



Exploring Changes in Foodscapes in Western Province, Solomon Islands

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Abstract

Food connects people and place, and weaves together issues of resource use, culture, and sovereignty. In the Pacific, a ‘nutrition transition’ towards store-bought and processed food is implicated in poor health outcomes and lowered resilience. We use a mixed methods approach to explore changes in the ‘foodscape’ – the interconnections between people and food in a place – at four rural sites in Solomon Islands. Our results indicate low dietary diversity driven by a range of environmental and social factors including commercial logging. Art-based methods show that a range of components of the foodscape, including Indigenous knowledge and practice and access to land, have supported resilience to external shocks. We argue that efforts to improve nutrition outcomes should build on place-based strengths and be designed to enhance local understandings of food sovereignty.

Keywords Resilience · Food systems · Biocultural · Dietary diversity · Nutrition transition · Local ecological knowledge · Western Province, Solomon Islands

Introduction

Food lies at the heart of resilience, forming a thread that connects people, place, markets, and sovereignty (Tendall et al., 2015). Communities across the Pacific rely on land and sea for nutrition and income (McMillen et al., 2014). In this context, food builds networks that enable people to withstand shocks (Dacks et al., 2020); knits communities together through shared preparation and consumption

(Campbell, 2015); and engages biocultural connections between people and the environment (McMillen et al., 2014). Across the region, these interactions between people and the environment shape patterns of resilience – the ability to prepare for, withstand, and recover from crises, including COVID-19 (Iese et al., 2021; Plahe et al., 2013).

The term ‘foodscape’ encompasses the spatial and conceptual factors that drive why, when, and how people relate to food, and in turn how these relationships impact resilience, health, and well-being in urban and rural settings. Vonthron et al. (2020) review the literature on foodscapes, identifying four main approaches (spatial, social and cultural, behavioural, and systemic) that address different issues related to food security. Based on this work, we define a foodscape as the dynamic connections between people and food in a particular place, which shape a multitude of factors including diets, health, identities, relationships, and economic systems. Foodscapes embrace elements such as the natural world, access, exposure, social norms, and individual motivations for food choices (Clary et al., 2017). Foodscape analyses illuminate changes in social-ecological interactions and help to identify specific mechanisms for promoting community food security (Lowitt, 2014).

The foodscape concept is relevant in the Pacific, where connections between people and place drive patterns of well-being and resilience (Sterling et al., 2020), and provides a

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useful lens to understand how patterns of food consumption are shaped by social and ecological context (Pollock, 2017). Pacific authors have emphasised the inseparability of food from its lived context, and noted the need to facilitate a “better appreciation of the way well-being intersects with wider cultural practices” (Panelli & Tipa, 2009, p463).

Pacific foodscapes are changing as the region is undergoing a ‘nutrition transition’ from access and exposure to predominantly locally grown and harvested food (e.g., fresh seafood, tubers, leafy greens) to processed and store-bought food (e.g., white rice, sugary drinks, instant noodles) (Charlton et al., 2016; Horsey et al., 2019; Sievert et al., 2019). As elsewhere, the transition is driven by several factors, including the changing social and economic characteristics of communities, ecological change, increasing availability of processed food, and urbanisation (Anderson et al., 2013; Hughes & Lawrence, 2005). By decreasing the linkages between people and place, and increasing reliance on stretched global supply chains, the nutrition transition has lowered food security. In turn, this has increased vulnerability to external shocks (Farrell et al., 2020; Ferguson et al., 2022) and decreased food sovereignty (Weiler et al., 2015).

The health outcomes of the nutrition transition are particularly concerning. Many Pacific communities struggle with several forms of malnutrition: adult obesity, stunting in children, and limited consumption of critical micronutrients (FAO et al., 2021). Dietary diversity (a common metric of nutritional status and corollary of food security (Dwivedi et al., 2017; FAO & FHI 360, 2016) is often low, reflecting limited intake of micronutrients (e.g., Albert et al., 2020).

In rural settings where nutrition and income stem from land and sea, changing diets can reflect fundamental adjustments to social-ecological systems (Aswani & Furusawa, 2007). Changing diets impact resilience in at least three ways: through negative trends in health and well-being (Fanzo & Davis, 2019) that leave people more vulnerable to environmental and economic shocks (Ferguson et al., 2022); through erosion of links to land and place that limit the transmission of local knowledge, ontology, and practice, and impacts on the effectiveness of resource management (Lyver et al., 2019); and through the erosion of place-based governance and growing dependence on international market economies (Ikerd, 2019).

Local communities throughout the Pacific have developed knowledge and institutions to sustain natural resources (McMillen et al., 2014). When the local environment is no longer the main source of sustenance, institutions and knowledge related to natural resources can weaken, reinforcing feedback loops that amplify sustainability challenges (Lyver et al., 2019). Shifts in food practices and norms are a central feature in community perceptions of social and environmental change (Fazey et al., 2011).

In Solomon Islands, access to rich land- and seascapes and a complex mosaic of customary knowledge and practice underpin resilience. Food comes from a wide variety of sources, including home gardens, coastal and offshore fishing, and stores in communities and provincial hubs (e.g., Aswani & Furusawa, 2007; Rabbitt et al., 2019). However, a number of drivers limit resilience of foodscapes in rural communities, including high population growth, shortages of arable land, declining health and productivity of nearshore reef resources, and erosion of traditional knowledge and practice around gardening (Albert et al., 2020). Dietary diversity is generally low and has been directly linked to many forms of malnutrition (Albert et al., 2020; Anderson et al., 2013; Horsey et al., 2019; Troubat et al., 2021; Vogliano et al., 2021). The global COVID-19 pandemic stressed the foodscape in Solomon Islands in various ways, although local agricultural production has formed a ‘cultural safety net’ that has become increasingly critical (Iese et al., 2021).

In addition to health implications, dietary trends reflect wider changes in use of land and sea across Solomon Islands. In Isabel Province, changing patterns of foodscapes are a component of ‘maladaptive’ trajectories of change (Fazey et al., 2011). In Malaita Province, local engagement in logging has led to dependencies on store-bought food, as well as a range of negative impacts on coastal food sources (Minter & van der Ploeg, 2021). In Western Province, changes in coastal management strategies have fundamentally impacted on diets (Aswani & Furusawa, 2007), while the ability to locate wild food (e.g., wild yams, *Dioscorea* spp.) supports adaptation to disaster events (Lauer et al., 2013).

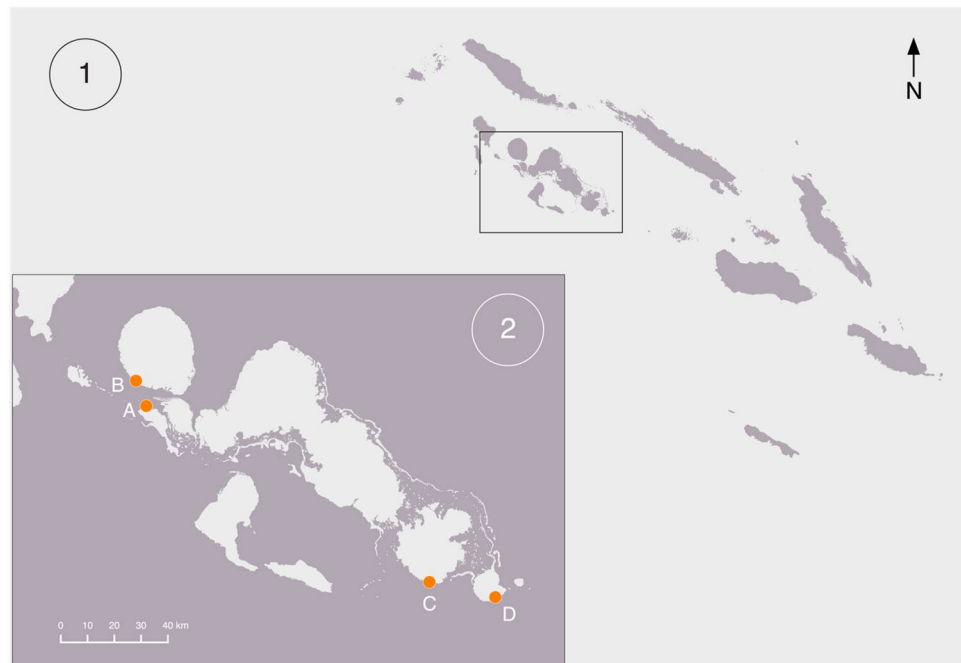
In Solomon Islands and elsewhere in the Pacific, government and non-government organisations have been seeking to promote local food consumption to improve health (Englberger & Johnson, 2013) and increase resilience to disaster events (Wentworth, 2020). We explore perceptions of the social and environmental drivers of dietary patterns in Western Province, Solomon Islands and ask three key questions:

1. What are patterns of diets in four rural communities in Western Province, and do they represent the aspirations of residents?
2. Do residents perceive there to have been changes in their foodscapes, and what are the key drivers?
3. What are the implications of foodscape changes for resilience and food security?

Methods

We conducted this research across four sites (Fig. 1) in Western Province. It formed part of a wider programme that examined biocultural approaches to developing well-being

Fig. 1 Solomon Islands (1), and Western Province (2) with study sites



indicators and supported resource management (McCarter et al., 2018).

All four sites are both rural and coastal, and derive a significant proportion of their nutrition and income from land and sea. The sites were part of a national network facilitated by the Solomon Islands Community Conservation Partnership (SICCP). Work in each site was founded on longstanding personal and professional relationships, as well as requests from leaders at the sites to support existing conservation planning.

The sites vary in several ways that may influence diets. Geographically, three are situated on high volcanic islands, while the fourth is on a lower-lying limestone island. There are also important differences in terms of distance of travel to market, major religious affiliation, and leadership (Table 1).

Mixed methods approaches are useful to examine complex issues, and we used a concurrent nested research design to address our key questions (Creswell & Plano Clark, 2007). This approach drew on quantitative, closed-ended questionnaires to compare our data with international standards, while using qualitative data and open-ended interviews to interpret results and provide cultural context.

Our research stems directly from participant-identified priorities for research-produced knowledge to inform management (c.f. McCarter et al., 2018 and references therein). A suite of workshops in 2015 set the agenda for the overall project and determined topics of interest and utility to communities at the four sites. Diet and nutrition were a consistent concern at all locations.

Following these workshops, we employed three methods: structured interviews, conducted 2–5 times at each site over 2015 and 2016; semi-structured interviews, conducted over three weeks at each site in 2016; and art-based methods, conducted using workshops in 2016. Methods were employed as part of a suite of community-led research approaches, and undertaken concurrently. Interviews were largely conducted in Solomon Islands Pijin, although research assistants provided translation to the appropriate local language if required.

Structured Interviews—Dietary Recalls

Twenty-four-hour dietary recalls, a common method of assessing dietary quality, have been used in a range of settings in the Pacific and in Solomon Islands (e.g., Albert et al., 2020). In particular, the FAO indicator of ‘Minimum Dietary Diversity for Women’ (MDD-W) is often used to provide a population-level assessment of micronutrient adequacy. It focuses on women of reproductive age because micronutrient adequacy is important for infant development (FAO & FHI 360, 2016).

We interviewed women from different households in each survey round. We aimed to interview 20 or more women per survey, representing around 40% of women at each site. Some women participated in multiple surveys. Sample selection was based on availability on the day of the survey and was structured to include a representative range of ages. Data collected by trained research assistants from the sites.

Table 1 Key characteristics of four study sites

	Site A	Site B	Site C	Site D
Relief / geography	Low-lying limestone island	High volcanic island; community gardens sited on large river plain	High volcanic island; community gardens sited on large river plain	High volcanic island; community gardens sited on plateau areas up steep hill
Catchment size (ha)	1,083	1,700	4,547	1,477
Gardened area (ha)	34.4	82.6	27.1	24
Resident adult population (July 2016)	90	110	102	77
Number of 'stores' ^a	6	3	3	2
Major religious denominations	United Methodist, Catholic, Christian Fellowship Church	Seventh-Day Adventist (SDA), Ba'hai	United Methodist	SDA
Resource management structure	No prior conservation efforts	Existing terrestrial and marine conservation areas	Existing terrestrial and marine conservation areas	Existing terrestrial and marine conservation areas
Time to access market (by boat)	C. 1 h	C. 1 h	C. 3 h	C.3 h

^aIn this context, stores tend to refer to small, community-owned and sporadically stocked stalls

Data were entered and coded in Microsoft Excel and analysed using R version 3.3.2 (R Core Team, 2016). First, we coded data according to the dichotomous MDD-W indicator, which denotes any individual who consumes five or more food groups out of ten as having achieved a minimally adequate diet in terms of micronutrients. Ingredients were considered part of a food group when they were estimated to have more than 15 g in a meal, as indicated by FAO standards (FAO & FHI 360, 2016). We assessed portion sizes using commonly-used measures (e.g., teaspoons), which we had weighed to determine if consumption met the 15-g threshold. We consulted Pacific Food Composition Tables (Dignan et al., 2004) to determine an item's food group. We coded foods that were grown locally from imported items, with particular attention to starchy staple foods (Monteiro et al., 2010).

Semi-Structured Interviews

We conducted semi-structured interviews with both men and women at each of the four sites (Table 2). The interviews covered a range of themes, including current diets, perceptions of change, and community responses, and reference to recent disaster responses (see Supplementary

Materials). We followed a standard set of prompts but allowed for discussion as required. Interviews took between 25 min and one hour. Most interviewees were aged 30 and over: we purposively sampled farmers, gatherers, and those responsible for providing food for their families. We used a snowball sampling technique (Creswell & Plano Clark, 2007), relying on interviewees to identify others to speak with.

All interviews were recorded and transcribed. We conducted basic deductive two-stage coding in Atlas 2.0 (ATLAS.ti Scientific Software Development GmbH), first identifying key themes within each suite of responses, then refining and recoding appropriately. We report quotes and descriptive statistics.

Art-Based Methods

Arts-based participatory techniques are useful for exploring themes, co-creating knowledge, and increasing engagement (Beavers & Hodgson, 2011; Polfus et al., 2017; Rathwell & Armitage, 2016). We used two key methods: we first asked focus groups of 10–15 women¹ to develop 'visual food diaries' depicting food consumed at morning, midday, and evening, and contrasted this with a 'dream plate' or ideal meal (Supplementary Materials). Participants worked individually but came together in plenary sessions to discuss workshop outputs.

Table 2 Semi-structured interviewees at the four sites

	Men	Women	Total
Site A	10	6	16
Site B	3	7	10
Site C	5	4	9
Site D	8	7	15

¹ The workshops focused on women because their diets tend to align with those of their wider household (FAO and FHI 360 2016).

Second, we hosted separate focus group discussions at each site to examine landscape change over time. We sourced a range of imagery dating between 1947 and 2016, including aerial photos from the Solomon Islands National Archives, Landsat, and high-resolution satellite data covering each site. We printed images in large format and used these over the course of two days to identify important social and environmental changes, elucidate drivers of change, and map future outcomes and aspirations for workshop participants. We used a range of approaches, including drawing on clear mylar sheets over the maps, small group discussions, and participatory resource mapping (Robinson et al., 2016). We invited broad participation from men and women at the sites, with typical attendance of between 20 to 30 participants of different ages.

To analyse visual food diaries, we coded identifiable food items and reported the number of citations. For the mapping workshops, we used workshop outputs (butcher paper and notes) to develop an indicative set of themes around landscape change over time.

Ethics

All work followed strict ethical guidelines based on the International Society of Ethnobiology's Code of Ethics (ISE, 2006), and was approved by the AMNH Institutional Review Board (FWA00006768). The ethics procedure included a continuous process of securing free, prior, and informed consent from participants. Consent at each of the sites was based on discussion of the short-, medium-, and long-term benefits of the project, which included assistance with planning and adaptation, relevant research work such as documentation of valued plants, and the direct financial benefits from team accommodation and meals. All assistants contributing significant time to project activities (defined as > 3 h) were compensated for their time at the rates set by the SICCP. All findings were published locally in 2018 to ensure they were useful and used at the sites, including in large-format

visual descriptions of the work and in-depth ethnobotanical descriptions.

Results

Dietary Diversity

Structured interview data indicate that diets across the four sites were low in diversity, with 5%–49% of respondents achieving minimum dietary diversity across all sites, while MDD-W scores for each community averaged between 2.89 – 4.56 (Table 3). Locally grown and harvested foods were significant, comprising between 51 and 73% of food items.

Almost all (99%) interviewees ate foods in the 'starchy staple foods' category, which included white- and purple-fleshed sweet potatoes, rice, cassava, taro, yam, and instant noodles. 'Flesh foods' (primarily tinned or fresh seafood) were the second most-consumed food group (70%). Tinned tuna was often added to dishes as a flavouring, but individuals consumed very little per meal. Fresh fish or seafood was eaten on its own and as an accompaniment and favoured over tinned tuna when it was available. Interviewees reported regular consumption from the food groups 'Dark green leafy vegetables' (49%), 'Other vitamin A-rich fruits and vegetables' (38%), and 'Other fruits' (46%). Of the 'starchy staple foods' category, overall less than half (mean = 45%; SD = 6%) were 'unprocessed or minimally processed foods' such as sweet potatoes, taro, and yams, the majority (mean = 55%; SD = 6%) being 'processed foods and refined grains' such as noodles and white rice. Site A had the lowest proportion of unprocessed or minimally processed starchy staples (36%) whereas Sites B and D had the highest proportions of these starchy staples (52% and 50%, respectively).

MDD-W varied significantly across sites (Table 3). All sites differed significantly from one another, except for D and A (Tukey's post-hoc test, $p < 0.05$), while interviewees exhibited different levels of dietary diversity (ANOVA, p -value < 0.001). Level of consumption of foods grown at the sites varied by community (ANOVA, p -value < 0.001).

Table 3 Summary statistics for dietary recall structured interviews

	Site A	Site B	Site C	Site D
Number of structured interviews	104	45	110	93
Number of women interviewed	42	47	53	43
Total number of surveys	4	2	5	4
Average MDD-W score	3.53	4.56	2.89	3.80
Percentage of interviewees achieving MDD-W*	21%	49%	5%	27%
Average consumption of local foods**	51%	70%	58%	73%
Average number of meals per survey	3.44	3.56	3.02	3.48

*Coded as percentage of women reaching five or more food groups in one survey

**Local foods are those grown at the site or vicinity (in contrast with shop-bought items)

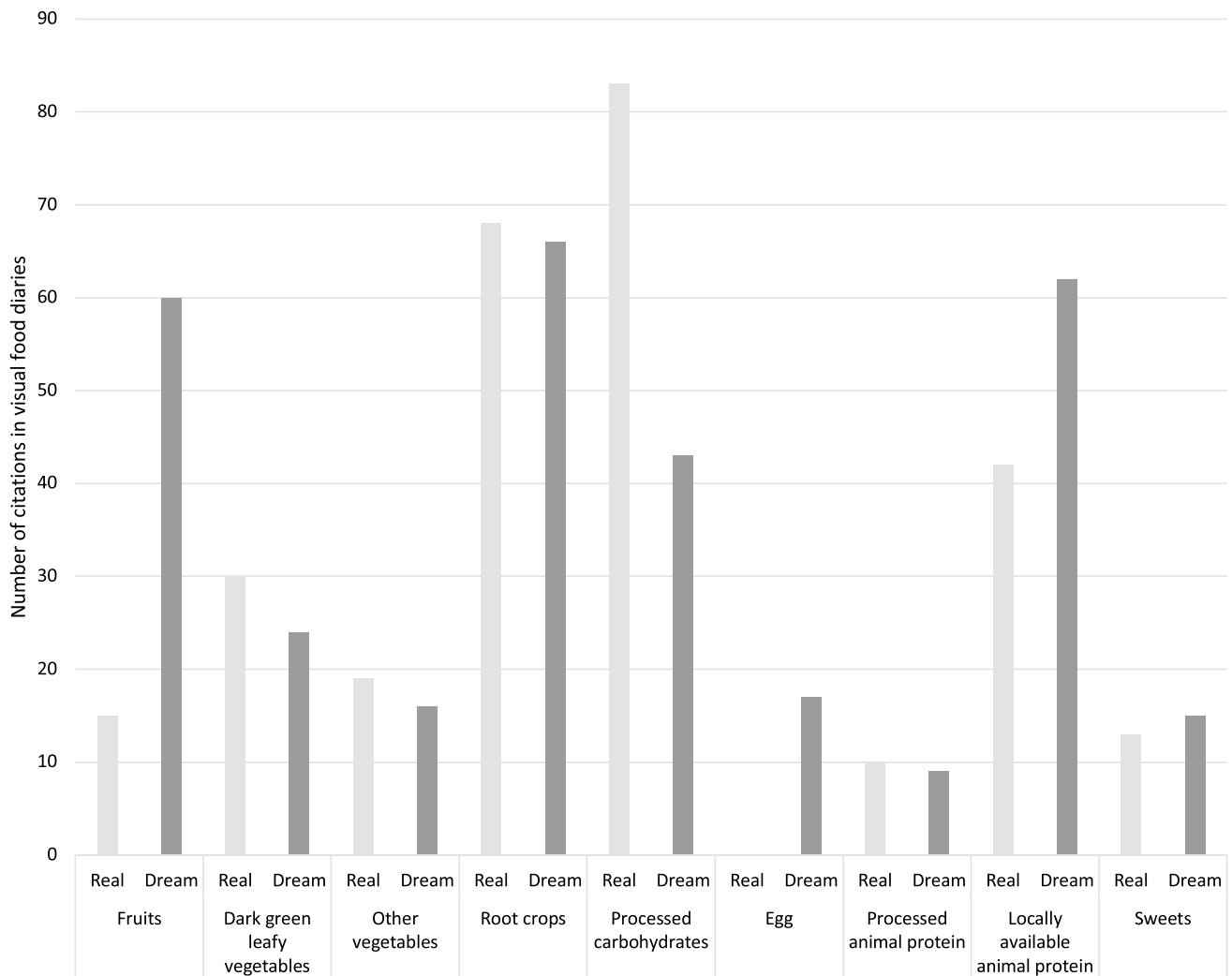


Fig. 2 Recorded 'dream' and 'real' plates in visual food diaries

We found significant differences in pairwise tests between all communities' local food consumption except between Site B and Site D and between Site C and Site A (Tukey's post-hoc test, $p < 0.05$).

Localised variation in the prevalence of different food groups over time reflected the seasonal availability of some foods (e.g., Ngali nuts, *Canarium sp.*). MDD-W scores also varied within communities at different times of the year; however, aside from one pairwise comparison (between November 2016 and June 2016 at Site C, Tukey's post-hoc test, $p < 0.05$) these were not significant.

Visual food diaries tended to support data from structured surveys, though we do not use them for quantitative

comparison. Of 619 citations of food items, participants reported limited consumption of fruit and vegetables (respectively, 5.1% and 10.1%), and high consumption of processed carbohydrates (28%) and root crops (a further 23.2%).

Perceptions of Dietary Diversity

All participants in visual food diary focus groups perceived current diets to be problematic. Interviewees commonly noted that the diets they described have impacts on health (e.g., "...this is what is causing sickness...this style of eating cassava all the time by itself, it is not good, we see boils and

diabetes” (40–60, Site A), as well as on wider social issues such as interruption of knowledge transmission (Fig. 2). Participants aspired to eat less rice and sweet potato, and more yam and taro, and while some expressed a desire for more sugary food, it was more common to want better access to fruit. Interviewees also indicated that they would like more sources of non-fish animal protein, particularly chicken ($n = 16$) and eggs ($n = 17$), which were not consumed by any interviewees. Tinned tuna was included as a ‘dream’ food by only two participants.

In focus groups, participants offered a range of explanations for differences between current and aspirational diets, notably lack of economic resources, isolation, and poor education. The bulk of the discussion, however, focused on systemic and profound changes in local food environments over current and previous generations.

Semi-Structured Interviews

Semi-structured interviews and workshops identified three areas of concerns: landscape-scale environmental changes; wide-ranging disruption to local agricultural capacity; and changing social and cultural norms around food.

Environmental Changes and Landscape-Level Drivers

In mapping workshops, participants highlighted different long- and short-term drivers for geographic changes to foodscapes (Table 4). Participants at Sites A and B noted that large-scale commercial logging operations had precipitated a number of changes to foodscapes, while those at Sites C and D noted social and economic changes, as well as the impact of weather events.

Agricultural pests were seen as an increasing burden that discourages investment into agriculture. Farmers identified a range of taxa and impacts on crops, including fungus (taro blight, *Phytophthora colocasiae*), several insect pests (e.g., sweet potato leaf folder, *Herpetogramma hipponalis*), birds (e.g., *Porphyrio porphyrio*), and wild pigs. Interviewees highlighted different pests across the sites: Site A, for example, experienced plague proportions of *H. hipponalis* in December 2015, and had consistent issues with larger beetles (probably *Oryctes sp.*) impacting banana and betel nut. Interviewees at Sites C and D were primarily concerned about the impacts of the taro beetle.

Commercial logging also had major impacts on terrestrial foodscapes at Sites A, B, and C. Logging activities decrease garden productivity by increasing invasive species, both with the introduction of new species and by disturbing the ecology of the agroforest mosaic. Exposure to market economies in the logging camps also brought a cascade of socio-economic changes: “When I was a kid we didn’t eat rice...we relied on local food, potato, fish, eel, that kind of

Table 4 Top five site-specific changes in food systems, from mapping workshops

Site A	Site B	Site C	Site D
Recent logging has greatly decreased primary forest cover, and created more garden area	Logging has decreased primary forest cover, and increased runoff. Resulting siltation has interrupted fish spawning	Expansion of village area, and destruction of nut and coconut trees	Logging in neighbouring areas, which increased garden extent by clearing primary forest
Coastal erosion, driven by sea level rise	Invasive and pest species, e.g., pigs, harming gardens	Deforestation at neighbouring communities, up to land boundaries	Decreases in water quality, linked to the June 2015 cyclone
Die off of certain species: e.g., <i>Heliconia</i> sp. used in food preparation	Changes in cultivation methods, from taro terraces	Heavier rain, leading to more landslides upstream	Lowered availability of wild food (e.g., ‘Boe’, <i>Paratocarpus venenose</i>)
2007 earthquake and tsunami, which raised the north-west corner of the island	Larger gardens, driven by individualism and market incentives	Reduction in water quality from the main river	Increased number of houses, driven by population growth
Introduction of new churches as families arrive from c.1970 onwards	Larger coconut plantations	Changes in taro cultivation, from terraces in rivers to open plots	Diversification of income sources, toward market crops

thing. Then...we moved to [the logging camp] about 1992 or 1991...and ate rice all the way. Flour, cake, biscuit, that kind of thing.” (Site C, 40–60).

Other changes were noted by interviewees at one or two of the sites: changes in weather and meteorological patterns made agriculture and access to marine resources more challenging: increased unpredictability of rains and lengthened dry spells, lower catches of both coastal fish and shellfish as a result of overfishing and sedimentation from flooding events. Interviewees, particularly in Sites A and B, also noted the impact of a 2007 tsunami, which altered the topography of the coastline (e.g., raising the shore and exposing reefs) and was perceived to have impacted cycles of agricultural pest abundance.

Changes to Local Agricultural Practices

Interviewees reported that changes in agricultural practice at the sites had reduced the amount of locally grown produce available and increased reliance on store-bought food. For one, farmers noted lowered agricultural variety, based on a limited number of sweet potato and cassava cultivars. Interviewees noted that that people largely rely on highly shared and fast-growing varieties of potato, and that the significant plantations of yam and taro that supplemented the diet in the past were no longer present. The decrease in taro cultivation was of particular concern in Site C, and was noted by all interviewees. Respondents described a pattern of scattered planting and disrupted harvest, particularly driven by the impact of taro blight fungus and a root-boring beetle (possibly *Papuana sp.*), to the point where farmers were unwilling to plant taro because of the lack of yield.

Interviewees also observed that soils had been depleted by repeated harvesting and limited use of shifting cultivation. In all communities, interviewees noted few people carve out new gardens from forest, focusing instead on re-using old patches. In Site C, for example, one informant noted that: “Starting in 1915, when the gospel arrived here, people were making gardens around here...same area for 10 years, same area for 20 years. Same area, then repeat” (Site C, 40–60). In addition, fallow periods are becoming shorter than in previous years.

Shorter fallow periods were driven by social and cultural trends. In Site A, for example, several families do not have access to land outside their immediate household surroundings, whereas in Site C all households have additional areas that could be cleared for gardening. The issue at Site C, however, was considered to be ‘laziness’ on the part of the men who were traditionally responsible for clearing gardens. At Site D, geography and population play a role, steep terrain and limited arable land constraining access for some.

Finally, older interviewees suggested that the reduction in agricultural productivity was driven by a lack of communal

knowledge, in particular the lack of transmission of local knowledge and practice of gardening. School attendance from age five keeps children from spending time in gardens with their parents and grandparents, which has reduced transmission of gardening skills. One elder noted that “I will talk about what happens inside our family. If we want to go to the garden, I will take the family there. But to sit down with them, and tell them how to do gardening...we do not do that” (Site C, 60+).

Social and Cultural Changes

Several wider social and cultural shifts have contributed to dietary diversity patterns. For example, store-bought foods are often preferred for convenience by people with limited time and wide-ranging commitments, while farming requires a level of commitment that is difficult to maintain. Other interviewees noted that family preferences tend to drive consumption patterns: children raised on store-bought food are unwilling to eat anything else: “...the kids have gotten used to food from the store, so they do not want to eat cassava and other food from the bush” (Site D, 40–60).

This reflects wider changes in attitudes to gathering food. Interviewees from all four sites noted that people have become unwilling or unable to spend time harvesting food from gardens and the sea. For some, particularly older interviewees, the youth of today are ‘lazy’ and simply do not put the time in to grow food successfully: “One thing I see a lot is mobile phones...people are only interested in looking at these things, and they have forgotten how to go and work in the garden” (Site A, 60+). Others noted that the hard physical work of the garden – combined with exposure to weather and biting insects, particularly the invasive little fire ant (*Wasmannia auropunctata*) – meant people prefer buying food from stores. In addition, the range of communal projects and obligations at the sites, as well as the need to earn money for basic expenses, including school fees and household items, make demands on people’s time. As one interviewee noted “...this time, people are busy. There is a lot of work for the community to be doing, so there is not enough time to go to the garden...then people are looking for money too much...” (Site C, 60+).

Some interviewees noted that the practices and attitudes of the people fundamentally affect the productivity of the garden in ways that reach beyond the equation of nutrients, time, and care. In Site C, for example, it is commonly understood that taro gardens respond directly to the comments and attitudes of the people in their vicinity. Similarly, in Site B, interviewees highlighted the importance of having a ‘good attitude’ in growing food and noted feedback loops between the garden and home: if garden production was low, this would create stress in the home, which would in turn lower garden productivity.

Foodscapes and Resilience

Interviewees noted that the primary long-term impacts of the current foodscape were on community and individual health. Many connected the prevalence of non-communicable diseases, in particular diabetes, to the prevalence of sugar in the diet, while others suggested that reliance on store-bought food had caused people to become more susceptible to common ailments (e.g., tropical ulcers). Others noted the reliance on a very limited range of staple crops was harmful. In Site C, for example, dietary recalls indicate it is common for people to eat only rice and a tuber over the course of a day.

Interviewees also emphasised that current foodscapes at the four sites leave them exposed to food shortages, particularly as a consequence of weather-related emergencies (e.g., a 2015 cyclone that destroyed a grove of Ngali nut (*Canarium sp.*) trees, a culturally important source of protein). In addition to reducing garden yields, they noted that extreme weather conditions can hamper fishing and shellfish gathering, stress familial and peer networks, harm or restrict access to certain areas, and cause lasting financial strain.

Nevertheless, many interviewees indicated that food poverty was rare, and that food systems are able to maintain food supplies even under stress. In Site D, for example, one participant noted: “I don’t think that anyone in the village goes hungry. People might miss a meal...but no matter if they are not too full, at least they will have some food” (Site D, 40–60). Interviewees indicated that this resilience stemmed from a number of sources (Table 5).

Importantly, these factors were not always present or consistent. At Site A, some noted that people were willing to share food in times of crisis, but that often there was simply not sufficient volume of key staples across the network. At Site C, interviewees noted that the building of their church over the year before the heavy rain meant that the food system was stretched, as people had not had time to invest in building reserves for sharing and were relying on store bought supplies.

Discussion

Foodscapes reflect wider patterns of social and ecological change (Vonthron et al., 2020). In Solomon Islands, where nutrition is closely linked to the health of surrounding forests and seas, the intricacies of customary tenure, and exposure to international markets, changes in diets can be understood only in the context of the wider social-ecological system. Our data support other findings from Solomon Islands in recent years that find a strong potential for resilience in local knowledge, networks, and crop diversity (Aswani & Furusawa, 2007). Overall, individual diets are limited in diversity (e.g., Albert et al., 2020), food security in rural communities is driven by

both short- and long-term environmental change (Andersen et al., 2013), and a constellation of wider social issues shape people’s ability to find culturally appropriate and nutritionally adequate foods (Fazey et al., 2011).

In general, our findings from structured 24-h food recalls align with other recent observations from Solomon Islands (Albert et al., 2020). These data indicate risks of malnutrition: diets that do not contain the vitamins and minerals provided by diverse diets contribute to the prevalence of child stunting and adult malnutrition, which in turn are linked to serious and long term health impacts (Albert et al., 2020; Andersen et al., 2013; Troubat et al., 2021). The semi-structured interviews reflected a high degree of concern from communities around current trends and indicate that availability and lack of certain foods at the sites has impacts across a range of aspects of community life.

These data give some cause for concern, although MDD-W is a limited metric that needs to be understood in context. For example, it does not speak to other aspects of dietary quality, or account for variation in nutritional values within key food categories (Trijsburg et al., 2019), which make it difficult to adapt to specific biocultural settings such as Solomon Islands. For this study, we place MDD-W in context using data from our interviews and workshops and note that dietary diversity and nutritional patterns stem from a range of social and environmental drivers (Fanzo & Davis, 2019; Fazey et al., 2011).

‘Resilience’ refers to the capacity of households to identify and manage risk, adaptive strategies in the face of major disturbances, and the resulting well-being outcomes (Bene et al., 2015; McDonald, 2018). Our data indicate that over the long-term, the ability of local-scale foodscapes to actively bolster resilience varies across time and space, mediated by several factors, including:

- **Geography** fundamentally shapes the foodscape in rural communities. Interviews confirmed that the only means most people have for accessing nutritious and fresh food is harvesting or growing from land and sea resources. Steep hills and long distances limit access for many, and increase the importance of alternative means of acquiring food.
- **Access to land** is patterned by social factors including tenure. For some households in at least two of the sites, access to productive and accessible land is limited by the allocation of customary rights. For others, access to new garden areas is restricted because of the significant physical labour required to clear existing forest. These patterns increase reliance on non-local foods and reduce the options available in times of crisis, decreasing food sovereignty.
- **Gender** fundamentally shapes foodscapes in Solomon Islands. At our research sites, women noted inequalities that leave them most of the work entailed in food produc-

Table 5 Perceived drivers of resilience in foodscapes across the four sites

Driver of resilience	Explanation	Exemplar quote
Availability of store-bought foods	Interviewees at all sites noted the critical role that store-bought foods play in ensuring access to protein and carbohydrate at all times, and particularly when there are shortages in the village supply	“If we relied only on local food, man, we would struggle – because you don’t plant today and harvest tomorrow, it takes time. So, food in the store saves us...” (Site B, 40–60)
Networks within the site	In-community networks are the first response to food shortages. Families in need can borrow food directly, ask for access to land on which to harvest, or borrow to purchase from stores. In Sites C and D, church and women’s networks were reported to be the primary food distributors; in Site A, sharing was perceived to be less common, which was ascribed to the presence of multiple churches and overlapping obligations	“Before, sharing might have been something that people did...there is not too much [now]. If you have money, you might go and buy food from another family. If you have a little bit of money...if you ask, people can give. Not like before. The work of the community to share food...” (Site A, 60+)
Networks outside the site	Family and peer networks outside sites—both local markets and in Honiara—were major sources of food in times of shortage. Rice and sweet potato were the most commonly shared items; for older community members, having children in formal employment was a benefit	“...people send rice. They will ring Honiara and get them to send down a bag of rice. Not sweet potato.” (Site D, 40–60)
Planting calendars and harvest timing	Some farmers indicated that planting practice can limit the impact of seasonal events. If planting is staggered throughout the year, and timed so that there are available crops at all times in a diversity of habitats, then it is possible to maintain food supply amid regular disturbance	“What we do is understand the seasonal weather patterns for this area. So, when it comes to the time for rain, the time for cyclones and the like, we plant things that will prepare us for this time...say if February is the time for rain, we might plant in October, so that we can harvest at the end of the year, or after the time of the big heavy rain.” (Site C, 60+)
Availability of terrestrial wild foods	Wild foods formed a key plank of responses for most interviewees. Swamp taro (<i>Cyrtosperma merkusii</i>) in particular plays a critical role, and communities at all sites have available patches of land (though these tend to be owned by only some families, who are called on to share). Other wild foods—including wild yams (<i>Dioscorea spp.</i>), wild leafy green vegetables (e.g., <i>Thelypteris pubirachis</i> / <i>paqulu ta kiakita</i>), tree nuts (e.g., <i>Canarium sp.</i>), and fruits—were noted to be important in Site C, but not noted elsewhere. Some noted that people only have enough knowledge of the landscape to rely on swamp taro at the present time	“So we haven’t looked hard at the...crops that can withstand rain, changes in climate, that happened before – the tinawulu, aruru, pokpoke [different varieties of wild tubers]...they are the ones that...the grandparents planted, and these were the ones that people ate when they needed to” (Site C, 60+)
Access to land	Links to land underpin resilience at all four sites. Tenure is not evenly held across communities, and neither is resilience: in Site D, for example, waterlogged soil was worse in flat areas, whereas families with well-drained and sloping land were able to maintain a garden food supply. In Site A, land access rights are particularly unevenly distributed, and some have less access than others. Other sites, particularly Site D, are steep and physical accessibility is limited to the fit and able	“Because in the coastal area there is not a lot of swampy area for swamp taro. So those that have a good area plant, but those that do not must borrow from them” (Site D, 60+)
Presence of local champions	Key actors at each of the sites were driving wider community responses to perceived challenges in the foodscape. These include championing Indigenous knowledge and practice, innovation with resilient varieties, diversification through opening of stores and accessing markets, adaptation of the practices of non-profit organisations, innovation in techniques to keep cuttings free from pest species	“I have tried new sites and ways of growing...so I have been able to help people, some people on this side have taken vines, other people have taken vines, and I have given taro to others.” (Site A, 40–60)

tion and preparation; the lack of engagement from men in cutting new gardens led to shorter fallows, and lack of time for women led to greater reliance on shop-bought and convenience foods. In one of our study sites women also identified high rates of domestic violence as closely linked to low garden yields: lack of food on the table increased family stress, while crops were perceived as responding poorly to angry or distressed farmers.

- **Local and Indigenous knowledge** Interviewees described several techniques for increasing agricultural productivity, but often observed that the modes of knowledge transmission had broken down. This was particularly evident for taro cultivation and reflects trends across a number of knowledge domains in the Pacific: increased time spent in formal education, less time spent in the landscape, including foraging for wild foods, and erosion of vernacular languages. Authors have suggested that this ‘biocultural hysteresis’ will limit adaptive capacity to environmental change (Lyver et al., 2019).
- **Commercial logging** Logging operations have repeatedly been shown to diminish resilience in many Solomon Islands communities (Minter & van der Ploeg, 2021). Logging operations have landscape-level impacts, including introduction of invasive species and sediment smothering of downstream shellfish resources. They also were noted to cause widespread social problems and increase reliance on store-bought food items.
- **Ability to deal with pest species** Pests and invasive species shaped interactions between farmers and their gardens. *W. auropunctata* (little fire ant), for example, has spread rapidly throughout the country, and increases abundance of other pest species as well as discouraging investment of time in gardening (Fasi et al., 2013). The ability to access knowledge, technology, and agrobiodiversity to mitigate these impacts varied across the sites and fundamentally influenced garden productivity.

These data highlight the importance of ensuring complementary sources of food are widely available. There is no doubt that store-bought foods are a practical and efficient means of responding to short-term challenges and play a key role in food security – particularly for vulnerable members of the community or after external shocks (e.g., cyclones). Interview data indicated that store-bought and processed foods also play key roles for those with limited time (i.e., in full-time employment) or at times of community-scale obligations (e.g., communal projects) when gardening is not prioritised.

However, the range of store-bought foods available in rural Solomon Islands rarely adds nutritional diversity to the foodscape. Moreover, interviewees raised several concerns, particularly around the national epidemic of

non-communicable diseases such as diabetes; increasingly market-driven production, which facilitates the erosion of networks of exchange; and the lowered productivity, diversity, and resilience of gardens. Ultimately these processes may hamper the ability of communities to adapt to change (Fazey et al., 2011), and our results indicate that locally grown foods and crop diversity will be key to building long-term resilience at the interview sites.

Our interview data highlight several opportunities to build on place-based and regional strengths to increase nutritional content and variety, and overall food sovereignty (Troubat et al., 2021). For example, campaigns might focus on reinforcing Indigenous and local knowledge of wild foods, culturally important species such as taro, and the role of champions within communities to increase the status of local and wild food in the foodscape. Regional networks – for example, the Fijian experience supporting taro cultivation (Vunibola & Scheyvens, 2019), or the support for the ‘kastom economy’ (Rousseau & Taylor, 2012) and ‘slow food’ movement (Mitchell et al., 2020) in Vanuatu – may offer lessons for strengthening foodscapes in Western Province. Engagement with these strategies would usefully supplement ongoing national efforts to improve awareness around dietary diversity, and reinforce access to culturally appropriate foods in rural Solomon Islands. Finally, improving the health and nutritional diversity of available food in local stores could provide additional options to consumers.

Conclusion

The foodscape plays a critical role in resilience of social-ecological systems. At the sites examined here, the fabric of the foodscape rests on interaction with the land and sea food resources, and efforts to understand resilience of these social-ecological systems need to take a systems approach. Dietary and nutritional advice cannot be separated from the context of the foodscape – wild foods, for example, are fundamentally linked to resilience at Site C through practice of culture and resource use. Future research that explores linkages among factors noted here and dietary diversity in coastal Pacific communities will be critical in ensuring interventions are well-targeted. Similarly, future research on how the dietary choices of coastal Pacific communities in turn impact foodscapes (e.g., selective pressure on fisheries) could broaden understanding of the concepts outlined in Vonthron et al., 2020.

Policies to address the dynamics discussed here could take a variety of forms. Engaging local biocultural context (e.g., wild foods) throughout community dietary interventions may improve uptake of advice and recommendations,

as well as improve nutritional outcomes. Interweaving Indigenous and scientific knowledge to support climate-resilient agricultural practices, particularly cultivation of fruit, vegetables, and alternative protein sources, could contribute to meeting community aspirations. Given the centrality of agriculture to rural life in Solomon Islands, programmes that support nutritious and culturally-appropriate foodscapes will continue to be important to support local resilience over the long term.

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Data Availability Statement The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request and subject to permission from community leaders at the sites.

Declarations

Ethical Approval All work followed strict ethical guidelines based on the International Society of Ethnobiology's Code of Ethics (ISE, 2006), and was approved by the AMNH Institutional Review Board (FWA00006768). The ethics procedure included a continuous process of securing free, prior, and informed consent from participants.

Informed Consent Consent at each of the sites was based on discussion of the short-, medium-, and long-term benefits of the project, which

included assistance with planning and adaptation, relevant research work such as documentation of valued plants, and the direct financial benefits from team accommodation and meals. All assistants contributing significant time to project activities (defined as > 3 h) were compensated for their time at the rates set by the SICCP.

Conflict of Interest The authors declare they have no conflict of interest.

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