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ORIGINAL ARTICLE

Development, global change and traditional food security in Pacific Island countries

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Abstract While islands have been identified in numerous discourses as being highly vulnerable, food security was a cornerstone of many traditional Pacific Island societies from inland and coastal communities in large islands with considerable natural assets to those that occupied extremely small, low-lying atolls with little or no soil and limited water resources. This was sustained through agro-ecological biodiversity, the production of surpluses which enabled food preservation and storage to be practiced and underpinned networks of exchange and mutual support that were particularly important during times of hardship such as disruptive extreme natural events, the use of resilient crops and using 'famine' foods. Colonisation, the introduction of new religions, the spread of capitalism, most recently in the context of globalisation, has seen many of these practices decline (some have disappeared altogether) as crop diversity has been reduced (making way for export products such as copra), food storage and preservation are now rarely practised, resilient crops have been replaced, famine foods have lost their importance in the face of disaster relief, and many traditional networks have declined. Food imports have become critical, not only in the growing urban areas, but also in rural communities. The paper concludes by addressing key challenges facing Pacific Island countries in order to revitalise those traditional elements of food security in ways that are likely to find acceptance in contemporary society and enable them to adapt to the effects of climate change.

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Introduction

Pacific Island countries (PICs) (see Fig. 1) are becoming increasingly dependent upon imported food although this dependency is not new and was observed in the mid-1970s when most countries in the region were still colonies (McGee 1975). This is not to suggest that Pacific Islands were traditionally closed systems, and there is ample evidence to suggest that interisland exchange underpinned food security in many parts of the region (Campbell 2006). However, with the advent of colonialism, and later globalisation, this inter-dependency has to a large extent been replaced by dependence upon food products imported from outside the region. This paper focuses on these issues particularly as they relate to environmental change. It should be noted, however, that in recent decades there has been a significant change in Pacific Island dietary patterns, particularly in urban areas that have resulted in increasing incidence of nutrition-related morbidity in areas such as hypertension, diabetes and obesity. In this paper, I examine traditional systems of sustaining food security, particularly in the face of environmental extremes and in a number of cases under conditions of considerable resource scarcity. I also outline how these measures have been modified during the colonial, independence and globalisation eras. These modifications have reduced the resilience of Pacific Island food systems and may place many Pacific Island communities in positions of considerable vulnerability to the effects of climate change. The paper concludes with an exploration of ways in which contemporary food systems

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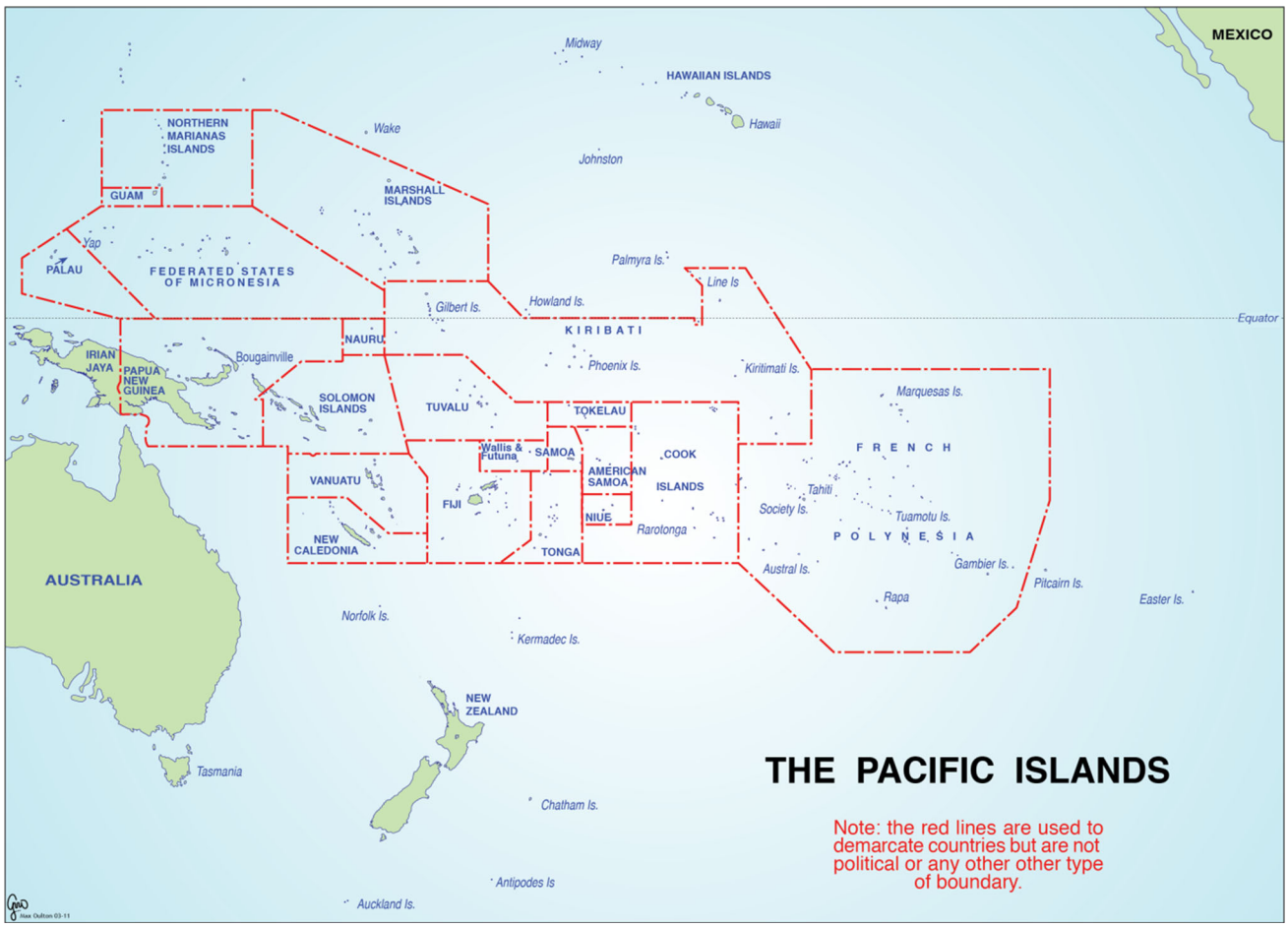

Fig. 1 Map of the Pacific Island showing the countries referred to in the text

might become more resilient and thus reduce the threats of climate change to island livelihoods.

Pacific Island environments

In a discussion of Pacific Islands, it is important to acknowledge the great diversity that exists within the Pacific region. This ranges from island geology, climate and biogeography, through social systems, culture and economies. They also have a variety of colonial histories and different levels of incorporation into global economic systems. From an environmental perspective, Pacific Islands may be categorised into four types. The first is continental type or inter-plate islands formed along the subduction zone (often referred to as the Pacific rim of fire) on the boundaries of the Pacific (oceanic) and Indo-Australian (continental) tectonic plates. The largest of these islands is New Guinea (approximately half of which is in the PIC region in as part of Papua New Guinea), which is the second largest island in the world. Generally, the inter-plate islands tend to be among the largest islands in the region and are found in the Melanesian Islands of the Western Pacific. These islands given their geology, location close to biological source areas of Asia and Australia, and in the usually warmer and wetter western quarter of the Pacific, have much greater biodiversity and resource availability than other PICs (see Rapaport 2013 for discussions of the physical and bio-geography of PICs).

The other three island types, which are often grouped together as oceanic or intra-plate islands, lie to the east of the Pacific rim of fire and owe their origins to island building volcanic activity as the Pacific plate moves over hot spots in the earth's mantle. The three broad island types are volcanic high islands, atolls (formed as the high islands are eroded) and raised limestone islands (atolls left stranded above current sea levels). Volcanic high islands are likely to have poor porous soils and poorly developed hydrological systems. They tend to have lower biodiversity than the larger islands of the Western Pacific, especially those which are located further away from the Western source areas of most islands species. Orographic rainfall

which is delivered to the islands by the easterly trade winds is the main source of fresh water. The third category is atolls, which are roughly circular rings of low-lying islets created by wave-deposited sand on coral reefs that surround a lagoon. They have virtually no soils and very low levels of biodiversity and are dependent upon convectional rainfall. There is no surface water, and a critical resource is the Ghyben-Herzberg fresh water lens, a body of fresh water lying below the atoll surface effectively floating on denser salt water that has permeated the coral base of the atolls. Raised limestone islands are atolls that have become stranded above existing sea levels

Pacific Islands are exposed to a range of environmental extremes—geological, biological and climatic. It is under extreme events that food security is most tested for many PIC communities. Most important are tropical cyclones and drought events but geological extremes may also affect food production, as in cases where landslides triggered by earthquakes destroy gardens. Maintaining food security in these different milieux required different approaches, but in many ways there were more similarities than differences in the modes of food security that were found. The ecological differences also served to enable exchanges of goods between communities with different resource bases.

The effects of climate change

Developing projections of climate change effects in the PIC regions is rendered difficult by the small size of islands in relation to the scale of the models used to generate climate change scenarios. The discussion in this session is informed by the regional assessment of climate change conducted by the Australian Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation (ABM and CSIRO 2011) and the report of the IPCC AR5 Working Group II on Small Islands (2014). Climate change is likely to affect the various Pacific Islands in a variety of ways. Given the great variety of island types, some islands may be more exposed than others and different islands will be exposed to different effects from each other. One way of examining the likely impacts of climate change is upon community security or the capacity of PIC environments to provide adequate life support for their inhabitants. This includes land security (the protection of the physical basis for settlements and livelihoods), livelihood security (food security and access to other forms of income) and habitat security (safety from harm and exposure to disease). For example, land security (the existence of land on which to live and conduct livelihoods) may be diminished or even lost in the face of sea-level rise or river bank flooding (from increased incidence of heavy rainfall events) and erosion. The places most at risk are likely to be atolls, coastal communities and river flood plain and deltas. Many parts of the region are exposed to drought events including the Papua New Guinea Highlands and most atolls, with loss of potable water supply (both quality and quantity) impinging on habitat security and reduced agricultural production threatening livelihood (including food) security. Changes in tropical cyclone frequency and/or magnitude may also increase stress on livelihood and habitat security, and changing disease vectors may also affect habitat security. Other effects include changing sea surface temperatures and ocean acidification that may cause degradation of coral reef ecosystems and fisheries, key elements of PIC livelihood security.

While much attention is placed on atoll communities, for some good reasons, it is important not to neglect the possible effects of climate change in other island types. The total atoll population of the Pacific in 2013 was slightly more than 200,000 people (based on SPC data 2014) and may increase to around 350,000 in mid-century (based on SPC data 2014; see also Campbell 2011). By way of comparison, the population of the Papua New Guinea Highlands exceeds 3,000,000 people, a figure that may well double by 2050 if the region follows national projections (as provided by SPC 2014).

Traditional food security

In Pacific Island societies, as is the case in many parts of the world, food does not simply fulfil a biological function. It has a variety of social, cultural and spiritual values (Pollock 1992), and in most parts of the region, certain foods are given special status. This applies both to staple carbohydrates [especially yam (*dioscorea* spp.) and taro (*colocasia esculenta*)] and forms of protein, especially specific species of fish and/or pigs. These high-status foods vary from place to place depending to a certain extent on ecological conditions. In many parts of the region, Pacific Island agricultural systems reflect the predominant climate regime with taro typical on the wet or eastern sides of islands (facing the moisture laden trade winds) and yams often found on the leeward or dry sides of islands (a classic distinction made famous by Barrau 1965). In a number of locations, irrigation systems were developed to enhance or sustain taro production given the cultivar's preference for moist conditions. Indeed, modification of the environment could be, and in same places still is, found in many places. One example is the use of large mounds in parts of the Papua New Guinea Highlands to support sweet potato cultivation (Waddell 1972). These mounds enable the cultivation of sweet potatoes at high elevations but are unable to offset the most extreme frosts (and drought

Table 1 Clarke's (1977) principles of agricultural permanence

Principle	
1	Paleotechnic—not requiring external inputs such as energy or fertilisers
2	Not self-polluting. Limited toxic outputs within assimilative capacity of environment
3	Strongly positive net energy yields. Much higher outputs than inputs, not counting solar energy
4	Contained within human rather than geological time scales (no fossil fuels)
5	Equitable distribution of outputs among members of population
6	Resources seen as productive capital to be preserved
7	Polycultural crop diversity

conditions) experienced in the Highlands during El Niño events (Allen 1989; Allen et al. 1989).

Many aspects of food security appear to have existed in many different parts of the region in precontact times, although sometimes in superficially different guises. William Clarke (1977) used the term structures of permanence to describe agro-ecosystems in the Papua New Guinea Highlands. This framework had seven principles as outlined in Table 1. In contemporary parlance, such systems would be called sustainable and their efficacy is illustrated in the large number of islands that, despite their representation as sites of human vulnerability, have continued to support their populations over several, and in some cases tens of, millennia. Moreover, despite most Pacific Islands having high levels of exposure to tropical cyclones and drought events, particularly associated with phases in the El Niño Southern Oscillation, among other climatic and geological extreme events, they have remained populated.

Surplus production

A feature of traditional food systems in PICs was the production of agricultural surpluses, especially food products. According to Fisk (1962, 1964), traditional Melanesian societies lived in conditions of subsistence affluence in which needs were met with limited labour input, surpluses enabled ceremonial feasting and other activities, supplies for times of shortage and people had ample time for leisure and recreation (see Conroy 2012 for a discussion of subsistence affluence). In a different context, Sahlins (1972) suggests that such 'affluence' was made possible by having limited material aspirations—a kind of 'Zen affluence'. Typically, precontact Pacific communities were characterised by subsistence production in which the producing and consuming units were one and the same with some surplus set aside for times of scarcity (seasonal or through extreme events) or used for a variety of forms of exchange (Campbell 2006).

Many Pacific Island food crops are seasonal and have periods when harvests are limited. While yams can be kept for prolonged periods if stored in a dry conditions, many of the other traditional staples [e.g. taro and breadfruit (*artocarpus* spp.)] require preservation in order to be kept for future use (Pollock 1992). Probably, the most widespread measure was fermentation, where crops were ensiled in leaf lined pits and covered with earth or sand to be dug up when required. Other methods included producing flour, simply leaving crops in the ground (e.g. alocasia and dioscorea) and drying (taro and breadfruit). Some observers have stated that food preservation was not as common in the more fertile large islands of the Western Pacific, especially in Melanesia, perhaps based on the assumption they were more fertile and had greater biodiversity than small islands to the north and west in Micronesia and Melanesia (e.g. Campbell 1992; Fischer 2002). However, Campbell (2006) indicates that food storage and preservation were practiced throughout the region and were as important in many parts of Melanesia that were exposed to climatic extremes that affected food crops.

Agricultural diversity

Biodiversity tends to be considered a key element of ecosystem stability new developments in ecology notwithstanding. It would appear that traditional Pacific Island agricultural systems tended towards maintaining a diversity of crops. This has been observed by Clarke (1977) and Thaman et al. (2002). This polycultural approach to agriculture reduced the likelihood of total crop losses during extreme events. While most areas had dominant staples, many other subsidiary crops were also grown with different levels of resistance to strong winds, heavy rains and water logging, salinisation and drought conditions. For example, as noted above, yams survive quite well in dry conditions but are averse to the wet. They are also relatively resistant to wind damage—while the above ground foliage may appear badly damaged after tropical cyclones, the underground roots themselves may receive little damage. If, however, heavy rains follow tropical cyclones, the roots may be damaged or destroyed in the water-logged soils. In comparison, taro struggle in dry conditions and while relatively wind resistant compared to, say, cassava (*Manihot esculenta*), damage caused by the stems blowing about in the wind may cause the roots to rot (cassava may be cut back to reduce the amount of stem and leaves exposed to wind damage but this stunts growth and, if predicted strong winds do not eventuate, production losses occur).

Diversity was not simply limited to the variety of crops grown but also to the locations of agricultural sites. While anathema to many agricultural economists for the related inefficiencies, agricultural fragmentation also enables some

gardens (based on elevation, different distances from storm centres and aspect or orientation) to experience less harm than others. Other crops that were traditionally cultivated include alocasia, and cyrtosperma (generally less preferred because of taste and status depending on environmental context) which were also less likely to incur damage compared to the colocasia taro. Bananas on the other hand are highly vulnerable to strong winds and can be easily damaged. On atolls, the range of food cultivars was more limited than on high islands but the principles of diversity still applied with food systems based on alocasia (grown in artificial soils created in baskets lowered into the fresh water lens), pandanus, breadfruit and coconuts.

Famine foods

The term famine food generally refers to those food plants (and animals) that were not usually consumed unless there was some kind of failure among the normally harvested crops. Famine foods covered a range from plants that grew wild (especially in natural forests) through those that, while not planted, were husbanded by their potential consumers, to specifically set aside parcels of land that can be used under emergency conditions. Some common examples of famine foods in the Pacific included sago (*metroxylon* spp.) and alocasia both of which require special treatment before becoming edible. Interestingly, these two famine foods are staples in some areas with limited resource bases or environmental conditions such as on atolls where alocasia is grown and some swampy lowland delta areas in Papua New Guinea where sago is the staple. Other common famine foods include wild yams (*Dioscorea bulbifera, Dioscorea nummularia*), arrowroot (*Maranta arundinacea*), and a wide range of nuts such as the Tahitian chestnut (*Inocarpus fagiferus*) as well as various ferns, fungi and leaves (Clarke and Thaman 1993).

Intra- and inter-community cooperation

A key to traditional food security was cooperation within and among communities. Many PIC societies monitored food production and consumption and had controls over premature harvesting such as first fruits ceremonies (e.g. Ferdon 1987). Most PIC communities had political systems that were characterised by forms of leadership that at times of food stress were able to ensure that consumption of food and water supplies was controlled. Several early reports from the region indicate that food and water were rationed during times of hardship (e.g. Wilkes 1845; United Kingdom Parliament 1887). Indeed, it is possible that along the lines of Sahlins' Zen affluence, traditional communities may have suffered considerable hardship at times of food stress.

A critical element for such cooperation was the maintenance (production, storage and preservation) of surpluses, which had an essential role beyond being a means of offsetting shortages brought about by seasonal patterns in crop productivity or by damage to crops caused by extreme events as described above. However, this role was not solely the establishment of emergency stocks but also sustaining political, social and kinship linkages with a range of exchange partners. Surplus production, then, provided a basis for intercommunity (often inter-island, or the case of "mainland" Papua New Guinea long-distance overland) exchange networks. Such networks often had important social, cultural and political reasons but also had a more prosaic element with basic items also being exchanged away from the spotlight of the ceremonial prestations among chiefs and other leaders. Surpluses enabled the ceremonial feasting associated with such exchanges and also underpinned the exchange of different food and other products exploiting ecological differences among communities.

One example of such networks is the *solevu* which operated at several scales in eastern Fiji. Thompson (1940; p. 73) describes such a system in Kabara, an island in the Lau group, eastern Fiji:

> Large competitive ceremonial exchanges (*solevu*) are made according to a definite ceremonial pattern based on the *sevusevu* rites which were formerly used to make offerings to the ancestor gods but are now used to present first fruits to the chief.
> On Kabara a *solevu* with deferred payment is occasionally held between the rival villages, Tokalau and Qaliqali, and between Udu and Lomati. Each village tries to outdo the other in quantity of food presented. Several months or years may elapse between the initial payment and the return payment.

The *solevu* also extended across eastern Fiji and linked together islands with differing specialisations as described by Thaman (1990; p. 70):

> Whereas Lakeba, Moce and Cicia, together with Moala and Matuku, are volcanic islands which produce a surplus of taro and other root crops. Kabara, Vulaga, and Ogea are limestone islands with poor agricultural potential, but extensive stands of *vesi (Intsia bijuga),* and other timbers needed for woodcarving, house building, and boatbuilding. Skilled artisans on these islands produce mats (*ibe*), bark cloth (*masi*), kava bowls *(tanoa)* and other wooden vessels, boats, and house timbers which are traded or exchanged for staple root crops, pigs, or other foodstuffs.

Sahlins (1962, p. 369) shows the link between this exchange system and food security:

> Not only are ecological potentials in each region thus maximised, boosting the productivity of the entire area, but near monopolistic production of certain craft goods sustains the trade potential of each particular island, and this can become critical if food supplies suddenly run low (e.g. after a hurricane).

These interdependent networks of kin, political allies and economic partners could be called upon by participants finding themselves in times of hardship facing food stress following extreme events. Exchange networks, albeit with different social and political contexts, were found across the Pacific region, not only among islands [e.g. the famous *kula* ring in the Trobriand Islands, Papua New Guinea (Malinowski 1922)] and the *suqe* or graded society of Vanuatu (Campbell 1990). Hughes (1977) describes extensive networks between the sea and the highlands of Papua New Guinea that enabled exchange of marine produce with goods from far inland. Waddell (1975, 1983) describes how during major crop failure in the New Guinea Highlands people obtained food from, and moved downslope to join, communities that had not been as adversely affected.

Food security in precontact PICs was sustained then through resilient agro-ecosystems (crop diversity and famine foods for example), surplus production, and the existence of inter-dependent networks based on kinship, political and social networks. This enabled communities to be sustained in 'normal' times and during periods of stress such as following the occurrence of extreme environmental events. These patterns were to change with the intrusion of European explorers, traders, missionaries and colonialists into Oceania.

Colonialism and independence: the decline of food security

Many of the measures that contributed to food security in the preceding section are no longer found in many if not most parts of the region and others have become much less important. There are two main reasons for this deterioration. The first relates to political, social, demographic, cultural and economic changes that began prior to colonisation and have continued through to the present. A major influence has been the expansion of the cash economy into the Pacific Islands during the early colonial era and its consolidation in the decades that followed. A key element of this change has been the introduction and then expansion of commercial tree crops. In a large part of the rural Pacific, and especially in many of the outer islands, this has taken place in the form of expansion of coconut cultivation for the production of copra. The coconut is one of the few crops that can be harvested, dried (in the form of copra) and then stored in order to be available for sale when trading vessels arrive. A significant demographic feature of many Pacific Islands was depopulation that began with introduced diseases (and the so-called 'labour trade' in Melanesia) and continued well into the twentieth century. As a result, population densities in many parts of the region declined and land that would formerly be used for food production was able to be planted in coconuts without threatening food security. A 'dual economy' emerged with communities producing subsistence food alongside commercial copra production. With the rebound in populations, beginning roughly around mid-twentieth century, and in many PICs now occurring with high rates of increase, a shortage of arable land for subsistence food production has emerged.

One response to this has been to reduce fallows in the subsistence food production sector, thereby reducing soil fertility and long-term yields. In many islands, a response to this process has been to replace traditional crops such as yam and taro with the introduced, nontraditional cultivar, cassava which, because of its lower soil and labour requirements, is becoming the predominant staple in many parts of the region. Rather than being polycultural, agro-ecosystems have emerged with two "monocultures" (one subsistence and the other commercial) existing side by side. While populations continue to increase, food yields continue to decline. At the same time, commodity prices for tree crops such as copra are notoriously unreliable and often cash returns are also very inadequate.

As well as these changes, many of the traditional exchange systems are no longer extant. In most of the archipelagic nations in the Pacific interisland, shipping has deteriorated in frequency and regularity and locally based forms of transport are used less frequently if at all. As a result, elements of the exchange systems have lost importance. For example, craft goods that once underpinned the *solevu* in Fiji are now made for very small returns to be sold to intermediaries who serve the tourism industry. In northern Vanuatu, the *suqe* has also declined, partly because the Melanesian Mission which dominated proselytisation in this region after 'tolerating' the institution decided to call for its abandonment in the 1920s as it was distracting people from participation in church activities. As well, valuable items such as shell money and mats lost their status as the shilling and the franc became the dominant currencies in the New Hebrides Condominium (Campbell 1990).

With the penetration of capitalism throughout the region into even some of the most isolated islands, store goods such as rice, biscuits and canned fish and meat replaced

preserved foods as a means of dealing with seasonal shortages. While population numbers remained relatively low, earnings from copra and other cash crops supported this change. However, when food production was hindered by extreme events such as tropical cyclones and droughts, cash crops were also likely to be affected. For example, coconuts might survive hurricane force winds but damage to the crown can halt production coconuts for as many as 7 years. With people no longer storing and preserving food, recourse to the trade store (if indeed it survived the storm) is not necessarily an option.

The second group of changes in food security were those related to traditional forms of disaster resilience. Most PICs are exposed to a range of environmental extremes including droughts, tropical cyclones, high-wave events and 'king' tides, the effects of all which are likely to be influenced by climate change and sea-level rise, and tsunami (the magnitude of which may perhaps also be affected by sea-level rise) and most of which may reduce agricultural productivity through such processes as soil moisture stress, wind damage, water logging and salinisation. The importance of famine foods has very much declined in many PICs. A key contributor to this process has been the provision of food relief that has diminished the need to sustain particular practices. Just as the introduction of capitalism undermined the need for surpluses to sustain kinship networks and inter-community exchange, the provision of food relief reduced the need for communities to store and preserve food and maintain the use and, importantly, the knowledge of how to use (e.g. how to obtain starch from sago) famine foods. Food relief also reduced the need for inter-community responses that were already under threat from other changes as described above. This entrenched the process in which food security was degraded with conditions leading into subsequent extreme events becoming increasingly marginal, further requiring disaster relief and in turn further increasing food dependency and reducing food security.

This process is outlined in Fig. 2, which shows both the long-term changes in food security punctuated by disaster events and the provision of relief. The term extreme event or environmental extreme has been used until now as often such events, because of the elements of traditional food security described in this paper, in addition with building and settlement characteristics and other forms of traditional knowledge, did not result in disasters (see Campbell 2006; Gaillard 2007; Gaillard and Mercer 2013; Mercer et al. 2009, for discussions of traditional knowledge and disaster reduction). However, the loss of food security has 'created' disasters where local communities cannot cope without external assistance. Disasters and changing responses to them have played a significant role in the reduction of food security in Pacific Islands. Many of the long-term changes (loss of inter-community exchange, loss of crop diversity and replacement of resilient crops) were offset following disasters by the provision of food relief, enabling the underlying changes to continue. At the same time, food relief negated the need for local food storage and preservation and the use of famine foods. The outcome is that many Pacific communities have become dependent on food imports, even during 'normal' times when there are no disasters and this dependency has become heightened after disaster events. While the provision of relief has played a significant role in undermining food security, if it were no longer provided a great hardship may follow. This provides a challenge as to how food security in PICs can be restored both under normal conditions and when disasters occur. Moreover, projections of climate change in the region suggest that climate extremes may become more severe and/or more frequent placing even more pressure on a system already under stress.

Food security in contemporary Pacific Island societies

As the preceding discussion indicates, perhaps with some exceptions (see for example Nunn 2007), food systems appear to have sustained most island communities over the millennia. However, levels of food security have declined since early colonisation and have continued to do so through to the present. In particular, urban communities in PICs are particularly dependent upon imported foods, and even in rural areas food imports have become increasingly important.

Rural food security

As with other characteristics in the region, rural communities differ in many ways. One category of rural is that of being an outer island community and applies to those communities on, usually small, islands away from the national capital or other centres of commerce. These are typically found in archipelagic nations and in many cases are isolated from national centres by infrequent and irregular shipping, or where there are airstrip expensive airfares. There are also inland rural communities such as those in the highlands of Papua New Guinea which are not connected to the national capital by road and experience some of the same features of isolation as the outer islands. These communities face problems of food security as outlined above. They have significant portions of arable land given to commodity production, leaving subsistence food production to be continued on the remaining land with decreasing fertility. At the same time, these islands are often supporting growing populations, although they are also contributing to urban population growth through outmigration.

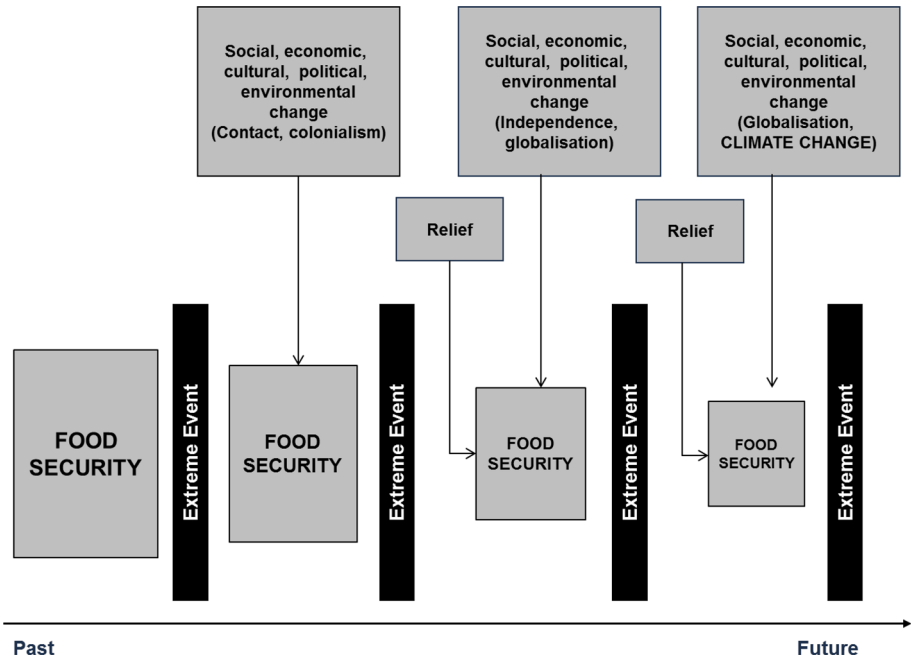

Fig. 2 Changing food security: the links between food security, long-term social and environmental change and environmental extremes. Traditional food systems provided sufficient security for most communities to survive the effects of extreme events. However, changes initially wrought by 'contact' and colonialism reduced levels of food security by changing agricultural and other social practices. As a result, extreme events began to give rise to disasters, the losses reflecting the levels of food security. Where communities were perceived to be badly affected, food relief was supplied further eroding aspects of food security, so that ensuing extreme events caused even greater levels of food stress. The figure shows changing long-term influences from contact through to the present and then into the future where climate change may be expected to further diminish levels of food security

The second group of rural communities are those close to urban centres, either on the same island or on nearby ones. Here, the degree of rurality often reflects distance, or more precisely level of accessibility, to the urban centre. For example, there are some outer island communities, such as Taveuni and Kadavu in Fiji, with relatively regular shipping services to Suva, and they too also serve the urban market. The communities serving urban centres are placed in a slightly different position as often their agricultural activities are still built around food crop cultivation (rather than tree crops), some for subsistence and some for sale in urban markets. These communities may find that their food security is less compromised and those with close proximity to urban centres may have access to other nonsubsistence livelihoods in addition to market gardening.

Urban food security

While the PIC region has low rates of urbanisation compared with other parts of the globe, the average rate of 23 % urban is to a large extent skewed by the dominance of the Melanesian countries with large populations and low percentages of population in towns and cities. Many Polynesian and Micronesian countries have much higher rates of urbanisation and as Bedford and Hugo (2012) observe, urban growth, in terms of absolute numbers, is going to be very significant in Melanesia over the next half century. In terms of food security, urban areas have, for a long time, often been identified as areas with the greatest levels of dependency on imported foods (McGee 1975). However, Thaman (1995) has found that in many urban areas in the region food production practices are continued and often with high levels of crop diversity. Nevertheless, while food imports make their way to all corners of PICs, there can be little doubt that the majority are consumed by urban dwellers. As urban populations grow, the demand for locally grown foods is likely to be even more difficult to satisfy and the need for increased food imports is likely to grow.

Transnational exchange networks

While many of the traditional exchange networks have declined in importance and in several cases have collapsed, new contemporary networks, especially based on kinship (as was often the case in traditional exchanges), have emerged with urbanisation within PICs and the establishment of large Pacific Island communities in the Pacific rim countries of Australia, New Zealand and the USA as well as some central locations within the region (e.g. Fiji and

Guam). The importance of remittances from these communities has been well researched and reported on (see Connell and Brown 2005 for an overview). Bedford and Hugo (2012) observe that more than any other part of the world, the Pacific region is dependent on remittances. Migration and remittances may also be seen as important elements of climate change adaptation (Barnett and Webber 2010; Campbell and Bedford 2013; Campbell 2014) enabling the remaining communities to have higher standards of living than would otherwise be the case, reducing the numbers dependent on local resources and providing money and goods for those who stay. In some ways, this process may be seen as contributing to food dependency among those who remain in the places of origin. However, this view neglects the two-way relations that exist between many Pacific migrants and their relatives at home.

Home remains a critical construct for most PIC migrants, and it is important to sustain their ties to it. This is embodied in the notions of 'roots and routes' (Jolly 2001) and 'the tree and the canoe' (Bonnemaison 1985). The very existence of ones roots (the tree) in land enables migration (along routes in the canoe) with the knowledge that there is a place one may return to. What is not clear is the degree to which this attachment may decay through time but many Pacific societies are unable to separate themselves from their land with the two elements being mutually constitutive, with the connection often likened to an umbilical cord (Pond 1997). The links between migrants and the stayers are often actively maintained and are not simply one way. Those who do not migrate have the responsibility to nurture the land and keep the link between the people and the land alive. They also often send items including food (where they are able to comply with biosecurity requirements at the destination countries) and other valued craft goods to the migrants. They keep the link alive, and this is returned with remittances. From this perspective, the process is more one of interdependent food security rather than of one dependency. It might also be claimed that migrants reduce the burdens on local food supplies. By keeping these linkages alive, communities also, as in the past, have recourse to external sources of disaster response when environmental extremes occur.

Options for food security in a changing world

What are the options for PICs in the relatively immediate future? By mid-century, the effects of climate change are likely to be manifested and the projected population will be almost double that of the present (SPC 2014). The numbers of urban dwellers is expected to increase significantly. Several questions remain to be answered. First, how will rural communities fare in the decades ahead? If they continue to contribute large numbers to urban areas, they may avoid increasing local population pressure on food resources. A major issue will be the role of capitalism in rural communities and how it is likely to be sustained. We have seen that expansion of commercial agriculture, especially for commodity production, has proceeded at the expense of food production and that the food systems that currently are found in the region are less resilient than those of the past. At the same time, the returns to commercial agriculture are often poor. If these trends continue, the push for out-migration from urban areas is likely to continue.

The second concern is how can food security be sustained among urban populations? At a national level, perhaps food security could be improved if local, including outer island, food production could replace imported food products. Problems here relate to the difficulties of shipping perishable items and the economies of scale, for example, of competing with large rice producers and even distant water fishing nations. It is possible that many PICs will struggle to be able to feed the growing urban populations adequately, especially if urban unemployment and underemployment levels remain high or even increase. Increasing urban population densities may also place pressure on the important urban subsistence gardening that Thaman (1995) discusses.

Most commercial agriculture has been limited to tree crops produced for global commodity markets. Chief among these is copra production from coconuts. In many outer islands, this has been the dominant, island-generated form of commercial income. While commodity prices are unreliable and copra has become increasingly unattractive, coconut trees may live for a century and people are often loth to cut them down, even for replacement let alone make way for food production. But, given the stresses faced by urban communities and the low incomes in rural areas, it is possible that an important way forward for PICs will be to increase opportunities for rural food production both for subsistence and for cash, and in turn providing food for urban markets. This may require changes in the way things are currently done. For example, food prices and shipping costs may need to be subsidised and ways of preparing food for transport improved. Alternatively, disincentives for food imports may be considered although this would run against existing free trade ideologies.

The third issue that needs to be approached is the role of migration and remittances and the concept of food interdependency rather than dependency. It is likely that climate change will induce a considerable amount of migration over coming decades as well as reducing the ability of Pacific Islands to provide the capacity to support their populations in terms of both subsistence and commercial livelihoods. While there has been concern that migration,

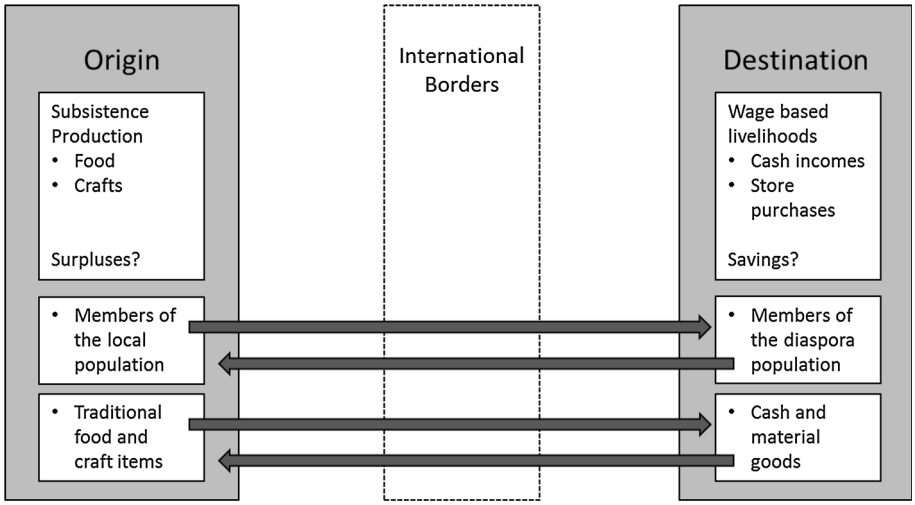

Fig. 3 Facilitating maintenance of transnational kinship linkages. One way of maintaining food inter-dependency is to sustain transnational kinship linkages which may, in a contemporary context, replace traditional intra- and inter-community networks. One way to do this is to facilitate two-way flows of goods and people between islands of origin and destination locations requiring new international arrangements for migration access including 'climate change migrants', border protection (e.g. biosecurity) and reducing the costs of international money transfers

particularly forced community relocation, is an indicator of in situ adaptation failure, a less apocalyptic view of climate change-induced migration is emerging (Hartmann 2010; Kelman 2014; Nicholson 2014). Increasingly, 'induced' climate change migration is being seen as a beneficial form of adaptation to climate change, especially where options for in situ adaptation are limited (Barnett and Webber 2010; Campbell and Bedford 2013; Campbell 2014). Climate change-induced migration has the capacity to a) reduce the pressure of population on a degrading resource base, leaving greater subsistence opportunities (or possibilities for food security) among those who remain and b) improve livelihoods when migrants are able to support the home communities with remittances that may in turn help reduce food insecurity and reduce, at least on outer islands, the need to increase dependency on a generally underperforming commercial agricultural sector.

This raises the question as to how food inter-dependency might be achieved, and most importantly sustained. As Fig. 3 suggests, several issues will need to be addressed. First, climate change-induced migrants will require access to metropolitan countries. Those countries with limited or no access will need some means of enabling members of their population to take part in climate change migration and contribute to food inter-dependency. There is also a need for more two-way exchange of people between PICs and the metropolitan countries. Bedford and Hugo (2012) suggest, for example, that this could be facilitated by providing migrants with dual citizenship. This may also help offset remittance decay through time as migrants and their descendants are more easily able to maintain contact with their places of origin. In order to sustain the mutually beneficial exchanges between migrants and their home island communities, there is a need for countries to consider ways of enabling two-way exchanges of goods, not only those from metropolitan nation to island, but also in return. This will require new ways of sustaining border biosecurity, for example.

Disaster risk reduction

As this paper has sought to show, there is a strong link between extreme events, food security and disaster occurrence. If climate change increases the exposure of PICs to increases in the frequency and/or magnitude of extreme events (not just tropical cyclones and droughts but also rainstorms, high sea events such as storm waves and king tides on a higher sea level, and incidence of more or new agricultural pests or diseases), it would follow that many Pacific Island communities will not be in a resilient position given the declining resilience in the face of existing patterns of extreme events. Accordingly, (re)building DRR is likely to become an issue of some urgency. As we have seen, much of the increased vulnerability has been related to reductions in disaster-related food security. The great challenge facing PICs is how to reverse the current trends. What lessons from the past can be reincorporated into contemporary food systems. How likely is it that contemporary and future PIC communities will be inclined to preserve fermented food, for example, or to revitalise the use of famine foods? If rural areas play a greater role in

urban food security, what will be the outcome for urban dwellers if rural food production fails in the event of extreme events such as droughts and tropical cyclones? There are possibilities for new forms of food preservation that may satisfy twenty-first century tastes such as drying taro or yams to make chips. Products such as these could also be directed towards urban markets reducing their dependence on imported food stuffs. But such activities need to be economically and technically feasible in the context of small outer island communities. One option may be to look at regional food security and the possibilities for intra-regional food security cooperation.

Conclusions

Pacific Islands were once places with high levels of food security, where people may have lived in 'structures of permanence' with subsistence affluence, albeit based on having moderate material aspirations. Today, such conditions do not exist, and both rural and urban communities in the region face high levels of food insecurity that are heightened by the occurrence of disasters caused by natural extremes. Projections of population growth and scenarios of climate change indicate that food stress may become worse rather than better unless measures are taken to redress the current problems. In this paper, I have suggested that this could be achieved through reintroducing food resilience, partly by changing the ratio of subsistence food production and tree crop commodities, by revitalising the use of famine foods and rekindling old, by adopting new ways of preserving food crops, and by building on transnational kinship networks to strengthen inter-dependency food development. If these measures are not taken, it is likely that many PICs will become increasingly characterised by food dependency and find themselves in an invidious position as climate change impacts unfold.

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