Traditional disaster reduction in Pacific Island communities

John R. Campbell

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J. R. Campbell, Department of Geography, Tourism and Environmental Planning, University of Waikato, Private Bag 3105, Hamilton 3240

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CONTENTS

FIGURES

TABLES

ABSTRACT

Pacific Island communities had a wide range of traditional measures that enabled them to ameliorate the effects of natural disasters. This study identifies four clusters of coping measures. Most important among these was food security made possible particularly through the production of surpluses. Not only were there many systems of food preservation and storage, but communities also maintained a diversity of food plants in addition to using wild or feral species. Fragmentation of garden land also enabled a diversity of food production sites reducing the likelihood of complete loss of food production following events such as tropical cyclones. A second important element in traditional disaster reduction was inter-community and intra-community cooperation. Cooperation was encouraged by building ties through feasting, ceremony and exchange of goods. This was also underpinned by the production of surpluses but enabled a wide range of co-operative strategies to be called upon in times of hardship. The third category of traditional disaster response included features of buildings in some parts of the Pacific region where hipped roofs, sennit bindings, deeply embedded hardwood posts and well sealed walls and roofs helped reduce damage from tropical cyclone force winds. Finally, traditional knowledge systems underlay all of the features above and also included strategies for predicting adverse weather events. Together these elements of disaster reduction enabled communities to be sustained for millennia in Pacific Island environments.

KEYWORDS

Disasters, hazards, Pacific Islands, reduction, response, traditions, traditional mitigation, traditional knowledge

1.0 INTRODUCTION

This report outlines the findings of a desktop study of traditional disaster responses in Pacific Island Countries and Territories (PICTs). It is part of a wider project on "Land Use Planning for Reduction and Recovery." This specific topic seeks to build our knowledge of "cultural understandings and traditional mitigation" in Pacific Island cultures. The purpose of the report is to bring together information showing the measures that were traditionally used in the Pacific Island region around the time of initial European contact and the colonisation which followed. While many of these measures appear to have fallen away it is possible that some may still be usefully applied in the contemporary context. At the least, it is important that governments and personnel involved in post-disaster relief and longer term disaster mitigation projects are aware of a long tradition of natural disaster reduction in PICTs.

2.0 DISASTER REDUCTION IN SMALL ISLAND DEVELOPING COUNTRIES – SOME GENERAL CONSIDERATIONS

Islands, particularly small islands, have for some time been considered as being highly vulnerable to natural hazards (e.g. Lewis, 1979). This concept remains popular and is outlined in the Hyogo Framework for Action 2005-2015:

> Disaster-prone developing countries, especially least developed countries and small island developing States, warrant particular attention in view of their higher vulnerability and risk levels, which often greatly exceed their capacity to respond to and recover from disasters. (International Strategy for Disaster Reduction, 2006, p. 5).

One aim of this research is to provide support for the idea that while island countries may seem to be particularly vulnerable, they also have, or at least did have, elements of resilience that were particularly effective.

It is also useful to clarify the terms used in this research project. As noted in the opening chapter the aim of this report is to examine cultural understandings and traditional mitigation of hazards in the Pacific. There is not a great deal written about the former although some information has been gathered about environmental knowledge especially as it pertains to climatic extremes. The major focus has been on traditional systems of disaster reduction (or mitigation). Many of these were deeply rooted within the cultures of various island communities and it is often difficult to know whether or not the roles that they played in regard to disaster reduction were incidental or emerged as purposeful adaptations. Many consider that the term traditional refers to practices that existed prior to European contact and colonisation. Some of these have persisted and others have fallen away as new 'non-traditional' practices have emerged. However, the term is quite difficult to define precisely as traditions change through time. For example, many, if not most, of the members of Pacific Island communities consider themselves to have a strong Christian tradition, although this is something that was established as a result of early-contact missionary activity and colonisation. It has also become common for many Pacific Island communities to use churches as safe places during tropical cyclones. In this sense tradition is fluid and changes through time and from generation to generation (e.g. Linnekin, 1983).

The term traditional may also have some pejorative connotations for some who consider it to be the opposite of modernity or progress. Nevertheless, we do know that, despite the ascribed 'vulnerability' of Pacific Island populations, and their exposure to a wide range of hazards, they appear to have thrived for several millennia prior to the advent of European intervention. Accordingly, it is useful to find out how this was achieved. In this study the term will be used to refer to those measures, or characteristics, of Pacific Island societies that existed around the time of European contact.[1] It is also important here to stress that so-called contact and colonisation were not carried out upon passive communities that could be easily be moulded by the agents of empire. Many communities resisted some changes and appropriated others, adapting them for their own ends. Accordingly, a number of traditions have remained until the present, and some have been lost or modified. From this perspective we are dealing with dynamic and flexible systems in which both continuity and change are contradictory characteristics.

The term mitigation has conventionally been used in disaster research to refer to activities that are put in place prior to disasters with the intention of ameliorating their effects (Coburn *et al*., 1991). The International Strategy for Disaster Reduction (ISDR) (2004, p. 5) similarly refers to mitigation as 'measures taken to limit the adverse impact of natural hazards …' From this perspective mitigation can refer to measures that range from engineering works that seek to modify the natural event (such as stop banks or sea walls) through land use planning to public education. However, its use has also been subject to considerable variation. For example, Smith (2004, p. 55) uses the term quite differently to refer to measures that "modify the loss burden" which he defines mainly in terms of loss sharing mechanisms such as disaster aid and insurance. To add to the confusion, the term is also often used in connection with global warming to refer to measures that reduce the emissions of greenhouse gases. In this report the term is used in its broadest sense to encompass what is currently termed 'disaster reduction'. From this perspective the term is used to include any measures that may serve to reduce the effects of extreme events upon Pacific Island communities. Generally, mitigation measures are represented as proactive steps to reduce disaster and are often separated from relief and rehabilitation or recovery as these are seen more as reactive responses. However, in terms of traditional disaster reduction, it will be seen that some measures existed that did not ameliorate the direct effect of disasters but enabled communities to survive through the provision of assistance from other communities. Such measures were dependent upon the maintenance of long-term sets of relationships, rather than simply being seen as short-term reactive responses.

2.1 The Pacific Islands Region

It is also necessary to define the term 'Pacific Island region'. In this study it is being used to refer to all political entities in the tropical Pacific Ocean regardless of their status as independent nations or otherwise. It includes all the islands that comprise the broad regions of Micronesia, Melanesia and Polynesia. It does not include the island communities of Asian countries.

There is a common tendency to consider the Pacific Islands region as being homogenous. However, the region is characterised much more by its diversity, both in terms of the island environments, and the cultural and social systems of the people who inhabit them. Given

[1] Of course all of our sources are post-contact and mitigation measures recorded in even the earliest writings may have already been subject to some modification.

this, the effects of extreme events and responses to them may be expected to show considerable diversity as well.

A commonly used classification of Pacific Island environments groups them into four main types. The first of these includes islands that are formed by subduction along the boundary between the oceanic Pacific plate and the continental Indo-Australian plate. Termed, rather paradoxically, as continental islands (Thomas, 1963) these islands tend to be large, have relatively mountainous topography and well developed river systems. All of these islands are found in the western Pacific and coincide with Melanesia. East of the plate boundary the islands are often referred to as oceanic. Formed over hotspots in the earth's mantle these islands begin as volcanic high islands (examples include Upolu and Savai'i in Samoa and Rarotonga in the Cook Islands) but, through plate movement and oceanic and atmospheric processes, subside and are eroded away. Barrier reefs, composed of coral, become atolls – roughly circular collections of low lying (often less than five metres above sea level) islands made up of coral sand with insignificant soils and a narrow biodiversity such as those which make up Tuvalu, the Marshall Islands and Tokelau. Finally, there are 'raised limestone islands' which are atolls that have been stranded above current sea levels (e.g. Nauru and Niue). Table 1 lists the characteristics of these island types and Figure 1 shows the predominant island type of each of the PICTs covered in this study.

Table 1 Types of Island in the Pacific Region

Island Type	Implications for Hazards
Continental Large High elevations High biodiversity Well developed soils River flood plains Orographic rainfall	Located along subduction zone and prone to earthquakes and volcanic activity. River flooding more likely to be a problem than in other island types. In PNG high elevations expose areas to frost (extreme during El Nino).
Volcanic High Islands Steep slopes Different stages of erosion Barrier reefs Relatively small land area Less well developed river systems Orographic rainfall	Because of size few areas not exposed to tropical cyclones. Streams and rivers subject to flash flooding. Barrier reefs may ameliorate storm surge and tsunami. More recent islands may be prone to volcanic eruption.
Atolls Very small land areas Very low elevations No or minimal soil Small islets surround a lagoon Shore platform on windward side Larger islets on windward side No surface (fresh) water Ghyben Herzberg (freshwater) lens Convectional rainfall	Exposed to storm surge, 'king' tides and high waves. Narrow resource base. Exposed to fresh water shortages and drought. Water problems may lead to health hazards.
Raised Limestone Islands Steep outer slopes Concave inner basin Sharp karst topography Narrow coastal plains No surface water No or minimal soil	Depending on height may be exposed to storm surge. Exposed to fresh water shortages and drought. Water problems may lead to health hazards.

The Pacific Islands region is commonly classified into three broad cultural regions: Micronesia, Melanesia and Polynesia (see Figure 2). There is considerable debate about the appropriate use of these regions, particularly in relation to the different cultural forms they are often used to differentiate (e.g. Thomas, 1989). PICTs display a great deal of social and cultural diversity, not only among these regions but also within them. While Polynesian countries are often characterised as having quite high levels of homogeneity, Melanesia is marked by very high levels of cultural diversity (for example Vanuatu with a population of around 216,000 has over 100 languages). Micronesia tends to lie somewhere between these two. The geographical distinctions among these regions are not always clear cut. Polynesian outliers, islands peopled by people of Polynesian ancestry, can be found in Melanesia and Micronesia. The boundaries between these 'regions' are also blurred. For example, while Fiji is considered to be part of Melanesia, there are strong Polynesian influences, especially in the east where the Lau group of islands has strong connections to Tonga. As is noted below some outliers and the Lau group are heavily represented in this study.

Table 2 Pacific Island Populations

Country	Region	Population 2004 (est.)
Papua New Guinea	Melanesia	5,695,300
Fiji Islands	Melanesia	836,000
Solomon Islands	Melanesia	460,100
French Polynesia	Polynesia	250,500
New Caledonia	Melanesia	236,900
Vanuatu	Melanesia	215,800
Samoa	Polynesia	182,700
Guam	Micronesia	166,100
Federated States of Micronesia	Micronesia	112,700
Tonga	Polynesia	98,300
Kiribati	Micronesia	93,100
Northern Mariana Islands	Micronesia	78,000
American Samoa	Polynesia	62,600
Marshall Islands	Micronesia	55,400
Palau	Micronesia	20,700
Wallis and Futuna	Polynesia	14,900
Cook Islands	Polynesia	14,000
Nauru	Micronesia	10,100
Tuvalu	Polynesia	9,600
Niue	Polynesia	1,600
Tokelau	Polynesia	1,500
TOTAL		8,615,900

Source: Secretariat of the Pacific Community (SPC) (2004)

There are also great variations in terms of demographic characteristics. Populations range from very small (e.g. Tokelau and Tuvalu) through to Papua New Guinea which is larger than New Zealand (see Table 2). As noted earlier, smallness has been associated with high levels of vulnerability to disaster: only one country in the region has a population exceeding 1,000,000 and there are 12 with populations below 100,000. Crude population densities range from 6 to 481 persons/km^2 and projected annual average growth rates over the next 10 years range from 3.1 to -3.8.

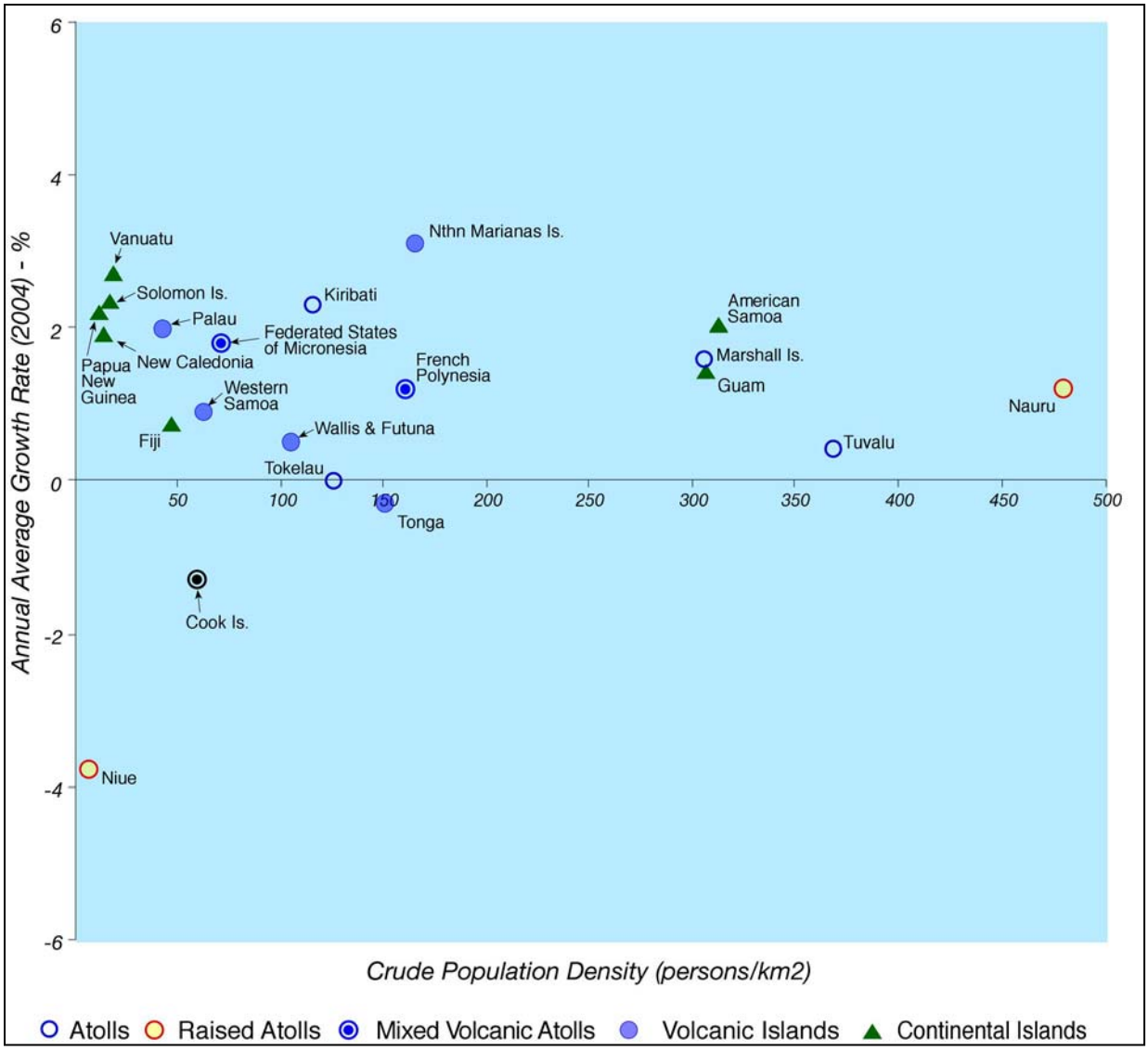

Figure 1 Population characteristics of Pacific Island Countries. Demographic data extracted from Secretariat of the Pacific Community (SPC) (2004). Note that this Figure also identifies the predominant island type found in each of the countries.

Figure 1 shows annual average growth rates and population density for PICTs. As the Figure shows, population densities are often considerably greater in the smaller countries including some of the atoll nations. On the other hand, the countries with the largest land areas have some of the highest growth rates (but low population densities). Of course, crude national averages obscure high levels of variation within countries. Countries with low annual growth rates are also of interest. Many of these are countries with high levels of emigration enabled by arrangements with metropolitan countries. Such a pattern is significant in contemporary disaster response as expatriates often send money and goods to their home communities after disasters.

2.2 The data

The study drew on ethnographic and early travel writings and from more recent research on disaster occurrence and response. A total of 184 items were entered into a bibliographic database and useful information (of varying degrees) was extracted from 177 of these. Figure 2 shows the geographical coverage of the source materials although this does not indicate the degree of detail in the respective sources.[2] In terms of the widely used broad cultural areas of the Pacific Islands region, Polynesia and Melanesia dominate. Here too there are problems: there are several Polynesian outliers in Melanesia and Micronesia and two of these have been subject to intensive ethnographic research: Tikopia (part of Solomon Islands) and, to a lesser degree, Kapingamairangi (part of Ponhpei State in FSM). Furthermore, eastern Fiji (the Lau group of islands), where quite a number of studies were drawn from, has strong Polynesian cultural influences.

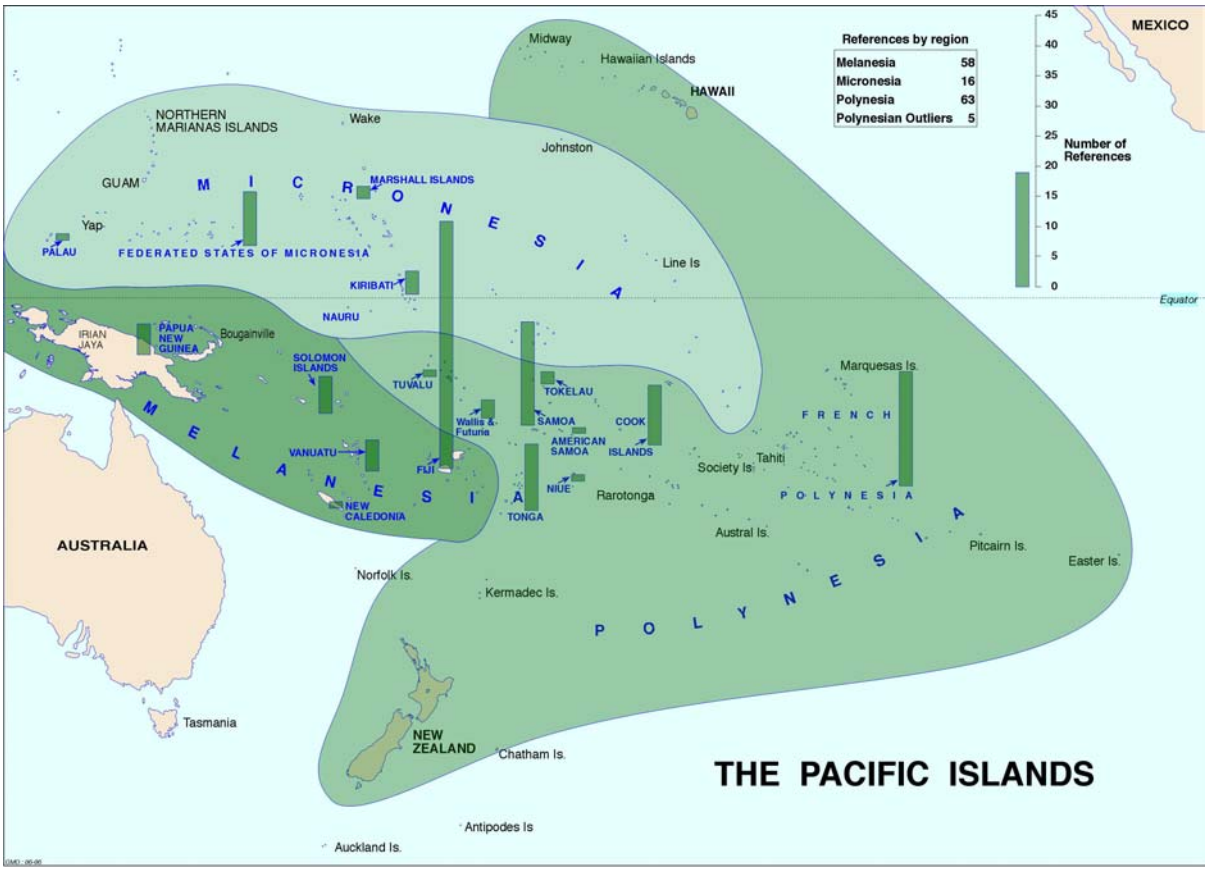

Figure 2 Map showing the geographical distribution of places included in the references, by country. Note: several texts referred to more than one country while other texts referred only to the broad 'culture' regions in general. Those texts which covered the entire area in general terms are not included.

[2] The allocation of contemporary political jurisdiction to places referred to in older writings is not always straightforward. In particular the former US Trust Territories of the Pacific Island were often described geographically as the Caroline, Mariana and Marshall Islands. While the latter remains today the Carolines have become divided among the four states of Federated States of Micronesia and the independent Palau. The Marianas now are divided into Guam and the Commonwealth of the Northern Marianas.

2.3 Natural Hazard

The term natural hazard is highly ambiguous. In common usage the concept of a natural hazard seems to be commonly conflated with that of a natural disaster: extreme natural events that cause widespread devastation and disruption. If we turn to a dictionary, however, the term hazard implies the potential for a negative outcome. From this perspective a hazard is a condition rather than a specific event. Accordingly, the tropical cyclone hazard in PICTs is the potential that such an event will occur, and that the result (for those who experience it) will be a negative one. This is the meaning of the term implied in the, mainly developed country based, work of Gilbert White and his followers (e.g. Burton, Kates and White, 1978, 1993).

Burton, Kates and White were seeking to draw attention to the role that humans have in creating disasters by failing to adjust appropriately to hazards so that when the potential for an extreme event was realised they experienced negative outcomes. These researchers sought to illustrate that failure to adjust successfully lay in people's (individuals, groups and governments) failure to fully understand the nature of hazards and the measures needed to ameliorate them. They adopted a systems approach in which 'rational' decision making was mediated by people's perception of their environment and ways of interacting with it. White's work was an outcome of the failure of a technocratic approach to disasters in the United States, where increasing investment in engineering approaches to flood protection were being matched by increasing losses from flood disasters. He and his followers saw human behaviour as a key to understanding why events, such as floods, caused so much devastation, despite massive investments in flood 'protection.' Land use planning approaches to hazard management that seek to keep people (including their buildings and other assets) away from the water, rather than the water away from them, are heavily influenced by this work.

The application of this approach to the developing world has delivered less promising results and some criticism (e.g. Waddell, 1977; Torry, 1979). In many developing countries people have little in the way of residential choice, either because of traditional systems of land tenure or because of poverty. Moreover, other land use activities such as agriculture have been heavily transformed by colonialism and the expansion of the global market economy. A seminal paper in *Nature*, by O'Keefe *et al.* (1976), questioned the very naturalness of 'natural disasters' pointing out that many disasters in the third world were caused by these so-called 'development' processes that rendered large numbers of people vulnerable. The solutions to hazard management lay not in understanding individual decision-making, but in economic systems which undermined people's livelihoods and exacerbated environmental degradation. They considered that understanding disasters in the third world requires not only accepting that nature cannot be 'controlled', but that individual choice and 'rational' decision making are made unachievable by political economic processes. This is most clearly articulated by Blaikie et al. (1994; second ed. Wisner et al., 2004) who outline a sequential process in which communities become vulnerable to hazards by the operation of systems of economic and political power relations. For them, hazards are not potential environmental extreme events, but actual events that devastate vulnerable communities. The focus of their work is reducing vulnerability, rather than reducing the magnitude of the extreme event (in their words, the hazard). This type of approach is gaining increasing acceptance among social scientists concerned with disasters in the third world. The concern of these writers is to draw attention to the role social processes play in producing

vulnerability. While it may be argued that patterns of extreme events may be changing, the rapid increases in third world vulnerabilities are due not so much to environmental change, but to social transformations resulting from processes such as colonialism, independence, development and globalisation.

This study does not focus on the causation of disasters in Pacific Island Countries and Territories, but on traditional measures that ameliorated the negative effects of extreme natural events. An implication is, nevertheless, that political economic processes have played a major role in the loss, or reduction of the importance and efficacy, of these measures. The study does, however, adopt the notion of hazard as a potential event, for many measures that we describe operated in the expectation that extreme events would occur from time to time, rather than as events which were responded to once they had happened. Table 3 outlines the range of extreme events that may be experienced in the Pacific Island region.

Table 3 Hazards in the Pacific Islands Region

Geophysical		**Biological**	
Meteorological	**Geological**	**Floral**	**Faunal**
Tropical Cyclone	Volcanic Eruption	Weeds	Pests
Drought	Earthquake	Fungal diseases	Disease vectors
Flooding	Tsunami	Human	Human
River	Slope Failure	Animals	Animal
Coastal	Erosion	Plants	
Frost	Slope		
	River bank		
	Coastal		

After Burton, Kates and White (1993)

The literature that was reviewed for this study, with only a few exceptions, focused almost entirely on meteorological hazards, particularly drought and tropical cyclones. Despite the location of the Melanesian islands in particular, along tectonic plate boundaries, little of the literature discusses the effects of geological hazards. Two exceptions are Schwimmer's (1969, 1977) anthropological work on the effects of the 1951 Mount Lamington eruption in Papua New Guinea and more recently the participatory work on the volcanic hazard on Ambae by Cronin et al. (2004). Blong (1982) examines a number of 'time of darkness legends', from different communities, pertaining to a major volcanic eruption in Papua New Guinea around 300 years ago. His work outlines the effects of the event but there seems to have been little in the legends about how people coped. Only one of the texts referred to in the present study reported in detail on response to earthquakes. However, these were not traditional responses but consisted of the provision of disaster relief. In some sources earthquakes are referred to, but the observation has been that they had little effect given the nature of the traditional buildings (perhaps indicating successful adaptation), and unless landslides resulted there was little damage to agriculture. There is some reference to tsunami events in the literature reviewed in this study but little on traditional responses to them. Alkire (1978) notes that a 'severe seismic wave' struck Pukapuka in the 1600s causing considerable destruction and some deaths. The chief of the island ordered that all survivors should be temporarily relocated. While the term 'tidal wave' was found in a number of the sources, it almost invariably referred to storm surges that accompanied tropical cyclones.

2.4 Traditional Mitigation

A contention of this report is that Pacific Island communities traditionally did indeed have a number of characteristics that reduced natural disasters (i.e. reduced the negative effects of extreme natural events). It would be easy to slip into a simple environmental determinism in assuming that these patterns emerged as a response to environmental extremes. Maybe some did, but others may have a myriad of social, cultural, economic and political reasons for their emergence. For example, later in this report the building of houses on raised mounds is listed as a factor that helped reduce the impacts of floods and storm surge. However, several early writers observed that these mounds had social and political roles: the higher the mound, the greater the status of the resident. That many traditional measures declined under a range of contact, colonial and post-colonial circumstances that had little to do with disaster occurrence suggests that adaptation to potential environmental extremes may not have been the motivation. However, other mechanisms also fell away because the provision of disaster relief rendered them unnecessary, suggesting that they were indeed adaptations to hazards. Whatever their rationale, it is important to recognise that many of these aspects of 'traditional life' did help offset the effects of disasters.

Four sets of traditional disaster reduction activity were identified in this study: cooperation (intra- and inter-community), food security, traditional knowledge systems and settlement characteristics. These are shown in Figure 3 together with a fifth category that includes changes to these traditional elements and new or contemporary practices. There is overlap among the various categories. For example, food preservation was often only achieved by cooperation among numerous community members as was traditional house building in many places. It should also be noted that the frequency of different facets of disaster reduction in the references does not necessarily reflect their relative importance. Most of the texts consulted were written with purposes other than disaster reduction in mind. For example, many of the anthropological works focused on material culture and included detailed accounts of house building techniques (many of which strengthened the structures) and accounts of food preparation methods often included descriptions of food preservation. The reports rarely note the role of these elements in disaster reduction.

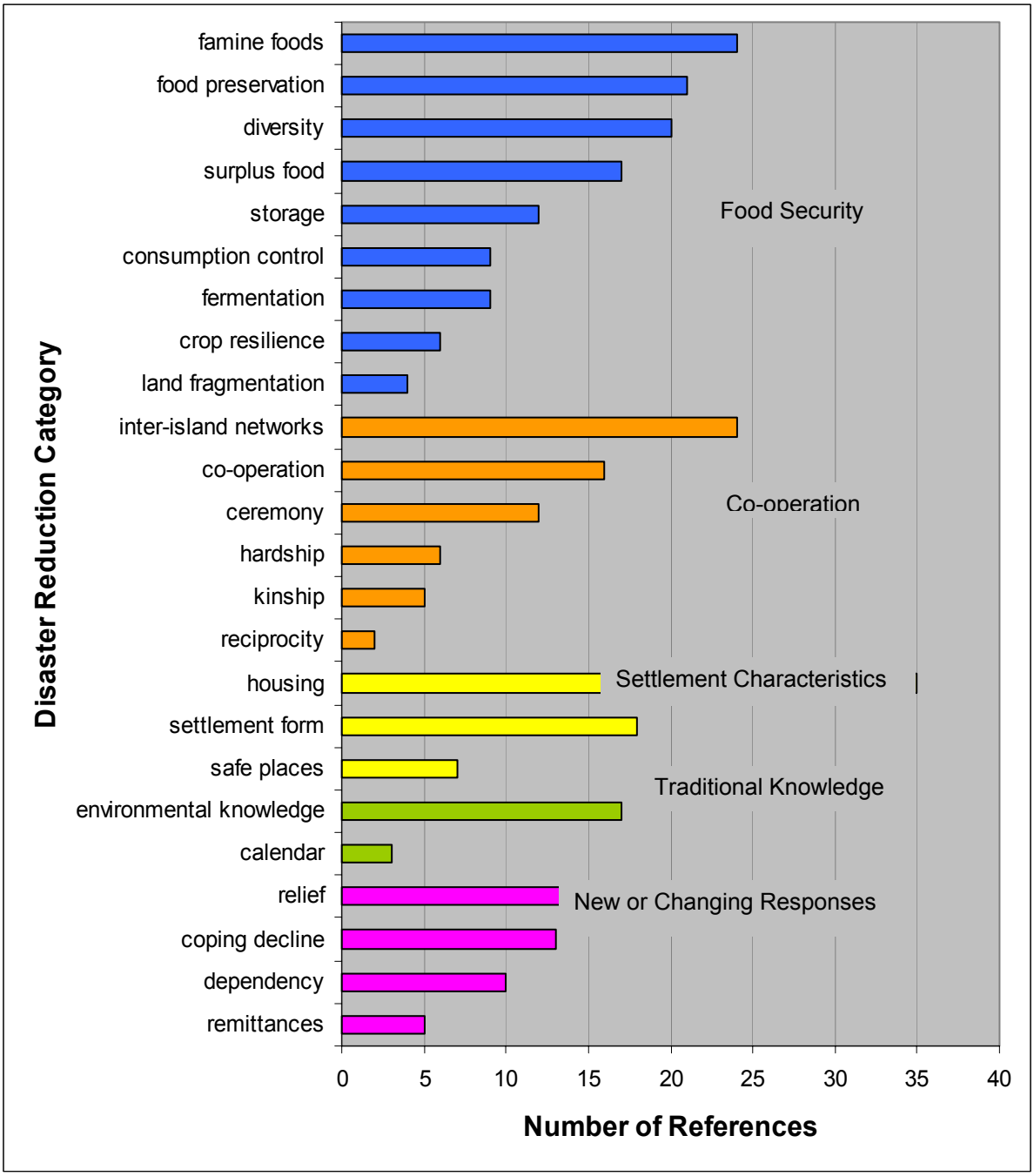

Figure 3 Summary of keyword occurrence in bibliographic database.

3.0 FOOD SECURITY

In traditional times Pacific island communities were composed of subsistence agriculturalists and throughout much of the contemporary Pacific region a strong subsistence economic sector remains. Today this is often supplemented by commercial crop production, such as coconuts from which copra is derived, or food crops for sale in urban markets. Climatological extremes such as tropical cyclones and droughts have the potential to cause considerable damage to agricultural systems through wind damage, salinisation, water logging, silting and moisture stress. While the immediate effects of a tropical cyclone often appear spectacular,

it may take a year or more for crops to recover.[3] It was, then, critical for Pacific island communities to maintain sustainable systems of food production and supply. This was achieved through the production of surpluses, the use of famine-foods, control of food consumption and the maintenance of agricultural resilience through a diversity of cultivars and the use of resilient crops.

3.1 Food Surpluses

Probably the most important element of traditional disaster reduction in Pacific communities was the production of food surpluses which underpinned a number of other disaster reduction measures. The economist E.K. Fisk (1962) described traditional Melanesian societies as living in 'subsistence affluence', a lifestyle in which all food and other needs, such as shelter, could be obtained with minimal labour and ample time for recreation, leisure and other social activities. Moreover, Fisk observed that such societies had ample surpluses which could be used for ceremonial and emergency purposes.

Belshaw (1957, p. 146), in writing about Hanuabada (a village located where part of Port Moresby now stands), provides an indication of the deliberate nature and magnitude of surplus food production. 'Traditional feasting was not a programme for the consumption of existing stocks of goods. It quite definitely involved the production of extra supplies. In early days there must have been a much greater proportion of feasts to population than now; thus agriculture must have been geared almost entirely to the feasts and dances.' The role of ceremony and its link to disaster response is discussed in a later section. But, surpluses were also used in many other ways.

3.2 Food Preservation and Storage

As much of the food produced in Pacific Island communities is seasonal, surpluses needed to be stored in some way. There were a variety of such methods ranging from simply leaving some crops in the ground and the use of yam houses through sophisticated methods of food preservation to storage as fat.[4] Most references to yam houses were linked to parts of Melanesia (e.g. Malinowski's (1921, 1922) descriptions of the storage of yams in the Trobriand Islands). However, storage houses have been reported elsewhere such as in Tokelau, and Manihiki and Rakahanga in the northern Cook Islands (Macgregor, 1937). Wilkes (1845) and Patterson (1925) indicate that yam houses were a common feature on the leeward parts of Fiji.

Atoll communities, in particular, have very narrow terrestrial resource bases with relatively few edible plants. Coconuts, breadfruit and pandanus are all salt tolerant and hardy, but only the former is not seasonal. The latter, especially breadfruit, are often preserved by storing in

[3] Although it is outside the scope of this report it should be noted that rural communities that cultivate coconuts as a cash component of their economy often lose earnings for a much longer period of time as the full recovery of coconut palms (which are often badly damaged rather than destroyed) may take as long as five to seven years. From this perspective incorporation of rural communities into the market economy has considerably increased their vulnerability.

[4] The following references included information on food storage and preservation: Aalbersberg, 1990; Aitken, 1930; Alkire, 1978; Angas, 1973; Baxter, 1980; Bell, 1931; Britton, 1987; Burrows, 1937; Campbell, 1992; Campbell, 1990; Chung, 1985; Crocombe, 2001; Emory, 1965; Ferdon, 1981, 1987; Firth, 1974; Fischer, 1966, 2002; Hurrell, 1984; Kirch and Yen, 1982; Oliver, 2002; Pollock, 1992; Pritchard, 1968; Sahlins, 1962; Talu et al., 1979; Thaman, 1982,1990; Thompson, 1940; Turner, 1984; Yen, 1980.

a leaf lined pit, which is covered by sand, and left to ferment until required. Such preserved food may last for up to two years. Twenty six of the references used in this study referred to atolls and the majority of these drew attention to the critical role of fermentation in maintaining the habitability of these low-lying environments. However, such practices were not confined to atolls. Fermented food was an important component of early Fijian diets (e.g. Hocart, 1929; Seeman, 1862; Thompson, 1940; Wilkes, 1845). On Mota Lava in northern Vanuatu, fermentation of breadfruit was carried out in order to offset seasonal food shortages and serve as an emergency food supply (Campbell, 1990). Pollock's (1992) work indicates that fermentation was widely practiced across Polynesia and Micronesia and was by no means confined to atolls.

Indeed, Pollock (1992) presents a comprehensive review of the role of food in the central and eastern Pacific, comprising mostly Micronesian and Polynesian islands. She points out that food has considerable social, cultural and spiritual value and is central to life beyond biological sustenance alone. However, she also notes the critical role that preservation plays in offsetting seasonal variations in food availability and periodic destruction of crops as a result of tropical cyclones and drought. Table 4 is drawn from Pollock's work and illustrates the wide range of foods and means of preserving them.

Table 4 Methods of food preservation in Central and Eastern Pacific (after Pollock 1992)

Method of Preservation	Country
Fermentation	
Taro	Hawai'i, French Polynesia, Wallis and Futuna
Breadfruit (in pits)	Federated States of Micronesia, Marshall Islands, French Polynesia, Samoa, Tonga, Fiji, Wallis and Futuna
Other foods in pits	Fiji (11 kinds), Anuta (5), Tikopia, Samoa (1)
Holding (in pits)	
Foods other than the above	New Zealand (kumara), Wallis and Futuna, Samoa, French Polynesia, Cook Islands (banana)
As Flour	
Pandanus (dried in cakes)	Marshall Islands, Nauru, Kiribati, Federated States of Micronesia, French Polynesia
Arrowroot	Guam, Northern Mariana Islands, Rapanui (Easter Is.), French Polynesia, Cook Islands, Samoa, Tonga, Niue, Wallis and Futuna, Tokelau, Marshall Islands, Federated States of Micronesia
Long baking	
Ti (cordyline)	Tonga, Niue, Fiji, French Polynesia, Cook Islands
Other foods	French Polynesia (breadfruit), Niue (*kape talo*, *he luku* fern root, *tau* banana plant root)
Leaving in Ground	
Alocasia	Kiribati, French Polynesia
Yams	Federated States of Micronesia
Drying	
Taro	Hawai'i, Guam

Source: After Pollock, 1992, p. 92. Note: Pollock identified individual islands. In this table only countries are shown.

Several of the texts, especially those which were general accounts of the Pacific region (e.g. Campbell, 1992; Fischer, 2002), suggest that food preservation was considerably less prominent in Melanesia. This appeared to be based on the assumption that the island environments in Melanesia, the larger continental type islands closer to the Asian source area of many plants and other species, were much more fertile and had greater biodiversity.

However, evidence from the island of Mota Lava, in northern Vanuatu suggests this was not the case. Mota Lava is a small island, but its crops are similar to the larger islands in Vanuatu. The main traditional root crop was yam (Dioscorea spp.) supplemented by taro. In addition, breadfruit played a very important role when in season. Nevertheless, several forms of food preservation were practiced in Mota Lava. These included pit fermentation of breadfruit and storing yams in the ground as well as in yam houses. The people on Mota Lava also had a method of drying breadfruit using intense heat. The breadfruit was then wrapped in several layers of leaves and stored in cupboards which were hung above the cooking stones inside the house and continually kept dry (see Figure 4). The method was still being used in the 1980s but with only relatively small amounts which when eaten with hot water and sugar, were considered something of a delicacy (Campbell, 1990).

Figure 4 Preservation of Breadfruit by Drying. A. The dried breadfruit with the central seeds and outer skin removed prior to heating., B. the Breadfruit is wrapped and, C. the drying cupboard which is hung from the roof above the cooking stones.

Hiroa (1950) describes the processing of rolls of pounded, dried and wrapped breadfruit in Kapingamarangi. It would appear that systems of food preservation and storage were found throughout the Pacific Islands region, including Melanesia. This is not surprising given that Vanuatu, Solomon Islands and Fiji have among the highest incidence of tropical cyclone occurrence.

3.3 Agricultural Resilience[5]

Another important contribution to food security was the maintenance of resilient agro-ecosystems by Pacific Island communities. William Clarke (1977) referred to these systems as ‘structures of permanence’. This was achieved in many ways. First, most Pacific island communities maintained a broad diversity of economic plant species. One benefit of such an approach is that different crops have different responses to different types of environmental

[5] Information on crop resilience was drawn from the following references: Barrau, 1961; Brookfield, 1988; Campbell, 1990; Chung, 1985; Clarke and Thaman, 1993; Firth, 1974; Fischer, 1966; Howlett, 1973; Kirch and Yen, 1982; Knapman, 1976; Maiasa, 1983; Ministry of Foreign Affairs, 1985; Nayacakalou, 1978; Paulson, 1993; Sahlins, 1962; Smythe, 1864; Thaman, 1982; Thaman, 1990; Turner, 1984; Ward, 1986; Whyte, 1990; Yen, 1980.

extreme. For example, yams tend to withstand high winds relatively successfully. The above ground foliage may become badly damaged but the root itself may escape unscathed. Taro, is a little less resilient to high winds as the stems under stress from the wind are often damaged where they join the root and this may lead to rotting. However, yams are much less suited to watery conditions and if water logging occurs as a result of a storm, then they may be adversely affected. Figure 5 shows the path of Tropical Cyclone Meli (1979) in eastern Fiji. The cyclone passed almost directly over the island of Nayau and very close to Lakeba and Cicia. Other islands in the southern Lau group lay at a variety of distances from the storm centre and were affected by winds of lesser velocity.

The effects of Meli on agriculture in the islands affected are revealing. As Table 5 shows, not all crops received the same degree of damage and some sustained quite high levels of damage even though they were located at some distance from the storm centre. In particular, yams appear in the table as being perhaps the most resistant and crops such as sweet potato, Alocasia and Xanthosoma, while suffering complete destruction at the storm centre, were relatively resistant at only short distances from the storm centre. The least resistant of the root crops was cassava (*manihot esculenta*) which is not a traditional crop (and in some places was introduced, ironically, as hurricane relief planting material). As might be expected given their greater exposure to the wind, tree crops tended to suffer higher rates of damage, but again there is variation with distance from the storm centre with Pandanus appearing the most resilient.

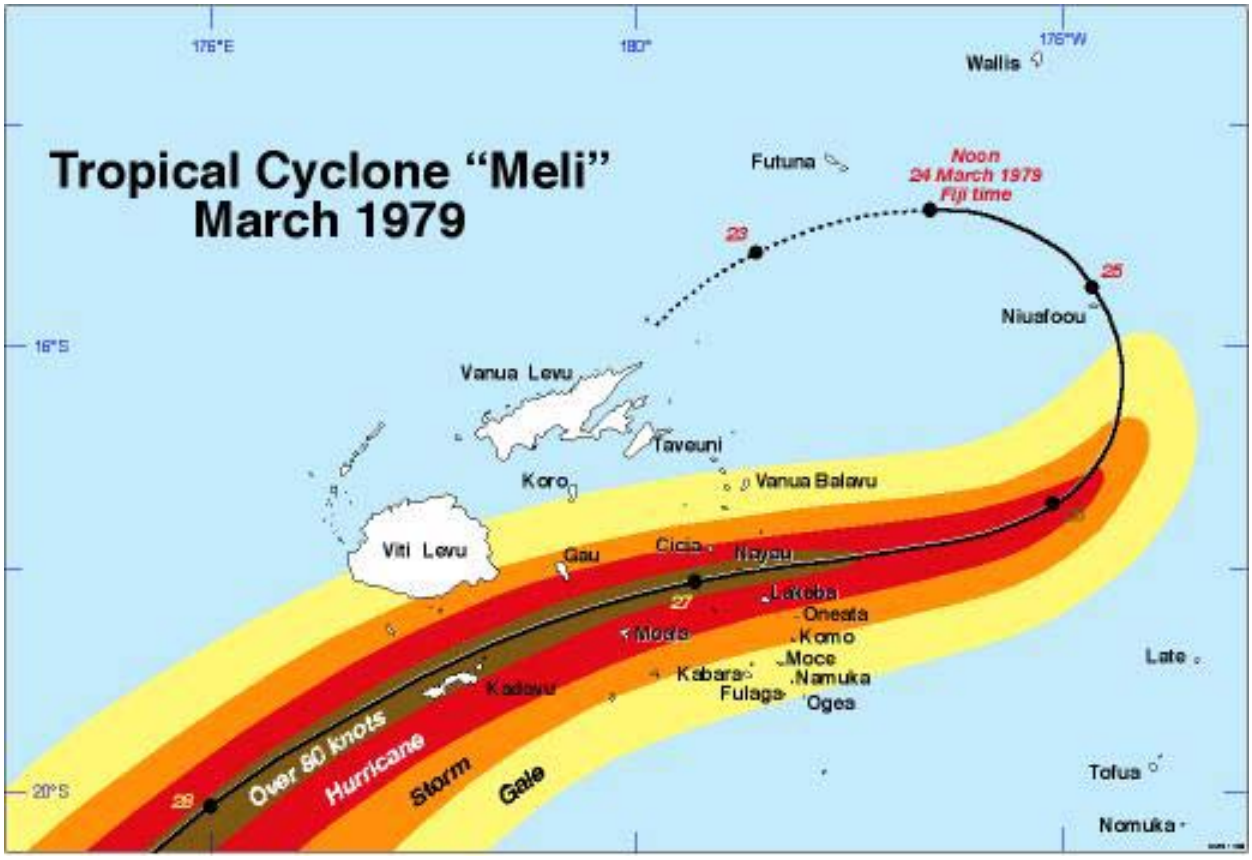

Figure 5 Tropical Cyclone Meli in the Lau Group, Eastern Fiji, in 1979.

Table 5 Damage to crops in the Lau Group, Eastern Fiji, recorded after Cyclone Meli (see also Figure 5.)

Island	Distance from Nayau (km)	Root Crops						Tree Crops			
		Yam	Taro	Cassava	Sweet Potato	Alocasia	Xantho-soma	Pandanus	Banana	Coconut	Breadfruit
Nayau	0	80	100	100	100	100	100	97	100	100	100
Cicia	30	54	96	100	80	100	56	59	100	91	100
Lakeba	30	48	55	94	87	88	28	20	82	75	50
Vanuavatu	45			75	75	50	25		75	60	50
Oneata	67	10		60	10	50			50	40	40
Komo	86			60	10			20	40	30	40
Moce	88	10		60	10			20	50	40	40
Namuka	99			50	20				50	15	30
Kabara	99	10		60	10			10	50	40	
Fulaga	129			50	5				40	10	30
Ogea	142			50	10			4	40	10	30

Source: Campbell, 1985

A further contribution to crop resilience was the protection given to swidden type gardens by the surrounding forest in which they were located. Many of these gardens were also characterised by considerable crop diversity which mimicked the natural forest (Clarke, 1977).

Land fragmentation resulting in households having gardens scattered in different locations throughout an island results largely from systems of land tenure such as the splitting of tenure arrangements through marriage or among descendents. Such fragmentation is often associated with inefficiency in agriculture in developing countries. However, it plays a not insignificant role in reducing damage from extreme events. Alkire (1965, p. 171) observed that many fragments were on land that was less fertile or suitable than the main agricultural areas but were still cultivated nevertheless.

> Human survival on small islands often depends on a maximum exploitation of available resources. Emergencies may take large areas of the island out of production for extended periods of time. Other areas of the island, where cultivation may not have been justified previously and whose production might have been considered surplus, can rapidly become production which spells the difference between survival and starvation. A situation such as this encourages a system of continual ownership of all areas, and thus recognition of alternative means for transmitting land from person to person or group to group with a minimum of dispute. And, in addition, lineage, sub clan, and clan land holdings, become dispersed, not only on individual islands, but also between islands.

On high islands, locations with different aspects may not all experience the same wind speeds with some being more sheltered than others. Land fragmentation, rather than being irrational and economically inefficient, may be seen as an effective disaster reduction measure.

3.4 Famine Foods

There were three approaches to the use of famine food identified in the literature review.[6] These included a) the use of plants that were not usually eaten but, even if not deliberately planted, were provided at least rudimentary agricultural attention, b) the use of wild plants that were obtained from natural forest, and c) the setting aside of land for cultivation, but for use only under emergency conditions.

> Wild food resources are among the most important products of agroforestry systems, particularly in Melanesia, where extensive stands of primary and secondary forest remain. Most notable among these are a great diversity of wild yams, ferns, fungi, fruits, nuts and leaves and birds, frogs, snakes, grubs, insects, fin fish, eels, freshwater prawns, and other foods that are found in agroforestry zones. Even in grassland areas and on atolls, wild yams, ferns, wallabies, kangaroos, birds, edible plants, and crabs constitute wild or emergency food resources. (Clarke and Thaman, 1993, p. 205.)

[6] The following texts referred to the use of famine foods: Alkire, 1978; Brookfield, 1988; Burrows, 1937; Chung, 1985; Clarke and Thaman, 1993; Craighill Handy, 1930; Crocombe, 1982; Crocombe, 2001; Eason, 1967; Ferdon, 1993; Firth, 1974; Holmes, 1881; Howlett, 1973; Ivens, 1930; Johnston, 1967; Kirch and Yen, 1982; Legislative Council of Fiji, 1965; Loeb, 1926; Maudslay, 1930; Nayacakalou, 1978; Oliver, 1955, 1975, 2002; Sahlins, 1962; Strathern et al., 2002; Thaman, 1982, 1990; Thompson, 1940; Turner, 1984 .

Thaman (1990) identified over 60 non-cultivated terrestrial and aquatic plants that were used in Fiji. Many wild species, especially those that grow in the forest or bush, are offered protection during events such as tropical cyclones and survive the events more effectively than exposed crops.

A number of species were identified as famine foods. Some of these require careful preparation in order to be edible. For example sago and Alocasia both require soaking in order to remove toxins and the former then has to be processed in order to make edible flour. Key wild sources of carbohydrate included wild yams (*dioscorea bulbifera, Dioscorea nummularia*), sago (*Metroxylon spp.*), alocasia and arrowroot (*Maranta arundinacea*). Interestingly, some of these so-called famine foods were used as staples in other island environments. The Alocasia is the *pulaka* or *babai* grown in the manufactured pits found on the atolls of Tuvalu and Kiribati and sago is a staple in some of the lowland swampy areas of Papua New Guinea.

There were also numerous nuts (e.g. the Tahitian chestnut (*Inocarpus fagiferus*)) and fruits that could also be gathered from the forest. As with the wild starches, these often also required elaborate preparation. Thompson (1940) described the preparation of the wagiri, a nut bush food used in the southern Lau group of Eastern Fiji. First, they were heated on hot 'coals' to crack the hard shell cases of the nuts and then soaked in brackish water for "at least four nights". However, they were still not ready until they were boiled or cooked in the earth oven. There were also numerous ferns, fungi and leaves that were consumed during times of shortage (Clarke and Thaman, 1993).

Ferdon (1993) speculated that some crops in the Marquesas that were eaten as famine foods, such as sweet potatoes and yams that grew at higher latitudes, had in fact been purposefully planted and left to go feral. MacGregor (1937) described the division of land on Fakaofo, in Tokelau, where two parcels of land were set aside by the chief for communal use. The coconuts and pandanus on this land could only be consumed when other food sources had failed. A similar system of "reserve land" was also observed on Pukapuka (northern Cook Islands).

3.5 Consumption Control[7]

A number of the references observed the social importance of food and its connection with mana (e.g. Bell, 1931). Often this was manifested in the provisioning of feasts and ceremonies. Equally important was the monitoring of crop production and its harvest often with the placement of restrictions on consumption at certain times. This helped to ensure that adequate, if not ample food supplies, would be available.

An important element was the concept of first fruits. In many traditional communities harvesting of crops was forbidden until permission was given by either a chief or crop custodian. Ferdon (1987, p. 218) describes the situation in Tonga where a position equivalent to "agricultural overseer" was given to a member of the chiefly class.

[7] The following texts provided information on consumption control: Barrau, 1961; Bell, 1931; Craighill Handy, 1927; Ferdon, 1987; Grimble, 1989; Macgregor, 1937; Oliver, 2002; Pollock, 1992; Thompson, 1940

> He and his deputies ensured that each farmer planted a prescribed quota of crops, presumably for use over and above his personal needs. When any given food source became plentiful, it was up to the overseer to see that his chief received the desired amount. However, of even greater importance was his ability to curtail the use of certain food sources that had become dangerously scarce. This he did by placing a religious sanction, or taboo, against their use until such time as production had been bought back to a level that assured their continuation. This sanction, known in Tonga as *tapu*, was so strong that only great chiefs could break it without pain of death.

There were many religious elements to these activities and first fruits were often given as offerings to deities such as those responsible for the fertility of the land. They also were highly political in that they served to reproduce power relations. Nevertheless, they played an important role in ensuring sustainable consumption of food products. Such practices were widespread. Alkire (1978) describes a restriction in Tongareva (northern Cook Islands), known as the *masanga*, that forbade use of specified coconut trees to in order to sustain their productivity. Barrau (1961) describes a system of *rahui* in French Polynesia in which consumption of crops from certain areas was prohibited. As the *rahui* were progressively lifted harvesting would move from one location to another effectively conserving the resource.

4.0 CO-OPERATION

The second broad category of disaster reduction was co-operation both within and among communities and within and among islands. As the previous section on food security indicated, surpluses and their management were not brought about through individual actions alone. Many of the activities such as preservation and consumption control required some form of political organisation and co-operation among community members.

4.1 Ceremony[8]

As noted in the previous section, ceremonial feasting was an important part of all Pacific Island cultures. Such feasting was underpinned by food production, and in particular, the production of surpluses. A number of the texts referred to the role of ceremonial feasting in redistributing food through a person of high status to other members of community. This enabled obligations to be established in which the chief or 'big man' (in the case of Melanesia) gained support from their community. In turn community members may expect assistance from their leader in times of hardship. Bell (1931, p. 126) noted, in relation to central Polynesia, that,

> The close relationship which exists between the method of producing food and the kinship group further emphasises the social importance of food. Looked at from this angle food acts as a direct means of keeping together members of the same kinship group; it is accessory to those ties which normally arise from blood relationship.

Without surplus food production it is possible that such strong bonds, which were critically important at times of disaster, may have been more difficult to sustain.

[8] The following references provided information on the role of ceremony: Bayliss-Smith et al., 1988; Bell, 1931; Belshaw, 1957; Campbell, 1992; Craighill Handy, 1927; Fischer, 1966; Grimble, 1989; Lewis, 1978; Maudslay, 1930; Oliver, 1955; Pollock, 1992; Thompson, 1940;

Kabara, in eastern Fiji is mostly a raised atoll with a small hill of volcanic origin providing a small amount of agricultural land. An important means of maintaining linkages among the island's four villages was a system of competitive ceremonial exchange known as the *solevu*. Thompson (1940, p.73) described *solevu* on the island.

> 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.

Interestingly enough, a post-disaster assessment team visited the Lau group, including Kabara, following cyclones Eric and Nigel in 1985 (some fifty years after Thompson's research on the island). They were largely unimpressed with many communities that seemed to be content to wait for the provision of relief but Kabara passed with flying colours.

> They observed that most of the islands were only slightly affected but people expected rations. The island most affected was Kabara. It was also the most well organised. The four villages had a combined meeting. Cyclone damages to houses, crops, water source, etc., were recorded on paper and community work organised. This included repairs to damaged houses and water holes and harvesting of crops (cassava). The cassava harvested was chipped and dried - probably the only community in the entire country which did some traditional food preservation. (Chung, 1985, p4.)

Perhaps the most important forms of co-operation were those that occurred under the most pressing hardship. The United States Exploring Expedition visited Viwa in Fiji in 1840 and was informed that "in times of scarcity each person was allowed no more than three coconuts a day (Wilkes, 1845, p. 314). Other cases of rationing were reported in Fiji following tropical cyclones in the 1880s (United Kingdom Parliament, 1887). Such rationing suggests that hardship was also a means of enduring disasters. When Lessa (1964, p. 331) reported on the response to Typhoon Ophelia which devastated Ulithi (now part of Federated States of Micronesia) he noted that relief was made available for the first time and expressed concern at the cultural effects this may have had.

> Had the people of Ulithi not hitherto been drawn into the world orbit, with inevitable consequences to its economy, political system, religion, and values, the storm would have merely created temporary dislocations without changing the *modus vivendi*. True, there would have been a severe decimation of the population due to the sudden loss of available foodstuffs, but in the pre-contact setting the typhoon would have been absorbed without appreciably changing the nature of the society or the culture.

Similar hardship was experienced elsewhere (e.g. Loeb, 1926). Buzacott (1866, p. 89) provides a sobering description of the effects of a tropical cyclone in Rarotonga in 1831.

> It was a pitiful sight to see men and women and children losing flesh. Many became as walking skeletons. This famine drained the strength, and weakened the constitution of the whole community, and thus made it an easy prey to the glandular disease, or scrofula, which, unfortunately, was soon after introduced into the island, and carried off the people by the hundreds in each village.

Crocombe (2001, p. 76) describes similar hardship in several parts of the region.

> In the Tuamotu atolls, more people died from famine after hurricanes than from the hurricanes themselves. To assuage hunger, they chewed pandanus fruits and coconut husks, massaged their stomachs and lay down to "hug their bellies in order to alleviate the hunger pains". The very old, the very young and the infirm did not survive. On rugged Rapa in the Austral Islands sea foods and root crops were abundant but the people went hungry when stormy weather prevented access to them. Frost or drought in the New Guinea highlands destroyed the sweet potato crop and caused starvation, wars, and migration.

It is important to keep in mind that such hardship did at times exist, and in so doing to avoid perhaps presenting an idealised image of the efficacy of traditional measures.

4.2 Inter-island networks[9]

But, feasting involved more than just members of a small community. Often it engaged people from different communities in which bonds were reinforced between their leaders and through that between the communities. There is little doubt that there were high levels of inter-community interaction in the Pacific region prior to colonisation. Figure 6 shows some of the larger 'trading' networks that existed in the region.

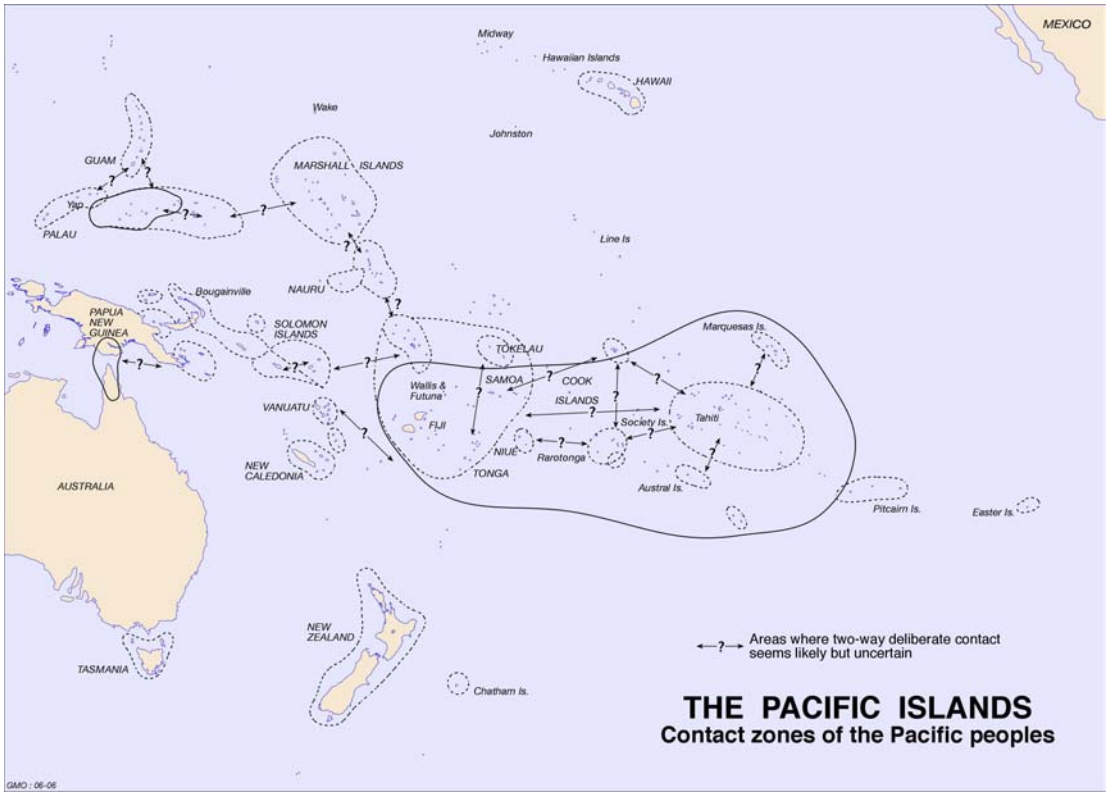

Figure 6 Map of the Pacific region showing some of the major contact zones or 'inter-island networks'. (After Lewthwaite, 1967)

[9] The following texts provided information on inter-island and other exchange networks: Alkire, 1965, 1978; Bayliss-Smith, 1975; Bayliss-Smith et al., 1988; Bell, 1931; Brookfield, 1988; Campbell, 1992; Fischer, 2002; Hurrell, 1984; Kirch, 2000; Kirch and Yen, 1982; Knapman, 1976; McLean, 1977; Mead, 1934; Nayacakalou, 1978; Reid, 1977; Thaman, 1990; Thompson, 1940; Yen, 1980.

There were many more localised networks as well. These networks helped solidify alliances between and among leaders and their communities, were often based on kinship linkages and frequently made use of environmental variations among different islands. The *solevu* described by Thompson extended well beyond the shores of Kabara to incorporate many of the Lauan islands.

> 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. (Thaman, 1990, p.77).

A similar pattern is found in northern Vanuatu where communities in the Banks Islands were traditionally linked through a social formation known as *suqe* (graded society). This was a system in which men increased their social rank by accumulating wealth in food, pigs, mats and shell money in order to pay their way into a higher grade. Wealthy men, of high status, would provide wealth to men of lower status to enable them to move up the ladder and in doing so created obligations. The items of value were found on different islands in the Banks' group thereby providing incentive for exchange among the different islands. Codrington (1863, p. 8) describes such an arrangement.

> It is the custom in the Banks' Islands for men to have in other places single special friends with whom they are connected by mutual good offices. Such a *pulsala* considers himself bound to provide food and lodging for his friend when he visits him, and will assist him in any way he needs it; and in return expects the same good treatment when occasion offers.

This pattern was described following a cyclone in 1873 when the people of Mota Lava assisted the communities on a nearby island, Mota, that had received greater devastation than their own.

> In 187[3], hearing that Mota was threatened with famine, the people met together and consulted how they could best send help. It was not a case of assisting out of their own abundance, for there was little enough food on the island, but it was agreed that a collection should be made … and with the [shell] money thus contributed they sailed across to Vanua Lava, the land of plenty, and bought a supply of food which they took over to Mota … (Anon, 1912, p. 24)

These inter-island social, political and economic networks, often underpinned by ecological variation among the islands concerned (see also Alkire, 1965), were important in disaster reduction in a number of ways. First, they could enable food to be made available to communities impacted by disaster. Second, it was not uncommon for people to stay with other communities while waiting for gardens to recover. Indeed, Hocart (1929) noted that people from Kabara had temporarily moved to Lakeba where they had planted gardens. The Melanesian Mission (1874, p. 17) noted that one community on Mota, after the tropical cyclone described above, 'migrated for the sake of food.' Third, members from non-affected communities would visit those impacted by disaster to assist in rehabilitation, perhaps bringing food, planting and building materials.

Not all communities were always marked by cooperative behaviour under stress. Spillius (1957) observed food theft and the breakdown of ceremony and ritual in Tikopia following a tropical cyclone in 1952. Similarly, McArthur (1967) reports missionary claims that famine in the Marquesas in the early nineteenth century led to major loss of life and cannibalism, and that post-storm famine in Mauke (Cook Islands) left the entire population weakened, providing an opportunity for an attack from nearby Atiu. However, the majority of reports are to the contrary indicating that communities largely survived in the Pacific over the millennia and co-operation was but one means by which this was achieved.

Co-operation, then, largely enabled by surplus food production played an important role in assisting communities to cope with the effects of environmental extremes. This occurred at the scale of individual communities, individual islands and groups of islands.

5.0 SETTLEMENT FACTORS[10]

Thus far, we have focused on food and ways in which Pacific Island communities traditionally ameliorated the effects of environmental extremes, such as tropical cyclones and drought, on food supplies. Food indeed was the priority following disasters: while rebuilding structures could be delayed (given the relatively warm climates of most PICTs) and temporary shelter found, food consumption could not be so easily deferred.

There was a wide range of settlement types found throughout the Pacific region, ranging from large villages on the one hand to scattered settlements on the other. Between these extremes were a variety of villages and hamlets of varying size. In some cases, such as Tonga and Tongareva in the northern Cook Islands, dwellings were scattered separately (Bellwood, 1978; Buck, 1932). Similarly, building styles vary greatly across the region from quite simple structures that could easily be replaced to complex houses and communal facilities.

There were certain settlement patterns that may have reduced the effects of tropical cyclones. For example, in many parts of the region communities lived away from the coast in higher areas that gave them protection from attack. One of the results of “pacification” brought about by missionaries and colonial governments was to encourage communities to relocate to the coast so they were able to exert greater influence over them. Accordingly, communities that had avoided exposure to storm surge now found themselves at considerable risk. Another element of settlements that can exacerbate the effects of tropical cyclones is to erect structures in rows that effectively channel the high velocity tropical cyclone winds. While early European visitors, such as missionaries and other travellers, may have disapproved, some villages were described in ways that indicated, whether by design or not, such an effect may well have been avoided.

[10] The following references provided information on settlement form and patterns: Angas, 1973; Bayliss-Smith et al., 1988; Bellwood, 1978; Buck, 1932; Crocombe, 1967; Davidson, 1969; Dunmore, 1995; Ferdon, 1993; Gill, 2001; Kirch and Yen, 1982; McLean, 1977; Park, 1991; Smythe, 1864; Spennemann, 1995; Turner, 1984.

> The arrangement of the houses in a village has no regard whatever to order. You rarely see three houses in a line. Everyone puts his house on his little plot of ground, just as the shade of the trees, the direction of the wind, the height of the ground etc., may suit his fancy. (Turner, 1984, p. 155)

It is likely that agents of colonialism sought to 'discipline' such patterns as Alkire (1977, p. 21) observes in relation to Chamorro villages on Saipan.

> There are no clear statements regarding the arrangement of houses in a village, although some pictures from relatively late post contact times show arrangements of houses in orderly rows … This may reflect Spanish regimentation for the purpose of controlling an often hostile population …

5.1 Housing[11]

Perhaps the most important aspect of settlements was the resilience or otherwise of dwellings and other structures. Table 6 lists the features of buildings that reduce or increase their resistance to high winds. Key elements identified in the table are the configuration of the roof (relatively steep and not gabled), the state of connections between joints (noting that forms of binding are considerably more effective than nails), firmly embedded posts (preferably hardwood and less likely to rot) and air tightness. This latter feature is very important as the most common way for buildings to be destroyed by winds is for air pressure to build up inside the building, creating a strong pressure differential between the interior of the building and the leeward side exterior (see Figure 7). In Fiji, Tonga and Samoa, many of these features were found in traditional buildings. Figure 8 shows several Fijian *bure*. As the photograph shows, these traditional style dwellings have relatively steeply sloped hipped roofs and no windows. There is little space between the thatched roof and the walls for air to make its way inside the structure.

Many Fijian *bure* and *vale* are built on mounds, called *yavu*, which are sometimes more than a metre high. These are said to reflect the importance of the house occupants and may have a range of cultural and social meanings attached to them. They are also a useful means of reducing the effects of floods and storm surges. Similar mounds are found in Samoan *fale* (see Figure 9) and Craighill (1930) indicates that they were widespread in the Society Islands (French Polynesia). It should be noted, that unlike the Fijian dwellings, the Samoan *fale* is characterised by having no walls. In the event of a tropical cyclone, winds could blow right through such a structure without the build-up of air pressure inside. Alternatively, mat walls can be lowered down to seal off the building.

[11] The following references provided information on housing: Bayliss-Smith, 1975; Bindman, 1992; Britton, 1987; Buck, 1932; Burchett, 1942; Burrows, 1936; Campbell, 1985; Chung, 1985; Craighill Handy, 1930; Dunmore, 1995; Dupon, 1984, 1988; Eason, 1967; Ferdon, 1981, 1993; Fischer, 2002; Gupta, 1992; Howlett, 1973; Hurrell, 1984; Legislative Council of Fiji, 1952; Lessa, 1964; Lewis, 1978; Loeb, 1926; Maiasa and Hamnett, 1983; Maudslay, 1930; McLean, 1977; Ministry of Foreign Affairs, 1985; Oliver, 2002; Park, 1991; Smythe, 1864; Talu et al., 1979; Thompson, 1940; Turner, 1984.

Table 6 Characteristics of houses that enhance resistance to damage from tropical cyclones

	Features that enhance resistance	Features that reduce resistance
Configuration of roof	Hipped (4-sided) Small or no eaves 30 -- 45% slope	Gabled Overhanging eaves Flat or slightly pitched
Structural connections	Binding Sennit Wire Bolts Metal Straps	Nails
Connection to ground	Treated posts Hardwood posts Deeply sunk posts "Anchors"	Stilts Piers Untreated posts Softwood posts Shallow posts
Air tightness	Closed spaces between wall and roof No windows Window shutters	Open spaces between wall and roof Louvers Gaps in walls
Elevation	Mounds	Floors at ground level

Source: After Campbell (1985, p. 53)

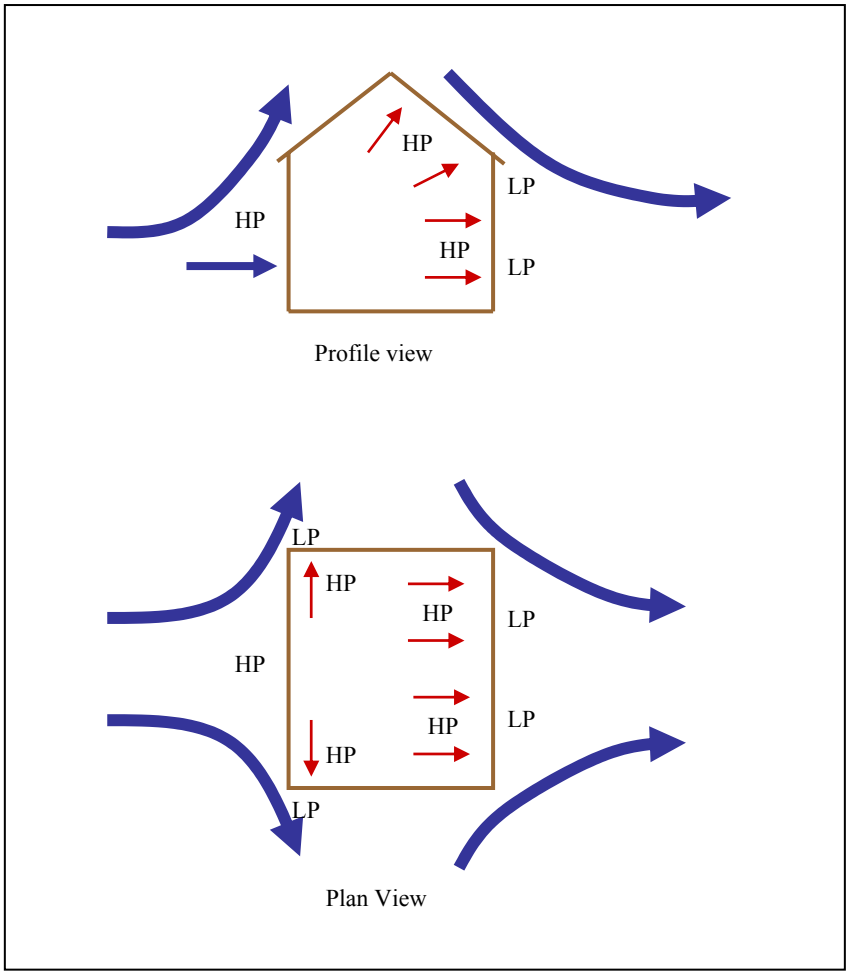

Figure 7 Simplified illustration of pressure differences between inside and outside of building. This causes the structure to 'explode' outward on the leeward side. Fijian *bure* and *vale* reduce the likelihood of this occurring as they traditionally had no windows, airtight walls and little space between the walls and the thatched roof.

Figure 8 Photograph of village in Fiji retaining traditional style housing. Note the relatively steep, hipped roofs and that there are no windows.

Figure 9 Samoan *fale* on the island of Savai'i. Note that these buildings have hipped roofs and are placed on significant mounds.

A feature of these buildings in traditional times was the beautifully designed sennit bindings that were used throughout the structures. Not only are they aesthetically pleasing, they provide considerable strength to all of the joints in the building.

Most of the information found in the study refers to Fijian, Tongan and Samoan houses. There were other interesting observations found in the literature search. Burchett (1942, p. 76) describes the roofing used in houses on the east coast of New Caledonia.

> A feature of the East Coast native huts is that the roof, instead of being of thatch straw as in other parts, is of niaouli bark inlaid with heavy rocks. Apparently the bark is laid on in big sheets, just as it is stripped off the larger niaouli trees, and placed on the frame of the roof, with big rocks laid on it to keep it down. This seems especially necessary along the East Coast where hurricanes are frequent. After a few heavy rains the niaouli bark goes into a sort of pulp, the rocks become embedded in it, and when it dries the whole roof is one solid mass of rock and bark.

Turner (1984) notes that in Samoa a layer of heavy coconut leaves was placed on the roofs of houses when a gale approached and Hurrell (1984) observes that in particularly severe storms people in Tonga would lift the roof of the house off the posts and place it on the ground where the structure would be particularly secure. Larger community members would sit on the beams giving added stability. In other parts of the Pacific some of the features of the houses described above appear to be absent. For example, many of the structures in Vanuatu appear to have large overhanging eaves and gabled roofs. It is possible that the lighter and seemingly less elaborate structures in some parts of Melanesia may well have been an adaptation to earthquakes which occur more regularly in many parts of the region than do tropical cyclones.

6.0 TRADITIONAL KNOWLEDGE

Much of this report is about traditional knowledge. Agricultural systems, as we have seen, were often guided by experts and all farmers would have had a good understanding of crop requirements. Systems of food storage and preservation, likewise, could not have been maintained without the pool of expertise and knowledge that was required. Similarly, inter-island navigation required sets of skills (from canoe building through sailing and navigation) without which inter-island exchange would not have been possible. The construction of many of the elaborate *vale* and *bure* in Fiji that often successfully withstood hurricane force winds was usually carried out under the guidance of expert carpenters.

In this section the use of traditional environmental knowledge as a means of predicting weather conditions is addressed.[12] There was relatively little in the literature that was canvassed in the preparation of this report that shed light on this issue. Two types of prediction were identified. First, there were those that suggested that a coming tropical cyclone season may be unusually severe and second are more immediate predictions that a tropical cyclone is imminent.

[12] Information for this section was obtained from the following references: Burrows, 1936; Craighill Handy, 1927; Derrick, 1951; Emory, 1965; Gillett, 1987; Goetzfridt, 1992; Holmes, 1881; Leon and de Brum, 1979; Lessa, 1964; Oliver, 2002; Park, 1991; Sahlins, 1962; Strathern et al., 2002; Ward, 1986.

Two references were found indicating that unusual flowering patterns portended a severe tropical cyclone season. Dyer (1945) referred to the unusual flowering of mangoes and bananas being such a sign among Fijians. Derrick (1951, p. 115) also reports that Fijians connected unusual behaviour of the mango with a coming severe cyclone season.

> Among the natives and old residents in the islands certain unusual phenomena - such as an abundant crop of mangoes in the wet zone, where the fruit does not usually set, or the free flowering of the reeds - are regarded as signs that a hurricane is to be expected.

Shorter-term indicators of an impending storm have also been outlined by Dyer and Derrick. These include an unusual surge of water at high tide, frigates flying lower than is usual, change in normal patterns of currents (Dyer, 1945) and unusually heavy surf breaking on the barrier reef during otherwise clam conditions (Derrick, 1951). Lessa (1964, p. 337) wrote that on Ulithi there was a magician who sought to pacify the waves. He also noted that there were experts who interpreted meteorological signs indicating a coming typhoon and who used 'natural ' rather than 'divinatory' clues.

Perhaps just as important as weather prediction, was traditional knowledge of the seasonal calendar that guided agricultural planning, utilisation of marine resources, spiritual life, and awareness of phenomena such as dry periods, wet periods and tropical cyclone seasons. They often formed the basis for planning the annual food 'budget' so that preserved and stored foods would be available during 'taem hungri' when harvests were restricted.

7.0 DECLINE OF TRADITIONAL MEASURES[13]

Many of the elements of disaster reduction outlined in this report have disappeared and others are now practiced only partially. The reasons for decline may be divided into two categories. The first refers to those measures that have been rendered redundant by the provision of disaster relief. Examples here include the diminished use of famine foods throughout the Pacific region.[14] The second includes all of the social, political, cultural and economic changes that have taken place in the Pacific region since the early days of European contact and colonisation through to the contemporary post-colonial era of globalisation.

Campbell (1990) outlines the decline of food security on the island of Mota Lava in northern Vanuatu. There were several factors. These included the introduction of commercial coconut cultivation (for the production of copra) at the expense of land and labour devoted to the cultivation of the staple yams. After a tropical cyclone in 1910 the people on the island used sago as a famine food in addition to the wild forest foods. The next major tropical cyclone, in 1939, saw the colonial government and the Melanesian Mission supply relief food and sago was not required. In the 1920s the Melanesian Mission sought to bring about the demise of the *suqe*, which was already under pressure as the people of Mota Lava began, through labour migration and copra production, to enter the cash economy and in doing so reduce

[13] The following references include information on coping decline: Baxter, 1980; Britton, 1987; Chung, 1985; Hurrell, 1984; Lessa, 1964; Lewis, 1978; Paulson, 1993; Thaman, 1982; Ward, 1986.

[14] An exception may be Tikopia. This island was devastated by cyclone Zoe in 2004 and there were major delays on the part of the Solomon Islands government in sending assistance to the island. Despite this it appears that there were no casualties although there may have been substantial hardship.

the importance of shell money, mats and pigs. Inter-island responses to the 1939 tropical cyclone were, as a result of this and the relief, relatively muted.

Following World War II the population of Mota Lava became increasingly engaged in the cash economy (even though it still remained less important than subsistence food production) and land for food crop production was reduced. As a result fallow periods in the yam gardens declined and yields soon followed suite. In common with many other Pacific communities the people of Mota Lava began to plant increasing amounts of cassava which is became a replacement for yams as it requires lower land fertility and labour inputs. The outcome is that Mota Lava has moved from a situation where food surpluses were the norm to one in which there are now probably deficits. Earnings from copra (the prices for which are notoriously fickle) are used to purchase imported foodstuffs. Expenditure on imported foods exceeds income generated locally (from copra) and is supported by remittances from Mota Lava people living in the towns. In addition to the food production deficit that now operates, the resilient yam is being replaced by cassava; food storage and preservation is no longer practiced to any significant level; and inter-community co-operation, particularly at the inter-island scale, no longer takes place.

Cyclones in 1972 and 1987 were followed by disaster relief operations. The latter took place in the context of an independent Vanuatu and involved the application of international assistance. The patterns of change on Mota Lava are illustrated in Figure 10.

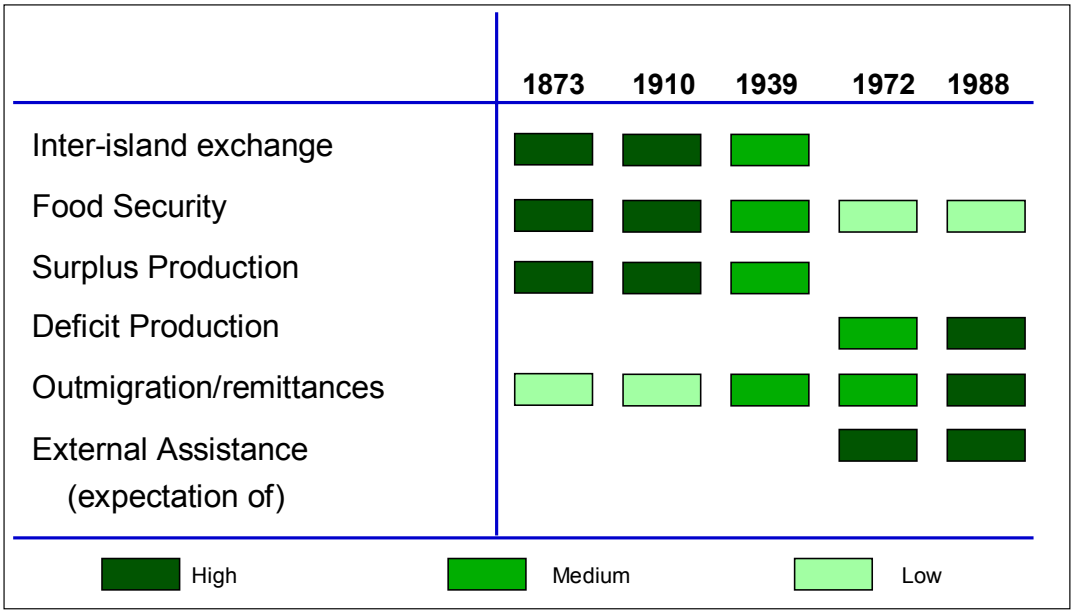

Figure 10 Changing food security in Mota Lava, Vanuatu. This diagram illustrates changing importance of a range of disaster reduction measures on Mota Lava. As the figure suggests the island has entered into a period of deficit production and dependency on support through remittances and relief. (After Campbell, 1990).

Similar patterns in reduction of food security are occurring elsewhere in the Pacific region (e.g. Campbell, 1985). Moreover, the expansion of cassava has added greater exposure to food loss as a result of tropical cyclones. Other changes are also taking place. Traditional building techniques are being replaced. This is partly an outcome of the introduction of

building materials such as nails (which are less effective than sennit) and masonite and other particle boards which rot easily when waterlogged. As well, in some countries, such as Fiji, government relief schemes have introduced 'hurricane resilient' homes after disasters rather than investing in local designs and supporting traditional experts.

It is also probably fair to suggest that exposure to the market economy for well over a century has seen changes in attitudes towards co-operative social systems in many Pacific Island Countries. Kinship bonds still remain important, but other forms of community solidarity may be less significant in contemporary societies.

8.0 CONCLUSIONS

Pacific Island communities traditionally did have a suite of measures that helped them to at least survive the effects of natural extremes. In this study four clusters of these measures have been identified. These were food security, co-operation, settlement factors and environmental knowledge systems.

Surplus production, particularly of food, underpinned many strategies for storing and preserving food that were commonly called on throughout the Pacific Island region during times of hardship.

Surpluses also supported the maintenance of intra- and inter-community linkages through feasting and ceremony. This enabled a wide range of co-operative strategies to be called upon when food crops failed in one location but not in another.

Food security was also sustained by maintaining a diversity of food plants, including both cultivars and wild or feral species. Land fragmentation enabled a diversity of food production sites reducing the likelihood of complete loss of sustenance following tropical cyclones.

It is likely that natural disasters did at times cause significant hardship and loss of life, mainly through reduction of food availability rather than the direct effects of the events. It is also evident that an important coping mechanism was through maintaining high levels of discipline during times of shortage through the imposition of rationing water and food.

In some parts of the Pacific houses were built with a number of positive features that enhanced their resilience to high winds, flooding and storm surge. These features included roof shape, the use of sennit to bind connections, deeply embedded hardwood posts, and well-sealed walls and roofs. In many locations houses were built on mounds which elevated them above possible flood levels.

In other areas, also prone to tropical cyclones, it appears that lighter, less elaborate structures were built. It is speculated that this may possibly represent an adaptation to the earthquake hazard along the subduction zone between the Pacific and Australian/Asian plates in countries such as Solomon Islands and Vanuatu.

A number of factors have led to a reduction in surplus food production, co-operative responses, significance given to traditional environmental knowledge and construction

practices. These have included social, economic, cultural and political changes since the early days of European intrusion into the Pacific region. However, ironically, the provision of disaster relief and rehabilitation assistance has also served to undermine traditional disaster reduction techniques.

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www.gns.cri.nz

Principal Location

1 Fairway Drive
Avalon
PO Box 30368
Lower Hutt
New Zealand
T +64-4-570 1444
F +64-4-570 4600

Other Locations

Dunedin Research Centre
764 Cumberland Street
Private Bag 1930
Dunedin
New Zealand
T +64-3-477 4050
F +64-3-477 5232

Wairakei Research Centre
114 Karetoto Road
Wairakei
Private Bag 2000, Taupo
New Zealand
T +64-7-374 8211
F +64-7-374 8199

National Isotope Centre
30 Gracefield Road
PO Box 31312
Lower Hutt
New Zealand
T +64-4-570 1444
F +64-4-570 4657