Climate change, agriculture and food security in the Pacific Islands

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ABSTRACT

In the past three decades climate change has become one of the most important global challenges. The Small Island Developing States in the Pacific are severely exposed to the impacts of climate change although they did not contribute meaningful to the creation of the challenge. Although food security there is lesser an issue than in many countries of Africa, Asia and the Caribbean many assessments highlight that Pacific Island Countries (PICs) can become exposed to food crisis, especially in times of natural hazards and consequent disasters. Food systems have been changing in recent decades in many Pacific Island countries creating increasing vulnerabilities. The major process in place relate to the change from subsistence agriculture to commercial agriculture. People more often depend on food from the market and supermarket rather than from own gardens with a big variety of food crops. Research in communities in the Fiji, Samoa, and the Solomon Islands that had been exposed to severe disasters however reveal that food security had not been the major challenge during the disaster and in the rehabilitation process. There is much evidence that communities with support of governments and relief organizations have been able to avert food crises relating to these disasters. It was found that in particular social capital contributed to this resilience.

Key words: Climate Change, Agriculture, Food Security, Pacific Islands.

INTRODUCTION

For long the international community hoped that it is possible to reduce greenhouse gas emissions to a level that dangerous climate change can be averted. With the failure of the Kyoto Protocol it became obvious that the mitigation strategy had failed. Further increases in average global temperatures and subsequently sea-levels seem to be unavoidable. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) highlights that small islands are particularly vulnerable to climate change. This is confirmed in the Fifth Assessment Report (IPCC, 2013) as well as in the IPCC report on disasters (IPPC, 2012).

During the last three decades global average surface temperature continuously increased. These decades had been warmer than any decade since 1850. Since 1880 the increase was 0.85 degrees centigrade on average (IPCC, 2013). Between 1901 and 2010 global mean sea level rose by 190 mm (around 1.7 mm yr^{-1}). In later decades the increase was much higher (e.g. 3.2 mm yr^{-1} between 1993 and 2010) suggesting that more recently sea level rise has accelerated (IPCC, 2013; Maharajan & Joshi, 2013).

Climate change and extreme events hit particularly rural and urban poor, who already have to live with many challenges (Archer et al., 2008; Fischer et al., 2005). They are less able to cope or adapt to additional pressures. They experience negative impacts on their livelihoods. They often live close to nature and from its resources they derive bigger parts of their livelihoods. When resources suffer, get degraded and decline in productivity poor people are often socially and economically immobile, not able to move to other ways of making a living. Spending a high percentage of their income on food they are most vulnerable to food price increases, especially when they don't have (enough) land to grown their own food.

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The same people are severely affected by natural hazards. They live in locations where they are exposed to such hazards, their housing structures are weak to withstand the forces of such hazards, and their socio-economic situation makes it difficult and lengthy to recover from the destruction of such hazards. The impacts of climate change do not only affect poor and vulnerable population severely, climate change has the potential to create new poverty and exacerbate existing inequalities. Climate change has the potential to undo the positive results of development efforts and repel people in their efforts to secure a decent standard of living.

CLIMATE CHANGE AND AGRICULTURE

Agriculture depends highly on physical factors such as soil, topography, and others. Climate parameters provide conditions that enable or restrict plant growth and influence survival (Downing, 1993). Extremes (low or high temperatures, lack of water (drought), too much water (flood, water logging) can have devastating results on plant growth (Gregory et al., 2005; Kang et al., 2009; Lobell, 2010; Schlenker, 2010; White & Hoogenboom, 2010) as well as the growth of pathogens and plant pests (Gregory et al., 2009). Most plants have a narrow scope under which their growth is optimal. Under sub-optimal conditions (below or above the optimal) decreasing yields or even plant death is happening. Humans can influence some of these conditions (e.g. through irrigation, glass houses), but technologies are costly and not everywhere available. China and India have more than one third of the globally irrigated areas. There as well as in other developing countries irrigation areas have come under great stress due to land degradation and conflicts over water distribution between and within countries (Weber, 2007; 2006; 1997; 1991; Weber & Hoffmann, 1997).

Crops are affected by a changing climate in many ways (Mendelsohn & Dinar, 2009). Some impacts have the potential to decrease productivity, while others have positive impacts (Lloyd et al., 2011). An increase in warmer days, in particular frost-free periods, prolong the vegetation period of temperate crops and help to extend production zones.

Higher temperatures and higher CO_2 concentration can support plant growth and output. Carbon dioxide is one of the most important ingredients for photosynthesis. A high carbon dioxide concentration increases water-use efficiency of some plants (Maharaj & Joshi, 2013). Whether yields increase as a result of higher temperatures and carbon dioxide concentration depends on the type of photosynthesis of a particular plant. The literature distinguishes between C_3 and C_4 photosynthesis pathways (Bunce, 2000; Ehleringer et al., 1997; 1991; Gunderson et al., 2010; Kirschbaum, 2004; Kubien & Sage, 2004; Pyankov et al., 2010; van Oosten & Besford, 1996; Zavalloni et al. 2009). C_3 crops (e.g. wheat, rice, barley, cassava and potato) respond best to increasing CO_2 while C_4 crops (e.g. maize, sugar cane, sorghum, millet and forage grasses) "are already optimized at the current CO_2 level [and] therefore have only a small response to higher CO_2 (Maharaj & Joshi, 2013, p.27). Kopp et al. (2005) and Spicer (1993) show that C_3 / C_4 photosynthesis pathways played already a crucial role in paleo climates and ecologies.

"Current research confirms that while crops would respond positively to elevated CO_2 in the absence of climate change […] the associated impacts of high temperatures, altered patterns of precipitation and possibly increased frequency of extreme events such as droughts and floods, will probably combine to depress yields and increase production risks in many world regions, widening the gap between rich and poor countries" (Fischer et al., 2005, p. 2067).

In the developing world agriculture provides livelihood to more than 70 percent of the population (Kotir, 2011; Mendelsohn & Dinar, 2009). The danger is great that additional stress on ecological fragile food production systems and socially vulnerable populations will lead to lower global food production and create great problems of hunger and starvation (Lloyd et al., 2011; Nelson et al., 2010). Many countries with challenges around food security are located in the arid and semi-arid regions of the world. Particularly countries in sub-Saharan Africa, South, North and West Africa, India and also arid locations in tropical and sub-tropical America are most vulnerable to food insecurity. Climate change will increase the danger of droughts in these regions and put additional stress to poor marginal farmers (Archer et al., 2008; CFS, 2012).

Still there are very limited studies that show, if overall net impacts on plant growth and yields will be positive or negative. Many authors assume that some regions will experience positive impacts on agriculture while others will be affected by climate change in a negative way. "Broadly, climate change may lead to increases in yield potential at mid and high-mid-latitudes, and to decreases in the tropics and subtropics" (Parry et al., 2005, p. 2137).

Temperature, the availability of water and CO_2 concentration in the atmosphere have also impacts on pests and pathogens (Maharaj & Joshi, 2013; Newton et al., 2011; Sharma and Prabhakar, 2014). A warmer climate favours growth conditions of pathogens, insects and weeds, produce bigger pathogen numbers and more generations. This compromises the growth of crops and makes pathogens more quickly resistant to pesticides. With an increase in carbon dioxide the efficacy of pesticides is declining (Ziska & Teasdale, 2000).

An increase in the intensity (and possibly frequency) of natural hazards has high potential to affect agricultural production. IPCC (2014) expects that such extreme events exacerbate other stressors and increase people's risks. "Climate-related hazards affect poor people's lives directly through impacts on livelihoods, reductions in crop yields, or destruction of homes and indirectly through, for example, increased food prices and food insecurity" (IPCC, 2014, p. 8).

Food production comes under pressure in many parts of the world while population especially in the countries of the South continues to increase (Branca et al., 2013). Population growth and the impacts of climate change are expected to lead to increased global food prices.

THE PACIFIC ISLANDS

There are 14 Pacific Island countries and 8 territories governed by metropolitan powers at the rim of the Pacific Ocean or Europe. In mid-2013 about 10.57 million people were living in this part of the world; Papua New Guinea alone has a population of 7.4 million leaving some 3.2 million to the remaining 13 countries and eight territories (SPC, 2014, Table 1).

Table 1: Pacific Island Countries and Territories - some demographic and physical characteristics

Country	Sub-Region	Population (2013)	Population (around 1960)	increase since 1960s (%)	Land Area (km^2)[1]	Exclusive Economic Zone (km^2)[1]	Population Density (per/km^2)	Atolls / Coral Islands	Raised Islands	Volcanic Islands	Total
Cook Islands	Polynesia	15,200	18,378[f]	(15)	237	1,960,135	64	7	0	8	15
Niue		1,500	4,864[f]	(70)	259	316,629	6	0	1	0	1
Samoa		187,400	114,427[f]	60	2,934	131,812	64	0	0	2 + 8 islets	2
Tonga		103,300	56,383[a]	84	749	664,853	138	a few	>100	a few	~170
Tuvalu		10,900	5,444[h]	106	26	751,797	419	9	0	0	9
Fed. States of Micronesia	Miconesia	103,000	39,284[c]	161	701	2,992,597	147	~600	0	>10	607
Kiribati		108,800	43,336[h]	115	811	3,437,345	134	32	1	0	33
Marshall Islands		54,200	13,928[c]	295	181	1,992,232	299	34	0	0	34
Nauru		10,500	4,613[f]	121	21	308,502	500	0	1	0	1
Palau		17,800	9,344[c]	121	444	604,289	40	<300	>10	>5	340
Fiji Islands	Melanesia	859,200	345,737[a]	146	18,333	1,281,122	47	2	a few	<100	~320
Papua New Guinea		7,398,500	2,184,986[i]	215	462,840	2,396,214	16	a few	a few	>600	>600
Solomon Islands		610,800	124,076[d]	346	28,000	1,597,492	22	a few	0	>900	>990
Vanuatu		264,700	78,088[k]	222	12,281	827,891	22	0		82	82
sub-total		9,745,800	n.k.	n.k.	527,817	16,270,313					
Territory											
American Samoa	Poly	56,500	20,051[e]	233	199	404,391	284	2	0	5	7
French Polynesia	Poly	261,400	84,551[g]	221	3,521	4,767,242	74	~80	a few	~40	130
Pitcairn Islands	Poly	57	n.k.	n.k.	47	880,000	1				
Tokelau	Poly	1,200	1,870[f]	(38)	12	319,031	100	3	0	0	3
Wallis & Futuma	Poly	12,200	8,546[m]	54	142	258,269	86	0	0	2	2
Guam	Micro	174,900	67,044[e]	187	541	221,504	323	0	0	1	1
Northern Mariana Islands	Micro	55,700	8,290[c]	666	457	749,268	122	0	0	15	15
New Caledonia	Mela	259,000	86,519[c]	192	18,576	1,422,543	14	0	0	7	7
sub-total		820,957	--	--	23,495	9,022,248	--				
overall		10,566,757	--	--	551,312	25,292,561	--				

[a]1956 [b]1957 [c]1958 [d]1959 [e]1960 [f]1961 [g]1962
[h]1963 [i]1966 [k]1967 [l]1968 [m]1969

Source: for Population Data: SPC Population Data 2011 and Time Series from 1900
for Island size and island type: Pacific Islands Yearbook, 1989
[1] Land Area and EEZ for Pacific Island Countries according to www.forumsec.org

The Pacific Ocean covers more than 165 million km^2 extending to about a third of the surface of the Earth. The Pacific Island region consists of 20,000 – 30,000 islands (Ridgell 2006) located south of the Tropic of Cancer. As a rough indication the region is sub-divided into Micronesia, Melanesia and Polynesia. The islands of the first sub-division are mainly situated north of the equator and those of the second and third category are situated in the southern hemisphere (Figure 1). The entire land area of the Pacific Island countries and territories is about 551,319 km^2. With this the 22 countries and territories are a little bit smaller than Kenya (569,000 km^2). Also here Papua New Guinea, the world's second biggest island after Greenland, dominates heavily with 462,840 km^2 leaving 88,472 km^2 (16% of the land area) to the rest of the countries and territories. Today most islands in the region belong to 14 independent states that are organized in the Pacific Islands Forum Secretariat (PIFS).

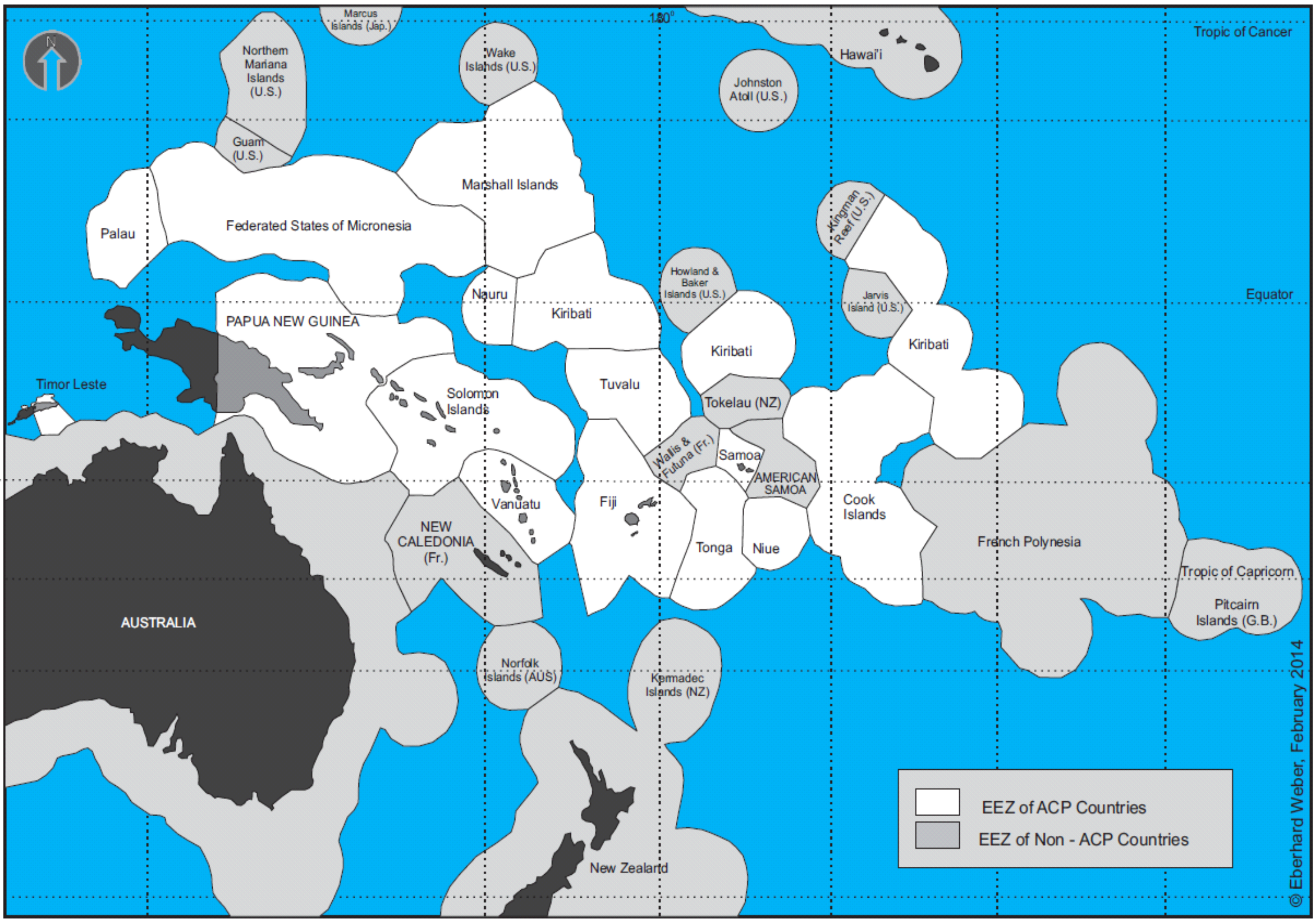

Figure 1: Pacific Island countries and territories and their Exclusive Economic Zones

Size, topography and soil types of islands are every relevant for agriculture. In Micronesia and Polynesia most of islands are tiny, low lying coral islands or atolls with very poor soils. Only a few, smaller islands are of volcanic origin, e.g. the major islands of Samoa and the Cook Islands (Table 1). In the coral islands and atolls agricultural production is often restricted to a few crops. Attempts to expand the variety of crops often results in crops of low size and quality (see also Barnett & Adger, 2003). Four of the countries in the Pacific Island region consist entirely of low lying coral islands and atolls, namely Kiribati, the Marshall Islands, Tokelau and Tuvalu. The Melanesian region on the other side is dominated by high volcanic islands that are big and usually have good soils of volcanic origin suitable for diverse subsistence agriculture. As a result of colonialism and more recently rapid urbanization commercial agriculture has been extended in the past decades in a few islands. The economic potentials of most of the Pacific Island countries however are generally low. Subsistence agriculture and fisheries dominate. Exceptions are Fiji, which has the most diverse industrial sector and Papua New Guinea, which has some industries and well developed mining industries.

Pacific Island countries are strongly affected by regional climate systems. Considerable climate variations are caused by El Niño Southern Oscillation (ENSO) (Delcroix, 1998; Gang et al., 2014; Gouriou & Delcroix, 2002; Li & Wang, 2013; Luo & Yamagata, 2001; O'Kane et al., 2014; Pan et al., 2011; Ronghui et al., 1998; Wang & Fiedler, 2006; Xu et al., 2004), the South Pacific Convergence Zone (SPCZ) (Brown, et al., 2013; 2012; Folland, 2002; Griffiths et al., 2003; Juillet-Leclerc et al., 2006; Matthews, 2012; Vincent, 1985, Vincent et al. 2011; Widlansky et al., 2011), the Intertropical Convergence Zone (ITCZ) (Leduc et al., 2009; Leech et al., 2013; Sachs et al., 2009) and the Western North Pacific Summer Monsoon (WNPSM) (Christensen et al., 2013; Lee et al., 2011).

Great challenges to agriculture are brought by El Niño events that can bring droughts to the south-western Pacific region and increased rainfall in the central Pacific. In El Niño years also the numbers of tropical cyclones seem to increase and affect regions further to the east than usual (Diamond et al., 2012). During La Niña years the numbers of tropical cyclones increase in the western tropical Pacific (Nicholls et al., 1998; see also Lavender & Walsh, 2011).

Changes in rainfall varies considerable in the Pacific Island region. The southern Cook Islands, the Solomon Islands, and Tuvalu will see their average rainfall increase during the wet season. On the other hand countries like Vanuatu, Tonga, Samoa, Niue, and Fiji will experience "a decrease in dry season rainfall accompanied by an increase in the wet season, indicating an intensified seasonal cycle" (Diamond et al., 2012, p. 1276).

To quantify the impact on precipitation however is rather difficult and does not provide a clear picture for the future: much wetter times seems equally possible than much drier ones. Referring to Ruosteenoja et al. (2003) Barnett (2011) provides the following precipitation scenario taking the period 1961–1990 as reference: "-3.9% to +3.4% by the 2020s; -8.23% to +6.7% by the 2050s; and -14% to +14.6% by 2080s" (Barnett, 2011, p. S230).

THE STATE OF FOOD SECURITY IN THE PACIFIC ISLANDS

The Pacific Islands are not amongst the hotspots when it comes to hunger and undernutrition in the Asia-Pacific region. Other countries have bigger shares of people vulnerable to food insecurity. As population sizes in the Pacific Islands are tiny the absolute number of vulnerable population is also small. However one has to consider that undernutrition is often much hidden from the eyes of observers (UNESCAP, 2009). Currey (1980) highlights that in particular natural hazards can cause food insecurity in Pacific Island countries.

Many publications on climate change in the Pacific Islands see increasing pressures on food security. Many reports however are vague and miss to draw detailed pictures of what impacts to expect. It does not help much to assume that agriculture and food security will be affected in one way or another. To prepare for the challenges more precise knowledge is necessary. Right now one can assume that Pacific Islands are resilient enough to avoid the most drastic forms of food insecurity. Other regions where big portions of population have been living at the edge of hunger and starvation will also be most at risk in future. In Pacific Island countries impacts of climate change on agriculture have great potentials to affect people's livelihood security. With this they are more likely to become serious development challenges rather than a question of life or death.

Although the majority of people in the Pacific Islands have rather low standards of living chronical under- and malnutrition is rare and restricted to few people and few locations. This is the essence of the UNESCAP (2009) report on sustainable agriculture and food security in Asia and the Pacific. Among the Pacific Island countries the Solomon Islands has the highest proportion of undernourished people in 2003-05 (20 percent), followed by PNG (13 percent) and Vanuatu (12 percent). Table 2 shows that comparted to earlier years considerable improvements have happened in all countries. The magnitude of undernourishment in Pacific Island countries is considerably smaller than in many countries of South, South-East, and East Asia. It has been declining over the last few decades, and this downward trend seems to continue.

Table 2: Prevalence of undernourished people in selected countries in Asia and the Pacific

Country	1990-92	2000-02	2010-12	% change
Georgia	60.4	23	25	-58.6
Viet Nam	46.9	20.9	9	-80.8
Lao, PDR	44.6	38.4	27.8	-37.7
Thailand	43.8	17.4	7.3	-83.3
Solomon Islands	23.0	14.0	13.0	-43.5
Samoa	13.0	5.0	5.0	-61.5
Vanuatu	11.0	8.0	8.0	-27.3
Kiribati	9.0	7.0	8.0	-11.1
Fiji	6.0	<5	<5	>-16.7

Source: UN ESCAP (2013), p. 160

Food systems have been changing in recent decades in many Pacific Island countries increasing vulnerabilities. Major processes relate to changes from subsistence agriculture and fishing to commercial agriculture and distant water fishing fleets that come to the South Western Pacific for its rich tuna resources. People more often depend on food from the market and supermarket rather than from own gardens. As a result they are more likely affected by food price changes. Often their food choices also lead to malnutrition in form of obesity and non-communicable diseases rather than undernourishment (Pacific Institute of Public Policy, 2011, Thaman, 2003). In 2008 food prices reached alarmingly high levels putting great pressures on poor countries that are food deficit and need to import bigger shares of their food needs. In the Pacific Islands countries with the highest share of imported food are atoll countries (Thaman, 2003). According to Sharma (2006) per capita food production declined in many Pacific Island countries between 1991 and 2002 and the dependency of imported food increased. The Pacific Institute of Public Policy (2011) notes that food production in the Pacific Islands is not keeping pace with population growth. Between 1961 and 2009 per capita food production declined by 64 percent in Kiribati, 58 percent in Vanuatu and 49 percent in Tonga.

Natural hazards that affect agriculture add to the challenge. A single hazard often affects entire countries, cause damages up to 20 and more percent of the annual GDP (Weber, 2014a, b) and destroy major food sources. In 2003 Cyclone Amit caused damages to Fiji's agriculture of about FJD 66 million (Sharma, 2006).

Many Pacific Islands experienced considerable depopulation in the later decades of the 19th century (Buxton, 1926; Frater, 1947). There is little evidence that this had been related to food insecurity, famine and starvation. Wars (Cordy, 1972; McNeill, 1994; Repa; 1932; Shlomowitz, 1989; Williams, 1932; Younger, 2009), introduced diseases (Archer, 2010; Bayliss-Smith, 1974; Cassels & Singer, 2010; Cliff & Haggett, 1985; Cordy, 1972; Lessa & Myers, 1962; McNeill, 1994; Rallu, 1992; Repa, 1932; Shlomowitz, 1989; Williams, 1932), emigration (Cordy, 1972), and the Pacific Labour Trade (Valjavec, 1986; Williams, 1932) were more important for population decline than drought, natural hazards or other natural events that can lead to hunger crises and famine (McNeill, 1994).

Schmitt (1970) highlights that "famine was by and large only a minor factor in Hawaiian depopulation. Hunger caused by drought and other natural disasters was too localized and easily escaped to produce catastrophic mortality" (Schmitt, 1970, p. 115). Currey (1980) notes that Pacific island bibliographies and papers have no references on documents relating to famine and also the most important surveys on world famine do not mention Pacific Islands at all (Currey, 1980, p. 447).

CLIMATE CHANGE AND AGRICULTURE IN THE PACIFIC ISLANDS

Barnett (2011) argues that climate change will adversely affect food systems in the Pacific Island region in several ways: the ability to produce food will be compromised as well as the ability of countries to import the food that is needed. Looking more at the micro -level Barnett predicts that households will have challenges to access and utilize food.

Still there are many reasons why Pacific Island populations are better protected against food insecurity compared to people elsewhere in the developing world. Although impacts of modernization and globalization are also felt in Pacific Island countries community cohesion is still strong and land tenure systems prevent that bigger parts of the population become landless. Many have entitlements to land and fishing grounds where they can carry out subsistence production. Urban-based citizens are often closely linked to relatives that live in villages and provide produce “fresh from the farm” regularly. Systems of reciprocity are much more than symbolic: they help urban populations to complement food they buy. Especially in Polynesian countries many have relatives living overseas (e.g. New Zealand, Australian and/or the USA), who send remittances regularly or at least when urgent needs arise (e.g. after natural hazards; see below experiences from Samoa after the 2009 tsunami).

Except of the atolls Pacific Island countries often have low population densities and much unused land that can be brought under agriculture to expand food production. Such prospects however should not be taken too lightly as land use changes often conflict with environmental concerns (Arnell, 2004).

A last point to highlight is that in most Pacific Island countries people possess traditional knowledge of how to preserve food and how to minimize damages in the case of natural disasters. Such traditional practices are at danger of getting lost and there should be proactive measures put in place that assure that also future generations learn about the importance to be prepared against natural hazards. Food security in this context plays a major role (Campbell, 2006; Thaman, 1982a, b, 1979).

VULNERABILITY AND COMMUNITY RESILIENCE

Research conducted in communities of Fiji (Yila & Weber, 2013; Yila et al., 2013), the Solomon Islands (Weber et al., 2015), and Samoa (Weber et al., 2015) suggests that food insecurity not necessarily is in the centre of negative impacts of natural hazards. Resilience help people to deal with such impacts and resilience can support them also when they have to adjust to the impacts of climate change. Building on resilience detected in the three research activities it should be possible to prepare communities to the challenges that come along with climate change. In this process improvements of food and livelihood security seems to be possible as well as improvements to the overall conditions and levels of people’s lives.

Two of the research activities look at impacts of tsunamis and do not directly relate to climate change. Still the studies provide insights into people’s resilience to severe disasters. Two of the studies (tsunami in Samoa and flooding in Fiji) were conducted immediately after the hazard events, while the third field study was conducted with a considerable time lapse, i.e. some five years after the actual hazard (tsunami in the Solomon Islands of 2007). For the tsunami event in Samoa a second round of fieldwork has been completed in July 2014, some 4.5 years after the event. In all cases food security of people had been severely threatened, but there were mechanisms in place that prevented serious food crises. In none of the communities visited widespread lack of food had been reported immediate after the disaster events and some considerable time later.

TSUNAMI IN THE SOLOMON ISLANDS, APRIL 2007

In April 2007 the Western Province of the Solomon Island suffered from an earthquake with a magnitude of 8.1 triggering a tsunami which caused damaged throughout the Western Province. Most affected were several villages on the southern coast of Ghizo Island (Fisher et al., 2007). Members of the Micronesian population of Ghizo Island had been particularly affected.

During fieldwork five years after the tsunami the scars of the event were still visible everywhere. However people interviewed highlighted that food security was not their major challenge, neither right after the tsunami nor five years later. Although most people lost virtually all their possessions food was secure as many plantations were spread over different locations and therefore some escaped the fury of the waves. While plantations and house gardens in the coastal zone were destroyed many families had additional plantations further inland which remained unaffected. This was in particular true for the Melanesian population, while the Micronesian populations had only few plantations away from the coast. In the first few days after the tsunami members of the Micronesian community received support and food supply from their Melanesian brothers and sisters. Later, and in those cases were also Melanesian plantations and gardens had been destroyed government agencies and relief organizations successfully helped to bridge the most serious times until a state of normality had been re-established.

In the long term the Micronesian population was able to extend their livelihood base when they started agriculture in the hilly terrain to where they had resettled. This considerably enlarged their livelihoods as they continued fishing, which had been their major source of livelihood prior to the tsunami. The vast majority of the population interviewed saw their situation some five years after the event rather positive. What food supply was concerned almost all people interviewed saw vast improvements compared to the situation before the tsunami. Members of the Micronesian community now have access to land with much better soils in the hilly terrain. Almost every family operates at least one home-garden with a great variety of crops. Some even started selling part of their produce at the fruit and vegetable market in Gizo town. Respondents were even saying that the tsunami that brought them to "their" new land was a 'blessing in disguise'. They only hope that they are not forced back to their settlements at the coast. The biggest challenge some five years after the tsunami is the question, if people are allowed to stay on the new land, which belongs to the government.

TSUNAMI IN SAMOA, SEPTEMBER 2009

End of September 2009 a strong earthquake with a magnitude of 8.1 triggered a tsunami that caused widespread damage in coastal areas of American Samoa, Samoa, and Niuatoputapu Island of northern Tonga. Like in the Solomon Islands also in Samoa government with support from local, national and international NGOs and relief organizations were tirelessly working to satisfy the most pressing needs of the people affected. Some two weeks after the disaster heavy machinery had almost completed their task of building roads to a number of new settlements inland. A few houses had already been completed, but the majority of people were still living in tents provided by relief organizations. Many relatives and friends of victims came all the way from New Zealand, the USA and Australia to help in reconstruction work. In the last quarter of 2009 Samoa received the by then highest inflows of remittances from New Zealand, worth 47 million Samoan Tala (ST) (Gibson, 2010). This amount seems to be even under-reported as many who came to support rehabilitation work also brought cash with them for construction works.

A notable difference to the situation on Ghizo Island is that in Samoa most of the families affected by the tsunami have resettled on their own land. The Polynesian land tenure system provided most families access to land at the coast as well as in the hilly terrain further inland. Conflicts over land are therefore not as frequent and sharp as it is the case on Ghizo Island.

FLOODING IN BA DISTRICT, FIJI IN 2009

Ba district is known for its severe problems of flooding. Floods in January 2009 and January 2012 (and again in March 2012) had affected the most vulnerable groups most severely, especially women and children. Farming communities sustained large economic losses due to inundation of farm land and erosion. More than 75 per cent of the households reported a considerable part of their livelihood lost to the two floods.

97 households surveyed in five villages had been severely affected by the floods in 2009 and January 2012. Many of the households (36 per cent and 24 per cent respectively) were forced to evacuate from their homes, which often were damaged. Degradation to agricultural land was also considerable and compromised livelihoods of many farmers, whose fields were situated along the banks of the Ba river and within the Upper Ba Watershed. A large proportion of sugar cane production was lost during the floods. 25 percent of households interviewed had lost land in the past five years due to flooding. Some farmers lost all their land, others suffered substantial damages. These damages did not pose biggest challenge to food security, but to livelihood security.

During and immediately after the floods mutual assistance between relatives and neighbours had been one of the most important feature preventing a food crises. The effect of social capital helped many to overcome the time, when crops were washed away, supermarkets were destroyed and transportation compromised. These aspects of social capital worked rather well and were supported by government support and the work of relief organizations. While charitable support turned out to be one-way, mutual assistance - food, short-term loans, free housing and shelter, tools and equipment, child care assistance, exchange of labour – constitutes a major strategy people deployed to provide support to one another. Such kind of support binds individuals and social groups together helping to increase the cohesion of communities. With this mutual assistance is crucial for future events. It helps to initiate community efforts that reduces vulnerabilities and enhances resilience.

Many people interviewed highlighted that cooperation during and after the flood has created a feeling of togetherness, mutual support and trust. Differences of ethnicity and wealth became less important and the community feels stronger as the experience of the flood and the support many people received from their neighbours, family and even strangers.

CONCLUSION

There is little doubt that climate change will change conditions under which agriculture operates in Pacific Island Countries. These challenges will be foremost be associated with natural hazards and disasters arising from such hazards (Weber 2014a, b). Still there is no convincing evidence that climate change, natural hazards or other disruptions will have impacts on food security severe enough to cause a food crisis or even worse. At this point of time nothing indicates that Pacific Island countries are prone to famine. It seems that also in the foreseeable future this is rather unlikely to change. Food insecurity does not top the list of urgent development challenges in the Pacific Islands.

While this is very good news it does not mean that climate change impacts on agriculture and food security are non-existing or negligible. Still disasters and also impacts arising from climate change have great potentials to negatively affect people's livelihoods. Climate changed and its impacts have the potential to destroy people's long time effort to improve, to enable a decent standard of living. Challenges do not only come from climate and other forms of environmental change. Challenges come from the declining position Pacific Island countries play in the world economy, their smallness and inability to benefit from economies of scale. On the positive site however their cohesiveness, the importance of social capital, which often translates also into financial capital in form of remittances from outside the region make Pacific Islanders resilient to various impacts. Of course there are enormous differences between Pacific Island countries, and more research on individual countries and their risks profiles need to be conducted. Much concern surely deserve atoll countries; not only as they are in particular exposed to the threats of sea-level rise, but because they have rather poor populations (e.g. Kiribati) with often low educational standards and are weak in social capital structures outside their countries.

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