomas, Republic of Fiji, 2010. *The American Journal of Tropical Medicine and Hygiene* 90(6): 1031–1038.
- Shanahan, D. F., Fuller, R. A., Bush, R., Lin, B. B. & Gaston, K. J. (2015) The health benefits of urban nature: how much do we need? *BioScience* 65(5): 476–485.
- SPREP (2012) *Pacific Environment and Climate Change Outlook*. Apia, Samoa: Secretariat of the Pacific Regional Environment Programme.
- Taylor, M., McGregor, A. & Dawson, B. (eds) (2016) *Vulnerability of Pacific Island Agriculture and Forestry to Climate Change*. Nouméa, New Caledonia: Pacific Community.
- Titifanue, J., Kant, R., Finau, G. & Tarai, J. (2017) Climate change advocacy in the Pacific: the role of information and communication technologies. *Pacific Journalism Review* 23(1): 133–149.
- Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y. & Kagawa, T. (2014) The influence of urban green environments on stress relief measures: a field experiment. *Journal of Environmental Psychology* 38: 1–9.
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. & Zelson, M. (1991) Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology* 11: 201–230.
- Utzinger, J., Wyss, K., Moto, D. D., Tanner, M. & Singer, B. H. (2005) Assessing health impacts of the Chad–Cameroon petroleum development and pipeline project: challenges and a way forward. *Environmental impact assessment review* 25(1): 63–93.
- Warrick, O., Aalbersberg, W., Dumar, P., McNaught, R. & Teperman, K. (2017) The 'Pacific adaptive capacity analysis framework': guiding the assessment of adaptive capacity in Pacific Island communities. *Regional Environmental Change* 17(4): 1039–1051.
- Weir, J., Stacey, C. & Youngetob, K. (2011) *The Benefits Associated with Caring for Country: Literature Review*. Canberra, Australia: Department of Sustainability, Environment, Water, Population and Communities and Australian Institute of Aboriginal and Torres Strait Islander Studies.
- Wilson, G., Edwards, E. & Smits, J. (2010) Support for indigenous wildlife management in Australia to enable sustainable use. *Wildlife Research* 37: 255–263.
- Wilson, G. & Woodrow, M. (2009) Kuka Kanyini, Australian indigenous adaptive management. In: *Adaptive Environmental Management: A Practitioner's Guide*, eds C. Allan, G. Stankey, pp. 117–141. Dordrecht, The Netherlands: Springer.
- Winkler, M. S., Divall, M. J., Krieger, G. R., Balge, M. Z., Singer, B. H. & Utzinger, J. (2010) Assessing health impacts in complex eco-epidemiological settings in the humid tropics: advancing tools and methods. *Environmental Impact Assessment Review* 30(1): 52–61.
- Wooltorton, S., Wilkinson, A., Horwitz, P., Bahn, S., Redmond, J. & Dooley, J. (2015) Sustainability and action research in universities: towards knowledge for organisational transformation. *International Journal of Sustainability in Higher Education* 16(4): 424–439.
- World Bank (2016) *Effects of Population Growth and Urbanization in the Pacific Islands*. URL <http://siteresources.worldbank.org/INTPACIFICISLANDS/Resources/Chapter+1.pdf>
- WHO (2011) *Adelaide Statement on Health in All Policies*. Geneva, Switzerland: World Health Organization.
- WHO (2015a) *The First 20 Years of the Journey towards the Vision of Healthy Islands in the Pacific*. Geneva, Switzerland: World Health Organization.
- WHO (2015b) *Connecting Global Priorities: Biodiversity and Human Health*. Geneva, Switzerland: World Health Organization and Secretariat of the Convention on Biological Diversity.
- WHO/UNICEF (2016) *Sanitation, Drinking-Water and Health in Pacific Island Countries: 2015 Update and Future Outlook*. Geneva, Switzerland: World Health Organization.
- World Population Review (2017) Oceania population 2018. URL <http://worldpopulationreview.com/continents/oceania-population/>