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Fisheries sector under climate change in the coral triangle countries of Pacific Islands: Current status and policy issues

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ABSTRACT

Pacific Island countries face food insecurity, limited availability of productive agricultural land, and deteriorating coastal and marine biodiversity where communities rely on these resources for food and economic sustainability. Climate change further impends these Pacific Island countries, jeopardizing land and aquatic ecosystems in addition to threatening the livelihoods and socioeconomic conditions of coastal communities. The national governments of Pacific Island countries have created a number of development policies and plans to enhance the economic conditions, safety assurance, environmental conservation and preservation and other critical requirements of the national populace. This first paper in this Special Section aims to present the economic contributions, types of fisheries and common fishing practices/gears, and the institutional set-up and the national development plans and policies related to the fisheries sector in four Pacific countries namely, Fiji, Solomon Islands, Vanuatu, and Timor-Leste. The paper discusses the common issues and the collective action surrounding the fisheries sector in these Pacific countries. The final section of the paper provides conclusions based on the findings of the four subsequent papers of this Special Section.

1. Introduction

The vulnerability of a country to climate change depends on its physical susceptibility to natural hazards and external shocks; and social, institutional and economic features. Vulnerability also tends to increase with relatively small geographic size; severity of food and water insecurity; limited opportunities for reaping the advantages of scale economies in production; geographic remoteness from markets of significant size; limited financial, technical and institutional capacities; dependence on food imports; relative degree of poverty; and relatively rapid rates of urbanization are factors on vulnerability [1]. Most, if not all, of these characteristics describe the Pacific Islands region, and consistent with the findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR) [2] on vulnerability of Pacific Islands to climate change. The recent IPCC Fifth AR [3] described temperature increase at an average rate of between 0.1 °C and 0.2 °C per decade while large differences in sea level rise were observed in tropical Pacific during the 20th century. On the other hand, annual projected change for 2081–2100 (relative to 1986–2005) include average surface temperature increase ranged at 1.2–1.4 °C; average rainfall at 1–2%; and sea level rise at 0.5–0.6 m in north and south tropical Pacific Ocean using the intermediate low-emissions scenario. Furthermore, coral reef sensitivity to changes in climate conditions were identified around Micronesia, Mariana Islands and Papua New Guinea. Warming, ocean acidification, coral bleaching and sea level rise made the reefs in these areas more vulnerable to the physical impacts of climate change.

The tropical Pacific Ocean accommodates 7500 islands of which 500 are inhabited. The 22 Pacific Island countries and territories are grouped into three sub-regions according to ethnic origin, (a) Melanesia: Fiji, Papua New Guinea, Solomon Islands, New Caledonia, Timor-Leste, and Vanuatu; (b) Micronesia: Kiribati, Palau, Northern Marianas Islands, Federated States of Micronesia, Marshall Islands and Nauru; and (c) Polynesia: Samoa, Wallis and Futuna, Tokelau, American Samoa, Tonga, Cook Islands, Niue and Tuvalu [4]. The Melanesian group is also part of the coral triangle of Pacific Islands, while Timor-Leste whose inclusion in the Pacific Island region is underway [5], also falls under the coral triangle countries according to the Coral Triangle Knowledge Network [6]. This paper focuses on Fiji, Solomon Islands, Timor-Leste, and Vanuatu.

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Table 1
Fish production (mt) and value (US$) in three Pacific Island countries, 2007.

Types of fisheries	Fiji[a]		Solomon Islands[b]		Vanuatu[b]	
	Production (mt)	Value (US$ million)	Production (mt)	Value (US$ million)	Production (mt)	Value (US$ million)
Offshore						
Foreign-based	490	0.53	74,404	120.89	12,858	2.6
Locally-based	13,740	29.29	23,619	32.66	81,092	Not available
Coastal						
Commercial	9500	33.75	3250	3.31	538	2.18
Subsistence	7600	0.06	15,000	10.98	2830	5.74
Freshwater	4150	4.29	2000	1.46	80	0.17
Aquaculture	247	0.0017	165 mt; 8200 pieces (pearls, corals)	0.04	31 mt; 2500 pieces	0.39

[a] [18].
[b] [9].

Fish[1] is critically important to food security and nutrition in Pacific Islands [7–9]. But diets have also been changing in these countries, with increasing consumption of cheaper food imports such as canned meat and fish, white bread, soda and others instead of the local food—traditional root crops, vegetables, and fresh fish. This dietary change is relatively unhealthy and may be unsustainable given the rising food import prices and the negative impacts of the trend on local and rural producers and traders [10]. Greater consumption of fish is needed for improving population health in the region [11].

The fisheries[2] sector also plays a vital role in providing livelihood, income, and foreign exchange export in Pacific Island countries [9,12]. Climate change poses a threat to maintaining these benefits [13]. This Special Section of Marine Policy reports and discusses the economic impact of climate change adaptation strategies on the fisheries sector in four Pacific Island countries.

This paper aims to give an overview of the current status of the fisheries sector and national development plans and policies surrounding the sector in Fiji, Solomon Islands, Timor-Leste and Vanuatu, to set the stage for the four subsequent articles in this special section [14–17]. Specifically, this introductory paper will describe the (a) economic contributions; (b) common fishing gears and practices; and (c) institutional set-up and national development plans and policies affecting the fisheries sector per country. A summary of the collective issues, constraints and opportunities in the fisheries sector of the three Pacific countries and Timor-Leste is likewise provided and lastly, the conclusions including highlights of each of the subsequent papers in this Special Section.

2. Fiji

2.1. Economic contributions

The total water area and exclusive economic zone (EEZ) of Fiji is estimated at 1.29 million km^2 [4]. The fisheries sector contributes about 1.7% of the total gross domestic product (GDP) of Fiji in 2000–2008 [9]. Out of US$518 million total exports, about US$63.3 million (12%) can be attributed to fisheries in 2007 [18]. Of this 12% fisheries export, tuna industry accounts for 60% [18]. More than half (51%) of tuna export is transported to Japan and the United States while the rest (49%) is sold to Australia, People's Republic of China, New Zealand, and European Union [18]. Table 1 presents fish production and value by major categories in Fiji in 2007. Although aquaculture is still under development, it has significantly high value compared to the rest of other fisheries resources.

Fisheries boosts the food and nutrition security especially of the rural coastal communities, livelihood and income generation, rural development, and environmental preservation. In 2007, the sector provides employment to about 3.8% of economically active Fijian population [18] (Appendix Table A1).

2.2. Types of fisheries and common fishing practices/gears

Fisheries resources are classified as (a) offshore capture fisheries; (b) coastal or inshore capture fish; (c) freshwater or estuarine fisheries; and (d) aquaculture. Table 2 presents the common fishing gears and practices in Fiji in 2012. Women and children carry out fishing activities in coastal areas during low tide through reef gleaning, mainly targeting shellfish, sea cucumber, octopus, sea urchins, eels, and small fish.

Fish aggregating devices (FADs) were introduced by the Department of Fisheries (DOF) during the last 5 years in Fiji [26]. FADs use readily available flotation materials (e.g., bamboos and coconut leaves) that are easily deployed once constructed. Harvest of aquarium fish for commercial purposes applies specialized fishing gears. Issuance of fishing licenses is the tracking system used by DOF to keep an inventory of the gear operated by domestic and foreign vessels.

In 1976, DOF initiated culturing of Nile tilapia in Fiji [26]. Freshwater prawn, grass carp, and silver carp are other cultured species while milkfish, seaweed, and pearls are under development. Riverine stocking of tilapia was initially practiced in Tailevu and Rewa Delta but was discouraged by DOF due to biodiversity concerns [26].

2.3. Institutional set-up and national development plans and policies

DOF of Fiji is under the Ministry of Fisheries and Forests. It is responsible for the management of freshwater and marine resources with a vision of building fisheries as one of the main sectors in socioeconomic development and generation of income growth where resource owners are equitably remunerated [26]. DOF developed the 1988 Fisheries Act, amended as the 1991 Fisheries Act Decree; 2002 Fiji Tuna Development and Management Plan; 2005–2010 Fiji Freshwater Aquaculture Sector Plan and others. Marine protected areas (MPAs) are clearly defined geographical areas recognized, dedicated, and managed through legal or other effective means, to achieve long-term natural resource conservation and protection with associated ecosystem services and cultural values [27]. These are covered under the National Biodiversity Strategic Action Plan and Fisheries Act. However there are crucial gaps in legislation and policies that impede MPA establishment in other areas such as (1) lack of any comprehensive protected area management legislation that deters carrying out

[1] Fish is used here in the broad term that includes finfish and invertebrates.
[2] Fisheries is used here in broad sense to include capture fisheries and aquaculture.

Table 2
Common fishing gears and practices used in four Pacific Island countries, 2012.

Types of fisheries	Fiji[a]	Solomon Islands[b]	Vanuatu[c]	Timor-Leste[d]
Offshore fisheries (commonly targeting tuna)	Long-line; Deep-sea drop-line, trolling; Hand-line (for snapper)	Long-line; Hand-line; Purse seine; Pole-and-line	Long-line; Hand-line; Purse seine	No information
Coastal				Gillnet; Fish trap; Hook-and-line; Spear guns; Crab pots; Small enclosing nets (hand nets, trammel nets); Reef gleaning; Skin diving
Commercial; subsistence	Hand-line; Gillnet; Trolling; Cast net; Low-cost inshore fish aggregating device; Fish trap; Seine net; Hand net; Line trawls Hook-and-line	Long-line; Hand-line; Gillnets; Traps; Spears and masks	Gillnet; Hand-line; Cast net; Trolling	
Subsistence	Line trawls; Reef gleaning; Skin diving; Spearfishing	Reef gleaning; Skin diving; Spearfishing	Gillnet; Hand-line; Cast net; Trolling; Fishing line; Spears and masks; Reef gleaning	
Freshwater and estuarine	Wading gillnet; Spearfishing; Free diving	Traps; Gillnets; Hand-lines; Spears and masks	Traps and spears	No information
Aquaculture	Monoculture (one species in a pond); Polyculture (two or more fish types stocked at the same time); Integrated fish farming (culturing fish with duck or chicken house built near or around the pond system); Backyard or small-holding farming (mostly for subsistence)	Seaweed; Corals; Clams	Pacific oyster; Malaysian freshwater prawn; Marine shrimp; Red tilapia; Trochus; Giant clams; Corals	Milkfish; Shrimp; Seaweed; Mud crab

[a] [18].
[b] [19–21].
[c] [22,23].
[d] [24,25].

best practices in integrated and networked areas; (2) fragmentation of legislation and policies where harmonization is needed, as well as administrative concerns; (3) the need for amendments to the Fisheries Act and regulations to encourage community participation in the identification, designation, and management of MPAs and enforcement of policies; and (4) recognition of locally managed marine areas (LMMAs) that contributes to integrated coastal zone management [28].

The Government of Fiji (GOF) developed other legislation or acts primarily to ensure the sustainable use of natural resources with or without the effects of climate change. A number of development policies and plans designed by GOF to enhance the economic conditions, safety assurance, environmental conservation and preservation among others are presented in Appendix Table A2.

3. Solomon Islands

3.1. Economic contributions

Solomon Islands has an EEZ of 1.34 million km^2 [29]. Fisheries resources contribute an average of 6.8% in total GDP in 2000–2008 [6]. Revenue from total fish export was calculated at US$22 million in 2007 [9]. Export is mainly from the tuna industry, with 65% of exports composed of albacore, bigeye, skipjack, and yellowfin. Sea cucumber, fish for the aquarium trade, seaweed, and shark fins are the non-tuna exports. World Bank [30] estimated around 12% of the 214,000 economically active population are formally employed under the fisheries sector in 2011.

Because of the vast sea area, offshore fisheries offer the highest fish supply at 98,023 mt valued at US$153.55 million particularly those harvested by offshore foreign-based fishing vessels in 2007. Fish production by major categories and estimated values is presented in Table 1.

3.2. Types of fisheries and common fishing practices/gears

Fishers from Solomon Islands use different kinds of gear as they move from coastal to offshore areas, as shown in Table 2. Edible shells, other invertebrates, and small fish are collected through reef gleaning, spears and masks, and skin diving, mostly by subsistence fishers. Women and children likewise harvest fisheries resources in the coastal areas by reef gleaning during low tide. FADs have been in operation in various provinces since 2010, and additional FADs were deployed in 2011 [19]. In 1984, aquaculture was introduced but political conflicts deterred its full realization and remains to be developed beyond a few operations.

3.3. Institutional set-up and national development plans and policies

The Ministry of Fisheries and Marine Resources (MFMR) of Solomon Island Government (SIG) is mainly responsible for the "orderly development and quality management of Solomon Islands fisheries and marine resources; and to ensure that Solomon Islands receives maximum economic and social benefits from the sustainable use of its fisheries and marine resources" as stated in the MFMR Corporate Plan 2011–2013 [31]. MPAs are under Solomon Islands LMMAs, of which 127 have been identified [32]. Recent geographic information system of the Coral Triangle Atlas recorded 162 LMMAs [19].

SIG developed other sectoral plans to support the economic development and environmental conservation of the country. International and regional agreements as well as the needs and concerns of Solomon Islanders were addressed through these development plans particularly those related to environment,

fisheries and climate change (Appendix Table A3). In 1992, SIG joined United Nations Framework Convention on Climate Change (UNFCCC) and later on signed as member of UNFCCC in 1994. SIG participated and ratified the Kyoto Protocol in 1998 and 2003 respectively. The Initial National Communication was submitted to UNFCCC in 2004. Other development plans include the Pacific Adaptation to Climate Change Project 2000; the Pacific Island Framework for Action on Climate Change 2006–2015; National Disaster Risk Management Plan 2006; and completion of the Second National Communication to the UNFCCC [33].

4. Vanuatu

4.1. Economic contributions

Vanuatu has the smallest total water area and EEZ compared to the rest of the Melanesian countries at 680,000 km^2 [9]. Fisheries sector contributed around 1.3% to total GDP in 2000–2008 while fish exports was estimated at US$62.7 million in 2007 [9]. Tuna fisheries dominate its EEZ comprised of bigeye, yellowfin, skipjack and albacore. Nearly 72% of the rural households are engaged in some form of fishing [34].

Largest fish production was found in offshore fishing area and harvested by locally-based fishing vessels at 81,092 mt in 2007 (Table 1) [9]. Interestingly, the highest value of fish was recorded from coastal subsistence fishers at US$5.74 million in 2007 [34].

4.2. Types of fisheries and common fishing practices/gears

Vanuatu fishers apply different fishing gear and practices as presented in Table 2. Gillnet and hand-line are the most common fishing gears in coastal areas being used by commercial and subsistence fishers. Similar to Fiji and Solomon Islands, Vanuatu women and children practice reef gleaning to collect shells and other edible invertebrates during low tide.

Introduction of oysters from Japan and US was the advent of aquaculture in Vanuatu during the 1970s [35]. However farming was discontinued due to pests as well as land disputes and lack of technical expertize. Farming of cultured species are classified as high-, medium-, and low-priority, depending on technology, capital, marketing, food security, and restocking of cultures. Marine shrimps, giant clams, freshwater prawns, tilapia, Trochus, green snails, and corals are high priority species. Sea cucumber, eel, and mud crab and others where technologies are still under development are medium-priority while low-priority are those where available natural seed supply, existing technologies, market access, and cultural perceptions place them at a relative disadvantage for producers. The Vanuatu Aquaculture Development Plan 2008–2013 was designed to identify and address the needs of the critical areas to produce development frameworks for high-priority species [35]. However, aquaculture remains mainly undeveloped.

FADs were in operation in Vanuatu offshore waters beginning in the early 1990s [36]. Their use gradually diminished due to reduced funding from financial agencies and government institutions in the 1990s until these were totally absent in 1996–1997. Recently, low-cost inshore FADs were established in various areas the country.

MPAs are also called community conservation areas in Vanuatu. These are customary areas covering both the land and the sea with traditional customs on resource management depending on the chieftains and communities.

4.3. Institutional set-up and national development plans and policies

The Government of the Republic of Vanuatu recently undertook reorganization of the different government ministries and agencies. The Vanuatu Fisheries Department is currently under the Ministry of Agriculture, Livestock, Fisheries, Forestry and Biosecurity. It is mandated to protect and preserve the fisheries resources particularly in terms of development and management of these and matters related to fisheries.

In 1993, Vanuatu ratified the UNFCCC and presented its Initial National Communication in 1999. This facilitated the development of institutional set-ups to ensure mainstreaming climate change into national legal frameworks. In 2001, Vanuatu ratified the Kyoto Protocol and was also a party to other UN conventions [37].

To address the concerns on economic development and environmental preservation and in compliance with the regional and international agreements, Vanuatu developed a number of national programs and projects addressing climate change. These include programs to reduce and/or mitigate greenhouse gas emissions; impacts on health, biosafety, and biological diversity; persistent organic pollutants; desertification; and other programs. Appendix Table A4 gives a listing of national development plans and policies targeting the coastal communities of Vanuatu.

5. Timor-Leste

5.1. Economic contributions

Timor-Leste gained its independence only in 2002, and data and information on fisheries is sparse. Before 2002, information are highly aggregated, coming from Indonesia [38]. It has a total land area of 14,874 km^2 and EEZ of roughly 72,000 km^2 [4]. In contrast to the three Pacific countries, Timor-Leste has only two islands, Atauro Island at 144 km^2 and Jaco Island at 8 km^2 [39].

The fisheries sector contribution to total GDP is estimated at 1.4% valued at US$5.7 million in 2004 [10]. Around 7600 people, including those in aquaculture, are employed in the fisheries sector in 2008 [38]. Coastal fishing is the major small-scale fishing activities because of the absence of domestic commercial fishing vessels exploring offshore fishing grounds. The government of Timor-Leste signed bilateral agreements in mid-2000s that will permit foreign fishing vessels limited access to fish in the country's deep-sea fishing grounds. However noncompliance and expired agreements led to the cancellation of these agreements. Freshwater fishing is restricted during the monsoon season and is mostly for subsistence.

In parallel with other Pacific countries, aquaculture has been identified as an avenue to improve food and nutrition securities, and income-generating activity for inland and coastal communities. This is chiefly a government-led initiative with assistance from other regional and international research agencies because of its costs and infrastructure needs, and little progress has been.

5.2. Types of fisheries and common fishing practices/gears

The common fishing gear and practices applied in the country is shown in Table 2. The gears are mostly provided by the National Directorate of Fisheries and Aquaculture (NDFA) via the fisher's assistance program [40]. Reef gleaning is mostly carried out by women and children during low tide, although the major fishing activities of women are fish processing and selling. FADs and MPA are prevalent in the country but with limited extent. NDFA is the key responsible agency in collaboration with other international and regional research agencies on FADs and MPAs. Seaweed culture is the principal cultured crop in Atauro Island with approximately 1500 farmers [41].

Table 3
Advantages and disadvantages of aquaculture in Pacific Islands.Sources compiled from [42,43].

Advantages	Disadvantages
• High demand of species associated with coral reefs: a) aquaculture and seafood markets in Asia (e.g., napoleon wrasse, grouper, sea cucumber, spiny lobster, Trochus, pearl oyster, giant clam, green snail) b) marine aquarium trade (e.g., clownfish, angelfish, hard coral, soft coral, giant clam) c) pharmaceutical trade (e.g., algae, sponge, soft coral, seahorse) • Availability of suitable grow-out sites in pristine habitats—presence of favorable environmental and coral reef conditions • Favorable geography for restocking and stock enhancement—cultured juveniles released in inshore waters cannot emigrate and are easy to recapture • Relatively inexpensive labor force	• Traditions and familiarity of coastal communities working with marine resources • Limited domestic markets • High-added-value export markets targeted • Transport problems • Socioeconomic factors—lack the infrastructure, capital, and skilled labor • Fragile habitats • Freshwater is limited, except for the large islands of Melanesia, which have extensive river systems • Cyclones

5.3. *Institutional set-up and policies*

NDFA under the Ministry of Agriculture and Fisheries is the key government agency accountable for the fisheries resources and fisheries-related matters of Timor-Leste. Although a relatively young country, Timor-Leste actively participated in several international conventions and agreements to confirm its commitments, particularly adaptation and mitigation measures for alleviating the adverse impacts of climate change to the Timorese and to the international community.

Timor-Leste ratified international conventions such as UNFCCC, UN Convention on Biological Diversity, and UN Convention to Combat Desertification in 2010 [25]. At the national level, the country has developed national resource management plans and policies that will benefit their coastal communities (Appendix Table A5).

6. Common issues and collective action surrounding the fisheries sector in the Pacific countries

The current status of the fisheries sectors in four Pacific countries, Fiji, Solomon Islands, Timor-Leste and Vanuatu were presented including the national development policies and plans created by the governments in response to sustainable use and equitable distribution of natural resources with or without the effects of climate change. Furthermore, these countries have joined and ratified international agreements related to climate change such as the Kyoto Protocol and the UNFCCC. However these countries likewise face some common issues surrounding the fisheries sector such as the need to:

- Resolve the economic and political concerns that influence fisheries and foster relationships to maximize benefits and avoid potential areas of conflict (e.g. with tourism sector);
- Promote sustainable growth of coastal fisheries, the most accessible resource, with the full participation of subsistence fishers;
- Provide subsistence fishers with technical assistance and other means of support to ensure and sustain traditional management and enable to cope with growing commercial pressure;
- Reverse the likelihood of diminishing nutrition supplied by fish due to declining per capita fish consumption because of increasing population and stagnant coastal fisheries production; and
- Promote the ability to meet fish demand in urban areas from local coastal areas because through reduction of high operational costs, and investment in transportation and other infrastructural needs.

At the production level, fish harvests are constrained in different levels, and these are listed below:

- Inshore resources are heavily exploited particularly those close to the urban market;
- Offshore resources are difficult to access for subsistence fishers;
- Aquaculture has developed slowly, missing the opportunity to contribute to domestic food supply;
- Small-scale fishers are affected by rising fuel costs and lack of appropriate fishing gear to access rich offshore fishing grounds;
- Infrastructure and other services are limited if not absent (e.g. ice plant, onshore fish processing facilities, fuel, etc.);
- Competition among small-scale fishers, offshore vessel operators and between small-scale and offshore fishers;
- Marketing of products involving (a) inability to access marketing opportunities in urban areas with the abundant marketing products from remote areas, (b) competition for more efficient foreign producers of fishery and aquaculture products, (c) stagnated market prices, and (d) declining profit margins; and
- Poor extension services result in lack of awareness by coastal communities of development limitations and consequences of over-exploitation and limited interaction among stakeholders.

Although aquaculture has strong potential to increase fish production, there are some challenges faced by this sector as presented in Table 3.

Pacific Island countries became interested on FADs because of anticipated benefits from the biological and socioeconomic points. The Secretariat of the Pacific Community [44] described two kinds of FADs, *artisanal FADs* to enhance the catch rate of fishers whose catch feed their families or sell excess amount in local markets; and *industrial FADs* to expand the catch rate of purse seine and pole-and-line vessels that target large schools of tuna. Sharp [45] presented detailed benefits as well as adverse impacts of FAD. Benefits include:

- Higher fish production leading to increased catch per unit of effort;
- Reduced fishing pressure on reef resources;
- Import substitution reduces reliance on fish imports for food;
- Export creation where higher fish catch enhances marketing of fish products;
- Commercial development that promotes market channel development; and
- Creation of jobs for fabrication, deployment, monitoring, and maintenance; post-harvest processing of tuna products.

On the other hand, adverse effects include the potential for market saturation; vandalism; and natural disasters.

7. Conclusions

The remaining papers in this special section [14,15,17] develop a rigorous analytical tool that is capable of comparative analysis of

alternative fisheries development scenarios under climate change, even under data-scarce situations. Country papers for Fiji, Solomon Islands, and Vanuatu/Timor-Leste show that under a baseline with climate change, rising per capita income and population will result in substantial growth fish demand through 2050 in all four countries. Growth in domestic fish production is projected to be relatively slow due to climate change and other constraints. In particular, under the climate change baseline, supply of fish from coastal fisheries is expected to decline due to climate change and other adverse environmental effects.

Country case studies present the results of modeling and scenario analysis. In Fiji it shows that promoting aquaculture can help raise aggregate fish production, consumption, and trade. Various NRM strategies, such as marine protected areas and locally managed marine areas, are projected to have positive impacts in Fiji, but current efforts on various NRM strategies are too small to have any meaningful impact to reverse the declining trends of coastal fisheries catch. Results for the Solomon Islands indicate that without appropriate climate adaptation strategy, per capita consumption of domestically produced fish will decline, which has serious negative food security implications for the country. Modeling results show that the national level net economic gains due to climate change adaptation strategies are substantial in Solomon Islands as well as in Fiji, Vanuatu and Timor-Leste. If cost and topographic conditions permit, low-cost inshore FAD are expected to be a good mechanism for augmenting domestic supplies of tuna and similar species in Solomon Islands. Vanuatu is currently a net exporter of fish and seafood, with domestic production far exceeding domestic consumption. However, it will most likely have to import coastal fish to meet expanding demand from population and income growth. Given that many of Vanuatu's poorer households rely on coastal fisheries for their consumption needs, this projected scenario will considerably affect food security of the country. On the other hand, modeling results indicate that application of adaptation strategies (FAD+NRM) is projected to reduce the country's fish imports and increase its net exports thereby positively influencing the socioeconomic welfare of the people. Timor-Leste is a net importer of fish and seafood, and this is projected to increase in the long-run under the baseline and various climate change adaptation scenarios. Aggregate fish demand is expected to rise substantially over time due to growth in population and real per capita income, thus increasing fish import to fill this escalating deficit in the domestic fish supply. Under the baseline with climate change, fish supplies from oceanic and coastal ecosystems are projected to decrease during 2010–2050. Only the freshwater ecosystems are projected to supply more fish in the future under the baseline. Given that oceanic and coastal fisheries supply about 94% of current fish consumption in Timor-Leste, enhanced investments in each of these ecosystems will be required to improve food security.

In conclusion, food security and nutritional status of these Pacific Island countries would be enhanced by better managed aquaculture and fisheries sectors. These management and technical options include the establishment and recognition of MPAs, low-cost inshore FAD, and development and expansion of aquaculture. National governments of Fiji, Solomon Islands, Vanuatu and Timor-Leste are actively looking into these climate change adaptation strategies as feasible approaches to ensure food security and economic livelihood particularly for the coastal communities whose food and income sources rely heavily on the aquatic resources. The results presented in this Special Section provide inputs to these governments for assessing the alternative options.

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Appendix

See appendix Table A1–A5 here

Table A1
Fisheries employment in Fiji, 2005.
Source: [46]

Category	People employed (no.)
Subsistence fishers	3000
Inshore artisanal	2137
Tuna cannery	800
Ornamental aquarium	650
Other fish processors	639
Aquaculture	550
Offshore fishery	510
Fish markets	340
Department of Fisheries	243
Input suppliers	185
Game and charter fishing	60
Slipways/ports	30
Total	9144

Table A2
National development plans and policies affecting fisheries and climate change of Fiji.
Source: Compiled by authors

National Development Policies and Plans
20-Year Development Plan (2001–2020)
National Strategic Development Plan (2007–2011)
Sustainable Economic Empowerment Development Strategy (2008–2010)
Environment
– National Environment Strategy (1993)
– Endangered and Protected Species Act (2002)
– Endangered and Protected Species Regulations (2003)
– Environmental Management Act (2005)
– National Biodiversity Strategy and Action Plan (2007)
– Ecosystem Based Management Plan (2009)
– National Biodiversity Strategy and Action Plan Implementation Framework (2010–2014)
Climate Change Policy:
– Fiji's First National Communication Under the Framework Convention on Climate Change (2005)
– Clean Development Mechanism Policy Guideline (2010)
– National Climate Change Policy (2012)
Coastal Development Policies:
– Environment Management Act (2005)
– Integrated Coastal Management Framework (2010)
Coastal/Capture Fisheries Policies:
– Fisheries Act (Cap 158)
– Marine Spaces Act (Cap 158 A)
Aquaculture Policies:
– Fiji Islands Freshwater Aquaculture Strategic Plan (2005–2009)
Management Plans
– Fiji Tuna Development and Management Plan (2002)
Marine Protected Areas and Biodiversity
– Fiji National Biodiversity Strategy and Action Plan (2007–2011)
– Implementation Framework (2010–2014)

Table A3
National development plans and policies of Solomon Islands.
Source: Compiled by authors

National Development Policies and Plans
National Development Strategy (2011–2021)
Vision 2020
National Economic Recovery, Reform and Development Plan (2003–2006)
Environment
– Environment Act (1988)
– National Environmental Capacity Development Action Plan (2008–2012)
– Wildlife Protection and Management Act (1998)
– National Biodiversity Strategic Action Plan (2009)
– Protected Areas Act (2010)
– Protected Areas Regulation (2012)
Climate Change Policies
– Solomon Islands National Plan of Action (2010)
– National Plan of Action—Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (2010)
– Solomon Islands National Climate Change Policy (2012–2017)
– National Adaptation Programmes of Action
Coastal Development Policies
– Environment Act
– Solomon Island National Strategy for the Management of Inshore Fisheries and Marine Resources (2010–2012)
Coastal/Capture Fisheries Policies
– Fisheries Act (No. 6 of 1998)
– Solomon Islands National Fish Aggregation Device Management Plan (2008)
– Fisheries Amendment Act (No. 6 of 2009)
– Fisheries (USA) (Treaty) Act, Cap 39
Aquaculture Policies
– Solomon Islands Aquaculture Development Plan (2009–2014)
– Solomon Islands Tilapia Aquaculture Action Plan (2010–2015)
Management Plans
– Tuna Management and Development Plan (1999)

Table A4
National development plans and policies for coastal communities of Vanuatu.
Source: Compiled by authors

National Development Policies and Plans
National Development Plan (1982–1986; 1987–1991; 1992–1996)
Environment
– Environmental Management and Conservation Act (2002)
Coastal Development
– Foreshore Development Act (1975)
– National Integrated Coastal Management Framework
Fisheries
– Fisheries Act (1982)
– Fisheries Act (amended) (1989)
– Fisheries Regulations (2004)
– Fisheries Act (2005)
– Decentralization and Local Government Act (1994)
Aquaculture
– Aquaculture Development Plan (2008–2013)
Management Plans
– Community Based Management Plans
– Vanuatu National Marine Aquarium Trade Management Plan (2009)
– Trochus Management Plan
– Sea Cucumber Management Plan
– National Tuna Fishery Management Plan (2000)
– Revised Tuna Management Plan (2009)
– Vanuatu Management Plan for the Regulation of Fish Aggregating Devices (draft)
Climate Change Policies
– Vanuatu National Adaptation Programme of Action
– National Action Plan

Table A5
National development plans and policies of Timor-Leste.
Source: Compiled by authors

National Development Policies and Plans
National Strategic Development Plan (2011–2030, 2011)
National Development Plan 2002
Environment
– National Biodiversity Strategic Action Plan (2011)
– National Adaptation Plan of Action (NAPA) to Combat Land Degradation
– Environmental Basic Law (under legislative process)
– Policy and Strategic Plan for Environment (for presentation and approval)
– Marine Protected Area— Marine Zoning
Fisheries
– Fisheries Sector Plan
– Fish for Sustainability. Our Strategic Plan for Fisheries (2006–2011)
– The Future of Fisheries: A Policy and Strategy for the Responsible Development and Management of Fisheries in Timor-Leste (2007)
– Fisheries Quarantine (2011)
Aquaculture
– National Aquaculture Development Strategy (2012–2030)
Management Plans
– Trochus Fishery Management
Climate Change
– NAPA
– NAPA for Climate Change
– NAPA for Coral Triangle Initiative

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