Resource extractivism, health and climate change in small islands

Hilary Bambrick
School of Public Health and Social Work, Queensland University of Technology, Queensland, Australia

Received 20 March 2017
Revised 16 August 2017
Accepted 21 August 2017

Abstract

Purpose – The extraction of natural resources has long been part of economic development in small islands. The damage to environment and health is extensive, even rendering once productive islands virtually uninhabitable. Rather than providing long-term benefits to the population or to the environment, the culture of "extractivism" – a nonreciprocal approach where resources are removed and used with little care or regard to consequences – has instead left many in far more fragile circumstances, increasingly dependent on external income. The purpose of this paper is to show how continued extractivism in small islands is contributing to global climate change and increasing climate risks to the local communities.

Design/methodology/approach – Through a series of case studies, this paper examines the history of extractivism in small islands in Oceania, its contribution to environmental degradation locally and its impacts on health.

Findings – It examines how extractivism continues today, with local impacts on environment, health and wellbeing and its much more far-reaching consequences for global climate change and human health. At the same time, these island countries have heightened sensitivity to climate change due to their isolation, poverty and already variable climate, whereas the damage to natural resources, the disruption, economic dependence and adverse health impacts caused by extractivism impart reduced resilience to the new climate hazards in those communities.

Practical implications – This paper proposes alternatives to resource extractivism with options for climate compatible development in small islands that are health-promoting and build community resilience in the face of increasing threats from climate change.

Originality/value – Extractivism is a new concept that has not previously been applied to understanding health implications of resource exploitation thorough the conduit of climate change. Small-island countries are simultaneously exposed to widespread extractivism, including of materials contributing to global climate change, and are among the most vulnerable to the hazards that climate change brings.

Keywords Adaptation, Climate change, Coal mining, Health impacts, Resource depletion, Small islands

Paper type Research paper

Introduction

The extraction and export of natural resources has long been part of economic development in the Pacific and nearby islands and is at its heart founded in colonialism. The damage to local environment and health as a result of resource extraction in a number of countries has been extensive and, in some cases extreme, even rendering once productive islands virtually uninhabitable. Rather than providing long-term benefits to the population or to the

International Journal of Climate Change Strategies and Management
Vol. 10 No. 2, 2018
pp. 272-288
Emerald Publishing Limited
1756-8692
DOI 10.1108/IJCCSM-03-2017-0068

environment or to the local economy, the culture of "extractivism" (Klein, 2015) – a nonreciprocal approach where resources are removed and used for monetary gain with little care or regard to consequences – has instead left many in far more fragile circumstances, increasingly dependent on external income and support.

The intention of the paper is to demonstrate through a series of case studies how extractivism has not only wrought havoc on small islands historically but that it is a practice that continues to occur to the present day. In particular, this paper intends to show that the negative impacts of extractivism are neither short-term nor limited to those islands. Rather, due to the nature of the resources now being extracted, these negative effects have increasingly global and long-term consequences, which in turn especially threaten the lives and livelihoods of those in the very communities from where the extracted resources originate.

The geographic scope of this paper is small islands in Oceania. These islands share similar colonial histories and countries involved in the resource extraction and are subject to similar kinds of environmental and health threats arising from extractivist practices. This paper is not intended to provide an exhaustive list of resource types and locations where extractivism has or does occur. There are many more examples of extractivism in small islands that have not been included here, as similar practices are repeated around the world (Klein, 2015).

The approach taken is to review and synthesize a selection of case studies that highlight the variety of resources that have been removed from small islands over time and where the benefits flow to external parties at significant cost to local communities – in resource depletion, environmental damage and impacts on community health and well-being. As the practice of extractivism continues, these themes of colonial power, inequity, short-term remain evident in the present day, with the added potential for damage to environment, health and society now on unprecedented scale.

Phosphate

Perhaps the best-known example of extractivism in small islands and the consequent damage to environment, society and health is from the island of Nauru. Located in Micronesia, Nauru, is a small island made up of phosphate rock. Phosphate mining commenced at the turn of past century and continued until resources were exhausted in the 1990s. Phosphate was extracted first by Europe and Australia, with about 30 per cent of it removed before independence in 1968, when the Nauruan government continued to extract it and place the money into a trust fund to create income for Nauruans (Gale, 2016, D'Odorico and Rulli, 2014). Prior to this nationalization of phosphate mining, the financial returns to Nauruans were microscopic (Pollock, 2014). With nationalization, the island nation subsequently underwent rapid economic development, and for nearly two decades, per capita income in Nauru was the highest in the world. This money, along with the phosphate reserves, is now gone (D'Odorico and Rulli, 2014).

The environmental loss has been extreme. Most of the island is missing, leaving just a coastal ring, and pollution from mining has also devastated surrounding fisheries from polluted run-off. Australia paid AU$135m in 1993 in compensation to rehabilitate the island, but rehabilitation has not occurred (Gale, 2016). With limited arable land and damaged local fisheries, the 10,000 residents of Nauru are almost entirely dependent on imported food. Despite a decline in recent decades, the reported prevalence of diabetes remains high at 14 per cent (Khambalia *et al.*, 2011), and an extremely high prevalence of obesity remains (71 per cent) [World Health Organization (WHO), 2014]. The heavy burden from the serious sequelae of cardiovascular disease, retinopathy and renal disease (Win Tin *et al.*, 2014)

means that "healthy" life expectancy is 12 years below life expectancy at birth for both women and men, and overall increases in life expectancy fall below those for its Pacific neighbors [World Health Organization (WHO), 2015]. Once rich in vegetation and marine life, Nauru is now crowded and largely barren, dependent on income from an Australian government offshore detention center for asylum seekers (Fleay and Hoffman, 2014), and on payment for the eventual resettlement of refugees within the already resource scarce and socially fragile nation.

Similarly, Banaba Island in Kiribati, a near neighbor to Nauru, has all but been destroyed by phosphate mining which took place from 1900 to 1979 (Taeiwa, 2015). Here phosphate mining by Britain also forced migration from the island; all of the 1,003 inhabitants were removed in 1945 and taken to remote Rabi Island in Fiji, more than 1,000 km away (Edwards, 2014). Since phosphate mining ceased, some Banaba people have returned to Banaba Island, but as on Nauru, decades of mining has removed all the soil from the center of the island, leaving only the coastal ring habitable and with any vegetation (Taeiwa, 2015). Similar to Nauru, Banaba island has variable annual rainfall and is prone to drought, threatening food security further where there is so little remaining arable land.

The Banaba Islanders' new home of Rabi Island has an official population of around 3,000, based on the most recent (2007) Fiji census count (Fiji Bureau of Statistics, 2017) and estimated population growth rates (2007-2014) for the Cakuadrove province (Fiji Bureau of Statistics, 2015) to which Rabi Island belongs. Locals estimate population size to be around 5,000 (Bambrick and Moncada, 2015). The people of Rabi are food insecure, with added risk from climate change causing declining rainfall and more intense cyclones which damage food crops and fisheries, and the supply of clean water is tenuous. As a consequence, Rabi Island has high rates of diarrhea and other communicable disease while also being at risk from vector-borne diseases such as dengue which may intensify with changing climate (Bambrick and Moncada, 2015). These problems are compounded by being a small ethnic minority on a remote Fiji island, with limited infrastructure, services and health care.

The mining of phosphate to produce fertilizer in the wealthy west has not only devastated the islands of Nauru and Banaba, leaving dependence and declining health standards in its wake, but also disrupted the distant ecological systems where it has been applied in industrial scale agriculture. While phosphate is naturally stored in rock and slowly released to plants, the intense application of phosphate-rich fertilizer to increase productivity pollutes the surrounding lakes, streams and oceans, triggering eutrophication and algal blooms, depleting oxygen in the water (United Nations Environment Programme, 2001).

Fisheries

The Pacific Ocean supplies half of the world's tuna (Jin *et al.*, 2015). The region has long been subject to large-scale fishing of skipjack, yellowfin and bigeye tuna by international fleets, often using the purse-seine technique, where a school of fish is encircled with a net and everything within it is captured. While some large-scale international fishing is regulated, and taxes on foreign fishing provide substantial income to many Pacific Islands (Bell *et al.*, 2013), much of the fishing is unsupported by international agreements and is therefore unregulated and frequently illegal (Grewe *et al.*, 2015). The immense size of the Pacific Ocean and the limited capacity for local surveillance means that the illegal extractivism of the Pacific's ocean resources can occur largely unabated and with no royalties being paid to the countries whose waters are being exploited. Furthermore, purse-seining risks substantial unintended by-catch, whereby other non-target species are caught in the nets. The massive scale of the (especially unregulated) fishing industry in the Pacific and the use

of purse seining threatens marine ecosystems and reduces the availability of fish for local use. Local catch rates are declining in the Pacific and are expected to continue to decline over coming decades (Albert *et al.*, 2015).

Climate change puts additional pressures on fisheries through its impacts on marine ecosystems and will have significant impacts on local food security where communities are dependent on coastal and offshore fisheries as a primary food source. There is less data available on the status of coastal fisheries (Albert *et al.*, 2015), but the consequences of climate change (in tandem with growing populations and therefore increased consumption pressures) are expected to be negative for fish availability and safety. This is particularly the case for coral reef fish for which climate change may cause a decline in abundance of 20 per cent by 2050 (Bell *et al.*, 2013). Rising temperatures may reduce local fish stocks, change species profiles and increase the risk of ciguatera contamination in reef fish by promoting the abundance of toxic algae (Llewellyn, 2010, Derne *et al.*, 2010).

Coral reef ecosystems, vital for sustaining coastal fisheries, may be further disrupted by coral fungal disease outbreaks from increased ocean acidification resulting from rising carbon dioxide levels and warmer ocean temperatures (Williams *et al.*, 2014). Ecological disturbance of reef systems can increase predominance of algal associated fish species (Feary *et al.*, 2007), and closed atoll lagoons with minimal flushing (such as in Kiribati and Marshall Islands) are especially at risk (Andrefouet *et al.*, 2015). Lack of fish affects not only food security in Pacific communities but also social cohesion and the capacity to continue local traditions, as fishing and activities around fisheries are frequently central to cultural and social events (Kittinger *et al.*, 2015). Perhaps more positively, the potential for warmer temperatures to increase tuna abundance in the eastern Pacific and possibly increase productivity of freshwater aquaculture (Bell *et al.*, 2013) could help offset overfishing and declines in reef and coastal fisheries and related threats to Pacific food security but would require a transition to oceanic fish becoming a more prominent local food source rather than where these fish are primarily extracted by foreign trawlers.

Logging

Illegal logging by foreign parties is another form of extractivism that takes place in the Oceania that is widespread throughout the region (Dinnan and Walton, 2016). While import and export bans have reduced the amount of forest loss that takes place, there remains a market for illegal and unregulated logging of high value timber (Felbab-Brown, 2011). In particular, foreign companies that enter under the umbrella of a local person or company as a means to avoid the logging and export bans that otherwise limit extractivism. Solomon Islands is a particular target because of their valuable hardwood forests and has experienced, for example, the smuggling of valuable unprocessed logs to international traders (Radio Australia, 2012) under the guise of nominating a local person as sole director of a foreign owned company to enter the country and commence business following barring by court order (Sanga, 2016). The rate of logging and export of primary forest in Solomon Islands is unsustainable and with no local processing there is little local economic benefit (Australian Centre for International Agricultural Research, 2012). This lack of manufacturing or value-adding to gain economic benefit from resource depletion is common in small islands with limited capacity for manufacture (including skilled labor, infrastructure, regulations), with only a few countries, such as Vanuatu and Fiji, having developed small-scale local industry associated with forestry (Australian Centre for International Agricultural Research, 2012). Unregulated logging creates local environmental problems such as erosion and increased landslide risk, and with loss of primary forest, loss of biodiversity (Franklin and Steadman, 2010) and invasion of pest species, including exotic

grasses that make forest re-generation more difficult (Denslow *et al.*, 2006). Further, like with fossil fuels (below), forest loss also contributes to climate change through the removal of carbon sinks and directly to carbon emissions if the wood is then burned.

Fossil fuels

The non-reciprocal approach to resource extraction in small islands in Oceania now extends to coal, oil and gas. As with phosphate, fisheries and logging, the extraction of fossil fuels causes local damage to environment (e.g. soil degradation, biodiversity loss) and health (Morrice and Colagiuri, 2013). With coal, oil and gas, however, the potential scale of ecological disruption is also much greater, with global implications through the release of greenhouse gases. Climate change is disrupting the earth's life support systems on a grand scale as carbon from fossil fuels, that has been trapped in the material for millennia, is released when it is burned (IPCC, 2013). The deleterious consequences of extractivism in Oceania are no longer confined to the region but rather extend worldwide.

Oil and gas mining is subject to extractivist culture in Oceania. Timor-Leste is a small, least developed country situated in the Indonesian Archipelago. Although Timor-Leste gained independence from Indonesia in 2002, it remains subject to a temporary maritime border which favors Australia in the ownership of major oil and gas fields that lie between the two countries, rather than a border that sits halfway between the two, which would favor Timor-Leste. This arises from an historical agreement between Indonesia and Australia (the Timor Gap Treaty) which in 1991 gave Australia rights to the area (Commonwealth of Australia, 1995). Since 2007, the profits from the oil and gas have been shared evenly between Australia and Timor-Leste (Commonwealth of Australia, 2006) although more recently relations between the two countries became strained with allegations of espionage against Australia as Timor-Leste mounted its case for what it sees as a fairer distribution of resources (Belot and Stewart, 2017). While the shared profits provide some much-needed income to Timor-Leste, the burning of this oil and gas for energy contributes to greenhouse gas emissions, and Timor-Leste is one of the most vulnerable countries globally to the impacts of climate change. It is poor and reliant on subsistence agriculture, with highly variable rainfall already subject to both severe drought and severe flooding and with both periods of drought and rainfall intensity expected to increase with climate change. The extremely mountainous topography adds to Timor-Leste's risk, with erosion and landslides associated with intense rainfall.

Despite the apparent economic benefits to developing countries, mining fossil fuels is not a healthy option. Oil and gas mining contribute to environmental damage and social disruption at source, but it is coal mining especially that has well-established direct risks to the workers and surrounding communities.

Coal mining has become a principle source of income in the region. Indonesia has begun mining coal in the Province of West Papua for use in its coal-fired power stations in Sulawesi (Somba, 2008), whereas the Government of Papua New Guinea, another country already damaged by extractivism in gold and copper mining, is also turning to coal, having recently invested millions in developing its own local industry (Wilson, 2017). Echoing the sequelae of phosphate mining in Nauru and Banaba, the local communities themselves see little economic benefit as profits flow instead to largely overseas owned mining companies, with some taxes going to government (Somba, 2008).

Coal dust is an important contributor to particulate air pollution, which is a cause of death and illness from cardiovascular and respiratory disease. The miners themselves are not the only ones who are affected, but the surrounding community and the communities through which coal is transported (Environment Defenders Office NSW, 2010). While there

are some data collected on the occupational health of miners (more so in wealthier countries with relatively functioning workplace safety regulations), there is very little data on the contribution of coal dust to respiratory disease in the broader population. Estimates from Australia do, however, give an indication of how substantial this might be. In the coal mining Hunter region in the state of New South Wales, it is estimated that 42 million kg of coal dust is distributed each year, largely through transport of the material to major ports (Environment Defenders Office NSW, 2010). Coal mining in West Papua may not be of this scale, but the environmental protections are even poorer. The mine produces poor health outcomes for local workers and residents; also the quality of coal is especially low and thus highly polluting, contributing to even more poor air quality and increased carbon emissions where it is burned for power in Sulawesi.

There are additional potential impacts from coal mining on the local communities. There may be increased income for workers (alongside the high occupational risks) and also increasing income disparity between those working in the mines and those who are not. Reliance on mineral exports for income is an established source of civil conflict (Ballard and Banks, 2003). The attraction of a higher income may trigger an exit from agriculture for creating livelihoods and a subsequent loss of local food production and a greater reliance on more expensive and possibly less nutritious imports.

Income flowing into communities from the presence of mining is also likely to be minimal with profits going to the private companies external to the communities. The inwards migration of workers for the mines may promote social disruption, causing local tensions and conflict and increased pressure on local resources of water, land and food.

Much of the world is now turning toward renewable energy (solar, wind and hydroelectric power). For some of these countries keen to develop economically, trying to extract what fossil fuels they can while it still has a dollar value has become a somewhat desperate undertaking. Some countries have relied on the money from mining to build their fragile economies, and the threat of economic collapse is very real if a mining company were to suddenly withdraw.

Health impacts of fossil fuel extractivism

The immediate health risks of coal mining to workers and surrounding communities are well-established (GBD 2013 Collaborators, 2015). Globally, around 25,000 people die each year from coal workers' pneumoconiosis (black lung) each year, and around 3.7 million people die from ultrafine particle outdoor air pollution each year (World Health Organization, 2016). A significant component of outdoor (ambient) air pollution which is black carbon originating from the processes of coal mining and transport, whereas the combustion of coal for electricity also adds nitrogen, sulfur compounds and heavy metals. Deaths from outdoor air pollution are mostly attributable to ischemic heart disease and stroke, chronic obstructive pulmonary disease or acute lower respiratory infections and lung cancer (World Health Organization, 2016). Even in relatively wealthy mining communities located in countries with established environmental and occupational protections, there are not inconsequential health risks to workers and communities. In Queensland, Australia for example, there have been 21 cases of coal workers' pneumoconiosis (black lung) since 2015 (Queensland Parliament, 2017) and pollution from a coal mine fire that burned for 45 days in the Australian State of Victoria was directly responsible for 10 or more deaths in the nearby town in 2014 (Victorian Government, 2015). The health consequences from the particulate pollution from coal dust distributed widely over communities during coal transportation is much more difficult to estimate but not insignificant; nationally the negative health impacts of coal mining, transport and combustion in Australia is estimated to cost around AU$2.6bn (US$2.05bn) every year (Australian

Academy of Technological Sciences and Engineering, 2009). The risk to community health is likely even greater in countries where there are fewer environmental protection regulations and less monitoring of particulate and gaseous emissions.

But importantly, the impacts of coal mining do not stop at the local or regional level; the health consequences of fossil fuel extractivism in the Pacific and elsewhere extend well beyond the proximate in both space and time. Coal's role in driving global climate change is unequivocal: burning coal is a chief villain in producing the emissions that are causing the planet to warm. The associated climatic changes have real health consequences, particularly in places which are already exposed to climate-associated health risks. Climate change, driven in large part by coal, will therefore increase the health burden in small islands. Exposure to increasing weather extremes including extreme heat, cyclones and storm surges augmented by sea-level rise are some direct consequences of global climate change of particular relevance to islands in Oceania, whereas less direct consequences include potential for increased transmission of vector-borne diseases, threats to water supply and food security through altered seasonal rainfall (McIver *et al.*, 2015). Meanwhile, the damage to natural resources caused by extractivism of coal and other materials and the related health impacts and economic dependence, impart reduced resilience in these same communities and minimize their capacity to cope with the new health and environmental hazards caused by climate change.

Small islands in Oceania are especially vulnerable to climate variability because of their isolation, poverty, limited land area, topography (low lying and subject to flooding, or mountainous and subject to landslides) and frequent reliance on subsistence farming and imported foods (Nunn, 2007, Mimura *et al.*, 2007). The poorest countries especially have few resources to adequately manage climate risks. Endemic poverty and minimal access to capital limit countries' capacity to respond and adapt to acute climate events and long-term changes (Boko *et al.*, 2007), whereas coping actions are necessarily reactive and targeted at immediate threats; longer-term vulnerability may even be enhanced by unsustainable and ineffective practices and emergency responses (United Nations Development Programme, 2007). In coming years, for example, islands in the Pacific are expected to experience increasing climate extremes; periods of drought and heavy rainfall, cyclones and heat may become more frequent and more intense, oceans may become warmer and more acidic and sea-level rise may contaminate artesian water supplies and cause flooding (Australian Bureau of Meteorology and CSIRO, 2011).

The negative health consequences are many, especially for communities which are already poor and have a high burden of ill health and which are subject extreme or variable climate. So far these have been well documented for Pacific Island countries (McIver *et al.*, 2015) and would be likely to be similar in other small islands in the region. The principal ways in which climate change affects health include:

- Direct trauma from extreme weather events, in particular cyclones and flooding, as events increase in intensity, and for flooding – frequency. Those especially at risk are people living in in exposed coastal and low-lying areas, or in mountainous areas (risk of landslide).
- Heat-related illness, as the frequency and intensity of hot days increases. Those especially at risk from the direct impacts of heat exposure are the elderly, people with underlying health conditions, young children and people who labor physically or outdoors.
- Vector-borne disease, in particular the mosquito-transmitted diseases such as dengue, chikungunya and zika viruses and malaria. As a general rule, mosquitoes

thrive in warmer, wetter conditions and disease transmission intensifies. While malaria is not currently widespread in the region, climate change acts against eradication efforts in countries such as Timor-Leste and increases the potential for widening the geographic areas of transmission. As new areas become more climatically suitable for transmission, previously unexposed and highly susceptible populations are at risk.

- Increased food- and water-borne disease, especially in areas where clean water supply and sanitation is already inadequate and also where infrastructure is damaged by flooding. Prolonged drought makes water unavailable for hygiene purposes and can increase concentrations of pathogens in the water that is available, whereas warmer ambient temperatures increase multiplication of pathogenic organisms in food and on preparation surfaces, for example. Food security is decreased through more variable and less certain rainfall patterns, with drought and flood damaging crops and destroying livestock, severe events such as cyclones or extreme heat damaging coral ecosystems on which reef fish depend.

Other priority health outcomes under climate change in the small islands in the Pacific and elsewhere are zoonoses (diseases transmitted by animals such as leptospirosis), respiratory illnesses (including asthma and allergy), psychosocial ill-health (e.g. arising from loss of lives, resources and community) and non-communicable diseases (e.g. diabetes and obesity, associated with less nutritious diet, greater reliance on imported and processed foods). The potential for a far greater health burden into the future is exacerbated with concomitant population pressures (including rapid growth and urbanization), inadequate health systems and limited technical capacity (McIver *et al.*, 2015).

Even these are all relatively simple and direct health consequences of climate change. But there are other, more complicated and less direct consequences that involve human systems and how they function.

Climate change is considered a "threat multiplier". Because of how it changes disease transmission (intensifying it in already exposed areas, expanding into fringe areas, and many of these diseases are related to poverty) and its impact on food production and water security, it makes poverty alleviation and attainment of other development goals more difficult. For example:

- As resources (food, water, land) become scarcer, conflict increases – especially in areas that are already more marginal or unstable (Bowles *et al.*, 2015). Climate change potentially overwhelms the coping mechanisms of individuals and communities, lowers the threshold at which violence occurs and weakens states.
- More time spent sick (e.g. with diarrhea) means less time spent in education or working for those who are sick and their careers, limiting earning capacity now and in the future.
- Displacement of people due to both long-term pressures of climate change, and also to sudden disasters, leading to social upheaval and oftentimes violence. Women are especially vulnerable to violence under such circumstances (Klein, 2004). Displacement may occur more as a trickle, with people leaving areas as they become less habitable or productive, or in case of a severe weather event or of conflict, displacement may be sudden, *en masse* and unorganized. In best case scenarios, it will occur in a more organized way on well-negotiated terms, with island nations already planning for "migration with dignity" (Maclellan, 2011).

It is well known that these health outcomes are all climate-sensitive because there is insufficient collection of health and climate data, it is difficult to estimate the size of the effect of climate variables on health in small and under resourced at risk islands (Hales, 2013). It is also known broadly what those risks are likely to be because there have previously been demonstrated connections between weather and/or climate and disease. Transmission of vector-borne diseases such as dengue and filariasis is dependent, for example, on rainfall, humidity and temperature, as these set the parameters for mosquito survival and behavior and pathogen replication and that many islands are exposed already to these and similar diseases, including chikungunya, Ross River virus and leptospirosis (Bambrick and Hales, 2013). Similarly, food- and water-borne diseases such as typhoid and cholera occur when water supplies are unsafe or disrupted, which may be seasonally associated or follow an extreme event such as a cyclone, drought or flooding (Hales, 2013, Bambrick, 2013). Extreme events cause deaths and injuries, and it is expected that these might become more frequent and more extreme.

Climate also affects wellbeing more broadly – food security, livelihoods and social and economic development – and these in turn affect regional security by driving high unemployment, social disintegration and involuntary and economic migration. Climate change contributes to poor health outcomes by exacerbating difficult living conditions. A warmer, wetter, more hostile environment, driven in part by resource extractivism, will widen the health and economic inequalities between those from whom resources are taken and those who are profiting from them.

While all small islands in Oceania have heightened vulnerability to the health impacts of climate change, some communities are at greater risk than others, depending on their exposure and underlying characteristics; climate change will exacerbate these existing vulnerabilities. Communities already suffering food insecurity and other climate-sensitive health problems will, without adequate adaptation, be at even greater risk, thus also increasing the likelihood – and associated social and economic costs – of forced migration (Westphal *et al.*, 2013, Mortreux and Barnett, 2009). Some population subgroups are at greater risk than others. Children are especially vulnerable to both increasing food insecurity and diarrheal disease, for example, because of demands of growth and development. The combination of poor nutrition and infectious disease lead to poor child growth and high rates of illness and mortality among children (Guerrant *et al.*, 2008, Picot *et al.*, 2012, Black *et al.*, 2013).

Ending the extractivism era – opportunities for adaptation

There are clear links between resource extractivism in Oceania, health and major ecological disturbances, not the least of which is climate change. Extractivism-fueled climate change is threatening not only the lives and livelihoods of small islands but also their very existence, and therefore strong and urgent action to limit the extent of global warming is required. Anote Tong, then President of Kiribati, a country at risk of disappearing under rising sea-level caused by climate change, took his country's call for a global moratorium on all new coal mines at the Paris Conference of the Parties (COP21) in 2015.

Despite knowing all about the far-reaching consequences of resource extractivism for environment and health, and as communities face devastation, there is little sign of abatement. Notwithstanding the extremely clear causal links between coal and climate change, and between climate change and poor health outcomes for vulnerable island communities, coal mining in the region persists. In fact, the push to extract coal is accelerating as mining companies attempt to maximize sales before coal becomes entirely globally unmarketable (Denniss, 2016).

Resource extractivism is not always about the actions of a foreign power but has, in some cases, been internalized, becoming a tool by some island governments to fast-track understandably desirable economic development by boosting indicators of national income. As seen, however, any gains made are not universal and may not even trickle down to the local communities, nor are they long-lived, and they come at considerable costs to environment, community and health.

"Climate compatible" development, in contrast, builds resilient communities and is urgently required to protect the health of island communities. Even if a total coal mining (and combustion) moratorium (on both new and old mines) was enacted immediately, the climate system is slow to respond. Because of the momentum of warming that is already in the climate system, an immediate cessation of all fossil fuel burning would bring an average rise of another 0.5°C over the next two decades before it can plateau and start to decline (IPCC, 2013). No matter how strong the emissions reduction actions are taken today, the health impacts that are already becoming apparent in Pacific communities will continue and intensify for some time and, importantly, hinder development and resilience building.

Alternatives to extractivism must be found, including income-generating activities that are climate compatible and lead to inclusive economic development. Ideally these activities are community-led, are health promoting and at the same time build resilience to climate change that is already occurring.

But where to start? A significant barrier to understanding climate change adaptation needs in small islands in Oceania, and in less developed countries elsewhere, is insufficient data. Studies of climate and health and have concentrated in the more developed countries and often at broad (i.e. average) population level over large areas (Bambrick *et al.*, 2015). The absence of suitable climate and health data, such as detailed watershed maps, national health surveys or hospital admissions, is a problem common to many developing countries including small islands (Bambrick and Hales, 2013). This absence of data, alongside minimal local capacity, has limited research in some of the world's most vulnerable communities. Data that does exist are frequently at large geographic scale, such as country or region (Nicholles *et al.*, 2012, Bambrick and Hales, 2013). Averaging the data over large areas may miss important local problems and have limited relevance at the village, town or even whole island level as important local risks are overlooked. Lack of routine collection or unstandardized collection may mean that data are temporally and spatially sparse, and seasonal and geographic effects are missed, so that an association between one or more climate variables (such as rainfall and temperature) and a given health outcome (such as a vector borne disease) are unable to be reliably quantified. The sporadic, out of date statistics on even basic health indicators compounds poor understanding of climate-sensitive health risks and limits capacity to appropriately plan for and manage very real and present risks. Adaptation activities risk responding to the wrong type of threat, leading to potentially wasteful and even maladaptive practices.

Because of this frequent uncertainty, a key approach to adaptation is to concentrate on building resilience and adaptive capacity – the set of resources and the ability to use those resources, that are a prerequisite to adaptation (Nelson *et al.*, 2007) – so that populations are better able to cope with the hazards of climate change, whatever they turn out to be. Population health and economic functioning are key determinants of adaptive capacity (Brooks *et al.*, 2005) and interventions that improve a fundamental aspect of community health, such as children's nutritional status, could contribute directly to enhancing adaptive capacity by reducing social and economic burden regardless of the specific climate hazards in a given community. This "no regrets" approach, whereby actions are undertaken that benefit population health without full knowledge of the specific shape or size of the impacts

that eventuate, is an essential strategy for taking meaningful and immediate action to bring substantial benefits to at-risk populations in both the short and longer term. Improving underlying population health could thus be considered a "first order" priority in climate change adaptation.

Work is currently underway, for example, by national governments and international development agencies to strengthen the health systems within small-island countries in Oceania. This includes implementing early warning systems for extreme events or for vector-borne disease which would benefit population health under current as well as future climate. Another, even more fundamental means of improving population health and increasing population resilience to climate change is to ensure clean water and adequate sanitation (Sheffield and Landrigen, 2011), and this has flow-on effects for economic and social functioning in families and communities. By reducing the burden of food- and water-borne disease, populations are healthier and more productive. In particular, the most vulnerable population groups benefit: Child mortality is reduced, and other key indicators of child health, such as height and weight status, are improved. Children spend more time in school and parents spend less time caring for sick children. Improving food security in areas already at risk from extreme weather is another pillar on which to build greater resilience. This might take the form of planting drought tolerant crops, changing the season in which to plant, changing locations of farms to more protected areas, storing water for irrigation and so on. Timing physical laboring to avoid the hottest parts of the day may be another relatively easy adaptive strategy that would bring immediate health benefits to workers' health and their productivity.

Beyond these basic yet essential first-order interventions that would contribute to health and consequently economic development are additional "second order" activities that would further help countries to reach their economic development goals. These not only need to be income generating but also should not damage health (or better yet, contribute directly to improved health), the local environment, nor contribute to climate change.

Rather than logging, for example, small-island communities and countries could look to grow their forest regions as global carbon sinks to offset emissions from elsewhere. With other countries seeking to offset their own emissions, there is increasing recognition of the potential market value of carbon capture, an essential ecosystem service. Other ways to maximize the value of their resource rich environment might include small-scale but high value production, such as niche agricultural and artisanal food production, and relatedly, building local business skills through enterprise training. In West Papua, for example, local communities would receive much greater income from sustainable fishing in unspoiled oceans than from the license fees paid by international mining companies, with development of coral reef ecotourism another option (Somba, 2008). Tourism that showcases unique and often spectacular natural environments is another potential avenue to develop, which again can be high value but small-scale so as not to overwhelm communities and environment. In Nauru, for example, the limestone pinnacles left by the removal of phosphate has produced an unusual landscape, whereas some unique native vegetation is beginning to return in some areas and if managed well could become a highly appealing attraction (Gale, 2016).

First-order and second-order adaptation priorities can counter some of the increased risk to climate change caused by local extractivism by building community resilience through improved heath and economic wellbeing. These relationships are illustrated in Figure 1.

Second-order priorities for inclusive development requires the right projects for the right communities that enhance rather than damage health. It is essential that these activities are community-driven and based on local needs and aspirations. Projects will be most effective if they are participatory and community managed and engage stakeholders throughout the

process (Ebi, 2008b). This added potential for economic development from such activities will in turn enhance the adaptive capacity of small-island communities to respond to climate change.

Ideally, targeted adaptation activities should be also evaluated for their effectiveness; their impacts on community health and on other resources that determine resilience, such as economic and environmental benefits. A successful community intervention used in one place, and properly evaluated, may be more efficiently implemented in other communities with similar characteristics, with lessons learned considered in subsequent iterations. Evaluation would also assist with evidence-based policy formation aimed at reducing adverse climate impacts (Ebi, 2008a) and decisions on whether to upscale projects to national level, for instance. In the absence of such evaluation, the potential benefits to other communities of similar interventions cannot be estimated, whereas mistakes that trigger unintended and adverse consequences could go unreported and risk being repeated time and again. Evaluation of adaptive interventions is unfortunately rare, and so there remain substantial gaps about the potential for compatible development activities to reduce these adverse impacts in more vulnerable communities, in Oceania and elsewhere.

Conclusions

Extractivism of local resources in in small islands in Oceania has contributed to environmental degradation locally through pollution and loss of natural capital. It has reduced food security, forced the migration of whole populations, promoted cultural loss and social instability and created fragile economies.

The key feature of extractivism is that a more powerful, often external body, be it another country or a corporation, profits disproportionately from the arrangement while causing loss and damage to the local community from where the resource is taken. In the case of coal mining in Oceania, this damage is both relatively direct and immediate (local environmental damage and health impacts of particulate pollution, as well as broader disruptive sociocultural consequences) as well as complex and longer term, the result of climate change caused by the burning of fossil fuels causing poorer health outcomes for generations to come.

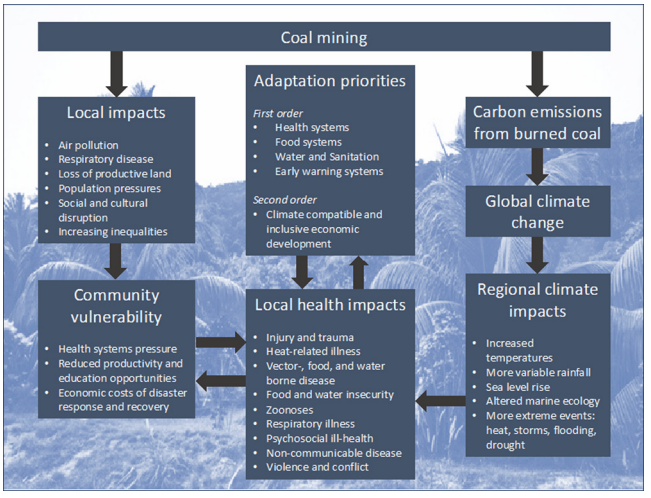

Figure 1.
How coal mining affects local health, both directly and through its contribution to climate change, and the role of adaptation priorities in improving community resilience

Extractivism depletes natural resources and causes environmental degradation, leaving those exposed increasingly dependent on external income, such as from international aid, mining royalties, or – in the case of the island of Nauru – dependent on Australia's asylum seeker industry. Not all extractivism causes system-wide ecological damage, sometimes "merely" local resource depletion, pollution and cultural loss. At its more extreme end as demonstrated in this paper, extractivism forces whole communities to relocate and, in the case of the coal mining, contributes to the disruption of an entire planetary system.

The continuing practice of extractivism by a colonial or foreign corporate power is not restricted to small islands in Oceania, but this resource-rich region has been exploited in a number of ways for well over 100 years, with significant consequences for health. Coal mining in the region is a continuation of an established and oft repeated, historical narrative. What makes coal as the extracted resource particularly destructive is both its demonstrable health impacts on the local communities *and* its longer-term contribution to global warming, which in turn adversely affects the health of these same communities.

The harmful consequences of extractivism in small islands in Oceania throughout past century were seemingly unintended although one could argue potentially foreseeable. The local damage was visible even in its early days, but the drive to remove resources for monetary gain was overwhelming. Lessons from history have not been learned, with coal and other fossil fuel extraction continuing to expand and bringing even larger-scale consequences. There are clear links between resource extractivism, health and ecological disturbances, including global climate change. Yet, despite all that is now known about the far-reaching consequences of resource depletion for environment and health, and as communities face devastation, extractivism continues.

Alternatives to resource extractivism are urgently needed to ensure inclusive development and healthier futures, but these must be community-led and locally appropriate. Climate compatible development in vulnerable small islands can bring immediate health benefits and build community resilience in the face of increasing threats from climate change. "Migration with dignity" is an adaptation action of last resort but is increasingly becoming the only option left for some island communities.

References

Albert, S., Aswani, S., Fisher, P.L. and Albert, J. (2015), "Keeping food on the table: human responses and changing coastal fisheries in Solomon Islands", *PLoS One*, Vol. 10 No. 7, p. e0130800.

Andrefouet, S., Dutheil, C., Menkes, C.E., Bador, M. and Lengaigne, M. (2015), "Mass mortality events in atoll lagoons: environmental control and increased future vulnerability", *Global Change Biology* Vol. 21 No. 1, pp. 195-205.

Australian Academy of Technological Sciences and Engineering (2009), *The Hidden Costs of Electricity: Externalities of Power Generation in Australia*, Australian Academy of Technological Sciences and Engineering (ATSE), Victoria.

Australian Bureau of Meteorology and Csiro (2011), *Climate Change in the Pacific: Scientific Assessment and New Research*, Vol. 1, Regional Overview, BOM and CSIRO, Canberra.

Australian Centre for International Agircultural Research (2012), ACIAR's Forestry Research in Pacific Island Countries.

Ballard, C. and Banks, G. (2003), "Resource wars: the anthropology of mining", *Annual Review of Anthropology*, Vol. 32 No. 1, pp. 287-313.

Bambrick, H. (2013), *Assessment Report on Climate Change Risks to Health at District Hospitals: Climate Adaptation Strategy for Health*, Government of Samoa and United Nations Development Programme.

Bambrick, H. and Hales, S. (2013), *Climate Adaptation Strategy for Health and Action Plan*, Government of Samoa and United Nations Development Programme.

Bambrick, H. and Moncada, S. (2015), "Managing climate-sensitive health risks in vulnerable pacific island communities: lessons from Rabi Island", *Our Common Future Under Climate Change*, Paris.

Bambrick, H., Moncada, S. and Briguglio, M. (2015), "Climate change and health vulnerability in informal urban settlements in the Ethiopian rift valley", *Environmental Research Letters*, Vol. 10 No. 5.

Bell, J., Ganachaud, A., Gehrke, P., Griffiths, S., Hobday, A., Hoegh-Guldberg, O., Johnson, J., Le Borgne, R., Lehodey, P., Lough, J., Matear, R., Pickering, T., Pratchett, M., Gupta, A., Senina, I. and Waycott, M. (2013), "Mixed responses of tropical pacific fisheries and aquaculture to climate change", *Nature Climate Change*, Vol. 3, pp. 591-599.

Belot, H. and Stewart, E. (2017), "East Timor tears up oil and gas treaty with Australia after Hague dispute", ABC News [Online], available at: www.abc.net.au/news/2017-01-09/east-timor-tears-up-oil-and-gas-treaty-with-australia/8170476 [Accessed 15 March 2017].

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., De Onis, M., Ezzati, M., Grantham-Mcgregor, S., Katz, J., Martorell, R. and Uauy, R., Maternal and Child Nutrition Study Group (2013), "Maternal and child undernutrition and overweight in low-income and middle-income countries", *Lancet*, Vol. 382 No. 9890, pp. 427-451.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007), "Africa. climate change impacts, adaptation and vulnerability. contribution of working group II", in Parry, M., Canziani, O., Palutikof, J., Van Der Linden, P. and Hanson, C. (Eds), *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.

Bowles, D., Braidwood, M. and Butler, C. (2015), "Unholy Trinity: Climate change, conflict and health", *in* Butler, C. (Ed.), *Climate Change and Global Health*, CABI, Wallingford, Oxfordshire.

Brooks, N., Adger, N. and Kelly, P. (2005), "The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation", *Global Environmental Change*, Vol. 15 No. 2.

Commonwealth of Australia (1995), "Treaty between Australia and the Republic of Indonesia on the zone of coopoeration in an area between the Indonesian Province of East Timor and Northern Australia (Timor gap treaty)", in Australian Department of Foreign Affairs and Trade (Ed.), *Australian Treaty Series*, 11 December 1989, Australian Government Publishing Service, Timor Sea.

Commonwealth of Australia (2006), "Treaty between Australia and the Democratic Republic of Timor-Leste on certain maritime arrangements in the Timor Sea (CMATS)", *in* Austalian Department of Foreign Affairs and Trade (Ed.), *Australian Treaty Series*, 12 January 2006: Australian Government Publishing Service, Sydney.

D'odorico, P. and Rulli, M. (2014), "The land and its people", *Nature Geoscience*, Vol. 7, pp. 324-325.

Denniss, R. (2016), "The great coal fire sale heats up", *Australian Financial Review*, 14 December 2015.

Denslow, J.S., Uowolo, A.L. and Hughes, R.F. (2006), "Limitations to seedling establishment in a mesic Hawaiian forest", *Oecologia*, Vol. 148 No. 1, pp. 118-128.

Derne, B., Fearnley, E., Goater, S., Carter, K. and Weinstein, P. (2010), "Ciguatera fish poisoning and environmental change: a case for strengthening health surveillance in the pacific?", *Pacific Health Dialog*, Vol. 16 No. 2, pp. 99-108.

Dinnan, S. and Walton, G. (2016), "Politics, organised crime and corruption in the Pacific", *State, Society and Governance in Melanesia*, 2016/24.

Ebi, K. (2008a), "Healthy people 2100: Modelling population health impacts of climate change", *Climatic Change*, Vol. 88 No. 1, pp. 5-19.

Ebi, K.L. (2008b), "Adaptation costs for climate change-related cases of diarrhoeal disease, malnutrition, and malaria in 2030", *Global Health*, Vol. 4 No. 9, p. 9.

Edwards, J.B. (2014), "Phosphate mining and the relocation of the banabans to northern Fiji in 1945: lessons for climate change-forced displacement", *Le Journal De La Société Des Océanistes*, Vol. 2014, pp. 138-139.

Environment Defenders Office NSW (2010), Technical Fact Sheet: Air Quality - Dust Monitoring.

Feary, D.A., Almany, G.R., Mccormick, M.I. and JONES, G.P. (2007), "Habitat choice, recruitment and the response of coral reef fishes to coral degradation", *Oecologia*, Vol. 153 No. 3, pp. 727-737.

Felbab-Brown, V. (2011), *Not as Easy as Falling off a Log: The Illegal Logging Trade in the Asia-Pacific Region and Possible Mitigation Strategies*, Brookings Institution, Washington, DC.

Fiji Bureau of Statistics (2015), "Population and labour force estimates of 2014", *Statistical News, 99*.

Fiji Bureau of Statistics (2017), Functional Age Groups - Total Population by enumeration area.

Fleay, C. and Hoffman, S. (2014), "Despair as a governing strategy – Australia and the offshore processing of asylum-seekers on Nauru", *Refugee Survey Quarterly*, Vol. 33 No. 2, pp. 1-19.

Franklin, J. and Steadman, D.W. (2010), "Forest plant and bird communities in the Lau group, Fiji", *PLoS One*, Vol. 5 No. 12, p. e15685.

Gale, S. (2016), "The mined-out phosphate lands of Nauru, equatorial western pacific", *Australian Journal of Earth Sciences*, Vol. 63 No. 3.

GBD 2013 Collaborators (2015), "Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the global burden of disease study 2013", *Lancet*, Vol. 385, pp. 117-171.

Grewe, P.M., Feutry, P., Hill, P.L., Gunasekera, R.M., Schaefer, K.M., Itano, D.G., Fuller, D.W., Foster, S. D. and Davies, C.R. (2015), "Evidence of discrete yellowfin tuna (Thunnus albacares) populations demands rethink of management for this globally important resource", *Scientific Reports*, Vol. 5 No. 1, p. 16916.

Guerrant, R.L., Oria, R.B., Moore, S.R., Oria, M.O. and Lima, A.A. (2008), "Malnutrition as an enteric infectious disease with long-term effects on child development", *Nutrition Reviews*, Vol. 66 No. 9, pp. 487-505.

Hales, S. (2013), *Health Risk Analysis: Climate Adaptation Strategy for Health*, Integrating Climate Change Risks in the Agriculture and Health Sectors in Samoa, Samoa.

IPCC (2013), *Climate Change 2013: The Physical Science Basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, in Stocker, T., Qin, D., Plattner, G.K., Tignor, M., Allen, S., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P. (Eds), Intergovernmental Panel on Climate Change, Cambridge and New York, NY.

Jin, S., Yan, X., Zhang, H. and Fan, W. (2015), "Weight-length relationships and Fulton's condition factors of skipjack tuna (Katsuwonus pelamis) in the western and central pacific ocean", *PeerJ*, Vol. 3, p. e758.

Khambalia, A., Phongsavan, P., Smith, B.J., Keke, K., Dan, L., Fitzhardinge, A. and Bauman, A.E. (2011), "Prevalence and risk factors of diabetes and impaired fasting glucose in Nauru", *BMC Public Health*, Vol. 11, p. 719.

Kittinger, J.N., Teneva, L.T., Koike, H., Stamoulis, K.A., Kittinger, D.S., Oleson, K.L., Conklin, E., Gomes, M., Wilcox, B. and Friedlander, A.M. (2015), "From reef to table: social and ecological factors affecting coral reef fisheries, artisanal seafood supply chains, and seafood security", *PLoS One*, Vol. 10 No. 8, p. e0123856.

Klein, A. (2004), *Preventing and Responding to Sexual Violence in Disasters: A Planning Guide for Prevention and Response*, LaFASA & NSVRC, Louisiana.

Klein, N. (2015), *This Changes Everything: Capitalism Vs the Climate*, Simon and Schuster, London.

Llewellyn, L.E. (2010), "Revisiting the association between sea surface temperature and the epidemiology of fish poisoning in the South Pacific: reassessing the link between ciguatera and climate change", *Toxicon: official Journal of the International Society on Toxinology*, Vol. 56 No. 5, pp. 691-697.

Mciver, L., Kim, R., Hales, S., Honda, Y., Spickett, J., Woodward, A., Bambrick, H., Hashizume, M., Iddings, S., Katscherian, D., Kim, H. and Naicker, J. (2015), Human Health and Climate Change in Pacific Island Countries.

Maclellan, N. (2011), "Kiribati's policy for 'migration with dignity'", Inside Story.

Mimura, N., Nurse, L., Mclean, R.F., Agard, J., Briguglio, L., Lefale, P., Payet, R. and Sem, G. (2007), *Small islands. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, in Parry, M.L., Canziani, O.F., Palutikof, J.P., Van Der Linden, P.J. and Hanson, C.E. (Eds), Cambridge University Press, Cambridge.

Morrice, E. and Colagiuri, R. (2013), "Coal mining, social injustice and health: a universal conflict of power and priorities", *Health & Place*, Vol. 19, pp. 74-79.

Mortreux, C. and Barnett, L. (2009), "Climate change, migration and adaptation in Funafuti, Tuvalu", *Global Environmental Change*, Vol. 19 No. 1, pp. 105-111.

Nelson, D., Adger, W. and Brown, K. (2007), "Adaptation to environmental change: contributions of a resilience framework", *Annual Review of Environment and Resources*, Vol. 32 No. 1, pp. 395-419.

Nicholles, N., Vardakoulias, O. and Johnson, V. (2012), *Counting on Uncertainty: The Economic Case for Community Based Adaptation in North-East Kenya*, New Economics Foundation and Care International.

Nunn, P. (2007), *Climate, Environment, and Society in the Pacific during the Last Millennium*, Elsevier, Amsterdam.

Picot, J., Hartwell, D., Harris, P., Mendes, D., Clegg, A.J. and Takeda, A. (2012), "The effectiveness of interventions to treat severe acute malnutrition in young children: a systematic review", *Health Technology Assessment*, Vol. 16 No. 19, pp. 1-316.

Pollock, N. (2014), "Nauru phosphate history and the resource curse narrative", *Le Journal De La Société Des Océanistes*, Vol. 2014 Nos 138/139, pp. 107-120.

Queensland Parliament (2017), *Black Lung, White Lies: Inquiry into the re-identification of coal workers' pneumoconiosis in Queensland Coal Workers' Pneumoconiosis Select Committee*, Brisbane.

Radio Australia (2012), *Asian Company Suspected of Smuggling Valuable Solomon Islands' Logs*, Australian Broadcasting Corporation (ABC).

Sanga, L. (2016), *Asian logging firm ignores Solomons court order, lands in West Guadalcanal. Pacific Islands Report*, East-West Centre Pacific Islands Development Program.

Sheffield, P. and Landrigen, P. (2011), "Global climate change and children's health: threats and strategies for prevention", *Environmental Health Perspectives*, Vol. 119 No. 3, pp. 291-298.

Somba, N. (2008), "Papua tribe questions govt over Issed mining licences", The Jakarta Post, 18 August 2008.

Taeiwa, K. (2015), *Consuming Ocean Island: Stories of People and Phosphate from Banaba*, Indiana University Press, Bloomington, Indiana.

United Nations Development Programme (2007), *Human Development Report*.

United Nations Environment Programme (2001), *Environmental Aspects of Phosphate and Potash Mining*, UNEP, France.

Victorian Government (2015), *Hazelwood Mine Fire Inquiry Report 2015/2016 Vollume II – Investigations into 2009-2014 deaths*, Hazelwood Mine Fire Inquiry, Melbourne.

Westphal, M., Hughes, G. and Brömmelhörster, J. (2013), *Economics of Climate Change in East Asia*, Asian Development Bank, Manila.

Williams, G.J., Price, N.N., Ushijima, B., Aeby, G.S., Callahan, S., Davy, S.K., Gove, J.M., Johnson, M.D., Knapp, I.S., Shore-Maggio, A., Smith, J.E., Videau, P. and Work, T.M. (2014), "Ocean warming and acidification have complex interactive effects on the dynamics of a marine fungal disease", *Proceedings Biological Sciences*, Vol. 281 No. 1778, p. 20133069.

Wilson, C. (2017), "Papua New Guinea moves to launch new coal mining industry", Mongabay, 16 May 2017.

Win Tin, S.T., Kenilorea, G., Gadabu, E., Tasserei, J. and Colagiuri, R. (2014), "The prevalence of diabetes complications and associated risk factors in Pacific Islands countries", *Diabetes Research and Clinical Practice*, Vol. 103 No. 1, pp. 114-118.

World Health Organization (2016), Ambient (outdoor) air quality and health. WHO.

World Health Organization (WHO) (2014), Noncommunicable Diseases (NCD) Country Profile: Nauru.

World Health Organization (WHO) (2015), Nauru: WHO Statistical Profile.

Corresponding author
Hilary Bambrick can be contacted at: h.bambrick@qut.edu.au