Chapter 15
Living in Oceania

Amit Singh, Atishma Lal, and Janez Susnik

Abstract The ever-increasing impacts of climate change have once again reignited the growing debate on natural resource scarcity in the Pacific Island Countries and Territories (PICTs). New scientific findings repeatedly suggest the situation is grave as we continue to push planetary boundaries for the sustainable use of natural resources, threatening natural systems and our own existence. In the PICTs the situation is especially critical, given the current and forecast impacts of climate change (Chap. 5) on these island nations. In an island setting where resources may be limited and vulnerable the issue of security requires appropriately scaled attention. Confounding this is a multitude of pressures presenting a complex problem of demand. Key pressures faced on many PICT resources are increasing human populations; competing demands; the emergence of new opportunities, markets, and consumers; the fragmented nature of resource governance; and climate change. These illustrate the new realism of physical and economic scarcity of resources we face in the era of globalization, even across the geographically vast region of Oceania. Amongst this, water, energy, and food (WEF), are most critical to the region. These three resources are critical for human sustenance, essential separately but intrinsically connected in their use and management needs. This resource and policy nexus must be actively managed as its mismanagement and insecurity impede social stability and economic growth for the region. This chapter aims to understand the applicability of the WEF nexus in the PICT context. This considers both nexus experience in the PICTs to date and the opportunities and challenges the WEF nexus presents in its operationalization specifically in a PICT context.

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15.1 Introduction

The Pacific region consists of twenty-two Pacific Island Countries and Territories (PICTs) and is home to 12.3 million people, which is 0.15% of the global population (Fig. 15.1). The PICTs constitute the largest ecosystem in the world, covering almost half the globe's sea surface (Seidel and Lal 2010). For the 12 million Pacific Islanders, the Pacific Ocean is their major economic, social, and cultural lifeline (Charlton et al. 2016; Seidel and Lal 2010).

The Pacific region is characterized by scattered nations composed of numerous islands of varying size, geological and hydrologic characteristics, and includes a

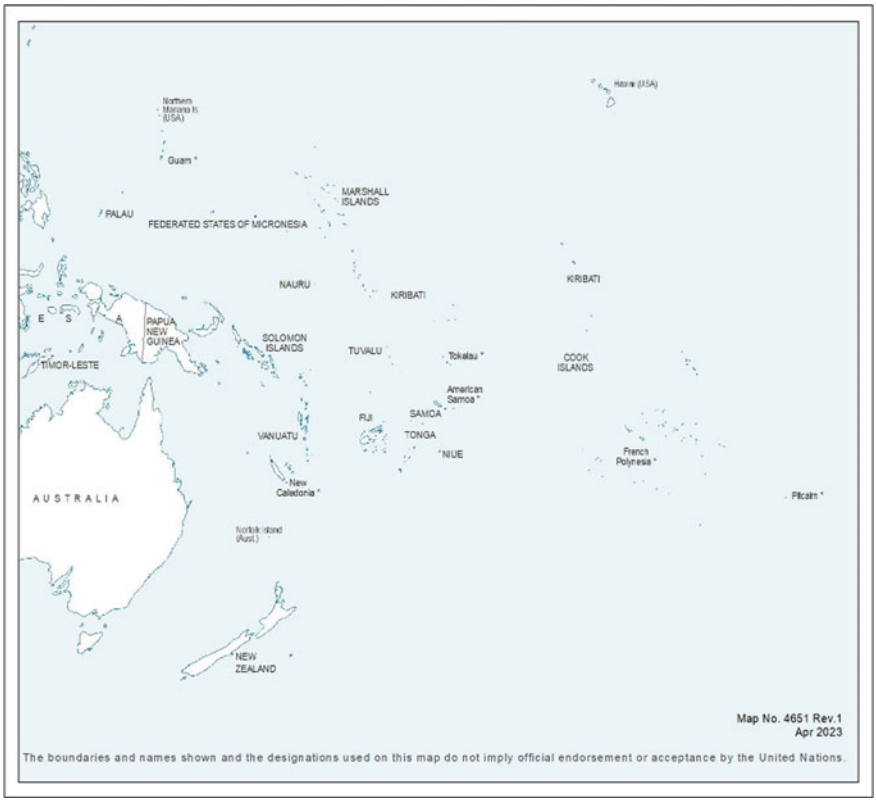

Fig. 15.1 Pacific regional map, adapted from UN Geospatial (2023)

variety of island types, ranging from the large, high volcanic islands to the tiny low-lying coral atolls; from the island with abundant surface water and groundwater to those that have no natural surface water systems, or very limited groundwater and are completely dependent upon rainwater catchments such as Niue and Tuvalu (Carpenter and Jones 2004; Dixon-Jain et al. 2014; Duncan 2011). Also see Chap. 2.

Globally, water, energy, and food are the most vital resources for societies, and these are key to human survival, wellbeing, and growth. While these resources may be considered renewable and readily available, demands for these resources has increased rapidly due to increasing population, uncertain climatic future and climate change impacts, and a shift towards increasingly urbanized lifestyles (Endo et al. 2017; Taniguchi et al. 2017). The increased demands are causing unsustainable pressures globally on water, energy, and food resources, presenting communities with an increasing number of trade-offs (Endo et al. 2017), potential conflicts over competing uses of these resources (Fader et al. 2018), and an urgent need for its safeguard and management (da Silva and de Moraes 2018). The situation in the Pacific is no different and given the geophysical characteristics of islands and its size, the trade-offs and conflicts amongst these resources are rather real and apparent.

To manage these trade-offs, it is essential to manage water, energy, and food through a nexus approach, a paradigm that has existed for some time now. However, a WEF approach uptake and practice are fairly new to the Pacific region. The WEF nexus illustrates debates around 'resource scarcity' and promotes an integrated approach in resource management, which accounts for co-benefits and trade-offs in policies related to energy, agricultural, and water sectors (Karatayev et al. 2017). It demonstrates the inter-linkages between the three resources calling for a policy nexus for its management.

PICTs are heavily dependent on natural resources for their economic development and likely to remain so for the near future, making resource management an issue of critical importance for economic development (Bell, Matthews et al. 2016; Bell, Taylor et al. 2016; Chand 2001). It is the scarcity of the resources and management into an uncertain climatic future (Chap. 11), that makes the WEF nexus approach in PICTs an important consideration in current and future resource planning and decision making.

Historically, PICTs contribution to global greenhouse gas emissions has been considered insignificant compared to large global polluters (Bogner et al. 2008), nonetheless, PICTs have been the planet's most vulnerable nations to the effects of climate change (Althor et al. 2016; Mcleod et al. 2019; Salem 2020) PICTs have historically been reliant on fossil fuel sources to attain energy requirements (Bijay et al. 2013; Michalena and Hills 2018), which is having an enormous impact on their economies (Mani et al. 2020; Michalena et al. 2018). The transport sector in the region uses approximately 75% of fossil fuel consumption and is the largest contributor to the regions GHG emissions (Holland et al. 2014; Newell et al. 2017; Nuttall et al. 2014). An analysis of the Second National Communication to the United Nations Framework Convention on Climate Change of PICTs illustrates that most of the emissions from PICTs are from the transport and energy sector (Mani et al. 2020) with many PICTs opting to focus on emission reduction in these two sectors by 2030

as the core of their Intended Nationally Determined Contributions (Goundar et al. 2017; Holland et al. 2014; Mani 2020; Michalena et al. 2018; Newell et al. 2017). The PICTs have demonstrated a willingness to transition to a low carbon economy for overall sustainable development. The security of water, energy, and food resources has been a long, where studied, deliberation in isolation and it is critical now these three resources need to be studied together in a nexus approach in PICTs context.

15.2 Characteristics of the Pacific Region—"*Islandness*"

PICTs have traditionally been classified as "high" or "low," with further classification into volcanic islands, atolls, and raised limestone islands (Carpenter and Jones 2004). The high islands primarily consist of rugged volcanic mountains surrounded by fringing or barrier reefs. Some islands also exhibit a fringe of low-lying coastal plains surrounding the mountainous interior (Forbes et al. 2013). Atolls consist of limestone reef deposits laid down on an underlying volcanic cone. In most cases, the portion of atolls above sea level is usually not more than a few meters high and have an area of a few square kilometres, for example, Kiribati and Tuvalu. It is the challenges associated with island size, remoteness, extreme vulnerability, and associated resource constraints that further contributes to "islandness" context of PICTs (Campbell, 2009; Kelman 2018, Malua and UNCTAD 2003). The PICTs smallness constitutes a major constraint on its resource management use of limited land for various resources—water, food, and energy.

The vulnerabilities associated with uncertain climate futures are real in PICTs. Almost 97% of Pacific people (excluding Papua New Guinea) live within ten kilometers from the coast, more than half of it live within one kilometers of the coast, and more than 90% of Pacific Islanders live within five kilometers of the coast (Andrew et al. 2019). All the population in the coral atoll nations of Kiribati, Tokelau and Tuvalu live within a kilometre of the ocean (Andrew et al. 2019). The coastal zones of PICTs are incredibly important areas for human habitation and economic endeavour, encompassing all the opportunities and risks that are associated with it. The "islandness" of PICTs are further illustrated in Table 15.1. It is within this 10 km coastal zone where most of the economic activities take place, resources are constantly exploited, and where the WEF nexus could be most applicable.

Four of the PICTs, Vanuatu, Tonga, Solomon Islands, and Papua New Guinea (PNG) are among the world's most disaster-prone nations (Radtke 2020). A further four PICTs even include the undesirable classification as being among the most vulnerable nations in the world to climate change. These are the low-lying coral atolls and reef islands, Kiribati, Tuvalu, Tokelau, and the Marshall Islands. As Pacific societies adjusts, responds, and adapts to the increasing vulnerabilities posed by the changing climatic future, the WEF nexus provides the complex opportunity to build resilience and mitigate threats.

The PICTs face unique and yet similar challenges in managing water, energy, and food security. Water, however, has featured most prominently as a challenge to

Table 15.1 Geographical, population, and risk characteristics of selected PICTs

Country or territory	Land area [km^2]	Sea area/EEZ [km^2]	Population	Ratio of the sea to land area	Island type	% living within 1 km from the Coast	World risk index
American Samoa (US)	199	390,000	56,813	1,960	High islands	61	–
Northern Marianas (US)	457	1,823,000	56,608	3,989	High islands	100	–
Cook Islands	237	1,830,000	15,281	7,722	High islands and atolls	91	–
Fiji	18,272	1,290,000	894,961	71	High island with a few minor atolls	41	12
French Polynesia (Fr)	3,521	5,030,000	278,908	1,429	High islands	100	–
FSM	701	2,980,000	105,503	4,251	High islands and atolls	100	–
Guam (US)	541	218,000	176,664	403	Uplifted ophiolite	30	–
Kiribati	811	3,550,000	118,744	4,377	Predominantly atolls	100	19
Marshall Islands	181	2,131,000	54,590	11,773	Atolls	100	–
Nauru	21	320,000	11,690	15,238	Raised coral island	93	–
New Caledonia (Fr)	18,576	1,740,000	273,015	94	High island	57	–
Niue	259	390,000	1,562	1,506	Raised coral island	25	–
Palau	444	629,000	17,930	1,417	High islands and atolls	93	–
PNG	462,840	3,120,000	8,934,475	7	High island with a few small atolls	8	6
Samoa	2,935	120,000	198,646	41	High islands	61	94
Solomon Islands	28,370	1,340,000	712,071	47	High island with a few atolls	65	4

(continued)

Table 15.1 (continued)

Country or territory	Land area [km^2]	Sea area/EEZ [km^2]	Population	Ratio of the sea to land area	Island type	% living within 1 km from the Coast	World risk index
Tokelau (NZ)	12	290,000	1,506	24,167	Atolls	100	–
Tonga	650	700,000	99,780	1,077	High island with a few small atolls	84	3
Tuvalu	26	900,000	10,580	34,615	Atolls	100	–
Vanuatu	12,190	680,000	294,688	56	High island with a few small atolls	64	1
Wallis and Futuna (Fr)	142	300,000	11,441	2,113	High islands	92	–
TOTAL	**551,390**	**30,571,000**	12,325,506	**55/310***	–		

Sources Population data is from Statistics for Development Division https://sdd.spc.int/topic/population
Percent of population living within 1 km of coast from Andrew et al. (2019)
World risk index data from Radtke (2019)

be addressed throughout the PICTs. PICTs are often subject to water extremes; too little or too much water. To address this requires long-term commitment. It requires both political support and local and innovative approaches to chart a course through a turbulent future by drawing from experience globally and tailoring it to suit the regional and national context. The WEF nexus approach attempts to provide such a pathway enticing PICTs to adopt an integrated approach in resource management, which accounts for co-benefits and trade-offs in policies related to energy, agricultural, and water sectors. Limitation due to "islandness" and also resource ownership regimes in PICTs means access to the natural resource is hotly contested.

15.3 The Resource Challenge in the Pacific

> "We have a young and fast-growing population. This means many mouths to feed and bodies to clothe and take to the clinic. We have only so much land for food gardens and our forests are declining from over-logging. We can choose to prepare for the future, or we can try to go back to the old ways that led to falling prosperity and violence and destruction of the ethnic tensions". Peter Boyers, Solomon Islands Finance Minister, Radio SIBC, 28 November 2005.

The PICTs have natural disadvantages imposed by their small sizes and remoteness. This has been rightly put by Peter Boyers, Solomon Islands Finance Minister (2005–2006). As dealt with in detail in Chaps. 5 and 10, climate change and extreme weather events are impacting the hydrological cycle in the Pacific. These events, such as irregular rainfall (with resulting floods and droughts), changing weather patterns, storm overtopping (Fig. 15.2), saltwater intrusion, and increased storm intensities, all have significant impacts on water availability and agriculture production and food security in the region. Moreover, energy continues to be a key priority in the region, given that almost all PICTs remain highly dependent on imported fossil fuels.

Like most countries in world, securing future food availability is a top priority in most of the Pacific Island Countries (ESCAP, 2013). The region is highly dependent on imported food, with agriculture still catching up to be a significant part of the formal economy in many PICTs. Agriculture accounts for less than 30% of GDP in all PICTs, and for most, it accounts for less than 20% (Barnett 2020, Piesse n.d.). As discussed by (Campbell 2015), food security in PICTs varies from country to country and is largely dependent on geo-physical characteristics of islands; ranging from raised volcanic island (Melanesia) with fertile lands, to low-lying atolls (Polynesia and Micronesia) (McGregor et al. 2009).

Both the Boe Declaration on Regional Security, signed at the Pacific Islands Forum in 2018, and the Pacific Islands Forum Summit Kainaki II Statement in 2019, reiterate 'climate change remains the single greatest threat to the livelihoods, security, and

Fig. 15.2 Sea level rise and overtopping are a ubiquitous risk throughout the Pacific (©Amit Singh)

wellbeing of the peoples of the Pacific' (Piesse, n.d.). The situation is critical for low atoll islands, many of which are only two to five metres above sea level at their highest point and are threatened by rising sea levels that are likely to weaken food and water security (Barnett 2011, 2020; Piesse n.d.).

15.3.1 Water Challenges

> "The challenges facing the region in terms of freshwater resources are immense. Many of these islands have limited water resources, not to mention human, financial and management resources. It is imperative that we improve water use efficiency to meet the basic human needs and to support sustainable development," Dr. Park Young-Woo, Regional Director of UNEP Regional Office for Asia and the Pacific—April 22nd, 2012.

Water resources are crucial for human, environmental sustenance, and ecosystem well-being (White and Falkland 2010). Atoll PICTs are most vulnerable in terms of availability of water resources (Oberle et al. 2017; White and Falkland 2010), continual impacts of climate change (Falkland and White 2020) and human activities (Falkland and White 2020). The vulnerability of water resources and associated socio-economic and environmental stresses in the Pacific is closely related to the availability of water (Duncan 2011), in terms of both quantity and quality. Climate change will further exacerbate water stress in PICTs, particularly small island states that rely on seasonal rain for their freshwater needs. The spatial and temporal variability of water further adds to water stress in larger islands in the Pacific. As population growth and urbanization rates in the region rise, the stress on PICTs water resources rapidly deepens with the need for investment in centralized systems and changing lifestyle demands.

The most water stressed PICTs are atoll nations (see examples in Table 15.2). They exhibit a spectrum of issues emanating from reliance on shallow freshwater lenses, most of which are less than 15 m deep (Oberle et al. 2017). Their susceptibility to pollution and contamination, resource degradation, over-exploitation, salinization, and drought-induced water scarcity make water security especially fragile. In such a landscape the competition over scarce available land area for groundwater protection, recharge and use, food production, and renewable energy installations are in constant conflict. The need to adopt water and resource management policies that promote and foster the sustainable use of water resources, while promoting economic growth is increasingly an important issue. In such a setting, the WEF nexus offers an integrated approach and sets a platform to analyze the synergies, trade-offs, and competing interest for a particular resource between the different sectors to maximize

the efficiency of the resource use. This then allows appropriate policies to be developed and adopted and institutional arrangements made to benefit from cross-sector synergies.

During the last two decades, there have been multiple attempts led by development partners, including GEF, EU, ADB, and World Bank for PICTs to adopt and follow Integrated Water Resources Management (IWRM) for water resources management and governance. Supported by multiple donors including the Global Environmental Facility (GEF) the United Nations Development Programme (UNDP), there was an attempt to formulate national water strategies and action plans and implement water policies grounded in IWRM principles, through the Sustainable Integrated Water Resources Management in the Pacific Project implemented by SOPAC in (2004–2008) and the EU-funded Pacific IWRM National Planning Programme (2008–2013). However, despite this regional effort in most countries, a significant gap remains in the implementation of the institutional framework, a vital pre-requisite for IWRM. There are multiple reasons for such delays, the most prominent ones include the sectorial-based approach to water management, leading to fragmentation of water sector management in many PICTs. It is quite evident that the water agenda in the region is set by concepts emanating out of the global discourse on water management, whether it be IWRM, water security, blue economy, etc. Water development and environmental management in the region is heavily contested with multiple international and regional agencies running parallel programs, aimed at providing water and climate related interventions. This includes the promotion of water and sanitation, water security, and groundwater management as distinct priority areas. This illustrates that there is to some extent a "niche" approach by agencies who work in the water sector in the region with water security seen through varying institutional lenses. These agencies have established a specialization in the broad water discourse and pursue them through projects implemented in the region. Critical analysis of projects implemented in the water sector in PICTs during the last decade (2008–2018), illustrate an investment of approximately USD 600 million in water sector (Lowy Institute 2019) including multiple projects in water sanitation and hygiene (WASH), water security, and groundwater. While this illustrates continuous development support to address water stress in the region, support in addressing water extreme events like floods, water efficiency, and irrigation efficiency are still yet to be tapped.

To support effective governance of water resources in the region there is an urgent need for an institutional and legislative enabling environment to be in place, before large infrastructure-based water projects could be implemented. There are very few countries (PNG, Palau Samoa, and American Samoa) (Mirti and Davies 2005) in the region that have water-related legislation. As such, it is critical to create modern water legislative instruments for integrated water management and governance. Moreover, greater efforts are required to revise and modernize archaic and existing laws and to strengthen the institutional capacity necessary for water management in the region.

Table 15.2 PICTs water, energy, and food information

Country or territory	Main water resources	% Population access to water	Renewable water resources $Mm^3.yr^{-1}$	Expenditure on imported food	Agriculture, forestry, and fishing, value added (% of GDP)	Electrification level % (2015)	Fuel import % of GDP
American Samoa (US)	SW, GW (limited)	93	–	–	–	–	–
Northern Marianas (US)	GW, SW	96	–	–	–	–	–
Cook Islands	SW, GW, RW	59	56	–	–	99	5.9
Fiji	SW, GW, RW, D (tourist resort only)	95	28,600	–	11.8	92	11.2
French Polynesia (Fr)	SW, GW, D	33	–	–	4.7	–	–
FSM	SW, GW, RW	37	2,034	–	22.5	65	12.9
Guam (US)	GW, SW	68	–	–	–	–	–
Kiribati	GW, RW, D (limited)	32	21	53	28.6	65	10.3
Marshall Islands	RW (from airport catchment and buildings), GW, D (emergency)	32	1.6	–	15.2	90	11.9
Nauru	D (regular use), RW, GW (limited)	119	–	–	4.2	99	9.6
New Caledonia (Fr)	SW, GW, RW	70	–	–	3.7	–	–

(continued)

Table 15.2 (continued)

Country or territory	Main water resources	% Population access to water	Renewable water resources $Mm^3.yr^{-1}$	Expenditure on imported food	Agriculture, forestry, and fishing, value added (% of GDP)	Electrification level % (2015)	Fuel import % of GDP
Niue	GW, RW	–	132	–	–	100	11.8
Palau	SW, GW, RW	67	1,160	–	3.2	98	12.9
PNG	SW, GW, RW	11	801,000	–	17.0	20	6.6
Samoa	SW, GW, RW	92	1,328	40	9.8	98	6.4
Solomon Islands	SW, GW, RW	10	44,700	30	29.7	43	7.1
Tokelau (NZ)	RW	–	–	–	–	–	–
Tonga	GW, RW	60	401	52	17.1	96	11.2
Tuvalu	RW (primary), GW (limited), D (emergency)	49	1	–	16.5	98	16.3
Vanuatu	SW, RW, GW	20	9,970	30	25.8	33	5.3
Wallis and Futuna (Fr)	SW	32	–	–	–	–	–

Notes SW = Surface water, GW = groundwater, RW = rainwater; D = desalination

Sources: Main water resources from SOPAC (2004); Percent population access to water from PWWA (2020); Renewable water resources from SOPAC (2011); Expenditure on imported food from Estimé et al. (2014); Agriculture, forestry, and fishing, value added (% of GDP) from World Bank (2020); Fuel import % of GDP from SPC (2017)

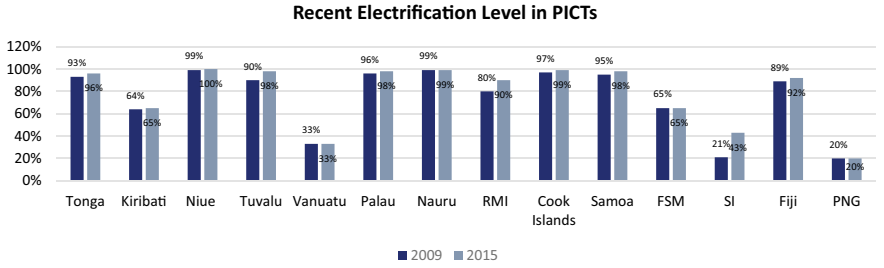

Fig. 15.3 Electrification levels in PICTs (population) (*Source* SPC [2017])

15.3.2 Energy Challenges

PICTs have one of the highest dependencies on imported petroleum fuel anywhere in the world (Table 15.2). See also Chaps. 3 and 12. Oil price volatility therefore often significantly challenges the energy and economic security of PICTs. Changes in global oil prices disproportionately affects PICTs by undercutting socio-economic stability (Jayaraman and Choong 2009; Narayan et al. 2008), operational costs of power utilities (Jayaraman and Choong 2009; Levantis 2019), and eventually household disposable income (Dornan 2015; Prasad et al. 2007). Despite PICTs importing a large amount of fossil fuels, energy access remains alarming low in most of the Melanesian countries, Vanuatu, Solomon Islands and Papua New Guinea, compared to other PICTs (see Fig. 15.3).

With almost all PICTs being highly dependent on imported fossil fuels, energy security continues to be a key regional priority. As PICTs continues their economic development, the energy demand will increase, whether it is provided through fossil fuel or renewable sources is at the hands of policy implementation and not just aspiration. Many PICTs through the National Determined Contributions (NDCs) as part of the Paris Agreement (Michalena and Hills 2018) have demonstrated the desire to move to renewables and have set an ambitious target for 2030, see Fig. 15.4, below. Resources constraints that allow effective and affordable policy implementation whether it be finance, technology, capacity or land and water (in atolls) will determine the future of renewable energy in the region. This is covered in detail in Chaps. 3 and 12.

15.3.3 Food Challenges

> …climate change will adversely affect food systems in the region, including the supply of food from agriculture and fisheries, the ability of countries to import food, systems for the distribution of food, and the ability of households to purchase and utilize food. (Barnett 2011)

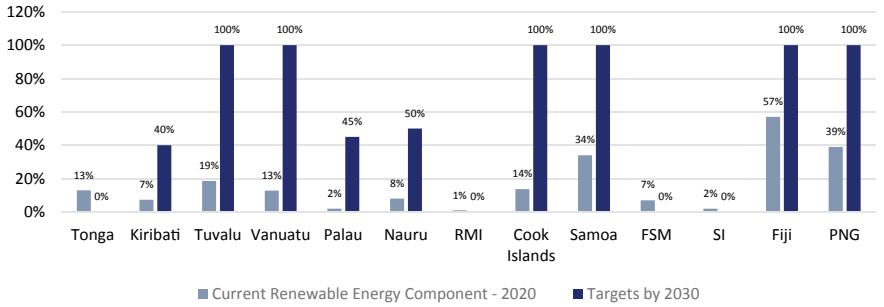

Fig. 15.4 PICTs renewable energy component (*Source* PPA Presentation during Pacific Resilience Meeting)

While PICTs have been identified as highly vulnerable in numerous discourses, food security has been key to many traditional Pacific Island societies, whether it be inland or coastal communities on large islands with considerable natural assets, or those that are on extremely small, low-lying atolls with little to no soil and limited water resources (Campbell 2020; Charlton et al. 2016). Food security in PICTs has been sustained through agroecological biodiversity (Iese et al. 2018), the production of surpluses, and food preservation and storage that has seen them through important times of hardship, such as extreme natural events, including the use of resilient crops and 'famine' foods (Campbell 2020). This however has changed with colonization (Chap. 11), and continuing urbanization, with many of above practices in decline (Chap. 4). Crop diversity and resilient crop strains have been sacrificed (Allen 2015; Campbell 2020) to make way for high priced export commodities. Resultingly, food import reliance has increased throughout the region especially in the low atoll islands of Micronesia (Connell 2015; McGregor et al. 2009).

The traditional food system in PICTs is designed such that traditional staple crops such as breadfruit, wild nuts, yams, taro, and fish and dried fish products provide an all-year-round supply of food (Allen 2015; Charlton et al. 2016; Iese et al. 2018); however, this is under threat by climate change induced water availability (Barnett 2011; Iese et al. 2018). This has led to transition in food in PICTs (Popkin 2006), inducing a shift in dietary patterns from typically complex carbohydrates, fresh fish and meat, and leafy greens, to increasingly modern diets, based on refined starch, oils, processed meats and confectionary (Charlton et al. 2016).

In the PICTs agriculture and tropical fruits grown in home gardens and commercially are vitally important; they determine food security and makes a huge contribution to the "livelihood of the populace and gross domestic product" (Rosegrant et al. 2015).

Climate change poses real and irreversible risks to the food security of individuals and PICT communities (Barnett 2020), and will affect both the agriculture and marine resources of the region. Given the proximity of farms to coasts, and the fact that almost 90% of Pacific islanders live within 10 km of the sea (Andrew et al. 2019), changes in sea level will exacerbate coastal inundation, soil salinization, and seawater intrusion

into arable farmlands, thereby affecting the sustainability of coastal agriculture and associated livelihood (Chaps. 2 and 4).

The discussion above illustrates that the Pacific region is largely a resource-stressed region. Confronting this stress requires radical re-thinking of current business as usual practice and charting a course to navigate through a turbulent and uncertain climatic future.

15.4 Understanding of the Nexus—Pacific Context

Human Right to Water

The Food and Agriculture Organization (FAO) projects that 60% more food and 80% more energy will be required by 2050 to meet global demand; an increase in total global water withdrawals by 50% in developing countries and 18% in developed countries by 2025 is projected. This situation is aggravated by a number of factors, for example, the increasing number of people adding meat to their diets, which is energy and water intensive. The inter-linkages between water, energy, and food are affecting the development of each of these sectors.

The nexus approach focuses on the interdependence of water, energy, and food; the understanding of challenges and opportunities; and provides motivation on new approaches for managing water, energy, and food resources (Liu et al. 2017). The versatile utilization of water, energy, and food from multiple sources is a reality in many of the PICTs. Addressing water, energy, and food uncertainties are prerequisites for social stability and economic growth. Yet in the region, management and governance of water, energy, and food are still sectorial with minimal interaction between the three, despite widespread and evident interdependence (Taniguchi et al. 2017). This fragmentation is typical and has been greatly discussed by (Weitz et al. 2017), when considering the governance around a WEF nexus approach.

Despite advances in WEF nexus research and understanding (including inter-relations, data integration, modelling, governance, and policy aspects) and the increased awareness of the close relationship of water, energy, and food there remain many challenges in operationalizing WEF nexus in PICTs. This is largely because in today's world water, energy, and food are sectorial managed and funding, policy-making, and oversight of these resources are sectorial based. This "silo" often leads to negative trade-offs impacting policy and technological choices. Observations that water, energy, and food are too often managed in various, and often very different spatial and temporal scales (Liu et al. 2017; Weitz et al. 2017) are very relevant and applicable in PICTs, given the current fragmented resource management paradigm in PICTs. A more holistic approach to resource management is required, whereby planning and policy making considers all three WEF sectors together, along with

their drivers and pressures (e.g., climate change, socio-economic development), in order to develop policies that consider cross-sectoral impacts and attempt to harness synergies while minimizing trade-offs.

15.5 Water, Energy, And Food Nexus Challenges in PICTs

The WEF nexus has inspired many discussions on new approaches for managing water, energy, and food resources led by agencies such as ESCAP and FAO at regional and international conferences such as 2nd Asia–Pacific Water Summit and the International Conference on Water, Energy and Food Nexus for Sustainable Development, 2014. In many ways, the WEF nexus approach and terminology has not enjoyed the same prominence and popularity as other paradigms such as "blue economy" and/or "green economy", certainly not in PICTs and the region. One of the reasons is that for the WEF nexus there were no PICT advocates to push the concept. It is interesting to note that though both "blue-green economy" and "WEF nexus" are foreign to the region and despite both stressing the complementarities between economic, environmental, resource objectives, and trade-offs, the uptake on "blue economy" is far greater than that of WEF nexus in the PICTs. Historically, international aid agencies, non-state actors, multilateral institutions, and regional organizations too often promote such discourse in the region, yet with WEF nexus this has not been the case.

It is not surprising that the regional natural resources policy space is heavily contested, PICT national governments adopt global discourse based on the relevance to their national agenda which determines their alignment and support for particular discourse. Given such observations, it becomes critical to explore the reasons for the lack of traction of WEF nexus in the region, of which there could be several. Three notable reasons are: (1) the challenge of incorporating and enhancing the components of this multi-centric nexus, especially in a fragmented resource governance architecture within most of PICTs, (2) as novel the WEF approach may be, it lacks concise narrative outlining mandate and affiliation to global commitments, such as the SDG's, and as such it is simply seen as repackaging of an existing framework, e.g., IWRM, around water, food, and energy. The WEF nexus is multi-faceted and is too often seen as either an analytical tool or a governance approach; however, the WEF nexus could also be realized as an emerging discourse (Liu et al. 2017) and provide a platform to start regional discussions on resource scarcity, trade-offs, and resource sustainability in PICTs. Such discussions are important in PICTs as apart from addressing national resources scarcity, it also provides the opportunity to combine efforts for realization of Agenda 2030, as water, energy, and food are present individually and in combination in most, if not all of the SDGs, although nexus approaches per se are not included in the goals. What this means for PICTs is that WEF nexus has not been able to mobilize any regional initiatives or projects. This in itself demonstrates the lack of prominence WEF nexus had at national, regional, and development space in PICTs. (3) the understanding and usage of the term WEF

nexus is "plural, fragmented, and ambiguous" as discussed by (Simpson and Jewitt 2019), and hence an energy sector speaks of the energy-water-food (EWF) nexus, a hydrologists and water engineers call it the water-energy-food (WEF) nexus, while those in the agricultural use the term, the food-energy-water (FEW) nexus (Liu et al. 2017). This variance in terminology illustrates that that the conceptual approach to the WEF nexus is generally dependent upon the perspective of the particular researcher, policy-maker, or agency, and different groupings embracing the WEF nexus with contrasting foci, e.g., sustainability, the green economy, trade-offs, livelihoods, climate, resource optimization, or scarcity (Simpson and Jewitt 2019). As such, driving such concept in a region becomes difficult.

The *water perspective* is still dominant in the WEF nexus discourse (Endo et al. 2017); however, as a nexus approach, there is a need to promote equal participation of all involved sectors (Nauditt 2018). In a resource-constrained low lying atoll environment, water is prioritized, so in such case "water for agriculture for food" does not take precedence nor does it make sense to push the agenda.

The *trade-off between water, energy, and food* is more drastic in PICTs compared to other parts of the world. One of the reasons is that there is no large-scale agriculture (Griswold 2021) or large dams in the region (Singh 2019), minimizing a need to quantify and address tangible large-scale trade-offs via a nexus approach. As with much of the international development agenda the WEF nexus approach is also seen as a neoliberal idea, with economic ties and pushing for rapid growth (Bell, Matthews et al. 2016; Bell, Taylor et al. 2016; Müller-Mahn and Gebreyes 2019; Wiegleb and Bruns 2018) and "development" rather than an interdisciplinary nexus approach for resource management.

It is too often seen that in the context of WEF nexus that *some components of each are included more often than others* and, in some cases, certain aspects are left out. For instance, looking at energy, electricity generation through hydropower dams often take key precedence, and more often water quality or environmental flow requirements are left out. Examples include dam operations of major dams around the world including Cahora Bassa in Mozambique and impacts of its operations on natural flooding and geomorphology in Zambezi delta (Singh 2017). This is a considerable trade-off in importance of what is prioritized, particularly when talking about agriculture and water interactions.

In PICTs most of the population live within 10 kms of the coast (Andrew et al. 2019) and marine-food sources. The WEF nexus may seem out of context in such a situation, as most of these dwellers largely depend on coastal fisheries for their sustenance (Chap. 4). The goal then is to re-imagine the Western WEF nexus and tailor it for the specificities of the PICT region, refocussing it to place the prominent issues of water supply, sustainable energy generation, and a shift to traditional food production at the centre of nexus analyses.

PICTs ability to untangle and uptake the WEF nexus as a policy consideration is also limited by the lack of systematic tools, information, and awareness on the trade-offs involved in the nexus, meaning the adoption and implementation of WEF nexus becomes extremely challenging. In this regard, the recently developed WEF

Nexus Index (https://wefnexusindex.org/) could play an important role in facilitating new WEF related discussions in the region.

15.6 Water, Energy, and Food Nexus Opportunities in PICTs

Understanding the opportunities that the WEF nexus presents for the management of water, energy, and food systems is becoming increasingly important and is critical to a sustainable and secure future for all PICTs. The Bonn 2011 Nexus Conference held in preparation for the United Nations (UN) Rio +20 Conference, further highlighted the need to address sustainability issues in the closely related sectors of water, energy, and food security.

> "The old ways of growing our economy, of developing our nation, are no longer adequate or acceptable. We need to reshape our development strategies away from the conventional growth model of exploiting particular resources for our own use in the here and now. We need to refine our existing approaches and forge a new development model—one that is more holistic, integrated, inclusive and above all sustainable … this Green Growth Framework will be one that is truly home grown, truly Fijian. And it will benefit not only Fijians but be ready to serve as a model for our island neighbours, who look to us for leadership on this issue as they do on other things relating to their own development"—Fiji's Prime Minister, Josaia Voreqe Bainimarama.

Nexus Opportunity Areas: The water, energy, and food sectors have numerous interlinked policy concerns ranging from sustainability, access, climate change adaptation/mitigation, and environmental impacts. These issues manifest in very distinct ways in each of the three sectors but often the impacts are closely related, as such, it becomes important to identify these interrelationships and maximize synergies and to resolve current, and avoid any potential conflicts (Hamdy et al. 2014). WEF Nexus opportunities present themselves by cutting across interlinked decision spaces and facilitating the identification of win–win solutions. Such opportunities include:

Synergy and trade-off awareness in resource management: The WEF Nexus provides the opportunity for policy coherence, ensuring that synergies and trade-offs among water, energy, and food are identified both in design and implementation policies, plans, and projects (Hamdy et al. 2014). This is where nexus approaches such as casual loop diagrams, developed with stakeholders via group model building exercises, can prove very useful (Purwanto et al. 2019). Excessive exploitation, non-sustainable management, and increasing demand have caused severe degradation of the natural resources in PICTs. Climate change and competition for land especially

in atolls have further exacerbated the issue and caused land degradation and reduced water and land productivity, in turn having an impact on biodiversity and a wide range of ecosystem services. The WEF nexus provides a pathway to maximize the use of scarce coastal agricultural land available in the region, allowing for water and energy infrastructure (e.g., solar farms) to compliment agricultural lands, maximizing the arable land use.

Integration of efforts: The WEF nexus, through its synergistic linkages of water, energy, and climate policy, allows policymakers to develop integrated policies and frameworks and explore and exploit synergies when dealing with water, energy, and food security. A WEF nexus approach can link a range of policy options to balance national and regional development and achieve a more comprehensive, resilient, and sustainable future. It also provides opportunities for sustainable economic, social, and environmentally responsible benefits for the people of the Pacific. A nexus approach further provides a paradigm shift away from conventional sectoral policy and decision making and gives way to an integrated approach that reduces trade-offs and builds synergies across water, energy, and food sectors through a nexus approach.

Transitioning towards a blue-green economy: To succeed, a blue-green economy must go beyond sectorial solutions and actively address the water, energy, and food security in line with human rights-based approaches. The terms "green growth" and, "blue-green economy," have gained considerable traction in the PICTs and informs national and regional policies (Dornan et al. 2018). The PICTs, through each country's national sustainable development strategies aspire to achieve greener and more inclusive economic growth, and a WEF Nexus approach can provide this. The nexus approach can support the transition to a green economy which aims among other things, at resource use efficiency and greater policy coherence between WEF sectors, to establish policy frameworks, and enhance the economy inclusive and positive to environmental sustainability. Indeed, the green economy itself is the nexus approach par excellence.

Moving forward, the WEF Nexus is still yet to be fully realized in the PICTs. There is an urgent need for institutional set-ups and procedures to support the mainstreaming of the WEF nexus approach into national policies, strategies, and activities of the PICTs. Integration of and deliberations on the WEF nexus at national and regional levels may provide opportunities to analytically analyze the nexus in respect to natural disasters and climate change, and in doing so improve and enhance the overall resilience of the country and the society.

While some PICTs may be more self-sufficient in food production than others, all PICTs are very much not self-sufficient in energy production. The production of energy from the renewable source has to the potential to positively impact most of the PICTs GDP, given agriculture, forestry, and fishery contributions to GDP has been on a decline in most of the PICTs (McGregor et al. 2016; Stewart 2006). Disparity in security for different parts of the nexus is observed in many relationships between water, energy, and food self-sufficiency and diversity in the region. Strengthening of WEF Nexus in the region requires a set of interventions to strengthen the awareness, information, institutional capacities, and the intra-regional dialogue, to enhance data collection and management, as well as to implement economic instruments and

integrated economic approaches to measure the impact of Nexus into the economy and employment.

The WEF nexus approach has the potential to greatly inform discussions on achieving interconnected SDG targets and subsequent monitoring of the SDGs. There is an opportunity to promote the WEF nexus as a conceptual tool for achieving sustainable development goals in the PICTs. WEF implementation has for too long been seen as nirvana concept (Molle 2008), and has failed to explicitly or adequately incorporate sustainable livelihoods perspectives (Biggs et al. 2015). However, there are clear synergies (socio-ecological pressures, governance, the environment, environmental and economic security) between the SDG's and WEF Nexus approaches. For successful implementation of a WEF Nexus approach in the region, moving forward the nexus framings need to consider key issues in food, water, and energy security through a sustainability lens in order to predict and mitigate against risks of future insecurity. Applying the WEF nexus approach in such a way would streamline its integration into national development plans and national adaptation plans, via regional instruments such as Framework for Resilient Development (FRDP).

References

Allen MG (2015) Framing food security in the Pacific Islands: empirical evidence from an island in the Western Pacific. Reg Environ Change 15(7):1341–1353

Althor G, Watson JEM, Fuller RA (2016) Global mismatch between greenhouse gas emissions and the burden of climate change. Sci Rep 6(1):1–6

Andrew NL, Bright P, Rua de la L, Teoh SJ, Vickers M (2019) Coastal proximity of populations in 22 Pacific Island countries and territories. PLoS ONE 14(9):e0223249

Barnett J (2011) Dangerous climate change in the Pacific Islands: food production and food security. Reg Environ Change 11(1):229–237

Barnett J (2020) Climate change and food security in the Pacific Islands. In: Connell J, Lowitt K (eds) Food security in small island states. Springer, Singapore, pp 25–38

Bell A, Matthews N, Zhang W (2016) Opportunities for improved promotion of ecosystem services in agriculture under the Water-Energy-Food Nexus. J Environ Sci Stud 6(1):183–191

Bell JD, Taylor MFP, Amos M, Andrew NL (2016) Climate change and Pacific Island food systems the future of food, farming and fishing in the Pacific Islands under a changing climate. CCAFS and CTA. Copenhagen, Denmark and Wageningen, the Netherlands.

Biggs EM, Bruce E, Boruff B, Duncan JMA, Horsley J, Pauli N et al (2015) Sustainable development and the water–energy–food nexus: a perspective on livelihoods. Environ Sci Policy 54:389–397

Bijay P, Schulte V, Prasad S (2013) An overview of climate-smart technologies in the Pacific Region. Climate-smart technologies-integrating renewable energy and energy efficiency in mitigation and adaptation responses. Climate change management. Springer-Verlag, Berlin Heidelberg, Germany, pp 3–18

Bogner J, Pipatti R, Hashimoto S, Diaz C, Mareckova K, Diaz L et al (2008) Mitigation of global greenhouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) fourth assessment report. Working group III (Mitigation). Waste Manag Res 26(1):11–32

Campbell J (2009) Islandness: vulnerability and resilience in Oceania. Shima Int J Res Island Cult 3:85–97

Campbell JR (2015) Development, global change and traditional food security in Pacific Island countries. Reg Environ Change 15(7):1313–1324
Campbell JR (2020) Development, global change and food security in Pacific Island countries. In: Connell J, Lowitt K (eds) Food security in small island states. Springer, Singapore, p 39–56.
Carpenter C, Jones P (2004) An overview of integrated water resources management in Pacific Island countries: a national and regional assessment. SOPAC Miscellaneous Report 554, p 37.
Chand S (2001) Managing natural resources in the Pacific Islands. Resource management in Asia Pacific developing countries. http://www.crawford.anu.edu.au/degrees/idec/working_papers/IDEC01-6.pdf
Charlton KE, Russell J, Gorman E, Hanich Q, Delisle A, Campbell B et al (2016) Fish, food security and health in Pacific Island countries and territories: a systematic literature review. BMC Public Health 16(1):1–26
Connell J (2015) Food security in the island Pacific: is Micronesia as far away as ever? Reg Environ Change 15(7):1299–1311
da Silva GNS, de Moraes MMGA (2018) Economic water management decisions: trade-offs between conflicting objectives in the sub-middle region of the São Francisco watershed. Reg Environ Change 18(7):1957–1967
Dixon-Jain P, Flannery E, Sundaram B, Walker K, Fontaine K, Stewart G et al (2014) Pacific Island groundwater and future climates: first-pass regional vulnerability assessment. Geoscience Australia Record 2014/43. Geoscience Australia, Canberra. https://doi.org/10.11636/Record.2014.043
Dornan M (2015) Renewable energy development in small island developing states of the Pacific. Resources 4(3):490–506
Dornan M, Morgan W, Newton Cain T, Tarte S (2018) What's in a term? "Green growth" and the "blue-green economy" in the Pacific islands. Asia Pac Policy Stud 5(3):408–425
Duncan D (2011) Freshwater under threat. Pacific Islands vulnerability assessment of freshwater resources to environmental change. United Nations Environment Programme, Bangkok, Thailand
Endo A, Tsurita I, Burnett K, Orencio PM (2017) A review of the current state of research on the water, energy, and food nexus. J Hydrol Reg Stud 11:20–30
ESCAP UN (2013) Water-food-energy nexus in Asia and the Pacific. United Nations. Bangkok, Thailand
Estimé MS, Lutz B, Strobel F (2014) Trade as a structural driver of dietary risk factors for noncommunicable diseases in the Pacific: an analysis of household income and expenditure survey data. Glob Health 10(1):1–15
Fader M, Cranmer C, Lawford R, Engel-Cox J (2018) Toward an understanding of synergies and trade-offs between water, energy, and food SDG targets. Front Environ Sci 6:112
Falkland T, White I (2020) Freshwater availability under climate change. In: Kumar L (ed) Climate change and impacts in the Pacific. Springer, Cham, p 403–448.
Forbes DL, James TS, Sutherland M, Nichols SE (2013) Physical basis of coastal adaptation on tropical small islands. Sustain Sci 8(3):327–344
Goundar A, Newell A, Nuttall P, Rojon I, Samuwai J (2017) King Canute muses in the South Seas: why aren't Pacific Islands transitioning to low carbon sea transport futures? Mar Policy 81:80–90
Griswold D (2021) Growing hope: island agriculture and refusing catastrophe in climate change adaptation in Fiji. Isl Stud J 16(2):136–155
Hamdy A, Driouech N, Hmid A (2014) The water-energy-food security nexus in the mediterranean: challenges and opportunities. 5th International Scientific Agricultural Symposium, Agrosym, pp 23–26
Holland E, Nuttall P, Newell A, Prasad B, Veitayaki J, Bola A et al (2014) Connecting the dots: policy connections between Pacific Island shipping and global CO2 and pollutant emission reduction. Carbon Manag 5(1):93–105
Iese V, Holland E, Wairiu M, Havea R, Patolo S, Nishi M et al (2018) Facing food security risks: the rise and rise of the sweet potato in the Pacific Islands. Glob Food Sec 18:48–56

Jayaraman TK, Choong C-K (2009) Growth and oil price: a study of causal relationships in small Pacific Island countries. Energy Policy 37(6):2182–2189
Karatayev M, Rivotti P, Mourão ZS, Konadu DD, Shah N, Clarke M (2017) The water-energy-food nexus in Kazakhstan: challenges and opportunities. Energy Procedia 125:63–70
Kelman I (2018) Islandness within climate change narratives of small island developing states (SIDS). Isl Stud J 13(1):149–166
Levantis T (2019) Oil price vulnerability in the Pacific. Pacific Econ Rev 23(2):214–225
Liu J, Yang H, Cudennec C, Gain AK, Hoff H, Lawford R et al (2017) Challenges in operationalizing the water–energy–food nexus. Hydrol Sci J 62(11):1714–1720
Lowy Institute (2019) Pacific aid map. https://pacificaidmap.lowyinstitute.org
Malua M, UNCTAD (2003) The Pacific Islands. UNCTAD: turning losses into gains: SIDS and Multilateral Trade Liberalisation in Agriculture. United Nations, New York and Geneva, pp 171–204
Mani FS (2020) Estimating geenhouse gas emissions in the Pacific Island Countries. In: Singh A (ed) Translating the Paris Agreement into action in the Pacific. Springer, Cham, p 3–27.
Mani SA, Mani FS, Kumar A, Shah S, Peltier RE (2020) Traffic related PM2. 5 air quality: policy options for developing Pacific Island countries. Transp Res D Transp Environ 87:102519
McGregor A, Bourke RM, Manley M, Tubuna S, Deo R (2009) Pacific island food security: situation, challenges and opportunities. Pacific Econ Rev 24(2):24–42
McGregor A, Fink A, Dawson B (2016) Implications of climate change for contributions by agriculture and forestry to Pacific Island economies and communities. In: Taylor M, McGregor A, Dawson B (eds) Vulnerability of Pacific Island agriculture and forestry to climate change. Pacific Community (SPC), pp 447–482
Mcleod E, Bruton-Adams M, Förster J, Franco C, Gaines G, Gorong B et al (2019) Lessons from the Pacific Islands–adapting to climate change by supporting social and ecological resilience. Front Mar Sci 6:289
Michalena E, Hills JM (2018) Paths of renewable energy development in small island developing states of the South Pacific. Renew Sust Energ Rev 82:343–352
Michalena E, Kouloumpis V, Hills JM (2018) Challenges for Pacific Small Island developing states in achieving their nationally determined contributions (NDC). Energy Policy 114:508–518
Mirti AV, Davies S (2005) Drinking water quality in the Pacific Island countries: situation analysis and needs assessment. Pacific Data Hub
Molle F (2008) Nirvana concepts, narratives and policy models: insights from the water sector. Water Altern 1(1):131–156
Müller-Mahn D, Gebreyes M (2019) Controversial connections: the water-energy-food nexus in the Blue Nile basin of Ethiopia. Land 8(9):135
Narayan PK, Narayan S, Prasad A (2008) Understanding the oil price-exchange rate nexus for the Fiji islands. Energy Econ 30(5):2686–2696
Nauditt A (2018) Discussion of "Challenges in operationalizing the water–energy–food nexus." Hydrol Sci J 63(12):1866–1867
Newell A, Nuttall P, Prasad B, Veitayaki J (2017) Turning the tide: the need for sustainable sea transport in the Pacific. Mar Policy 75:249–259
Nuttall P, Newell A, Prasad B, Veitayaki J, Holland E (2014) A review of sustainable sea-transport for Oceania: providing context for renewable energy shipping for the Pacific. Mar Policy 43:283–287
Oberle FKJ, Swarzenski PW, Storlazzi CD (2017) Atoll groundwater movement and its response to climatic and sea-level fluctuations. Water 9(9):650
Piesse M (n.d.) Climate change threats to food and water security on Pacific atolls. Future Dir Int
Popkin BM (2006) Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. Am J Clin Nutr 84(2):289–298
Prasad A, Narayan PK, Narayan J (2007) Exploring the oil price and real GDP nexus for a small island economy, the Fiji Islands. Energy Policy 35(12):6506–6513

Purwanto A, Sušnik J, Suryadi FX, de Fraiture C (2019) Using group model building to develop a causal loop mapping of the water-energy-food security nexus in Karawang Regency, Indonesia. J Clean Prod 240:118170
PWWA (2020) Benchmarking report 2020: Pacific Water and Wastewater Association 10 years of performance improvement recorded (2009–2019)
Radtke K (2019) World risk report 2019. In: Bündnis Entwicklung Hilft/IFHV (eds). https://weltrisikobericht.de/wp-content/uploads/2019/09/WorldRiskReport-2019_Online_english.pdf
Radtke K (2020) World risk report 2020. https://weltrisikobericht.de/wp-content/uploads/2020/12/WRR_2020_online_.pdf
Rosegrant M, Valmonte-Santos RA, Thomas T (2015) Climate change, food security, and socioeconomic livelihood in Pacific Islands. Asian Development Bank
Salem S (2020) Climate change and the sinking island states in the Pacific. E-International Relations
Seidel H, Lal PN (2010) Economic value of the Pacific Ocean to the Pacific Island countries and territories. IUCN, Gland, Switzerland, p 74
Simpson GB, Jewitt GPW (2019) The development of the water-energy-food nexus as a framework for achieving resource security: a review. Front Environ Sci 7(8)
Singh A (2017) Historical analysis of change in rainfall, flow regime and river morphology [Case study: Zambezi Delta]. UNESCO-IHE Institute for Water Education, Delft
Singh A (2019) The sustainable development of Fiji's energy infrastructure: a status report. Pacific Econ Rev
SOPAC (2004) An overview of integrated water resources management in Pacific Island Countries: a National and Regional Assessment SOPAC miscellaneous report 554
SOPAC (2011) Freshwater under threat—Pacific Islands Report
SPC (2017) Pacific fuel imports
Stewart R (2006) An economic survey of developing countries in the Pacific region. Economic Round-Up, Spring 2006, 91–115
Taniguchi M, Endo A, Gurdak JJ, Swarzenski P (2017) Water-energy-food nexus in the Asia-Pacific region. J Hydrol Reg Stud 11:1–8
UN Geospatial (2023) Map of the World. Copyright United Nations. https://www.un.org/geospatial/content/map-world-1
Weitz N, Strambo C, Kemp-Benedict E, Nilsson M (2017) Closing the governance gaps in the water-energy-food nexus: insights from integrative governance. Glob Environ Change 45:165–173
White I, Falkland T (2010) Management of freshwater lenses on small Pacific islands. Hydrogeol J 18(1):227–246
Wiegleb V, Bruns A (2018) What is driving the water-energy-food nexus? Discourses, knowledge, and politics of an emerging resource governance concept. Front Environ Sci 6(128). https://doi.org/10.3389/fenvs.2018.00128
World Bank (2020) World development indicators. https://data.worldbank.org/indicator/