



Research

## Social–ecological change and implications for food security in Funafuti, Tuvalu

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**ABSTRACT.** This article examines food security in Funafuti, Tuvalu in the context of recent social–ecological changes. We consider both social and ecological processes in order to provide a holistic account of food security. An analysis of data collected through a fixed-question survey and freelists with 50 households and semistructured interviews with 25 key informants reveal that access to food of sufficient nutritional and cultural value is the primary driver affecting food security, more so than general food availability. Ten percent of the households surveyed experienced a shortage of food in the previous month, and 52% ate less desirable imported foods, which tended to be nutrient poor because they could not access preferred local foods. Factors and processes affecting access to local foods include: availability of and access to land; declining involvement in local food production; the convenience of imported foods; unreliable interisland shipping; and climate and environmental changes that have negatively affected food security and are expected to continue to do so.

**Key Words:** *climate change; food security; imported foods; local foods; Pacific Islands*

### INTRODUCTION

The challenges of food security in the Pacific Islands have long been recognized (Campbell 2015, Food and Agriculture Organization (FAO) 2008). Over the past half century, agriculture, fishing, and local (incountry) food production (per capita for domestic consumption) have declined as a dependence on nutrient-poor imported foods has increased, something implicated in the expansion of noncommunicable diseases (Thaman 1982, McGregor et al. 2009). Diabetes, obesity, hypertension, and cerebrovascular diseases have become common causes of premature death in the Pacific Islands and are commonest among people living in urban settings who have largely nontraditional diets. Pacific Islanders have some of the highest rates of diabetes and obesity in the world, with the prevalence of both diseases having risen disproportionately fast in this region over the past three decades (Hawley and McGarvey 2015).

Social, cultural, and economic factors contributing to the lowered nutritional quality of Pacific Island diets include: the introduction of imported foods, often industrially processed and high in sugars and fats (Evans et al. 2001, Gewertz and Errington 2010, Konishi et al. 2011); postcolonial social change, which has altered food habits in Pacific Island societies (McLennan and Ulijaszek 2014); the spread of cash cropping, which has taken up land once used for the production of subsistence crops with higher nutrient value (Connell 2013); the introduction of cash economies, which has forced many Pacific Island people, particularly urban dwellers, to buy imported foods that are cheaper and more readily-procurable than local foods (Ulijaszek 2002, Cassels 2006, Turner et al. 2007); urbanization and population growth, both of which have reduced the per-capita supply of local foods and raised their production costs (Connell 2015); and dependence on nutrition assistance programs and foreign food relief after natural disasters (Denman and Dewey 1989, Campbell 2015). The pattern of declining local food consumption, increasing consumption of nutrient-poor

nontraditional foods, substantial decreases in health, changing food-sharing networks, and increases in diet-related disease documented in Pacific Islands are similar to that observed elsewhere, particularly among indigenous populations (e.g., Gracey, 2000, Lowitt, 2014, Scelza et al. 2014, Ghosh-Jerath et al. 2015, Laberge Gaudin et al. 2015, Mertens et al. 2015, Collings et al. 2016).

Ecological factors, like climate change, have also contributed to food-system stress in Pacific Islands, and this is expected to increase in the next few decades (Nurse et al. 2014). With regard to climate-change effects on incountry (local) food-production systems, especially agriculture and fisheries, there are expected to be impacts on both quantity and quality resulting from sea-level rise (increasing lowland flooding and groundwater salinization), ocean acidification and warming, and extreme weather events (Intergovernmental Panel on Climate Change (IPCC) 2013). In terms of threats to the globalized food network of which Pacific Islands are inexorably part, climate change may cause a whole series of economic stresses, including revenue losses at both household and national levels that will inhibit the ability to pay for food imports, and declines in food aid as greater exigencies emerge in more densely populated parts of the world (Barnett 2011). It should also be noted that climate change is not a stressor operating in isolation. Human diets have been changing, and local production systems have been declining in many parts of the region for several decades, a point that climate adaptation initiatives need to acknowledge.

Despite evidence of challenges to food security in the Pacific Islands, not all islands, communities or households necessarily fit this dominant narrative (Birch-Thomsen et al. 2010, Allen 2015). The Pacific Islands region is characterized by geographical, biological, socioeconomic, and cultural diversity, which shapes local food systems and influences how people experience and respond to environmental stress. It has been argued that islands

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in Melanesia, which are comparatively large and close together, are more food secure than those of Polynesia and Micronesia because traditional food production is easier to sustain on larger, higher islands than on smaller ones (Campbell 2015). Furthermore, rural and outer island settlements are generally more food secure than urban settlements, the difference explainable by the lower population pressure, better access to sufficient land, and nearshore resources to harvest/produce subsistence foods (Allen 2015, Connell 2015, McCubbin et al. 2015, Vengiau et al. 2014).

To date, there has been little empirical research on food security in the Pacific Islands region conducted from a social–ecological perspective (Allen 2015). Recent research on food security and climate change in the Pacific Islands region, for example, has examined food security at a regional scale, is mostly based on anecdotal evidence and assumptions, and focuses on either social or ecological systems. Although this research has increased our broad understanding of the expected direct impacts of climate change on food availability, it tells us less about the holistic food system in which both social and ecosystem processes are important. As such, we have an incomplete understanding of the state of food security in the Pacific Islands generally and under changing climatic conditions specifically. This is cause for concern as many Pacific Islands are experiencing rapid population growth and other socioeconomic changes at the same time that land and natural resources important for food production are becoming increasingly scarce.

In this article, our aim is to examine food security in Funafuti, Tuvalu in the context of recent social and ecological changes in order to provide a holistic account of the factors and processes shaping experiences of food security. To do so, our objectives are to: (1) characterize the food system in Funafuti; (2) document experiences of food security (i.e., availability, access, quality), including food preferences and consumption, and; (3) identify and describe social and ecological system factors and processes affecting food security. The study builds upon previous research in Funafuti that examined vulnerability to climate change in the context of multiple stressors and identified food security as a priority concern (McCubbin et al. 2015). The following sections define food systems and food security and provide a brief description of Funafuti and the methods employed in the study. The results are then presented and discussed in the context of societal practices and ecological factors that govern the availability of, and access to, food in Funafuti.

### Defining food systems and food security

Food systems are inherently holistic social–ecological systems. According to Gregory et al. (2005:2141), a food system comprises “dynamic interactions between and within biophysical and human environments which result in the production, processing, distribution, preparation and consumption of food.” It is widely considered that food security exists when people have access at all times to sufficient, safe, and nutritious food to maintain a healthy and active life in a manner that maintains human dignity (FAO 2002). This includes both physical and economic access to food that meets people’s dietary needs as well as their food preferences (van Esterik 1999, World Health Organization (WHO) 2015). “Food availability” refers to the availability of sufficient food, or the overall ability of the food system to meet

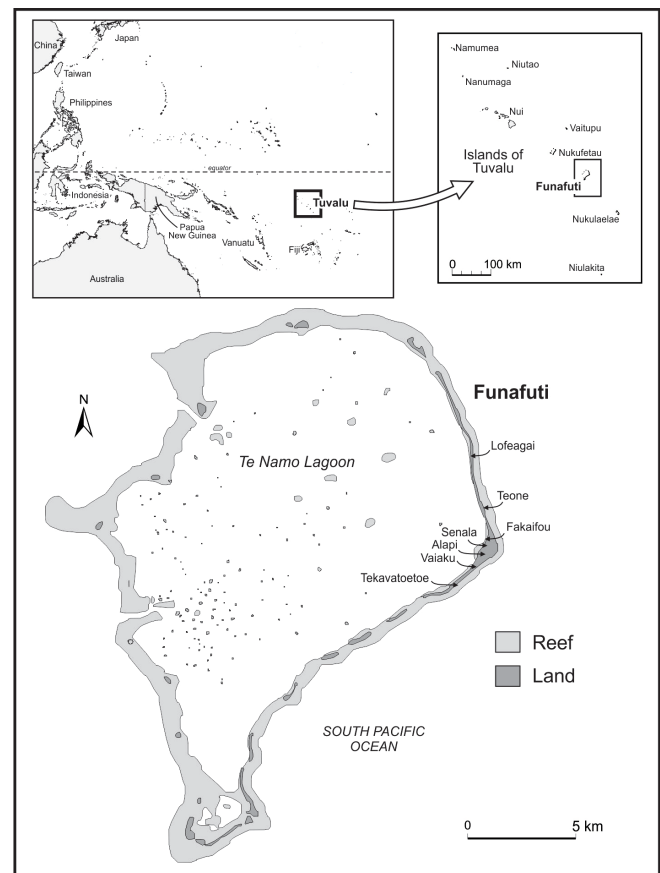
demand. “Food access” is the ability of households and individuals to access adequate resources to acquire foods for a nutritious diet. “Food quality” refers to the ability to obtain food of sufficient nutritional and cultural value. Food security is not a dichotomous concept—either you have it or you do not have it—but should be considered in degrees; you can be more or less food secure, food security may be limited by various factors, and may vary by season and over time (Mangum 1999).

### CASE STUDY

#### Funafuti, Tuvalu

Tuvalu lies in the western South Pacific Ocean between 176° E–180°E and 5°S–11°S. The country comprises five coral atolls and four low raised limestone reef islands, with a total land area of approximately 26 km<sup>2</sup> (Fig. 1). The maximum island height above mean sea level typically ranges from 3–4 m. Tuvalu is classified by the United Nations as a least-developed country and is regarded as especially vulnerable to the effects of climate change, particularly sea-level rise (Nurse et al. 2014).

**Fig. 1.** Funafuti and the location of Tuvalu among Pacific Islands.



Tuvalu has a population of approximately 11,000 people, with Funafuti, the capital, home to over 6000 people (Government of Tuvalu 2012). Funafuti is a typical atoll characterized by a discontinuous string of islets surrounding a lagoon. With the exception of a few families (approximately 12 people in 2013)

living on the other islets, the entire population is concentrated on Fongafale Islet, a long narrow strip of land, 12 km long and between 10 and 400 m wide. With a population density of approximately 4300 persons/km<sup>2</sup>, Fongafale is crowded. Most residents live in one of seven loosely differentiated villages on the islet, which form one contiguous urban area (Fig. 1). Hereafter, “Funafuti” will be used to refer to Fongafale Islet, consistent with the way that locals refer to it. The other islets of Funafuti Atoll will be referred to as “the islets” or by their proper names.

Urbanization, among other factors, has fundamentally altered land use and vegetation cover in Funafuti (Yamano et al. 2007). Whereas the population was originally concentrated in two villages in the center of the island, the surrounding areas being for food cultivation and harvesting, much of Funafuti is now urbanized and therefore no longer available for these purposes. Impacts of population pressure on food production have also been documented elsewhere in the Pacific (Umezaki et al. 2000). The ecological health of the lagoon has declined in recent years, and many fishers now travel outside the lagoon to access fish (McCubbin et al. 2015). Funafuti depends on rainfall for freshwater. There is no surface freshwater, and only very limited nonsaline groundwater, which is vulnerable to salinization from sea-level rise (Nakada et al. 2012). Rainwater is captured and stored in tanks of varying capacity belonging to individual households, communities, churches, and the government. This system is usually effective as Funafuti usually receives plentiful rainfall for most of the year, although interannual variability is associated with the El Niño–Southern Oscillation (ENSO) phenomenon. During the most recent drought in Tuvalu (2011), a State of Emergency was declared because households did not have enough water stored to meet basic needs. Fresh water and temporary desalination plants were delivered by New Zealand to Funafuti for assistance.

Household income in Funafuti comes from employment in the public sector, on projects financed by international aid, and through private sector activities such as small businesses. Other important sources of household income include the selling of fish and handicrafts, as well as property income and remittances. The communal nature of Tuvaluan culture buffers people from some of the hardships of poverty like starvation and homelessness, although there is some hardship linked to “poverty of opportunity”—the inability of people to lead the kinds of lives they aspire to (Asian Development Bank 2003).

As described in the Results and Discussion section, the food system in Funafuti is a dual system composed of both local and imported foods. In this paper, “local food” refers to that which is harvested in Tuvalu from the sea (primarily fish) or land (e.g., coconut, breadfruit, pandanus, local greens) or cultivated in plantations and home gardens. Cultivated local foods include “pulaka” (a crop grown in Tuvalu that is a traditional, staple food), taro, banana, pawpaw, cabbage, cucumber, pumpkin, chickens, and pigs. Based on key-informant interviews and personal observation, in terms of its nutrition and cultural value, Tuvaluans consider local food to be high quality food and the most culturally appropriate for consumption. On the other hand, “imported food” refers to that which is imported from outside of Tuvalu and sold in shops. Although we distinguish between local and imported foods in this paper, it is important to note that there

is some overlap between these categories. For example, although Tuvaluans consider taro a local food, imported taro is also available for purchase in Funafuti shops. Despite some instances of overlap between these categories, we retain the distinction between local and imported foods because it enables a description of the dual and changing nature of the food system.

## METHODS

### Data collection

Most of the data for this paper were collected over a 6-wk period between August and October 2013. Multiple data-collection techniques were used, including a fixed question household survey and freelist (n = 50), semistructured interviews using open-ended questions (n = 25), participant observation, and analysis of secondary sources (e.g., government documents, climate data, published research). Survey questions collected data on basic household demographics, the food system in Funafuti, food preferences and consumption in the past year, as well as experiences of and processes affecting food security in the past year (Table 1). Three types of nonprobabilistic sampling were used to recruit respondents: purposive sampling was used to recruit respondents who were most involved in making food choices in their households, were over 18 years of age, and were residents of Funafuti (not visiting from an outer island); quota sampling was used to ensure that a representative number of respondents from each village were included; and snowball sampling involved asking respondents and community research partners to identify people who might be willing to take part in the research. Forty-two women and eight men were surveyed (Table 2). The disproportionate number of women in the sample reflects the situation that meal planning and food preparation is mainly the role of females in Tuvaluan society.

**Table 1.** Themes and topics covered in household survey

Theme	Topics Covered
Background information	Basic household demographics (age, gender, size) Village Length of time lived in Funafuti Livelihood activities (employment status, student, retired, etc.)
Food preference Food system	Food production activities (does anyone in your household go: fishing, keep a garden, pigs, a pulaka pit, chickens, or harvest food from trees?) What are your favorite foods? Foods consumed most often Consumption frequency of local foods (e.g., fish) Relative consumption of local and imported foods Food harvesting, purchasing, sharing
Issues affecting the food system	Food availability Food access Food quality Coping mechanisms

At the completion of the survey, respondents were asked to complete a freelist task. Freelist is a well-established ethnographic method that can be used to identify and calculate the culture salience of items in a cultural domain (Quinlan 2005). Here, freelists were used to generate cultural salience data on food preference and consumption patterns. Participants were asked

“What are your favorite foods?” and then given 2 min to list as many items as came to mind. They were then given an additional 2 min to freelist responses to the question, “What foods do you eat most often?” In most cases, respondents did not use the entire 2 min to generate their lists. Freelists in response to the question “What are your favorite foods?” ranged in length from one to ten items, and the median was three items. Freelists in response to the question “What foods do you eat most often?” ranged in length from one to seven items, and the median was two items. The short duration of the freelisting activity and few items listed likely reflect the limited diversity of foods consumed by participants. Freelisting for cultural salience is based on the assumptions that people list items in order of familiarity and that items listed by most respondents indicate locally prominent items.

**Table 2.** Personal characteristics of household survey respondents

Age (years)	Women	Men
18–29	11	0
30–39	7	2
40–49	7	1
50–59	13	3
60–69	3	1
70–79	1	1
Total	42	8

Semistructured interviews were conducted with key informants using open-ended questions. Ten interviews were conducted with fishermen ( $n = 6$ ), pulaka farmers ( $n = 2$ ), and shopkeepers ( $n = 2$ ) to gain insight into the stresses faced by these sectors of the food system. An additional 15 interviews were conducted with representatives from community, government, and international organizations, including the Department of Agriculture, Fisheries Department, Public Health Department, Department of Women, Office of Marine and Ports Services, Tuvalu Meteorological Service, Red Cross, Tuvalu National Council of Women, and the Ekalesia Kelisiano (Tuvalu) Church. These interviews provided contextual information to better understand the broader social, economic, cultural, and ecological factors affecting the food system. The open-ended structure was used to minimize interview bias and allow respondents to share their knowledge and experiences in terms that made sense to them and reflected their priorities (Fienup-Riordan 1999).

Data collection methods were designed to examine food security in the context of social–ecological changes. Household survey questions about the food system were designed to capture both social and ecological factors affecting food security. For example, survey questions about household fishing practices and fish consumption elucidated responses about social conditions (e.g., changing dietary practices) and ecological conditions (e.g., the declining state of the reef fishery). Semistructured interviews were conducted with key informants who were experts in both social and ecological aspects of food security in Funafuti. For example, a key informant from the Fisheries Department provided insights about the ways in which the declining ecological condition of the lagoon affected food security, and a key informant from the Department of Women provided insights into the ways in which household and family dynamics affected food security. Finally, secondary sources relevant to both social and ecological factors

were analyzed. The Government of Tuvalu’s *Household Income of Expenditure Survey* (2010) provided insights on household food purchasing and production, and the academic articles from environment science disciplines (e.g., Fujita et al. 2013) provided insight into the way in which domestic wastewater pollution is impacting the condition of the reef fishery in the Funafuti lagoon.

Data were collected by the lead author and a local research collaborator. The local research collaborator was engaged throughout the research process to ensure the relevance and appropriateness of the research design and to assist with data collection and interpretation. Data collection was conducted in the preferred language of the respondent, Tuvaluan and/or English. In most instances, surveys and interviews were conducted partly in English and partly in Tuvaluan. When responses were given in Tuvaluan, they were translated into English in real time and manually recorded.

### Data analysis

Data from the fixed-question surveys were entered into a Microsoft Excel spreadsheet and analyzed using descriptive statistics. Freelist data were analyzed using salience analysis, which accounts for the frequency of mention weighted by list position (Smith et al. 1995). First, freelists were removed from the analysis if the respondent did not follow the instructions for freelisting. In total, two freelists were removed from the analysis of “favorite foods,” and one freelist was removed from the analysis of “foods consumed most often.” In these cases, respondents did not list individual food items but rather wrote something general like “local food.” Then, to find the salience of listed food items for each respondent, we first ranked foods on a respondent’s list inversely (final item listed equals one, and items increase by moving up the list). We then divided the rank by the number of foods the respondent listed. Next, we tabulated a composite/mean salience value for each food item listed in all freelists. Here, we summed all salience scores for each food item and then divided by the number of respondents ( $n = 48$  for freelists of “favorite foods;” and  $n = 49$  for freelists of “foods consumed most often”). A larger salience score indicates greater consensus within the culture (Quinlan 2005). Informal and semistructured interviews were used to enhance the depth of ethnographic understanding of the cultural domain in question, food preference, and consumption, and to crosscheck freelist results. Data from informal and semistructured interviews were transcribed and analyzed using the principles of latent content analysis to identify common/recurring themes related to food security (Bernard 2000).

### Research limitations

A limitation of the fixed-question survey is that some respondents may have reported greater food security in their household than actually existed. Tuvaluans take pride in being able to provide food for their families and community, and this may have biased responses. Efforts were made to account for this potential limitation in the research design as much as possible. The local research collaborator reviewed the survey and the semistructured interview guide prior to data collection. Her feedback was incorporated to ensure that questions were worded in an appropriate and sensitive manner to elicit responses that were as accurate as possible. Survey questions that were deemed by the



local collaborator to consistently elicit biased responses were not included in the analysis.

The timing of data collection may also have influenced findings (Guo et al. 2015). Responses to the same questions asked could vary depending on the season and the state of the shipping schedule, which is variable throughout the year. Data collection occurred during the transition period from the dry season to the wet season. It is unlikely that this timing had a notable influence on the results because there is not a distinct growing season in Funafuti; that is, most local foods (e.g., bananas, pawpaw, breadfruit, coconut) grow and are harvested year round. With respect to the shipping schedule, data collection took place during a time when the shipping schedule was disrupted: the *Nivaga II* had been out of service for 3 mo and the *Manu Folau* had been out of service for 3 wk. Shipping schedule disruptions of this nature occur frequently, and their impacts on food security were captured in this research.

## RESULTS AND DISCUSSION

Results are reported in three sections: the first characterizes the Funafuti food system, the second reports on experiences of food security, and the third identifies and describes social and ecological factors and processes affecting food security. The latter section aims to provide a holistic account of the linked social—ecological processes shaping food security. Where relevant, findings from other studies are included to complement data collected in this research.

### The Funafuti food system

The precolonial Tuvaluan diet was based primarily on nearshore marine foods and coconut and was supplemented by the cultivation of local root crops, pulaka and taro (see David 1913, Koch 1961). Starting in the late 19th century, through sustained contact with European and American traders, the food system in Funafuti shifted to a dual mode based on local and imported foods, with an increasing dependence on the latter. The results of the food survey conducted for this study show that 58% of respondents obtained 50% or more of the food they consumed in the previous month from imported sources. This finding is consistent with the 2010 Household and Income Expenditure Survey (HIES; Government of Tuvalu 2010) report that found that 85% of household foods in Funafuti are imported, 10% are home produced, and 5% are both imported and local foods received in kind. Other surveys report similar findings, for example, that sugar, rice, biscuits, and flour are the top four foods consumed, representing about 40% of daily energy requirements for a Funafuti resident (Secretariat of the Pacific Community (SPC) and Commonwealth Scientific and Industrial Research Organisation (CSIRO) 2011).

Despite an increasing dependence on imported foods, local fish continues to be the main animal-source food for most households, and 66% of respondents reported consuming fish every day. There is both subsistence and commercial fishing in Funafuti. Subsistence fishing is conducted primarily inshore using nets, spears, and rods, and 64% of respondents said that a member of their household went fishing at least once monthly in the past year. Yet the quality of the inshore fishery has declined in recent years owing to pollution from the discharge of domestic wastewater and leaching from open-pit dumping (Fujita et al. 2013, 2014), as well as overfishing (Sauni and Fay-Sauni 2005).

Nearshore pelagic fisheries just outside the lagoon are more productive and are becoming the primary source of fish. There are a number of fishermen in Funafuti with motorboats who fish full time for their livelihoods. They fish mostly by trolling outside the lagoon and sell their fish for an average of \$4/kg. The 2010 HIES Report found that 63% of household fish and seafood in Funafuti was purchased, 32% was caught by a household member, and 5% was received in kind (SPC and CSIRO 2011).

Local agricultural production in Funafuti is minimal and constrained by limited access to small areas of poor-quality land. Land tenure is governed by a familial system called “kaitasi” or “eat from the same land.” Kaitasi applies to those people who are living on or subsisting from a piece of land (Government of Tuvalu 2008). In Funafuti, all members in the kaitasi group must agree upon decisions affecting kaitasi land, which cannot be sold, although it can be exchanged or leased. Since Funafuti became the capital of Tuvalu at independence in 1978, rapid internal migration has caused the population of Funafuti to boom with outer Islanders settling in the capital, mostly in search of jobs and access to centralized services. Today, 83% of Funafuti’s population is not indigenous to Funafuti (Government of Tuvalu 2012), meaning they do not have access to the use of land in Funafuti for food production. Although the kaitasi system of land tenure prohibits land access to outer islanders who have settled in Funafuti, indigenous Funafuti people with land entitlements do not fare much better in terms of food production. Urbanization of Funafuti has meant that very little land is available for food production as most land has been built upon. Yet most households raise pigs and some raise chickens because they can be raised in small areas of marginal land, for example along the runway or the borrow pits. Seventy-eight percent of respondents said they kept pigs, and 26% of respondents said they kept chickens. Pigs are primarily kept for special occasions and as contributions to community feasts; they are eaten during times of environmental or economic stress and occasionally sold to local Chinese restaurants.

Coconut, breadfruit, and pandanus are harvested on Fongafale. The food harvested from these trees technically belongs to the Funafuti landowners but is often shared with tenants, friends, neighbors, and relatives of the landowners. Banana and pawpaw trees are commonly planted outside homes, and some households maintain small gardens with cucumber, cabbage, and pumpkin. Pulaka is also cultivated on Funafuti but less than in the past. It is estimated that between 50% and 80% of the pulaka pits in Funafuti have been abandoned because of changing dietary preferences, declining interest in pulaka cultivation, and environmental stress, including periodic drought and saltwater intrusion.

The majority of the local food consumed in Funafuti today comes from the outer islands. Fresh and dried fish, pulaka, bananas, coconut, and breadfruit are distributed among extended family via an informal trading system whereby family members in Funafuti send store-bought goods (e.g., food and other items) to family members in the outer islands in exchange for local foods from the outer islands. As one respondent described:

*There is a bit of a market going on... I'll give you an example. You know those Chinese floor coverings you can buy? My wife's sister wanted one so she sent us a whole bunch of coconuts and then said, "can you*

*possibly...?” So I knew in my mind this is trading. She provided us with what she can provide, so we provided her with what she wants. (Key informant 6 from Funafuti, 16 October 2013.)*

This respondent was careful to assert that his ability to engage in this informal market was enabled by having access to income, something that does not apply to everyone in Funafuti. The outer islands are the primary source of local food in Funafuti, and food that arrives on Funafuti from the outer islands is shared extensively between neighbors and relatives.

Crossborder food imports to Tuvalu include some fresh, but mostly processed, foods that are shipped from Fiji to Tuvalu in a cargo ship that arrives about every 3 wk. Staple items available in shops include rice, flour, sugar, breakfast crackers (biscuits), chicken, and tinned fish. Rice is the staple food in the modern Tuvaluan diet, and the country imports 100 tonnes of rice every 3 wk (Mackenzie Kiritome, Director of Mackenzie Trading Ltd., *personal communication* 2013). Chicken is the second most common animal-source food next to fish, and 64% of respondents reported eating store-bought chicken one to two times per week, particularly on Sundays. At one of the stores in Funafuti, Sulani Trading Ltd., there are two kinds of chicken available: less expensive fatty legs imported from the USA, and mixed pieces of chicken (wings, drumsticks, thighs) imported from New Zealand that are slightly lower in fat but more expensive. The store sells three times as many shipping containers of the fatty legs in one and a half months as it does the containers with mixed pieces (General Manager, Sulani Trading Ltd., pers. comm. 2013). Countries elsewhere in the Pacific are using trade-related food policy initiatives to reduce the supply of imported fatty meats (e.g., Samoa, Fiji, Tonga) (Thow et al. 2011).

Imported food is not commonly shared in the way that local food is. Imported food tends to be shared among families only during times of need or at feasts and special occasions; the cultural imperative to share does not appear to apply as strongly to imported food as to local food.

**Experiences of food security**

The results suggest that there is an adequate amount of food available in Funafuti to meet basic food needs, but several respondents reported struggling to access food of sufficient nutritional and cultural value. Only 10% of respondents reported having skipped meals, reduced portions, or felt hungry in the last month because they did not have enough food, but 40% of respondents said that they ate foods they did not particularly like because they were easier or cheaper to get, and 52% indicated they ate foods of lower nutritional value because they could not get more nutritious foods either because of availability or cost (Table 3).

Freelisting data, when considered in the context of other data collected, indicate that most respondents consumed imported foods more often than local foods and suggest that there is a preference for local foods or, at least, a desire to consume more local foods. Tables 4 and 5 report freelist data for foods listed by three or more respondents. They demonstrate a kind of cultural agreement with regard to food preference and consumption. Frequently mentioned foods among individuals (composite salience) indicate general preferences for foods and common consumption of foods. When respondents were asked to freelist,

“What are your favorite foods?” the most salient responses were fish (0.52) and breadfruit (0.52) (Table 4). In comparison, when respondents were asked to freelist, “What foods do you eat most often?” the overwhelmingly salient response was rice (0.82), followed by fish (0.37) and chicken (0.29) (Table 5).

**Table 3.** Experiences of food security in the past month among household survey respondents

Component of food security	Survey question	Total respondents who answered “yes” (%)
Availability	In the last month, did you or anyone in your household skip meals, reduce portions, or feel hungry because you did not have enough food?	5 (10)
Access	In the last month, did you or anyone in your household eat foods that you do not like as much as other foods, because they are easier or cheaper to get?	20 (40)
Quality	In the last month, did you or anyone in your household eat lower quality foods because you couldn’t get higher quality, healthier foods?	26 (52)

**Table 4.** Freelisting results for food preference (“What are your favorite foods?”)

Foods listed by three or more respondents	Salience scores for each food	Composite Salience <i>ln</i> (n = 48)
Fish	24.95	0.52
Breadfruit	24.95	0.52
Taro	8.95	0.19
Rice	7.71	0.16
Pulaka	7.58	0.16
Chicken	4.85	0.10
Coconut	4.39	0.09
Banana	4.22	0.09
Cassava	2.23	0.05

**Table 5.** Freelisting results for food consumption (“What foods do you eat most often?”)

Foods listed by three or more respondents	Salience scores for each food	Composite salience <i>ln</i> (n = 49)
Rice	40.44	0.83
Fish	18.94	0.37
Chicken	14.43	0.29
Breakfast crackers	2.98	0.06
Breadfruit	1.90	0.04
Kopai (local bread)	1.70	0.03
Bread (imported)	1.25	0.03

Most respondents reported consuming imported foods more than local foods. The freelisting data support this finding because rice, fish, and chicken were the three most salient responses. Although the freelisting data do not discriminate between fresh fish and tinned fish, key informant and household survey data suggest that when respondents listed “fish” on their “favorite foods” freelist, they were referring to fresh fish; on the other hand, when respondents listed “fish” on their “foods consumed most often” freelist, it is likely they were very often referring to tinned fish. As one key informant explained, for example, tinned fish is less expensive to serve in Tuvaluan households than fresh fish because of the way it is prepared. She said, “[f]or bigger families, it is easier to make tinned fish go further than fresh fish. If you bring fresh fish home, the favorite way to eat it is raw, so it will not go as far” (Key Informant 10, 23 September 2013). The finding that respondents consume more imported food than local food is also consistent with the results of the household survey in which 56% of respondents reported that they were not able to access local food all the time within the previous year, and 58% said that less than half the food they ate in the last month was local. This finding is also supported by secondary sources of information such as the 2010 HIES Report, which found that 85% of household foods in Funafuti are imported, as well as participant observation including eating meals in Tuvaluan households. This finding is also consistent with the remarks made by numerous survey respondents and key informants. For example, when commenting about the lack of local food her family consumes, one survey respondent said, “[r]ice is eaten because there is no breadfruit” (Respondent 3, Lofeagai, 19 September 2013).

The freelisting data also support the notion that, in Funafuti, there is a preference for local food over imported food or, at least, a desire to eat more local food than is currently available in Funafuti. It is notable that freelists for foods consumed most often are generally shorter than the freelists of favorite foods. We interpret this as further evidence of the extent to which diets in Funafuti are limited; that is, diets are dominated by very few foods (i.e. rice, chicken, fish). That the lists of favorite foods are longer supports the finding that people in Funafuti desire more diverse diets, preferably containing more local foods. This interpretation is supported by the statement of a respondent who, when asked to freelist “What are your favorite foods?” did not provide a list but rather responded by saying, “I don’t have a choice, I have to eat rice” (Respondent 5 from Vaiaku, 16 September 2013). It is likely that freelisting responses to “What are your favorite foods?” were, in part, shaped by the limited availability of local foods in Funafuti. Therefore, it may be more accurate to view the freelisting data as indicative of a desire for more local food in Funafuti rather than a preference for local food per se. Teasing apart the complexity of food preferences and consumption in this dual food system is beyond the scope of this paper, but our evidence points to a clear desire for a more diverse diet in Funafuti, particularly one that includes more local foods.

#### **Factors and processes influencing food security**

Access to food of sufficient nutritional and cultural value in Funafuti is affected by a number of interconnected social and ecosystem factors and processes operating from local to global scales. These include: (1) availability and affordability, (2) cultural practices, (3) changing way of life, (4) shipping schedules, (5) access to land, and (6) climate change.

#### **1. Availability and affordability of food of sufficient quality**

Imported, processed foods, many which are nutrient poor, are more readily available to residents of Funafuti than local foods and need to be purchased from stores. Several respondents were frustrated about having to depend on imported foods:

*Because we are eating imported food, the big question is money, because we have to pay for it. Before, we didn't need money to get our food. All we needed was time and energy: get your fish, go to your plantation in the bush, get your food, that's all you needed. But now you need to look first for money. You can't get the rice from your land, you have to buy it from the shop. (Key informant 1 from Funafuti, 15 October 2013.)*

Fish is the preferred animal-source food for most respondents (see Table 4), but reef fish are fewer than they once were (due to overfishing and pollution of the Funafuti lagoon—see *Ecological and climate change* below), and pelagic fish like tuna are expensive to catch and purchase because of the costs associated with running a motorboat. In comparison, high-fat chicken leg imports are among the least expensive meat options. Carbohydrate-rich white rice is also eaten in large quantities at nearly every meal because it is inexpensive and widely available. Respondents frequently described knowingly preparing meals that were nutrient poor simply because they were the most cost-efficient way of feeding their household.

*Today we have chicken soup, tomorrow we have tin fish soup. Sometimes I change the menu to fish, but as we all know [local] fish is expensive here. But really we want fish more than chicken and tin fish. Luckily, last night we had fresh breadfruit and fresh fish—wow, that was a good dinner last night! So we all enjoyed our dinner last night. (Respondent 3 from Lofeagai, 19 September 2013.)*

#### **2. Role of culture**

Tuvaluan culture is communal and the sharing of work and food were once central. Traditional food-sharing practices served as a type of social safety net, the means through which food was produced and distributed to ensure community well-being under challenging, atoll ecological conditions (McCubbin et al. 2015). Yet today, in less traditional urban Funafuti, it is implicitly acknowledged that there are some ways in which food sharing beyond one’s immediate nuclear family may threaten its food security. For example, the obligation to provide food for community and church feasts can be a notable challenge for many families. Some respondents noted that the only time they bought healthy, high quality foods was when they were preparing a meal for such a feast. Likewise, the cultural obligation for individuals to host and provide for extended family members is upheld even when it comes at the expense of their household’s food security.

*Sometimes [we worry that our food will run out] because we think we have enough but when the boat comes from the outer islands we have more family coming to the hospital so we become overcrowded. (Respondent 8 from Fakaifou, 16 September 2013.)*



*We don't have the option to cook the food we want because of the way we are living with extended family. We have to budget for the whole family. We have to make sure everyone has the same meal, even though we can afford to buy our own healthy food [for our nuclear family]. It is just the mentality; it is just a cultural thing. (Respondent 5 from Alapi, 24 September 2013.)*

Cultural values about food also affect food security in Funafuti. Meals involve the preparation of large amounts of food, which are placed buffet style on a table; it is considered culturally inappropriate to control portions or ration meals. It is also considered shameful if women do not provide a sufficient quantity of food for their families and as contributions to community feasts. As a result, Tuvaluans prioritize quantity over the quality of food they prepare. Valuing food quantity over food quality, together with often overcrowded households, means that people frequently eat meals that are nutrient poor. In the words of one key informant:

*Traditional Tuvaluan culture is such that food is simply placed on the table and everyone helps themselves. There are no meal times and separate portions are not dished out. It is shameful to control people's portions, and it is very offensive to ration meals. Tuvaluans pride themselves on having lots of food. It is shameful to not provide enough food. It is important that the women of the household make sure that there is food available whenever someone wants it . . . Here, when we cook, we go by quantity rather than quality. (Key informant 10 from Funafuti, 23 September 2013.)*

Respondents also described cooking in ways that allowed them to use a small quantity of food to serve a large number of people, such as taking a small amount of fish (often tinned fish) and making it into a soup with a lot of water.

*We face difficulties sometimes. If [the men] come back and there were not so many fish, we make fish soup. Once we know there is not enough fish, we try to make it enough so we put it in a soup with curry instead of fried fish and raw fish. The Tuvaluans love raw fish and fried fish but if there is not enough, we do fish soup. We make it with coconut cream to make it more, more soup for the big family. We made it this afternoon. Plenty of rice, less fish, and plenty of water. At least you taste the fish. Sometimes the kids they will eat the fish, but the adults they will just eat the soup with no fish. (Key informant 2 from Funafuti 15 October 2013.)*

### 3. Changing way of life

The combination of changing dietary preferences among younger people, declining subsistence food production, and the spread of imported foods has led to a decrease in the availability and subsequent consumption of local foods and a concomitant increased reliance on imported foods over the past few decades in Funafuti.

Key informant interview data and anecdotal evidence shared by survey respondents (particularly older adults) during and after the survey suggest a relationship between

age and food preference, with younger people generally preferring to eat imported foods, and older people generally preferring local foods. There also appears to be a declining interest among youth in local food production. Very few land-entitled Funafuti residents still tend to their pulaka plantations and those who do are mostly over 50 years in age. The convenience of imported store foods vs. local foods also appears to play a role in the popularity of imported foods. Not only is home gardening extremely difficult in Funafuti because of insufficient space and poor soil quality, but the method of preparing local food is more time consuming than for store foods like rice. The following quote from a key informant, age 44, well illustrates the complexity of these trends; that is, young people prefer imported foods to local foods, young people are not interested in the work required to grow local foods, and local foods are more difficult to harvest and produce than they were in the past.

*If you go and get pulaka for the family, and put it on the table, the kids would still rather eat rice. So I think it is partly changing tastes, and there is also ease of availability. To go and grow a pulaka will take you 3 mo. Or, you can go to the shop and buy taro in 2 min. And, there is the changing lifestyle. Like, people would rather play sports on the runway and go drinking beers instead of going down to the pulaka pit. Another thing is population growth here. If you go fishing, the amount of effort you put in to get a certain amount is so much more. Like before [in the past] you could just go out to the jetty and get enough fish to feed your family for 2 d. Now you could sit there for 2 d and get enough fish to feed a chicken —so you just go buy the chicken instead!. (Key informant 6 from Funafuti, 16 October 2013.)*

Some key informants expressed that the changing way of life in Funafuti is having a much greater impact on food security than climate change, which is often talked about as a primary driver of food insecurity in Pacific Islands. One key informant said:

*They were saying it's because of climate change, that salt water is entering the plantations, but people are just not tending to the plantation. Hardly anyone is doing it in Funafuti anymore. (Key Informant 2, 14 October 2013.)*

This is not to say that climatic factors are not impacting food production in Funafuti. Climatic factors, including high tide events and severe drought, have impacted food security in Funafuti in recent years (McCubbin et al. 2015). However, this key informant makes the important point that social and climatic factors are often considered in isolation from one another in examinations of food security in Pacific Island countries.

### 4. Shipping schedule

Many respondents shared that their main (sometimes only) source of local food was from the outer islands of Tuvalu, so when the interisland shipping schedule is disrupted, as it often is, their household does not have local food.

*From Nui we get taro, breadfruit, coconut, dry fish. It comes on every ship. We don't have to ask [our family] they just send [it]. We are very happy now because just this morning the ship went to Nui, but before, 3 mo*



*[passed with] no ship. When there was no ship in the last 3 mo, we ate rice and we cooked some local foods with flour and banana. (Respondent 3 from Fakaifou, 3 October 2013.)*

According to the interisland shipping schedule, each outer island is supposed to be visited by a ship every 2–3 wk, but bad weather, the need for boat repairs and maintenance, and politics all contribute to schedule disruptions. For example, in late September 2013 the interisland boat *Nivaga II* had been out of service for 3mo, and the *Manu Folau* had been out of service for 3 wk. Occasional disruptions to the schedule of the international cargo ship that brings imported food to Funafuti sometimes cause stores to run out of staple imported food items such as rice.

*When cargo ships are delayed, everyone is looking for local food. And the Funafuti people want to keep their food for themselves. (Respondent 5 from Alapi, 24 September 2013.)*

## 5. Access to land

Eighty-three percent of Funafuti residents are not indigenous to Funafuti, rather they are from the outer islands and come to Funafuti for a variety of reasons, including for employment, to visit relatives, and to access centralized services. These residents do not have rights to land on Funafuti on which to grow or harvest food. Many residents from outer islands cited not having land among the main reasons why local food was difficult to access.

*It is very difficult to get local food here. In Nui, we always had local food. Here, we don't have lands. (Respondent 3 from Fakaifou, 3 October 2013.)*

Yet even respondents indigenous to Funafuti with land entitlements there identified a lack of land as a constraint on their ability to produce a sufficient quantity of local food for their households.

*Here in Funafuti, because there are so many people here and the island is too small, there is no space so you can't really count on doing gardening. (Respondent 3 from Lofeagai, 19 September 2013.)*

Even where land is accessible and available in Funafuti, the poor quality of much of the land and soil is another factor limiting local food production. One respondent pointed to the borrow pits and coral rubble surrounding their house as reasons they could not produce food.

*Look at our house. Our surrounding is so rocky we cannot plant. (Respondent 5 from Teone, 17 September 2013.)*

## 6. Ecological and climate change

Current ecological and climate conditions have implications for food security in Funafuti. Ships carrying imported foods and local foods from the outer islands are exposed and sensitive to extreme weather conditions like strong winds and heavy rains that prevent them from docking and unloading at the wharf (Key Informant 12, *personal communication*, 27 September 2013). Strong winds and

extreme sea levels affect pulaka crops and home gardens by saltwater intrusion, and respondents from households living directly next to the ocean or in the narrow ends of Funafuti explained that the salt spray from the ocean prevented them from gardening.

As Funafuti is primarily dependent on rainfall for freshwater, home gardens are quickly neglected during periods of little rainfall in order to conserve water.

*For us, because we have only one [water] tank, I have to use little water for watering my plants. There was a drought this year recently. Not really a drought, but no rain for a few weeks, and that affected us. My garden didn't die, but they were not growing, they didn't look healthy. The other problem is the sea level. During the king tide my pumpkin died. (Respondent 1 from Teone, 9 October 2013.)*

The condition of the Funafuti lagoon has declined dramatically in recent years. Ecological factors such as domestic wastewater pollution (Fujita et al. 2013) and overfishing (Key Informant 16, *personal communication*, 10 October 2013), together with climatic conditions like sea-surface temperature and ocean acidification, have already negatively affected reef fisheries (Kuchinke et al. 2014), as is evident by the decreased availability, size, and quality (i.e., ciguatera contamination) of fish from the lagoon. One key informant, a fisherman who has been fishing in Funafuti since 1983, described that there are much fewer fish in the lagoon than in past:

*Before, in the '80s and '90s, you knew a good spot [for fishing], and you could be done in 2–3 h. Now, you go to these spots and only get a small bucket so you have to go to different places. Before, you could go to one or two spots, now you must go to 10, 15, 20 spots. Day and night. It is very tiresome. (Key informant, fisherman 1, 1 October 2013.)*

Fishermen and household survey respondents alike also described that fish from the lagoon are much smaller than they were in the past, and that fish are more frequently contaminated with ciguatera. As such, people in Funafuti rely upon the pelagic fish outside the lagoon, which, as discussed in previous sections, are more expensive to catch and purchase due to the costs associated with running a motorboat.

## CONCLUSION

The aim of this study was to examine food security in Funafuti, Tuvalu in the context of recent social–ecological changes. The study responds to the expressed need to examine food security in Pacific Island countries at the community scale and to consider social and ecological factors affecting food security (Ericksen 2008, McMillen et al. 2014, Janif et al. 2016). To this end, data were collected on each pillar of food security, access, availability, and quality. The results show that although most respondents have access to an adequate amount of food, the food available does not always meet their dietary needs or their food preferences. Local foods are often considered to be nutritionally superior and preferred but are consumed less often than nutrient-poor imported foods: local foods are sometimes not available because of limitations in local food production (availability of arable land and motivation for food production) or interruptions in

interisland shipping, whereas imported foods are generally inexpensive, require little time to prepare, and are readily available.

The research highlights the role that culture plays in governing availability and access to local foods. Communal food production and sharing are key elements of Tuvaluan culture and are traditional sources of resilience in the local food system. Yet today, the Funafuti food system is being affected by a clash of cultures. The traditional Tuvaluan food system was based on land assets and cultural values for food distribution based on principles of caring and sharing. Land was owned, cultivated, and cared for communally by families, and food was shared as needed. Today, the population of Funafuti has expanded greatly, most residents (83%) are not landowners, and the way of life for many has consequently shifted away from local food production and consumption to a greater focus on imported foods. For many residents of Funafuti, money rather than land is now the primary means for acquiring food. Although money has supplanted land in the modern food system, many of the cultural practices about food—such as valuing the quantity over the quality of food and providing for the community over the nuclear family—have remained intact. These practices once served to enhance food security by encouraging the production of surpluses and equitable food distribution, yet in the modern context, where some residents of Funafuti have neither access to land nor a source of reliable income, they serve to undermine food security by encouraging the consumption of cheap and abundant but nutrient-poor foods and by lowering the food security of households by dispersing limited resources.

Although most respondents preferred local over imported foods, there was a growing disinterest in participating in local food production. Local food production—cultivating, harvesting, preparing, and storing—is time consuming and laborious, whereas imported foods are convenient, especially for wage earners who have limited time and may also be without land. Most imported foods available at the stores are processed, nutrient poor, and of low quality, meaning that food-purchasing decisions are often based on what is available and affordable, rather than what is of good quality.

Funafuti, like many national capitals in the Pacific Islands, has a rapidly expanding population and a limited land size. The research findings reveal that it is perhaps unrealistic to assume that local food production could meet the food demands or preferences of a growing and changing population, but some level of local food production continues to be desirable. This requires supporting efforts to reclaim and care for sources of local food production (e.g., arable lands, fruit trees, lagoon) and promoting the generation and sharing of knowledge for food production and storage among older and younger generations. This could serve to enhance traditional sources of resilience in the food system and increase self-sufficiency, which has long been a defining characteristic of Tuvaluan culture. Efforts could also be made to improve the flow of local food from the outer islands to Funafuti. This would require more reliable interisland transport and the addition of cold storage and packaging (e.g., wooden crates) onshore on the outer islands and on ships to ensure the safe storage and transportation of food on and between islands (Key Informant 7, *personal communication*, 18 October 2013). Finally,

efforts could be made to improve the nutritional value and cultural relevance of imported foods. Other Pacific Island countries (e.g., Samoa, Fiji, Tonga) have used trade-related food policy initiatives to reduce the supply of fatty meats, and Tuvalu could do the same. The concept of food sovereignty, which contends that “people should be able to have more control over their own food and agriculture than the current global food system allows” (Walsh-Dilley et al. 2016), is a pertinent guiding principal for improving food security in Tuvalu.

The research findings demonstrate the importance of examining food security at a community scale and considering the social and ecological links among factors affecting food security operating across scales. Results show that experiences with food security in Funafuti fit the dominant food security narrative for urban atolls in the Pacific (Allen 2015). This study contributes to our understanding of food security in urban atolls by providing empirical data to substantiate the particular ways in which this dominant narrative is experienced in the daily lives of Tuvaluans living in Funafuti. It is important to note, however, that this case study does not represent the reality of food security in Tuvalu as a whole. A case study of food security in Tuvalu’s rural atolls would likely yield much different results that do not fit the dominant narrative so closely.

Although the case of Funafuti shows congruence with the dominant Pacific food security narrative, the findings raise concerns about an emerging Pacific narrative, that is, the dominant discourse about climate change and the vulnerability of Pacific Island food systems. Discourse about climate change in the Pacific Islands region focuses largely on biophysical hazards, particularly sea-level rise, and work on climate change and food security in the Pacific tends to suggest technocratic responses that do not address the sociocultural or political-economic factors shaping food security in particular locations. One such technocratic response commonly suggested for the Pacific Islands region is the introduction of salt-tolerant plant species to ensure resilient crop production under sea-level rise (FAO 2008). The findings of this study show that technocratic solutions like the introduction of salt-tolerant species would do little to enhance food security in Funafuti or likely in other Pacific island communities. Understanding food security and what it means for residents of Pacific Islands requires working at the local scale and in partnership with residents to examine social and ecological factors affecting food security that are relevant and important to them and what potential responses are appropriate.

#### **AUTHOR CONTRIBUTIONS**

Dr. Tristan Pearce, Dr. James Ford, and Sandra McCubbin designed the research reported in the paper, and data were collected by Sandra McCubbin in Funafuti, Tuvalu in 2012, 2013. Dr. Tristan Pearce and Sandra McCubbin conceptualized and wrote the paper with assistance from Dr. James Ford and Dr. Barry Smit.

*Responses to this article can be read online at:*

<http://www.ecologyandsociety.org/issues/responses.php/9129>

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**LITERATURE CITED**

- Allen, M. G. 2015. Framing food security in the Pacific Islands: empirical evidence from an island in the Western Pacific. *Regional Environmental Change* 15:1341–1353. <http://dx.doi.org/10.1007/s10113-014-0734-5>
- Asian Development Bank. 2003. *Priorities of the people: hardship in Tuvalu, Manila*. Asian Development Bank, Mandaluyong, Philippines.
- Barnett, J. 2011. Dangerous climate change in the Pacific Islands: food production and food security. *Regional Environmental Change* 11(Supplement 1):S229–S237. <http://dx.doi.org/10.1007/s10113-010-0160-2>
- Bernard, J. 2000. *Social research methods: qualitative and quantitative approaches*. Sage Publications Incorporated, Thousand Oaks, California, USA.
- Birch-Thomsen, T., A. Reenberg, O. Mertz, and B. Fog. 2010. Continuity and change: spatiotemporal land use dynamics on Bellona Island, Solomon Islands. *Singapore Journal of Tropical Geography* 31:27–40. <http://dx.doi.org/10.1111/j.1467-9493.2010.00383.x>
- Campbell, J. R. 2015. Development, global change and traditional food security in Pacific Island countries. *Regional Environmental Change* 15:1313–1324. <http://dx.doi.org/10.1007/s10113-014-0697-6>
- Cassels, S. 2006. Overweight in the Pacific: links between foreign dependence, global food trade, and obesity in the Federated States of Micronesia. *Globalization and Health* 2(10):1–8.
- Collings, P., M. G. Marten, T. Pearce, and A. G. Young. 2016. Country food sharing networks, household structure and implications for understanding food insecurity in Arctic Canada. *Ecology of Food and Nutrition* 55(1):30–49. <http://dx.doi.org/https://doi.org/10.1080/03670244.2015.1072812>
- Connell, J. 2013. *Islands at risk. Environments, economies, and contemporary change*. Edward Elgar, Cheltenham, UK.
- Connell, J. 2015. Food security in the island Pacific: is Micronesia as far away as ever? *Regional Environmental Change* 15:1299–1311. <http://dx.doi.org/https://doi.org/10.1007/s10113-014-0696-7>
- David, C. M. 1913. *Funafuti or three months on a coral island: an unscientific account of a scientific expedition*. John Murray, London, UK.
- Denman, V. M., and K. G. Dewey. 1989. Food self-sufficiency in Micronesia: effects of a nutrition assistance programme on food consumption. *Food Policy* 14:330–346. [http://dx.doi.org/10.1016/0306-9192\(89\)90076-6](http://dx.doi.org/10.1016/0306-9192(89)90076-6)
- Ericksen, P. J. 2008. What is the vulnerability of a food system to global environmental change? *Ecology and Society* 13(2): 14. [online] URL: <http://www.ecologyandsociety.org/vol13/iss2/art14/>
- Evans, M., R. C. Sinclair, C. Fusimalohi, and V. Liava'a. 2001. Globalization, diet, and health: an example from Tonga. *Bulletin of the World Health Association* 79(9):856–862.
- Fienup-Riordan, A. 1999. Yaqulget qaillun pilartat (what the birds do): Yup'ik Eskimo understanding of geese and those who study them. *Arctic* 52(1):1–22. <http://dx.doi.org/10.14430/arctic905>
- Food and Agriculture Organization (FAO). 2002. *The state of food insecurity in the World 2001*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Food and Agriculture Organization (FAO). 2008. *Climate change and food security in Pacific Island Countries*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- Fujita, M., Y. Ide, D. Sato, P. S. Kench, Y. Kuwahara, H. Yokoki, and H. Kayanne. 2014. Heavy metal contamination of coastal lagoon sediments: Fongafale Islet, Funafuti Atoll. *Chemosphere* 95:628–634. <http://dx.doi.org/10.1016/j.chemosphere.2013.10.023>
- Fujita, M., J. Suzuki, D. Sato, Y. Kuwahara, H. Yokoki, and H. Kayanne. 2013. Anthropogenic impacts on water quality of the lagoonal coast of Fongafale Islet, Funafuti Atoll, Tuvalu. *Sustainability Science* 8:381–390. <http://dx.doi.org/10.1007/s11625-013-0204-x>
- Gewertz, D., and F. Errington. 2010. *Cheap meat: flap food nations in the Pacific Islands*. University of California Press, Berkeley, California, USA.
- Ghosh-Jerath, S., A. Singh, P. Kamboj, G. Goldberd, and M. S. Magsumbol. 2015. Traditional knowledge and nutritive value of indigeneous foods in the Oraon tribal community of Jharkhand: an exploratory cross-sectional study. *Ecology of Food and Nutrition* 54:493–519. <http://dx.doi.org/10.1080/03670244.2015.1017758>
- Government of Tuvalu. 2008. *Tuvalu lands code 2008 revised edition*. CAP. 46.20.2. Government of Tuvalu, Funafuti, Tuvalu.
- Government of Tuvalu. 2010. *Household Income Expenditure Survey*. Central Statistics Division, Government of Tuvalu, Funafuti, Tuvalu.
- Government of Tuvalu. 2012. *Tuvalu 2012 population and housing census: preliminary analytical report*. Government of Tuvalu, Funafuti, Tuvalu.
- Gracey, M. 2000. Historical, cultural, political, and social influences on dietary patterns and nutrition in Australian Aboriginal nutrition. *The American Journal of Clinical Nutrition* 72:1361S–1367S.
- Gregory, P. J., J. S. L. Ingram, and M. J. Brklacich. 2005. Climate change and food security. *Philosophical Transactions of the Royal Society B* 360:2139–2148. <http://dx.doi.org/10.1098/rstb.2005.1745>
- Guo, Y., L. Berrang-Ford, J. Ford, M. P. Lardeau, V. Edge, K. Patterson, IHACC Research Team, and S. Harper. 2015. Seasonal prevalence and determinants of food insecurity in Iqaluit, Nunavut. *International Journal of Circumpolar Health* 74:27284. <http://dx.doi.org/10.3402/ijch.v74.27284>



- Hawley, N. L., and S. T. McGarvey. 2015. Obesity and diabetes in Pacific Islanders: the current burden and the need for urgent action. *Current Diabetes Reports* 15:1–10. <http://dx.doi.org/10.1007/s11892-015-0594-5>
- Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate change 2013: the physical science basis. contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, P. M. Midgley, editors. Cambridge University Press, Cambridge, UK and New York, New York, USA.
- Janif, S. Z., P. D. Nunn, P. Geraghty, W. Aalbersberg, F. R. Thomas, and M. Camailakeba. 2016. Value of traditional oral narratives in building climate-change resilience: insights from rural communities in Fiji. *Ecology and Society* 21(2):7. <http://dx.doi.org/10.5751/es-08100-210207>
- Koch, G. 1961. *The material culture of Tuvalu*. Institute of Pacific Studies, Suva, Fiji.
- Konishi, S., C. Watanabe, M. Umezaki, and R. Ohtsuka. 2011. Energy and nutrient intake of Tongan adults estimated by 24-hour recall: the importance of local food items. *Ecology of Food and Nutrition* 50:337–350. <http://dx.doi.org/10.1080/03670244.2011.586315>
- Kuchinke, M., B. Tilbrook, and A. Lenton. 2014. Seasonal variability of aragonite saturation state in the western Pacific. *Marine Chemistry* 161:1–13. <http://dx.doi.org/10.1016/j.marchem.2014.01.001>
- Laberge Gaudin, V., O. Receveur, F. Girard, and L. Potvin. 2015. Facilitators and barriers to traditional food consumption in the Cree community of Mistissini, Northern Quebec. *Ecology of Food and Nutrition* 54:663–692. <http://dx.doi.org/10.1080/03670244.2015.1072815>
- Lowitt, K. N. 2014. A coastal foodscape: examining the relationship between changing fisheries and community food security on the west coast of Newfoundland. *Ecology and Society* 19(3):48. <http://dx.doi.org/10.5751/es-06498-190348>
- Mangum, C. 1999. Hunger in New York State. *Human Ecology Forum* 27.1(winter 1999):8–11.
- McCubbin, S., B. Smit, and T. Pearce. 2015. Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. *Global Environmental Change* 30:43–55. <http://dx.doi.org/https://doi.org/10.1016/j.gloenvcha.2014.10.007>
- McGregor, A., R. M. Bourke, M. Manley, S. Tubuna, and R. Deo. 2009. Pacific island food security: situation, challenges and opportunities. *Pacific Economic Bulletin* 24:24–42.
- McLennan, A. K., and S. J. Uljaszek. 2014. Obesity emergence in the Pacific islands: why understanding colonial history and social change is important. *Public Health Nutrition* 18(8):1499–1505. <http://dx.doi.org/10.1017/s136898001400175x>
- McMillen, H. L., T. Tickin, A. Friedlander, S. D. Jupiter, R. Thaman, J. Campbell, J. Veitayaki, T. Giambelluca, S. Nihmei, E. Rupeni, L. Apis-Overhoff, W. Aalbersberg, and D. F. Orcherton. 2014. Small islands, valuable insights: systems of customary resource use and resilience to climate change in the Pacific. *Ecology and Society* 19(4):44. <http://dx.doi.org/10.5751/es-06937-190444>
- Mertens, F., M. Fillion, J. Saint-Charles, P. Mongeau, R. Tavora, C. Jose Sousa Passos, and D. Mergler. 2015. The role of strong-tie social networks in mediating food security of fish resources by a traditional riverine community in the Brazilian Amazon. *Ecology and Society* 20(3):18. <http://dx.doi.org/https://doi.org/10.5751/ES-07483-200318>
- Nakada, S., Y. Umezawa, M. Taniguchi, and H. Yamano. 2012. Groundwater dynamics of Fongafale islet, Funafuti atoll, Tuvalu. *Groundwater* 50:639–644. <http://dx.doi.org/10.1111/j.1745-6584.2011.00874.x>
- Nurse, L., R. McLean, J. Agard, L. Briguglio, V. Duvat-Magnan, N. Pelesikoti, E. Tompkins, and A. Webb. 2014. Small islands. Pages 1613–1654 in V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, L. L. White, editors. *Climate change 2014: impacts, adaptation, and vulnerability. Part B: regional aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, New York, USA.
- Quinlan, M. 2005. Considerations for collecting freelists in the field: examples from ethobotany. *Field Methods* 17:219–234. doi: 10.1177/1525822X05277460 <http://dx.doi.org/10.1177/1525822X05277460>
- Sauni, S., and L. Fay-Sauni. 2005. Vulnerability and dependence: the nearshore fisheries of Tuvalu. Pages 11–26 in I. Novaczek, J. Mitchell, and J. Veitayaki, editors. *Pacific voices: equity and sustainability in Pacific Island fisheries*. Institute of Pacific Studies, University of the South Pacific, Suva, Fiji.
- Scelza, B. A., D. W. Bird, and R. Bliege Bird. 2014. Bush tucker, shop tucker: production, consumption, and diet at an Aboriginal outstation. *Ecology of Food and Nutrition* 53:98–117. <http://dx.doi.org/10.1080/03670244.2013.772513>
- Smith, J. J., L. Furbee, K. Maynard, S. Quick, and L. Ross. 1995. Salience counts: a domain analysis of English color terms. *Journal of Linguistic Anthropology* 5:203–216. <http://dx.doi.org/10.1525/jlin.1995.5.2.203>
- Secretariat of the Pacific Community (SPC) and Commonwealth Scientific and Industrial Research Organisation (CSIRO). 2011. *Food security in the Pacific and East Timor and its vulnerability to climate change*. Australian Government Department of Climate Change and Energy Efficiency by the SPC in conjunction with CSIRO, Noumea, New Caledonia.
- Thaman, R. R. 1982. Deterioration of traditional food systems, increasing malnutrition and food dependency in the Pacific Islands. *Journal of Food and Nutrition* 39:109–121.
- Thow, A. M., P. Heywood, J. Schultz, C. Quested, S. Jan, and S. Colagiuri. 2011. Trade and the nutrition transition: strengthening policy for health in the Pacific. *Ecology of Food and Nutrition* 50:18–42. <http://dx.doi.org/10.1080/03670244.2010.524104>
- Turner, R. A., A. Cakacaka, N. A. J. Graham, N. V. C. Polunin, M. S. Pratchett, S. M. Stead, and S. K. Wilson. 2007. Declining



reliance on marine resources in remote South Pacific societies: ecological versus socio-economic drivers. *Coral Reefs* 26:997–1008. <http://dx.doi.org/10.1007/s00338-007-0238-6>

Ulijaszek, S. J. 2002. Modernization and the diet of adults on Rarotonga, the Cook Islands. *Ecology of Food and Nutrition* 41:203–228.

Umezaki, M., Y. Kuchikura, T. Yamauchi, and R. Ohtuka. 2000. Impact of population pressure on food production: an analysis of land use change and subsistence pattern in the Tari Basin in Papua New Guinea Highlands. *Human Ecology* 28(3):359–381. <http://dx.doi.org/https://doi.org/10.1023/A:1007053430771>

van Esterik, P. 1999. Right to food; right to feed; right to be fed. The intersection of women's rights and the right to food. *Agriculture and Human Values* 16, 225–232. <http://dx.doi.org/https://doi.org/10.1023/A:1007524722792>

Vengiau, G., M. Umezaki, S. Phuanukoannon, P. Siba, and C. Watanabe. 2014. Associations of socioeconomic status with diet and physical activity in migrant Bougainvilleans in Port Moresby, Papua New Guinea. *Ecology of Food and Nutrition* 53:471–483. <http://dx.doi.org/https://doi.org/10.1080/03670244.2013.855206>

Walsh-Dilley, M., W. Wolford, and J. McCarthy. 2016. Rights for resilience: food sovereignty, power, and resilience in development practice. *Ecology and Society* 21(1):11. <http://dx.doi.org/10.5751/es-07981-210111>

World Health Organization (WHO). 2015. *Food security, trade, foreign policy, diplomacy and health*. World Health Organization, Geneva, Switzerland.

Yamano, H., H. Kayanne, T. Yamaguchi, Y. Kuwahara, H. Yokoki, H. Shimazaki, and M. Chikamori. 2007. Atoll island vulnerability to flooding and inundation revealed by historical reconstruction: Fongafale Islet, Funafuti Atoll, Tuvalu. *Global and Planetary Change* 57:407–416. <http://dx.doi.org/10.1016/j.gloplacha.2007.02.007>