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Social and cultural issues raised by climate change in Pacific Island countries: an overview

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Abstract Climate-related disasters such as tropical cyclones, floods and droughts are not new to Pacific Islanders, who have developed customary or ‘traditional’ practices to enable communities to adapt and recover from such hazards. Some of these practices have been degraded and some assisted by modernisation. Through their effects on the island environment, these hazards have a range of socio-economic impacts on food (fisheries and crops) and water supply, tourism, and coastal buildings and infrastructure. The varied impacts of climate change not only exacerbate those hazards but also raise new threats, such as sea level rise and ocean acidification, that have no precedent in the past 500 years, and for which there are therefore no traditional adaptations, although Pacific innate ingenuity and resilience remains strong. These issues are particularly acute for the low-lying atoll countries whose continued existence is threatened by sea level rise, but also affect those that live on higher islands in coastal settlements, where most of their population is concentrated. Climate change thus sharpens social and cultural issues of equity

(reflecting disparities in location, income, education, gender, health and age), made even more acute by increased levels of voluntary or forced migration within, and even more so beyond, island country boundaries. Consequently, many islanders see climate change as a moral challenge to the richer countries to reduce their greenhouse gas emissions that are causing the problem.

Keywords Climate change · Pacific Islands · Small islands · Social impacts · Adaptation

Introduction

This paper gives a perspective from three researchers who have lived and worked in the Pacific Islands for many years on key issues about climate change affecting that region. Many of these issues are similar to those facing other small island developing states (SIDS) in other parts of the world.

We first outline major projected biophysical impacts of climate change in the Pacific Islands and describe some of the many adaptations already under way in response, both traditional and modern. We also point to some impacts, notably inexorable sea level rise and ocean acidification, for which there are no precedents in the past few centuries, and consequently no extant traditional adaptation measures. This sets up the core of the paper, an overview of key social and cultural issues raised by climate change impacts, adaptation and mitigation. These include impacts on issues of equity based on location (e.g. inner/outer island residents, urban/rural, landowners/squatters), or reflecting disparities on the basis of wealth and income, gender, education level, health and disability and age.

These issues are particularly acute for the low-lying atoll countries, whose continued long-term lifestyle and survival

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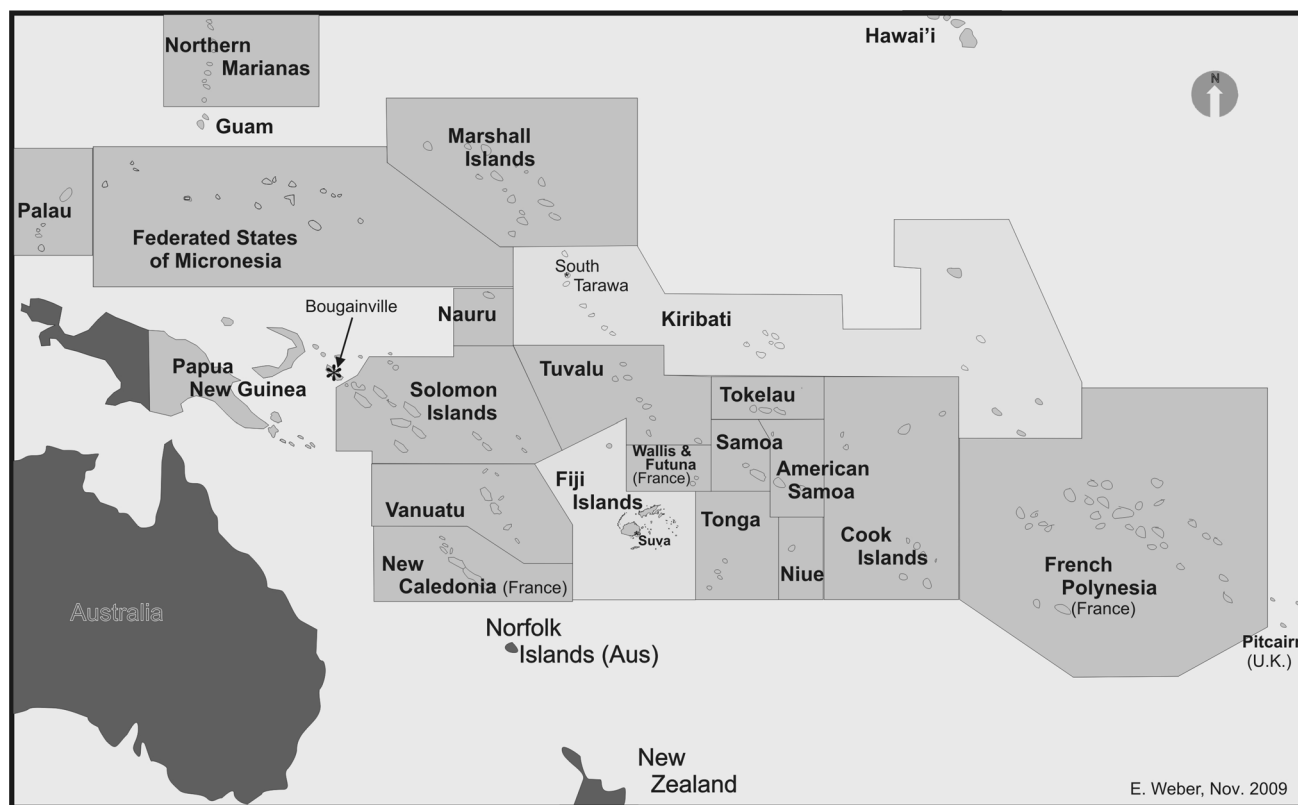


Fig. 1 Map of the Pacific showing the Pacific SIDS. The map also shows some neighbouring island territories that are not classified as SIDS due to their political affiliations, including New Caledonia, French Polynesia and Wallis and Futuna (France), Tokelau (New

Zealand), Pitcairn Island (United Kingdom), Norfolk Island (Australia) and Guam, Northern Marianas and American Samoa (USA). [Map by courtesy of E. Weber, pers. comm.]

are threatened. The populations of most Pacific Island countries (except Papua New Guinea) are concentrated in coastal areas, which are particularly threatened by sea level rise and its consequences, and most have inadequate financial or technical resources to fully deal with these consequences, making them particularly vulnerable to climate change. Whilst migration is an age-old practice in the Pacific, the prospect of forced migration, both within an island country (most commonly to the capital) or to other countries, is an issue made even more difficult by the strong link between land and culture in Pacific societies.

The paper concludes by looking at several of the roles that island governments can and do play in addressing climate change and the social issues it raises and the challenges that remain for both governments and Pacific peoples.

The Pacific Islands context

The 15 independent SIDS of the Pacific, often referred to as PICs (Pacific Island countries), comprise many islands scattered across almost one-third of the earth's surface in

various political and geographic configurations (Fig. 1). For example, Kiribati comprises some 50 islands, spanning about 3000 km from west to east and Fiji has over 300 islands (though two are much larger and more heavily populated than the rest), whilst Nauru and Niue comprise a single island each. All the Pacific SIDS are small in land area and population, except for Papua New Guinea (PNG), which is the only PIC with a population exceeding 1 million. The remainder have a total population of about 3 million¹ and a total land area of only about 90,000 km² (Crocombe 2008; SPC 2015). Geographic characteristics of the Pacific Island countries, such as their physical and political fragmentation, their remoteness and their small size, are fundamental constraints on their economic development (Connell 2013; Tumbarello et al. 2013), although strong cultural relationships beyond national borders (Polynesian, Melanesian, Micronesian) counter these influences to some extent (Adger et al. 2009; Barnett and Campbell 2010). Most Pacific Island countries remain heavily dependent on their marine and land resources for both subsistence and

¹ Cook Islands, Nauru, Niue, Palau, Marshall Islands and Tuvalu each have populations of <50,000.

Table 1 Impacts of climate change in small island countries and the oceans surrounding them

General impact according to (IPCC 2014b: Assessment Box SPM-2) ^a	Risk rating according to (IPCC 2014b) [1 = very low, 5 = very high] ^b	Specific effect on Pacific Islands
Reduced biodiversity, fisheries abundance and coastal protection by coral reefs due to heat-induced mass coral bleaching and mortality increases, exacerbated by ocean acidification, e.g., in coastal boundary systems and subtropical gyres	Now: 3 2030: 4 2100 (2 °C): 5 2100 (4 °C): 5	Inshore fish make up most of the protein input for many islanders Tourism (based on the attractiveness of beaches which might erode and corals which could be killed by climate change) is the economic mainstay of several Pacific Island countries
The interaction of rising global mean sea level in the twenty-first century with high-water-level events will threaten low-lying coastal areas	Now: 3 2030: 4 2100 (2 °C): 5 2100 (4 °C): 5	In all Pacific Island countries, (except Papua New Guinea), most people live in <i>coastal</i> towns and villages, the very places most vulnerable to inundation and erosion because of sea level rise
Coastal inundation and habitat loss due to sea level rise, extreme events, changes in precipitation, and reduced ecological resilience, e.g., in coastal boundary systems and subtropical gyres	Now: 3 2030: 4 2100 (2 °C): 4 2100 (4 °C): 5	Cyclones (very strong storms), the most frequent ‘natural disasters’ in the PICs, are expected to become more severe as ocean temperatures increase The 2011–2012 drought in Tuvalu, induced by a strong la Niña season, indicates the drastic social impact that reduced water resources can have in the Pacific
Loss of livelihoods, coastal settlements, infrastructure, ecosystem services and economic stability	Now: 2 2030: 3 2100 (2 °C): 4 2100 (4 °C): 5	‘Inundation’ by salt water, if frequent enough, makes land incapable of growing crops High population growth in some islands (e.g.: South Tarawa in Kiribati, and Funafuti in Tuvalu) increases the demand for freshwater and thereby significantly reduces the freshwater lens. Replenishment of the lens on atolls is primarily rained
Distributional shift in fish and invertebrate species and decrease in fisheries catch potential at low latitudes, e.g., in equatorial upwelling and coastal boundary systems and subtropical gyres	Now: 2 2030: 3 2100 (2 °C): 3 2100 (4 °C): 4	Tuna are a major income source for several PICs and may move systematically eastwards to follow warmer parts of the ocean (as they do now in an El Niño year)

^a For more detail see (Nurse et al. 2014)

^b ‘high risk’ (rating 4) indicates ‘severe and widespread impacts’. The Table shows the ratings without adaptation; adaptation can lower most of these ratings by 1 point. 2 and 4 °C refer to projected temperature increase in 2100 above pre-industrial

livelihoods, although some have broader agricultural and tourist potential. Overseas aid and remittances for islanders working abroad make major contributions to the GDP of many PICs (Connell 2013; Rao et al. 2008).

Biophysical impacts of climate change

It is clear from the latest summary by IPCC Working Group 2 on the impacts of climate change that a rise in global mean surface temperature (GMST) of 4 or 5 °C would have consequences for ecosystems, water supply, food, coasts and health that would be dangerous to a large proportion of the world’s population, particularly the poorest (IPCC 2014b). The IPCC further detailed that for SIDS and other small islands such dangers include ‘Risk of death, injury, ill-health, or disrupted livelihoods ...due to storm surges, coastal flooding, and sea level rise’ (IPCC 2014b: Assessment Box SPM-2).

Table 1 lists the key IPCC points about the impacts of climate change in tropical small island countries and on the oceans surrounding them (IPCC 2014b). For each, the extent to which these impacts affect life for Pacific Islanders is highlighted. The middle column (based on Table 29–4 of Nurse et al. (2014)) indicates that many impacts are already occurring, and that the risk of grave consequences will increase as the rate and magnitude of climate change continues to increase with time towards 2030. Even if global emissions have passed their peak by 2100 (the ‘2 °C’ scenario), the concentration of greenhouse gases (GHGs) will remain high enough to produce very high risks of coral reefs and coastal settlements.

In the Pacific Islands in particular, coral reef ecosystems (which are vital for coastal protection, food security and tourism) are already suffering major impacts from climate change. The warmer ocean will drive an increase in the strength of tropical cyclones and other rainstorms, which already inflict severe economic and social damage.

Coupled with the rise in sea level, this is increasing the incidence of seawater inundation of coastal regions and coral atolls, which leads to the groundwater becoming saltier and thus unusable for drinking or crop growing (See Online Resource 1 for more detail). These effects on reefs and on cyclones are almost certain to occur, no matter what action is taken, as they require only a relatively small increase in GMST, and further warming of ocean waters over the next century that is virtually certain given the heating effect of the current concentration of GHGs (Hoegh-Guldberg et al. 2014: FAQ30.1).

The impacts indicated in Table 1 could be even worse if the global climate system passes certain ‘tipping points’ where abrupt changes occur, such as irreversible melting of the Greenland ice shelf or bulk release of methane from permafrost regions. The increases in temperature required for this to happen (~ 4 °C) are consistent with IPCC projections of the future we face should global fossil fuel use continue to increase at current rates (IPCC 2014a: Fig.SPM.5; Schellnhuber et al. 2006).

Many Pacific Islands are already challenged by a range of social, economic and environmental stresses that reduce island sustainability and ability to adapt. Key stresses include population growth (especially in urban areas), pollution (of land, freshwater and ocean) and over-harvesting of land and ocean resources (especially water, forests and lagoon fisheries). Together with land degradation and invasive species, these result in food and water insecurity and in health issues such as the increase in non-communicable diseases (which is aggravated by poor diet and urban lifestyle) and in social issues such as lack of paid employment (Connell 2013; ESCAP 2010; Tumbarello et al. 2013). Whilst climate change is not the main cause of any of these stresses, it is likely to make many of them worse and thus make ‘sustainable development’ even harder to achieve than it is already.

International negotiations and mitigation

In the PICs, all fossil fuel is imported. In the smaller island states, fuel imports have accounted for around 30 % of GDP in several recent years and around 7–15 % of GDP in the larger PICs (SPC 2012). Consequently, it makes economic sense for Pacific Island countries to strive to decrease their use of fossil fuels, including by greater use of renewable energy. Doing so will also reduce their emissions of CO₂, and set an example and challenge to the bigger countries, although as the PICs account for less than 0.3 % of global greenhouse gas (GHG) emissions, these efforts will have negligible effect on the mitigation of climate change. China, the USA and the EU between them account for over 50 % of global

emissions, and so all of them must substantially reduce their emissions if dangerous climate change is to be avoided (WRI 2014).

International negotiations on climate change continue each year, with the Alliance of Small Island States (AOSIS, which includes all Pacific SIDS) pushing strongly for strengthening existing treaties and seeking new agreements with even stronger provisions. Although the recent Paris Agreement (2015) is a positive step in the right direction,² it is fair to say that those countries most responsible for the increase in the tonnage of GHGs in the atmosphere that is causing climate change, have failed for the past twenty years to reduce global emissions of GHGs, and thus failed to assume their responsibility under the United Nations Framework Convention on Climate Change (UNFCCC) to prevent dangerous climate change.

Adaptation

Adaptation refers to ‘a process by which strategies to moderate and cope with the consequences of climate change, including variability, are developed and implemented’ (Lim et al. 2004). Less formally, adaptation has colloquially been described as ‘managing the unavoidable’, in contrast to mitigation as ‘avoiding the unmanageable’ (e.g. Bierbaum et al. 2007).

The IPCC Synthesis Report (IPCC 2014a: sec. SPM 3.3) concludes that:

“Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness.”

In the Pacific Islands, local communities (i.e. villages) are the main sites where action will need to take place and although awareness is high of many current aspects of local change, many communities lack technical understanding of the global nature of such changes and their causes and of non-traditional options for adaptation. Whilst most PICs have examples of government- or NGO-led demonstration or pilot projects, much more is needed. The problem is exacerbated by geographic fragmentation: many countries comprise hundreds of islands, each with tiny populations, thus increasing access costs and reducing opportunities for economies of scale.

² See Pittock and Weir (2016) or (Kumar 2016) for a brief summary of the key provisions of the Paris Agreement from a SIDS perspective.



Fig. 2 Some impacts and traditional adaptations. **a** An atoll being inundated with salt water during a storm, despite the best efforts of the man repairing a sea wall. [Photo taken at Temwaiku, South Tarawa in October 2009 by NTK Video, reproduced with permission]. **b** Food

garden with a diversity of crops, (Teouma, Efate, Vanuatu). Crops in this garden include taro (2 varieties), yams (2 varieties), ‘island cabbage’ (*Bele*, several varieties) and bananas. *Note* Further photos of impacts and adaptations are in Online Resource 2

Pacific Islanders have many traditional adaptive mechanisms. Although the rate and magnitude of extreme climatic events are changing, Pacific Islands have long been exposed to extreme events such as cyclones, floods, droughts and heatwaves, to which the people have developed traditional coping mechanisms and a spirit of resilience over many generations (McMillen et al. 2014; Nunn et al. 2016). Some examples are shown in Fig. 2 and more in Online Resource 2 and by McNamara and Prasad (2013). Food security can be improved by growing a diversity of crops, some of which cope better with drought and others with prolonged wet spells (Fig. 2b) and some traditional crops can be preserved for months by careful storage (e.g. yams) or fermentation (e.g. breadfruit). In the past, houses were built of local materials which often meant that although they were easily destroyed by cyclones, they could be rebuilt quickly without assistance from outside the community. However, although some traditional houses are flimsy and easily rebuilt, in some Pacific cultures traditional buildings, if carefully built, are actually designed to let a cyclone flow around or through them without serious damage as shown in various cyclones in Vanuatu, Samoa and Solomon Islands (Yates and Anderson-Berry 2004).

However, many traditional coping strategies were lost or degraded in colonial times, with imported food and materials replacing well-adapted traditional self-reliance mechanisms. This together with changing aspirations, increasing populations and urbanisation has increased consumer demand, putting additional and often unsustainable pressure on natural resources, reduced use of customary adaptive solutions and increased dependency of

islanders on outside help when extreme events occur (Campbell 2015; Hofmann 2014).

The modern situation is more complex. Preferred ‘modern’ houses require cash and time to build or rebuild, aggravated by the limited access to building insurance in most PICs and the social stresses that may ensue on distant family members pressured to increase remittance levels. On the other hand, well-constructed modern houses—with special attention to fastenings, like those in Koroipita in Fiji which withstood Cyclone Winston in 2016 (Fox 2016)—are usually more resilient in the first place (See the housing photos in Online Resource 2). Many communities in the high (non-atoll) islands adjoin streams or rivers, making them vulnerable to flooding after heavy rain, although houses in such villages are often built on stilts, giving protection against all but the worst floods. Rainwater tanks are another widespread modern adaptation measure, capturing water from modern corrugated iron roofs, giving some buffer against the occasional seasonal or longer droughts associated with the ENSO (El Niño Southern Oscillation) weather patterns that periodically affect the Pacific.

Some of the main physical effects of climate change in Pacific Island populations occur as a result of climate extremes becoming more intense or more frequent or both (IPCC 2013). Revival or strengthening application of customary techniques is likely therefore to increase adaptation (McMillen et al. 2014). There is a strong need to identify, revive/develop and disseminate community-based adaptation strategies that are suitable for use in Pacific Islands that, despite their diversity, share similar climate adaptation challenges. Such strategies need to be environmentally, socio-economically and

culturally sustainable. Limalevu et al. (2010) suggest some guidelines for successful long-term implementation of such strategies (see Online Resource 3 for a summary). A wide range of barriers may need to be overcome in achieving adaptation in small island states (Adger et al. 2013; Betzold 2015; Mortreux and Barnett 2009).

There are mixed messages in international funding assistance. In theory, funds available for adaptation have significantly increased since the failed treaty negotiations at Copenhagen in 2009, with increased commitments from many rich countries seemingly keen to show the small island countries that they are taking *some* action. But in reality, access to funds has proven difficult, and even when they do flow, funds are often given as loans rather than grants (Nakhouda et al. 2013). It remains to be seen whether the Paris Agreement will lead in practice to an increase in useable funding.

Beyond adaptation

There are limits to adaptation. With time, the impacts of climate change are likely to exceed the ability of many affected communities to adapt physically and/or socially, as in the examples below, and transformation to some new condition will eventuate (Kates et al. 2012). Examples of such ‘transformation’ would include migration and major changes to new crops and a new diet. It is this realm beyond adaptation that is the driver for islanders’ push in international UNFCCC climate negotiations for fair Loss and Damage provisions to be made that can provide resources for islanders to address unadaptable climate impacts. Although SIDS were successful in ensuring that the Paris Agreement (2015) makes mention of this issue, there is much work still to do on fleshing out what this implies in practice.

Some hazards related to climate change worsen steadily from one year to the next—indeed from one century to the next: such as average air and water temperatures, sea level rise and ocean acidification. Traditional adaptation techniques, evolved to cope with recurring short-term extreme events like cyclones, may be less effective against these more insidious changes, some new to recent human experience and others altogether new. Gradual increases in average temperature and sea level are likely to cause accelerating problems when they pass certain critical thresholds that vary with the hazard type (IPCC 2014a).

Rise in average temperatures of air and water

As indicated in Table 1, the continuing rise of average temperatures of both atmosphere and ocean poses insidious threats to Pacific agriculture and fisheries, affecting crop varieties, pests and whole fisheries (Bell et al. 2013), human

health and disease (Hanna et al. 2011) and biodiversity numbers, distribution and relationships (Hills et al. 2011). However, it is the rise in increasingly intense extreme temperature events that has the most extreme impacts (IPCC 2012), evidenced in the ocean as coral bleaching, fish kill and toxic algal events and in the atmosphere as heat waves that lead to excess human and animal deaths.

Sea level rise

IPCC Working Group 1 (2013: sec E.6) project that sea level may rise by up to 92 cm by the end of this century if global CO₂ emissions are not curbed and that sea level will continue to rise (at an increasing rate) for many centuries beyond that due to the long time required for heat inputs to heat the full depth of the ocean. As most land on atolls is less than 2 metres above mean sea level, such a rise is likely to swamp substantial parts of many coral atolls, although the rate of loss of atoll islands is still uncertain given the ability of healthy reef-building processes to keep pace with modest sea level rise in some circumstances (McLean and Kench 2015). Even more concerning recent reviews suggest that if greenhouse gas emissions continue unabated we may soon pass the tipping points for loss of various major ice sheets that will irretrievably make sea level rise several metres higher in the following centuries (Hansen et al. 2016; le Page 2015).

In reality, atolls would become uninhabitable long before they are totally submerged, because saltwater incursion will pollute freshwater supplies, which are held underground in a ‘lens’ of freshwater floating on top of salt water in the porous coral rock. Saltwater incursion from below is aggravated by extra high tides (king tides) and storm surges, which also bring in salt water from above as they wash over the land (see Fig. 2a and Online Resource 2). This is already happening to many atolls in the Pacific, with the Carteret Islands of PNG and Funafuti (Tuvalu) being well-publicised cases (Mathiesen 2015). Currently, this occurs every 2–3 years in Tuvalu (K O’Brien, pers.-comm.). Observations and modelling suggest that the lens takes about 12 months to recover to freshwater in the absence of further saltwater influx (Terry and Chui 2012; Terry and Falkland 2010).

Therefore, it is reasonable to infer that if sea level rises to the stage that saltwater inundation occurs every few months instead of every few years, then the lens will remain salty and the island will become effectively uninhabitable, with little freshwater available and crops unable to grow. At current rates of sea level rise, this could occur within the next 30 years or so, i.e., as early as 2040 (Storlazzi et al. 2015; Weir and Virani 2011).

For those PICs that consist almost entirely of atolls, notably Kiribati, Tuvalu and Marshall Islands, such

impacts may increase pressure for all or most of the inhabitants of these countries to migrate to other countries by about 2040 (Weir and Virani 2011; Weiss 2015; Wyett 2014). This is a controversial issue, as although migration demand for other reasons such as education, work or family reunion is already strong, awareness of the social costs of loss of land, sovereignty and cultural identity underlie a strong reluctance of many to leave, and there are other significant barriers to migration in any case (Barnett and Chamberlain 2010; Campbell 2014).

Ocean acidification

Ocean acidification chemically attacks the structure of coral and the calcifying creatures that live on it, thus making the reefs weaker and less able to recover from damage from other causes, and reducing its habitat complexity and biodiversity. Given the importance of these reefs as protection from storms, as sources of food and other resources and as attractions for tourists, these ecological impacts have grave consequences for the livelihoods of coastal Pacific Island people (Schmutter et al. 2016). Since ocean acidification itself cannot be averted without long-term global action, the best that can be done to lessen these socio-economic impacts in the short to medium term is to reduce local pressures on the reef that are directly caused by humans, such as pollution from onshore sewage, ‘mining’ reefs for building materials and human overharvesting of marine resources.

Social and cultural issues raised by climate change impacts, adaptation and mitigation

Large-scale forced emigration, whether as a result of the direct or indirect effects of sea level rise, and regardless of eventual timing, would obviously have a huge social and cultural impact on the countries concerned (Burson 2010; Leckie et al. 2012; McAdam 2010). Some analysts regard such large-scale forced migration as an extreme adaptation to climate change (Nunn 2009), whilst others argue it should be classified as an *impact* on the small islands and compensated accordingly by the countries whose emissions caused the problem (Barnett and Campbell 2010).³ The Kiribati government under President Tong squarely faces this issue and aims to lessen its impact on both the sending and receiving countries by seeking ‘relocation with dignity’ to nearby metropolitan countries, most likely through a gradually increasing and targeted education programme

and through labour migration (Kono 2015; Maclellan 2012). Tuvalu, another atoll state, by contrast aims to stick it out in situ (Smith and McNamara 2015) and is even ‘reclaiming’ land from Funafuti lagoon to accommodate its increasingly crowded population (P Glendenning pers. comm. 2015; see also SOPAC (2011)).

Since most Pacific Islanders (except in PNG) live on the coast, many of those in non-atoll countries, particularly those now living right on the coast or in low-lying river deltas, may also be forced to move, though most likely to other parts of the same country. Campbell (2014) rightly points to the ‘essential link’ between Pacific Islands people and their land as a key issue that poses major problems not only for those forced to leave but also for communities within the region that may be required to give up land for relocatees. Pacific people have a strong social and cultural attachment to their land, which is recognised in many countries by continued traditional ownership structures. Land and *culture* are intertwined, so that being forced to relocate to someone else’s land or (even more so) to another country is seen as a threat to the continued identity and culture of a people (Adger et al. 2013; Barnett and O’Neill 2012; Campbell and Warrick 2014; Crocombe 2008: chapter 11).

President Tong of Kiribati has frequently referred to climate change as a ‘moral challenge to the world’ (Kono 2015; Tong 2015; Tong 2011), as has Pope Francis (2015) and the World Council of Churches (WCC 2008, 2015). Because of these moral and social justice aspects, churches—still important community leaders in most Pacific countries—can play a key role, not least because of their wide reach to communities. The Pacific Conference of Churches is actively working on this front, not least by facilitating relocation of communities within their own country and to other PICs (Edwards 2013).

Pointing to [pre-]historical precedents, Nunn (2013) notes that within the next few decades changes in climate and sea level will drive fundamental irreversible changes in island geography, settlement, patterns, subsistence systems, societies and economic development. Others argue that the economic and social changes which are already rapidly occurring are more critical and confronting (Connell 2013: p 240). Either way, there is an urgent need for effective and sustainable adaptation of livelihoods in the Pacific Islands region, with or without forced migration.

Food availability and people’s access to food are among the first things to be affected following natural disasters. It therefore seems obvious that any significant change in not only climate extremes but also climate averages on a global scale will impact local agriculture and therefore affect the world’s food supply (FAO 2008; Ganpat and Isaac 2015). It will also affect marine food resources, which make up a high proportion of protein intake in the PICs (Bell et al.

³ The latter view drives the SIDS insistence on having a Loss and Damage mechanism under the Paris Agreement.

2013). In a changing climate regime, the need to strengthen food security is, therefore, paramount.

Human *health* likewise is expected to be affected by climate change, with increased heat stress, changes in the availability of clean water and the spread of vector-borne diseases such as dengue and malaria (e.g. *Anopheles* mosquitoes are migrating inland into formerly mosquito-free cooler upland areas of Papua New Guinea) (IRIN 2008; Hanna et al. 2011).

Poorer countries, and the poorest people within each country, are expected to bear a disproportionate burden from climate change, because of their inability to make the necessary adjustments without help. Thus, climate change raises issues of *equity* between countries. But climate change also raises issues of equity *within* a country—that is, unequal access to economic and technical resources and opportunities, such as between rich and poor, between rural and urban dwellers, between men and women, between old and young, disabled and healthy, adult and child and between villages favoured with an adaptation pilot project against those without (Nunn et al. 2014).

A key component of dealing with climate change in the Pacific is the active involvement of rural communities/villages. Success is possible only with communities who recognise their need and are taking ownership and seeking help. Participation of the whole community in planning and implementation is vital (Buggy and McNamara 2015). This often requires special effort to ensure that women, youth and minority groups are facilitated to fully participate to ensure their knowledge and skills are appropriately accessed. In this way, adaptation can draw on both traditional knowledge and on appropriate modern technology—both of which contribute to ‘adaptive capacity’ and both of which are usually needed for successful projects (Limalevu et al. 2010; Warrick et al. 2016).

Movement between islands is a long-standing norm. In most PICs, there has been considerable migration over the past few decades from the periphery (i.e. the outer islands) to the core (i.e. the island where the national government is located), driven mainly by young people seeking education and paid work (Connell 2013; Locke 2009). Consequently, villages in outer islands are sometimes missing their most dynamic people (i.e. young adults) leaving a beyond-average percentage of elders, disabled and young children—precisely those least likely to be able to access or choose to take up international migration opportunities (if they become available), as the older people have the strongest bond to their traditional land, and all these groups have the least cash available for the usually expensive transport and other costs involved (Connell 2013:p127-133). On the other hand, the elders are the people most likely to retain the traditional knowledge required to best attempt to adapt to the hazards of climate variability.

Notwithstanding popular perceptions and historically oriented policies that focus on rural populations, in many PICs a considerable and growing proportion of the population now lives in urban and peri-urban areas mostly in and around the national capitals (SPC 2015). Many national governments are having difficulty in grappling with this new reality, as this rapid urbanisation in some Pacific countries leads to the formation of large informal settlements of poorer people, often in areas vulnerable to climatic hazards such as flooding or landslides (Connell 2011). In terms of adaptation and disaster risk management, these looser ‘communities’ lack much of the base of traditional knowledge and social structures that underpin decision making in Pacific communities. These settlements are therefore likely to require different policies and programmes from those in rural areas, perhaps requiring more direct involvement by their national governments.

Risk perception everywhere is mediated by cultural values and beliefs (Adger et al. 2013; Christie et al. 2010). In the Pacific, strongly held biblical beliefs have sometimes led to maladaptive perspectives, e.g., in Tuvalu that ‘we will be saved from flooding by sea level rise because we are godly people, unlike the sinners that were destroyed when Noah and his family escaped, as told in the book of Genesis’ (Mortreux and Barnett 2009). Pacific theologians have attempted to counter this interpretation by reminding their congregations that although God promised Noah that He would not cause such a flood again, this did not rule out such a flood being caused by human action (Rubow and Bird 2016; WCC 2004), as is the case with the current and projected sea level rise and storms (IPCC 2013).

However, the cultures of many PICs, already changing due to the increasing incursion of modern consumption-based aspirations into traditional village-based ways of life, may also be affected by the impacts of climate change if they are particularly exposed to the changes underway. However, in many places, there is little recognition of climate change yet, despite climate variability and climatic extremes and hazards being an accepted part of life (Aswani et al. 2015; Nunn et al. 2014). Many PICs are exploring the use of formal or informal teaching in schools as a way to alert the wider population to the issues raised by climate change (Hiebert 2013). There are also courses at university level (Scott-Parker et al. 2016).

Role of governments

Firstly, national governments are the main players for SIDS in the international negotiations on climate change, with a view to strengthening the provisions of the United Nations Framework Convention on Climate Change (UNFCCC) on both reduction of GHG emissions and on assistance for

adaptation. PIC governments pursue these goals largely through collective action in regional organisations such as the Secretariat of the Pacific Regional Environment Programme (SPREP) and the Pacific Community (SPC)⁴ (Robinson and Gilfillan 2016), through international organisations such as the UN organisations and the World Bank, and through wider political groupings such as AOSIS, mentioned above. Several key points in the Paris Agreement (2015) are the fruits of such collective action, notably the ambitious 1.5 °C target and the provisions on ‘loss and damage’ (Kumar 2016).

In practice, almost all funding for adaptation measures in SIDS comes from developed countries, with relatively little coming from their own sparse national budgets (Nunn 2013). In our observation, such of this funding that reaches local communities outside the capital cities comes largely through NGOs, although much of this comes ultimately from metropolitan governments. For example, the Red Cross societies in each PIC have a widespread network of trained community volunteers, though their role is ‘badged’ as disaster risk reduction or disaster relief.

Nevertheless, SIDS national governments can and do make policies that set a framework for action in their countries, including priorities for funding. In particular, some PICs (those classified as ‘least developed countries’) have developed and published National Adaptation Programmes of Action (NAPAs), prepared under the auspices of the UNFCCC, which set out key priorities for adaptation funding, though varying in quality and therefore utility to both the country and potential donors. National governments are beginning to recognise the reality that ‘development’ that is not climate-proof is not sustainable; it is little use building a new coastal road if it will be eroded away in a few years’ time by sea level rise and storm surges. The key to ensuring this is ‘mainstreaming’ of climate adaptation and mitigation funds and responsibilities into sectoral budgets, rather than having a separate lumped budget for ‘adaptation’, especially when administered by the environment department, which is usually a minor player. However, some PICs (e.g. Samoa, Vanuatu and Cook Islands) have reviewed their climate change administrative arrangements and centralised climate change coordination in an influential central agency, which also deals with disaster risk reduction more generally (Nalau et al. 2015; Newport and Tutangata 2011). The most effective way to foster policy integration is by encouraging policy coherence between related areas (Dovers and Hezri 2010).

Conclusion: challenges for the Pacific Islands

The biophysical impacts on the Pacific Islands of scenarios where global emissions of CO₂ continue to increase at the current rate are disturbing and would have huge social impacts, especially as they may include the reluctant relocation of many Pacific communities. Adaptation measures that cope with current climate extremes can also help alleviate many of the lower-level impacts of climate change, but only if much stronger international action is taken so that climate change is held within manageable limits. The technologies to enable this exist now, but the political will and economic and institutional structures required do not.

Although Pacific Island leaders have spoken for years about the dangers of climate change and the need to constrain global warming to 1.5 °C, we are now seeing a wide range of on-the-ground adaptation actions, though widely scattered and many of these still depending on external funding, such as through the EU-ACP Global Climate Change Alliance. But such actions will ultimately be in vain unless the USA, China, the EU and other large industrialised countries respond to the moral challenge of climate change by substantially reducing their emissions of greenhouse gases.

Traditional knowledge and the social capital of coherent village communities have been vital in the Pacific Islands for effective and adaptive responses to disasters and extreme events in the past. But because of consumerism and urban migration, especially affecting the younger generation, these may be waning even at village level. Traditional tight social structures are much less evident in the informal urban and peri-urban settlements where many now live, and traditional knowledge is hard to apply to potentially vulnerable components of national infrastructure such as roads, town water supplies and hospitals, schools, port and airport facilities. Worse: climate *change* poses some new problems, such as sea level rise, that go beyond the scope of traditional practices to protect against the extremes of climate variability.

In the modern world, effective adaptation incurs real costs, even for small-scale village projects. So who pays? The communities directly affected have little cash income. National governments even when they ‘mainstream’ climate issues into their own budgets have only limited funds, reflecting the low per capita incomes of PICs. Bearing in mind that climate change today is clearly caused by the collective GHG emissions of the larger and richer countries of the world, the moral case is strong that funding for adaptation in the PICs (and in the SIDS more generally) should come from those big emitters. We can only hope that this obligation is taken up not just in the text of

⁴ The Pacific Community (its new name since November 2015) was founded in 1947 as the South Pacific Commission and known since then mainly by those initials (SPC)—including still on its own website!

international treaties and public promises of funding but more importantly in the actions that follow to ensure resources reach the communities in an adequate, timely and efficient manner.

In short, for the Pacific Islands, climate change should not be treated as a matter of science shaped by computer modellers from outside, but as a vital social and cultural issue affecting almost every aspect of future development, which raises many challenges for all our institutions and communities (Barnett and Campbell 2010). Many of these challenges stem from the physical remoteness (geographic isolation), and relative size (smallness) of the islands, especially in terms of financial resources and skills base. One challenge is learning to live now with gradual shifts in climate on top of both climate extremes and of the local human-mediated environmental and population challenges. Other challenges stem from recent changes in culture arising from interaction between traditional village-based societies and the modern economy—particularly a tendency towards shifting away from the self-help ethos of centuries past to a cargo-cult-like dependence on overseas aid.

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References

- Adger W, Dessai S, Goulden M, Hulme M, Lorenzoni I, Nelson DR, Naess OL, Wolf J, Wreford A (2009) Are there social limits to adaptation to climate change? *Clim Change* 93:335–354. doi:10.1007/s10584-008-9520-z
- Adger W, Barnett J, Brown K, Marshall N, O'Brien K (2013) Cultural dimensions of climate change impacts and adaptation. *Nat Clim Change* 3:112–117. doi:10.1038/nclimate1666
- Aswani S, Vaccaro I, Abernethy K, Albert S, Fernandez-Lopez de Pablo J (2015) Can perceptions of environmental and climate change in island communities assist in adaptation planning locally? *Environ Manage* 56:1487–1501. doi:10.1007/s00267-015-0572-3
- Barnett J, Campbell J (2010) Climate change and small island states: power, knowledge and the South Pacific. Earthscan, London
- Barnett J, Chamberlain N (2010) Migration as climate change adaptation: implications for the Pacific. In: Burson B (ed) Climate change and migration: South Pacific Perspectives. Victoria University of Wellington, pp 51–60
- Barnett J, O'Neill S (2012) Islands, resettlement and adaptation (commentary). *Nat Clim Change* 2:8–10
- Bell JD, Ganachaud A, Gehrke PC, Griffiths SP, Hobday AJ, Hoegh-Guldberg O, Johnson JE, Le Borgne R, Lehodey P, Lough JM, Matear RJ, Pickering TD, Pratchett MS, Sen Gupta A, Senina I, Waycott M (2013) Mixed responses of tropical Pacific fisheries and aquaculture to climate change. *Nat Clim Change* 3:591–599. doi:10.1038/nclimate1838
- Betzold C (2015) Adapting to climate change in small island developing states. *Clim Change Special Issue Clim Justice Interdiscip Res* 133:481–489. doi:10.1007/s10584-015-1408-0
- Bierbaum R, Holdren JP, MacCracken MC, Moss RH, Raven PH (eds) (2007) Confronting climate change: avoiding the unmanageable and managing the unavoidable. Sigma Xi and the United Nations Foundation, Washington, D.C
- Buggy L, McNamara KE (2015) The need to reinterpret “community” for climate change adaptation: a case study of Pele Island Vanuatu. *Clim Dev*. doi:10.1080/17565529.2015.1041445
- Burson B (ed) (2010) Climate change and migration: South Pacific perspectives. Institute of Policy Studies (Victoria University), Wellington
- Campbell JR (2014) Climate-change migration in the Pacific. *Contemp Pac* 26:1–28. doi:10.1353/cp.2014.0023
- Campbell J (2015) Development, global change and traditional food security in Pacific Island countries. *Reg Environ Change* 15:1313–1324. doi:10.1007/s10113-014-0697-6
- Campbell J, Warrick O (2014) Climate change and migration issues in the Pacific. Apia, United Nations (ESCAP)
- Christie I, Jackson T, Rawles K (2010) Ethical social and behavioural impacts of climate change. Foresight project on the international dimensions of climate change. Department of Business Innovation and Skills, London
- Connell J (2011) Elephants in the Pacific? Pacific urbanisation and its discontents. *Asia Pac Viewp* 52:121–135. doi:10.1111/j.1467-8373.2011.01445.x
- Connell J (2013) Islands at risk: environments, economies and contemporary change. Edward Elgar, UK
- Crocombe R (2008) The South Pacific, 7th edn. University of the South Pacific, Suva
- Dovers SR, Hezri AA (2010) Institutions and policy processes: the means to the ends of adaptation. *Wiley Interdiscip Rev Clim Change* 1:212–231
- Edwards JB (2013) Climate justice and the Pacific Conference of Churches: Moving the relocation agenda in the Pacific. Paper presented at the Sustainable alternatives for poverty reduction and ecological justice Conference, Orthodox Academy of Crete, Greece, 27–30 Sept. 2012
- ESCAP (2010) Sustainable Development in the Pacific: progress and challenges. Suva, United Nations (ESCAP)
- FAO (2008) Climate change and Food Security in Pacific Islands Countries. Food and Agriculture Organization of the United Nations, Rome
- Fox L (2016) Cyclone Winston: village built by Australian man for Fiji's poor survives unscathed (<http://www.abc.net.au/news/2016-02-27/village-built-for-fiji-s-poor-survives-cyclone-winston-unscathed/7204826>). Australian Broadcasting Corporation, Melbourne
- Francis (2015) Laudato Si': an encyclical letter of the holy father Francis on our common home. The Holy See, Rome
- Ganpat W, Isaac W-AP (eds) (2015) Impacts of climate change on food security in small island developing states. Inf Sci Ref, Hershey
- Hanna E, Harley D, Xu C, McMichael AJ (2011) Overview of climate change impacts on human health in the Pacific Region. Department of Climate Change and Energy Efficiency, Commonwealth of Australia, Canberra
- Hansen J, Sato M, Hearty P, Ruedy R, Kelley M, Masson-Delmotte V, Russell G, Tselioudis G, Cao J, Rignot E, Velicogna I,

- Kandiano E, von Schuckmann K, Kharecha P, Legrande AN, Bauer M, Lo K-W (2016) Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that global warming is highly dangerous. *Atmos Chem Phys* 16:3761–3812. doi:10.5194/acp-16-3761-2016
- Hiebert M (2013) Education for sustainable development in small island developing states. Commonwealth Secretariat, London
- Hills T, Brooks A, Atherton J, Rao N, James R (2011) Pacific Island biodiversity, ecosystems and climate change adaptation: building on nature's resilience. Secretariat for the Pacific Regional Environment Programme (SPREP), Apia, Samoa
- Hoegh-Guldberg O, Cai R, Poloczanska ES, Brewer PG, Sundby S, Hilmi K, Fabry VJ, Jung S (2014) The Oceans. In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) *Climate Change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects. Contribution of working group II to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge
- Hofmann R (2014) The cultural space of climate change, adaptation, and mobility in the Pacific Islands. In: Gesing F, Herbeck, J, Klepp, S (eds) *Denaturalising climate change—migration, mobilities & space* (Artec-paper Nr. 200). University of Bremen, Berlin
- IPCC (ed) (2012) Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
- IPCC (2013) Summary for Policymakers. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM (eds) *Climate change 2013: the physical science basis: contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge
- IPCC (2014a) *Climate Change 2014: synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change*. Geneva
- IPCC (2014b) Summary for policymakers. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (eds) *Climate change 2014: impacts, adaptation, and vulnerability. Contribution of working group II to the fifth assessment report of the Intergovernmental Panel on Climate Change, vol Part A: global and sectoral aspects*. Cambridge University Press, Cambridge
- IRIN (2008) Papua New Guinea: climate change challenge to combat malaria. <http://www.irinnews.org/report/77993/papua-new-guinea-climate-change-challenge-to-combat-malaria>
- Kates R, Travis WR, Wilbanks TJ (2012) Transformational adaptation when incremental adaptations to climate change are insufficient. *PNAS* 109:7156–7161. doi:10.1073/pnas.1115521109
- Kono H (2015) Kiribati eyes migrant fate amid rising waters. PACNEWS/Yomiuri Shimbun. <http://www.pina.com.fj/?p=pacnews&m=read&o=181016893055767745723ef626867d>
- Kumar M (2016) Paris agreement: what it means for the Pacific. *Isl Bus* 42(1):29–31
- le Page M (2015) Five metres and counting. *New Sci* 226(3025):8–10
- Leckie S, Simperingham E, Bakker J (eds) (2012) *Climate change and displacement reader*. Routledge, Oxford
- Lim B, Spanger-Siegfried E, Burton I, Malone E, Huq S (eds) (2004) *Adaptation policy frameworks for climate change: developing strategies, policies and measures*. UNDP/Cambridge University Press, Cambridge
- Limalevu L, Aalbersberg W, Dumar P, Weir T (2010) Community adaptation in a small Island developing country. *Tiempo* 77:16–19 <http://www.tiempocyberclimate.org/newswatch/feature100723.htm>
- Locke J (2009) Climate change-induced migration in the Pacific Region: sudden crisis and long-term developments. *Geogr J* 175:171–180. doi:10.1111/j.1475-4959.2008.00317.x
- MacLellan N (2012) Kiribati's policy for "migration with dignity". The devpolicy blog (http://devpolicy.org/kiribati_migration_climate_change20120112)
- Mathiesen K (2015) Losing paradise: the people displaced by atomic bombs, and now climate change. *Guardian* (10 March 2015). <http://www.theguardian.com/environment/2015/mar/09/losing-paradise-the-people-displaced-by-atomic-bombs-and-now-climate-change>
- McAdam J (ed) (2010) *Climate change and displacement: multi-disciplinary perspectives*. Hart Publishing, Oxford
- McLean R, Kench P (2015) Destruction or persistence of coral atoll islands in the face of 20th and 21st century sea-level rise? *Wiley Interdiscip Rev Clim Change* 6:445–463. doi:10.1002/wcc.350
- McMillen HL, Ticktin T, Friedlander A, Jupiter SD, Thaman R, Campbell J, Veitayaki J, Giambelluca T, Nihmei S, Rupeni E, Apis-Overhoff L, Aalbersberg W, Orcherton DF (2014) Small islands, valuable insights: systems of customary resource use and resilience to climate change in the Pacific. *Ecol Soc*. doi:10.5751/ES-06937-190444
- McNamara K, Prasad S (2013) Valuing indigenous knowledge for climate change adaptation planning in Fiji and Vanuatu. *United Nations University Traditional Knowledge Bulletin Topical Issues Series*
- Mortreux C, Barnett J (2009) Climate change, migration and adaptation in Funafuti, Tuvalu. *Glob Environ Change* 19:105–112. doi:10.1016/j.gloenvcha.2008.09.006
- Nakhouda S, Watson C, Schalatek L (2013) *The global climate finance architecture*. Overseas Development Institute, London
- Nalau J, Handmer J, Dalesa M, Foster H, Edwards J, Kauhiona H, Yates L, Welegtabit S (2015) The practice of integrating adaptation and disaster risk reduction in the south-west Pacific. *Clim Dev*. doi:10.1080/17565529.2015.1064809
- Newport C, Tutangata TF (2011) *Mangoes in July. Report on Cook Islands public service climate change functional review and institutional structure development*. Cook Islands Office of the Public Service Commissioner, Rarotonga
- Nunn PD (2009) Responding to the challenges of climate change in the Pacific Islands: management and technological imperatives. *Clim Res* 40:211–231. doi:10.3354/cr00806
- Nunn P (2013) The end of the Pacific? Effects of sea level rise on Pacific island livelihoods. *Singap J Trop Geogr* 34:143–171. doi:10.1111/sjtg.12021
- Nunn P, Aalbersberg W, Lata S, Gwilliam M (2014) Beyond the core: community governance for climate change adaptation in peripheral parts of Pacific island countries. *Reg Environ Change* 14:221–235. doi:10.1007/s10113-013-0486-7
- Nunn P, Runman J, Falanruw M, Kumar R (2016) Culturally-grounded responses to coastal change on islands in the Federated States of Micronesia, northwest Pacific Ocean. *Regional Environmental Change*, special issue on SIDS. doi:10.1007/s10113-016-0950-2
- Nurse LA, McLean RF, Agard J, Briguglio LP, Duvat-Magnan V, Pelesikoti N, Tompkins E, Webb A (2014) Small Islands. In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach KJ, Bilir TE, Chatterjee M, Ebi KL, Estrada YO, Genova RC, Girma B, Kissel ES, Levy AN, MacCracken S, Mastrandrea PR, White LL (ed) *Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects. Contribution of working group II to the fifth assessment report of the Intergovernmental Panel*

- on Climate Change. Cambridge University Press, Cambridge, pp 1613–1654
- Paris Agreement (2015) Text. http://unfccc.int/meetings/paris_nov_2015/in-session/items/9320.php. UNFCCC, Bonn
- Pittock J, Weir T (2016) Human dimensions of environmental change in small island developing states: some common themes. *Regional Environmental Change*, special issue on SIDS
- Rao BB, Sharma KL, Singh R, Lata N (2008) A survey of growth and development issues in the Pacific Islands. *Pac Econ Bull* 23:102–123
- Robinson S, Gilfillan D (2016) Regional organisations and climate change adaptation in small island developing states. *Regional Environmental Change*, special issue on SIDS. doi:10.1007/s10113-016-0991-6
- Rubow C, Bird C (2016) Eco-theological responses to climate change in Oceania. *Worldviews Glob Relig Cult Ecol* 20:150–168
- Schellnhuber HJ, Cramer W, Nakicenovic N, Wigley T, Yohe G (eds) (2006) *Avoiding dangerous climate change*. Cambridge University Press, Cambridge
- Schmutter K, Nash M, Dovey L (2016) Ocean acidification: evaluating vulnerability of socio-economic systems in small island developing states and globally. *Regional Environmental Change*, special issue on SIDS. doi:10.1007/s10113-016-0949-8
- Scott-Parker B, Nunn P, Mulgrew K, Hine D, Marks A, Mahar D, Tiko L (2016) Pacific Islander understanding of climate change: from whom do they source information, and to what extent do they trust it? *Regional Environmental Change*, special issue on SIDS
- Smith R, McNamara KE (2015) Future migrations from Tuvalu and Kiribati: exploring government, civil society and donor perceptions. *Clim Dev* 7:47–59. doi:10.1080/17565529.2014.900603
- SOPAC (2011) Tuvalu's crippling drought offers important lessons to the Pacific. SOPAC Division of Secretariat of the Pacific Communities, Suva
- SPC (2012) Fiji energy security indicator profile 2009. Economic Development Division, Secretariat of the Pacific Communities, Suva
- SPC (2015) Population indicators. Secretariat of the Pacific Community (<http://www.spc.int/nmdi/population>), Suva
- Storlazzi CD, Elias E, Berkowitz P (2015) Many atolls may be uninhabitable within decades due to climate change. *Sci Rep*. doi:10.1038/srep14546
- Terry JP, Chui TFM (2012) Evaluating the fate of freshwater lenses on atoll islands after eustatic sea level rise and cyclone-driven inundation: a modelling approach. *Glob Planet Change* 88–89:76–84. doi:10.1016/j.gloplacha.2012.03.008
- Terry JP, Falkland AC (2010) Responses of atoll freshwater lenses to storm-surge overwash in the northern Cook Islands. *Hydrogeol J* 18:749–759
- Tong (2011) Pacific leader addresses climate change issue. *USP Beat* (Suva) 2011:1
- Tong (2015) Speech at leaders event of COP-21, Paris 30 Nov 2015. UNFCCC Secretariat (online at unfccc.int)
- Tumbarello P, Cabezon E, Wu Y (2013) Are the Asia and Pacific Small States Different from the Other Small States? IMF working paper (Asia and Pacific Department), Washington DC
- Warrick O, Aalbersberg W, Dumaru P, McNaught R, Teperman K (2016) The 'Pacific adaptive capacity analysis framework': guiding the assessment of adaptive capacity in Pacific Island communities. *Regional Environmental Change*, special issue on SIDS
- WCC (2004) Otin Tai declaration: a statement and recommendations from the Pacific Churches' consultation on climate change, Tarawa, Kiribati (March 2004). Geneva
- WCC (2008) Climate change and the world council of churches <http://www.cws.org.nz/files/WCC_ClimateChange_BackgroundInfo2008.pdf>
- WCC (2015) Statement of faith and spiritual leaders on the upcoming United Nations climate change conference, COP21 in Paris in December 2015. World Council of Churches, Geneva
- Weir T, Orcherton D (2013) Climate change issues in the Pacific Islands: an overview. In: Leal W, Filho FM, Mohee R, Schulte V, Suroop D (eds) *Climate-smart technologies: integrating renewable energy and energy efficiency in mitigation and adaptation responses*. Springer, Berlinpp, pp 51–64
- Weir T, Virani Z (2011) Three linked risks for development in the Pacific Islands: climate change, disasters and conflict. *Clim Dev* 3:193–208. doi:10.1080/17565529.2011.60319
- Weiss K (2015) Before we drown we may die of thirst. *Nature* 526:624–627
- WRI (2014) Climate analysis indicators tool: WRI's Climate data explorer. Washington, DC. <http://cait2.wri.org>
- Wyett K (2014) Escaping a rising tide: sea level rise and migration in Kiribati. *Asia Pac Policy Stud* 01:171–185. doi:10.1002/app5.7
- Yates L, Anderson-Berry L (2004) The societal and environmental impacts of Cyclone Zoë and the effectiveness of the tropical cyclone warning systems in Tikopia and Anuta, Solomon Islands, December 26–29, 2002. *Aust J Emerg Manag* 19:16–20