



Ba River, Navala village, Viti Levu island, Fiji

The impact of natural and ecological factors

on the development of South Pacific island economies*

ABSTRACT

The South Pacific region consists of numerous loosely scattered islands. The remote geographical locations and weak infrastructure of those island economies make them difficult to attract external funding for economic development. The lack of resource diversity of those economies results in a specialized economic structure. Due to their small domestic markets and small economic volume they are susceptible to external economic shocks, and their economies often suffer roller-coaster growth trajectories. Their economic growth is often hindered by

* THIS CHAPTER IS NOT PEER-REVIEWED.

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severe bottlenecks in capital, technology, and human talent. As a result of their special geographical location and land size, these economies are also more likely to be exposed to the consequences of natural disasters. Excessive human activities have already exacerbated ecological and resource degradation. Greenhouse effects and rising sea levels now pose another serious threat to the survival of these economies.

In the face of these and other environmental challenges, those island states and territories may benefit from the synergies associated with international collaboration. Individual states can also deal with these challenges through strengthening their legislation and restructuring their economies. This chapter suggests that these small island economies would be better served by stronger regional integration through trade and cooperation to achieve resources complementarity. They could also attract more foreign investment and enhance programs on improving their human resource training through cooperation with countries outside the region.

INTRODUCTION

There are about 100,000 inhabited islands in the world, which are home to more than 600 million people (Wu, 2006). The land area of islands accounts for about one-fifteenth (Cui & Ying, 2016) of the world's total. Thus, islands are both important homes to human and other species, and significant anchors to protect and utilize the surrounding ocean. For thousands of years, islands have been important sites for human life and economic production.

Island economies share the following features. First, an island economy could be an independent island, or part of a group of islands. Second, the land and marine resources both on land and in its surrounding sea have been exploited and utilized to develop its own economy. Third, although islands vary significantly in size, from several million km² to only a few dozen km², an island economy has a certain level of administrative and economic organization. The administrative units could be a country or part of a country. The economic development of island economies differs by a substantial margin. Some have advanced economies and complete industrial systems while others may still remain in a mono-economic structure or in a high level of foreign dependency. Because of an ever-expanding global footprint of human activities, the ecosystems of islands are increasingly susceptible to human impacts. Due to its unique nature, an island ecosystem is highly sensitive to natural and human interference. Once disrupted, the ecosystem will face severe dysfunction and structural imbalance, which in turn will threaten the survival and development of its inhabitants.

South Pacific islands are small specks of land scattered in the vast Pacific Ocean. Thus, their economic development is heavily impacted by their unique natural conditions and ecological environments. At present, most island economies in the region face such challenges as climate change, natural disasters, environmental pollution, coastal and marine resource mismanagement, ecological imbalance, inconvenient transportation, lack of funds and technology, as well as slow economic growth. This chapter focuses on the impact of natural geographical conditions and ecological factors on South Pacific island economies.

NATURAL CONDITIONS AND ECOLOGICAL FEATURES OF SOUTH PACIFIC ISLAND ECONOMIES

Geographical conditions

South Pacific island economies generally refer to the 27 island economies situated between 30°N-50°S and 120°E-150°W. Comprised of over 10,000 islands, this expansive region covers a land area of around 550,000 km² and has a total population of 6.9 million (Peng, 2012). Based on geographical and cultural characteristics, the South Pacific islands can be divided into three major groups: Melanesia, a diagonal expanse of islands running from northwest to southeast, situated to the south of the Equator and to the west longitude 180°; Micronesia, extending from east to west, located largely to the north of the Equator and to the east longitude 180°; and Polynesia, stretching from northwest to southeast, located to the east longitude 180° and between 30°N-30°S. Generally speaking, these island economies have the following natural and geological features.

Small in land size and vast in sea area. The islands of the South Pacific, or Oceania as islanders prefer to call the region, vary greatly in land area. Papua New Guinea, the Solomon Islands, Fiji, and Vanuatu, which have land areas of 462,800 km², 28,000 km², 18,000 km², and 12,000 km², respectively, are relatively large. However, Samoa, which covers less than 3,000 km² and other similar islands are quite small in size, ranging from several hundred km² to as small as 26 km² (Tuvalu) and 21 km² (Nauru). However, this is not the complete story. According to the United Nations Convention on the Law of the Sea, islands which are able to “sustain human habitation or economic life of their own” have responsibility for an area extending roughly 200 nautical miles from the furthest point of land (i.e., the Exclusive Economic Zone or EEZ). Therefore most of these island economies control decision-making over vast marine areas. For instance, the Cook Islands, which possesses a land area of only 240 km², has a massive sea area of 1.83 million km². The Marshall Islands has 2.13 million km² of sea area compared to a mere 181 km² of land area (see Table 3.1).

TABLE 3.1: Basic information about South Pacific island economies

Island economy	Land area (km ²)	Sea area (km ²)	Population (2016)
Papua New Guinea	462,840	2,400,000	8,084,991
Solomon Islands	28,450	1,600,000	599,419
Fiji	18,333	1,290,000	898,760
Vanuatu	12,190	680,000	270,402
Samoa	2,934	120,000	195,125
Kiribati	812	3,500,000	114,395
Tonga	747	700,000	107,122
Micronesia	702	2,980,000	104,937
Palau	458	629,000	21,503
Cook Islands	240	1,830,000	13,100 (2015)
Marshall Islands	181	2,131,000	53,066
Tuvalu	26	750,000	11,097
Nauru	21	320,000	13,049

Source: Ministry of Foreign Affairs, P. R. China; the World Bank; Xu, 2003.

Islands are numerous and scattered, resulting in difficulties in both internal and external transportation. The over 10,000 islands in the South Pacific Ocean, which are scattered sporadically in the vast waters between Asia, Oceania, South America, and North America, are far away from landmasses and other islands. For instance, the Solomon Islands is 4,000 km away from Sydney, and 2,900 km from Tokyo; Fiji is 2,797 km from Sydney and 1,840 km from Auckland, New Zealand; Tonga is 4,827 km away from Hawai'i, 1,770 km from New Zealand, and 650 km from Fiji; the Solomon Islands is 306 km away from Kiribati; Vanuatu is 965 km away from Fiji, and 170 km away from the Solomon Islands (see Table 3.2). These island economies rely primarily on air and sea routes for external transportation. Intra-regional transportation is limited, comprised mainly of roads within individual islands and air and sea routes between the islands. In terms of rail transportation, Fiji has 820 km of railway and Nauru has only about 5 km of dedicated railway lines for phosphate minerals transportation; other islands have no railways. Among the few roads built, most of them are dirt paths. Nauru, with the least mileage, has only 30 km of roads. For the few economies that do have asphalt roads, due to poor construction quality and heavy rainfall, the roads are pitted with holes and dilapidated and thus extremely difficult to drive on (see Table 3.3).

TABLE 3.2: Distribution of Pacific Island states

Island State	Distribution of islands	Distance to landmasses or other islands
Papua New Guinea	600 islands distributed between 141°-156° E and 2°-12° S	—
Solomon Islands	6 major islands and 900 smaller islands scattered between 157°-170° E and 7°-13° S	1,600 km to Australia
Fiji	332 islands (106 inhabited) scattered between 175° E-178° W and 15°-22° S	2,797 km to Sydney; 1,840 km to Auckland, New Zealand
Vanuatu	83 islands (68 inhabited) scattered between 166°-171° E and 13°-21° S	About 1,600 km to Australia; 965 km to Fiji
Samoa	9 islands scattered between 171°-173° W and 13°-15° N	128 km to East Samoa
Kiribati	33 islands (21 inhabited) scattered between 169° E-150° W and 13° N -12° S	722 km to Tarawa to Nauru; 265 km to Ocean Island of Nauru
Tonga	172 islands (36 inhabited) scattered between 175°-177° W and 15°-23°30' S	4,827 km to Hawaii; 650 km to Fiji; 1,770 km to New Zealand
Micronesia	607 islands (65 inhabited) scattered between 137°-135° E and 6°-8° N	—
Palau	340 islands (9 inhabited) scattered between 134°-162° E and 2°-10° N	—
Cook Islands	15 islands scattered between 156°-167° W and 8°-23° S	1,100 km to French Polynesia
Marshall Islands	1,225 islands (24 inhabited) scattered between 160°-173° E and 5°-15°N	—
Tuvalu	9 islands scattered between 176°-180° E and 5°-11° S	1,300 km to Fiji
Nauru	167°E and 0°32' S	4,000 km to Sydney; 4,160 km to Hawai'i

Source: Ministry of Foreign Affairs, P. R. China; Xu, 2003.

TABLE 3.3: Transportation infrastructure

Island State	Railway	Traffic roads
Papua New Guinea	No railway	Around 30,000 km
Solomon Islands	No railway	1,900 km of mostly rural mud roads
Fiji	820 km	5,300 km of roads, including 1,340 km of asphalt roads
Vanuatu	No railway	around 1,900 km of roads
Samoa	No railway	976 km of roads, including 332 km of asphalt roads
Kiribati	No railway	—
Tonga	No railway	950 km
Micronesia	No railway	240 km
Palau	No railway	61 km
Cook Islands	No railway	—
Marshall Islands	No railway	152 km
Tuvalu	No railway	—
Nauru	5 km	30 km of roads, including 24 km of asphalt roads

Source: Ministry of Foreign Affairs, P. R. China

Rich marine and tourism resources, but limited terrestrial resources for most economies. South Pacific island economies have 17,296 million km² of exclusive economic zone, which is 8% of the world's total surface area and 10% of the world's sea area (Yao, 2014). The region is endowed with abundant fishery resources. Tuna production in these economies in 2007 reached 2.396 million tons, accounting for 55% of the world's total (Cui & Ying, 2016). Among the major tuna producers, Papua New Guinea has an annual catch potential of 300,000 tons and an annual production of around 200,000 tons (MFA, PRC, n.d.); the Solomon Islands has an annual catch of

around 80,000 tons (MFA, PRC, n.d.); and Palau's annual production stands at 60,000-70,000 tons. In terms of tourism resources, the Solomon Islands, Palau, Micronesia, and Vanuatu are well-known paradises for divers. In terms of forest resources, Papua New Guinea and the Solomon Islands have a forest stock volume of 1.2 billion cubic metres and 127 million cubic metres, respectively (MFA, PRC, n.d.). Fiji and Samoa, respectively have about 250,000 hectares and 13,600 hectares of economically recoverable forests (MFA, PRC, n.d.), while other Pacific island economies do not have reasonably large stretches of forest with economic recoverability. In terms of mineral resources, Papua New Guinea has 20 million tons of copper deposits, 3,110 tons of gold deposits, and around 400 million tons of copper-gold ores (MFA, PRC, n.d.). Gold and copper production in the country ranks 11th and 10th in the world, respectively (MFA, PRC, n.d.). While most of the phosphate minerals have already been mined, Nauru still has a small quantity. In comparison, most other Pacific island economies are short of mineral resources.

Ecological features

The ecological environment is of vital importance to the sustainable social and economic development of a region. Without a sound ecological environment, it is impossible to sustain the long-term and healthy development of such industries as agriculture, fishery, and tourism. The South Pacific island economies, mostly remote and small islands with simple terrains far away from landmasses and other islands, have extremely vulnerable ecologies. Their eco-environments have the following features.

Small animal and plant populations and a single ecological structure. According to ecological theories, there are four types of natural speciation: allopatric, sympatric, peripatric, and parapatric. In addition, continuous geological distribution, diversity of species, balanced biotic components, and matching environments are also necessary conditions for sound ecological sustainability. The size of an island and its distance from landmasses has a huge impact on the heredity of biotic populations and diversity of species thereon. Studies suggest that most species on islands are built up after immigration. According to Arhenius and Gleason's theory (Tjørve, 2003), the number of species in a habitat is closely related to the area of that habitat. For every tenfold increase in area, the number of species doubles on average. Among the South Pacific island economies, the larger islands include the Island of New Guinea (on which Papua New Guinea is located); Viti Levu (10,429 km²) and Vanua Levu (5,587 km²) of Fiji; Guadalcanal (5,336 km²), Malaita (3,840 km²) and Choiseul (3,294 km²) of the Solomon Islands; and Santo (3,947 km²) of Vanuatu. Other islands are all very small, some even only a couple of square kilometres in size. Most of these small islands have thin and barren soil; therefore terrestrial vegetation on the islands lacks diversity. In addition, difficult immigration into these faraway habitats, along with food and space constraints, has resulted in limited species, small populations, and simple biotic structures.

Ecological structures and functions are susceptible to damage. Diversity of species is not only the foundation of a diverse ecosystem, but also serves as a major stabilizer of the system. Each species is like a rivet in a machine in the ecosystem: damage or loss of a single species may not have a severe impact on the ecosystem in the short term, but will probably lead to a breakdown in the long term. In an ecosystem, once a species experiences a certain level of loss, the whole ecosystem may become undermined. As a general law, a wild animal species needs to sustain at least 500 individuals to achieve a certain level of evolution through natural selection, or else it may end up in extinction. Since South Pacific islands are extremely isolated, only highly migratable species can enter. This usually brings about the following consequences. First, there is limited gene exchange among species. The small biotic population on islands may lead to inbreeding, simple hereditary structure, and easy extinction of local species: the smaller the island, the more likely the extinction. Second, the small number of a species and lack of competition between populations on islands have resulted in poor adaptation and competitiveness of those species, and those species easily fall prey to invading ones. Due to the simple structure of native species and limited space on islands, the invasion of alien species will pose a serious threat to the growth and development of native species, therefore wreaking havoc on biodiversity on islands. Some experts believe that 90% of the extinct species on the South Pacific islands since 1800 are victims of alien species invasion (Peng, 2012), many of which come via the shipping industry—an important way for South Pacific islands to communicate with the outside world. According to statistics, the South Pacific region is home to over 400 types of unique birds and 30% of rare plants unseen anywhere else. Endangered birds there account for 25% of the world's total, and most have already become extinct (Peng, 2012).

Once damaged, the ecological system is difficult to recover. The ecological system on islands is a composite system of natural and cultural elements. Along with the increasing types, scope, and intensity of human activities, the island ecological system faces ever more human interference and significantly higher risk of damage. Far away from landmasses, South Pacific islands have small animal and plant populations and simple hereditary structures because of little exchange of substance and hereditary information with the outside world. Due to poor self-adjustment and vulnerability to external interference, the ecosystem, once undermined, can hardly recover to pre-damage conditions through self-adjustment. Besides, South Pacific island economies are plagued by frequent natural disasters. No sooner has the impact of the previous disaster been digested than another one hits, which brings new damage to the ecosystem under recovery. Finally, to recover the island ecological system through artificial measures is costly; thus it is an unaffordable burden for those island economies with lean budgets.

CONSTRAINTS OF NATURAL CONDITIONS ON INDUSTRIAL DEVELOPMENT OF SOUTH PACIFIC ISLAND ECONOMIES

Small land area, inconvenient transportation, and uneven distribution of resources severely constrain economic development of these island economies and subject them to extreme vulnerability. Although since the 1960s the South Pacific island economies have adopted various measures to diversify their economies, to boost national income, and to satisfy people's living requirements, due to their geological disadvantage, weak economic base, and inadequate funds, technology, and labour forces, most economies still have to rely on fishing, mineral resources, and tourism as their foundation for survival and development. Some countries need to rely on foreign aid to make up for their budgetary deficits.

"Specialized economies"

Resources are of critical importance in a country or region's economic development, and the South Pacific island economies are no exception. Due to an uneven distribution of resources, these economies have long formed a specialized economic structure with tropical cash crop farming as a key economic sector; mineral resources and agricultural produce as the main source of foreign exchange; and tourism and marine fishing as pillar industries. Economies in this region, which rely on tourism, include the Cook Islands, Micronesia, Fiji, Vanuatu, Kiribati, Palau, and the Marshall Islands. Among them, tourism revenues account for approximately 50% and one third of the national GDP of Palau and Vanuatu, respectively, and takes up 15% of the entire labour force of Fiji (MFA, PRC, n.d.). Economies that rely on fishing as a pillar industry include the Solomon Islands, Tonga, the Cook Islands, Palau, Tuvalu, and the Marshall Islands. For example, the annual tuna catch in the Solomon Islands and Palau stands at around 80,000 tons and 60,000-70,000 tons, respectively (MFA, PRC, n.d.). A total of 85% and 40% of labour forces in Papua New Guinea and Tonga, respectively, are engaged in agriculture (MFA, PRC, n.d.). Samoa is an agricultural nation where 77% of the total population is involved in agriculture (MFA, PRC, n.d.). Most of Tonga's exports are agricultural and fishing products (MFA, PRC, n.d.). Economies that rely on mining as a main source of economic income include Nauru, Papua New Guinea, and New Caledonia. In addition, sugarcane processing is the key industry of Fiji (MFA, PRC, n.d.). In Tonga, agriculture and fisheries combine to provide the majority of foreign exchange earnings (MFA, PRC, n.d.).

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Attracting external investment

Far away from the centre of world economic development and constrained by expensive transportation and specialized resources, South Pacific island economies generally suffer from slower development. Since the 1960s, when South Pacific island states emerged from their colonial past as independent economies, they have relied mainly on farming and the export of tropical cash crops grown on plantations. After independence, these isolated economies found it difficult to attract external technical skill. Therefore, industrial and agricultural production of most economies in the region is extremely underdeveloped. Agricultural production in some economies still remains at the subsistence level. Major industrial products and even grain are mostly imported. Some economies don't even produce food or vegetables for their own consumption. For instance, Nauru has very limited amounts of agricultural produce and nearly all its food and drinking water is imported; the Marshall Islands needs to import food; Tuvalu almost has no industry; agriculture in Micronesia is heavily dependent on climate conditions; Kiribati does not have any grain crops or vegetable farming; and the industry accounts for only 5% of the national GDP of the Solomon Islands (MFA, PRC, n.d.).

The rural population on the Solomon Islands, who mainly engage in crop farming, accounts for over 90% of the nation's total population and agricultural income makes up 60% of the country's GDP (MFA, PRC, n.d.). In addition, the manufacturing industry in these economies has an extremely weak base. For instance, the Solomon Islands relies on imports for most of its manufacturing and fossil fuels; Vanuatu has only a small level of production of food, wood products, and soap; Micronesia has practically no manufacturing; and the Marshall Islands, Tuvalu, and Kiribati need to import most of their industrial products. Although there are recent signs of improvement, several of the South Pacific island economies are listed among the world's least developed countries. For instance, the United Nation's Least Developed Countries Report 2018, issued by the United Nations Conference on Trade and Development, listed Kiribati, the Solomon Islands, Tuvalu, and Vanuatu among the group of least developed countries (UNCTAD, n.d.).

Volatile economic development

South Pacific island economies generally have small populations. With the exception of Papua New Guinea (8.08 million), Fiji (approximately 900,000), and the Solomon Islands (approximately 600,000), most of the other island economies in the region have populations ranging from only 10,000 to 100,000. Based on 2016 data, in terms of economic volume—except for Papua New Guinea, Fiji, and the Solomon Islands whose GDP stood at USD 19.905 billion, USD 4.67 billion, and USD 1.3 billion, respectively—these other island economies have annual GDPs of only a few hundred million dollars

TABLE 3.4: Annual GDP of each economy (USD 100 million)

Economies	2013	2014	2015	2016	2017
Papua New Guinea	212,61	230.6	206.39	199.05	–
Fiji	41.9	44.83	43.62	46.71	50.61
Solomon Islands	11.3	11.7	11.55	12.33	13.03
Vanuatu	8.01	8.14	7.37	7.87	–
Samoa	8.04	8.03	8.03	7.86	–
Tonga	4.50	4.43	4.35	4.01	4.26
Tuvalu	3.75	3.72	3.55	3.65	–
Micronesia	3.16	3.17	3.15	3.29	3.36
Palau	2.25	2.45	2.93	3.02	2.92
Marshall Islands	1.90	1.83	1.79	1.94	–
Kiribati	1.87	1.78	1.69	1.81	1.96

Source: The World Bank.

each. The Marshall Islands and Kiribati, with the smallest economic volume, only have a GDP of USD 194 million and USD 181 million, respectively (GDP of each economy found in Table 3.4). For such a small market, it is difficult to drive economic development primarily through domestic demand. Any changes in external markets will have a major impact on its development and lead to a roller-coaster growth trajectory. Take Palau as an example: its economic growth rate reached 4.234%, 9.384%, and 5%, respectively, in 2014, 2015, and 2017. But growth rates in 2013 and 2016 were -2.409% and 0, respectively. Vanuatu saw a 4% and 4.5% growth rate in 2016 and 2017, respectively, but in 2015 it dropped to as low as -0.801% (see Table 3.5).

TABLE 3.5: Growth rate of South Pacific island economies

Economies	2013	2014	2015	2016	2017
Papua New Guinea	–	–	5.3	1.9	-1.7
Solomon Islands	2.95	–	3.734	3.5	3.2
Fiji	3.47	–	3.6	0.4	3.8
Vanuatu	1.969	2.331	-0.801	4	4.5
Samoa	-1.931	1.196	1.635	3.015	1.509
Kiribati	5.782	2.409	3.497	3.075	2.479
Tonga	-0.566	2.897	3.412	2.726	2.441
Micronesia	-3.562	-3.403	-0.165	1.054	0.722
Palau	-2.409	4.234	9.384	0	5
Marshall Islands	-1.074	0.398	1.379	1.745	1.75
Tuvalu	1.292	2.236	2.642	3.952	2.268

Source: The World Bank.

Heavy reliance on external aid

Poor economic development has resulted in insufficient fiscal revenues in most economies. Some island economies rely on long-term foreign aid to make up for their fiscal deficits. For instance, in 2017, Papua New Guinea had USD 3.567 billion of fiscal revenue and USD 4.123 billion of expenditure, running a deficit of USD 556 million (MFA, PRC, n.d.). In fiscal year 2017/2018, Papua New Guinea received AUD 546 million of aid from Australia alone (MFA, PRC, n.d.). In fiscal year 2016/2017, the estimated foreign aid in Tonga and Samoa was respectively USD 88.17 million and 1.569 million (MFA, PRC, n.d.), and Tonga was listed as a “high risk” country by the World Bank. Foreign aid that Vanuatu and the Marshall Islands receive annually accounts for, respectively, 17% of Vanuatu’s GDP annually and more than 60% of the financial budget of the Marshall Islands (MFA, PRC, n.d.). The Cook Islands received aid from New Zealand and Australia totaling NZD 19.3 million and AUD 3.4 million in the fiscal year 2016/2017, respectively (MFA, PRC, n.d.). In addition, according to the Compact of Free Association between the Federated States of Micronesia and the United States renewed in 2003, Micronesia will receive a total of around USD 1.85 billion in aid from the United States from 2003 to 2023 (MFA, PRC, n.d.).

MAJOR CHALLENGES

Due to their geographical location, South Pacific islands are especially prone to natural disasters such as earthquakes, hurricanes, and storm surges. Excess human activities have also exacerbated ecological degradation. Lacking in human capacity and financial resources, these island states find it difficult to implement national or regional resource conservation and management measures, consequently endangering sustainable management on natural resources. Regional political instability, along with major flaws in administrative mechanisms and governance capacity, has rendered these economies particularly vulnerable to natural disasters. Ecological degradation and natural disasters have posed a serious threat to the very survival of some island economies.

Impacts of global warming and rising sea levels

In recent years, the build-up of human-induced greenhouse gases has resulted in rising sea levels and shrinking land area on these islands, posing a threat to their very survival. According to the IPCC Fifth Assessment Report (IPCC, n.d.), the global average and combined land and ocean surface temperature show a



The Samoan islands were battered by a tsunami in 2009.

warming of 0.85 (0.65 to 1.06) °C in the period 1880 to 2012. The Arctic sea ice shrank at an average rate of 3.5 to 4.1% every ten years in the period 1979–2012 (0.45 to 0.51 million km² every ten years). Global average sea level rose at an average rate of 1.7 (1.5 to 1.9) millimetres per year in the period 1901–2010, 2.0 (1.7 to 2.3) millimetres per year in the period 1971–2010, and 3.2 (2.8 to 3.6) millimetres per year in the period 1993–2010. By the end of 2100, global average sea level is predicted to rise by 0.52 to 0.98 metres. The average elevation of many Pacific islands is generally very low. For example, the land area of the Marshall Islands, most islands in Micronesia, the Gilbert Islands, the Phoenix Islands, and the Line Islands of Kiribati and Tuvalu are between 3 and 5 metres above sea level. At this rate, many islands in the South Pacific island economies will be inundated. Mr. Tavalakate—Chief Forecaster at the Tuvalu Meteorological Administration—said in an interview that sea levels at Tuvalu had risen by 9.12 centimetres during the 16 years between 1993 and 2009 (Wang, 2009). At this rate, Tuvalu’s sea level will rise by 37.6 centimetres in 50 years, which means 60% of

the country, with a maximum sea level of 4.5 metres, will sink below the sea (Wang, 2009). If the sea level continues to rise at such a rate, other countries and regions with a low average elevation above sea level, such as Nauru, Vanuatu, Eastern Samoa, Tonga,

IF SEA LEVELS CONTINUED TO rise, over 70% of the surveyed households in Kiribati and Tuvalu would consider moving their families overseas.

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and Kiribati, will also be faced with serious threats. According to a Kayodo News report, the United Nations University's Institute for Environment and Human Security showed at the United Nations Framework Convention on Climate Change, COP21 in Paris, that based on a survey of around 7,000 residents in Kiribati, Tuvalu, and Nauru, if sea levels continued to rise, over 70% of the surveyed households in Kiribati and Tuvalu would consider moving their families overseas (Wang, 2015). Although climate change is only one of many factors related to emigration, it should be noted that from 2005 to 2010, 15% and 10% of the respective populations in Tuvalu and Nauru had already moved abroad (Wang, 2015).

Impacts of marine and geological disasters

Situated near the Equator, South Pacific islands are particularly prone to tropical hurricanes and marine storm surges. Disastrous waves and storm surges will sabotage coastlines, ports, dikes, houses, and the ecological environment on the islands, jeopardizing residents' lives and triggering coastline erosion and salt-water intrusion. For instance, large areas of forests in the Samoan Islands were devastated due to the impact of tropical cyclones in 1990, 1991, and 1993 (Cui & Ying, 2016). On 13 March 2015, Vanuatu was hit by tropical cyclone Pam. At least eight people died and 90% of the houses in Port Vila were destroyed (Zheng, 2015). Vanuatu's President Baldwin Lonsdale said in an interview that annual economic losses in Vanuatu as a result of natural disasters were equivalent to 6% of its GDP (Wang, 2015). On 20 February 2016, cyclone Winston slammed into Fiji, causing at least five deaths (Chunmei, 2016). It also disrupted power and communication in many locations, inflicting huge losses on the local economy. Located at the intersection of the Pacific Plate, the American Platen, and the Antarctica Plate, South Pacific islands are also frequently struck by earthquakes and volcanic activities. Due to the special geological formation and topography of islands, strong interaction between land and ocean, and frequent geological activities in the region, these islands are easily affected by geological disasters. Rockslides, landslides, mudslides, and other disasters triggered by earthquakes and volcanic eruptions are detrimental to the landform, vegetation, and facilities on the islands. South Pacific



Flooded land in Fiji

islands are also frequent victims of earthquakes and tsunamis. About 80% of the world's earthquakes and tsunamis happen in the Pacific arc-trench areas (Yang & Wei, 2005). In the Pacific Ocean, there is a level-4 earthquake-tsunami with a maximum surge of 20 metres every ten years, a level-3 earthquake-tsunami with a maximum surge of 10 metres every three years, a level-2 earthquake-tsunami with a maximum surge of 5 metres every year, and four level-0 earthquake-tsunamis with a maximum surge of one metre every year (Yang & Wei, 2005). According to media reports, on 30 September 2009, the Samoan Islands was hit by a severe earthquake measuring 8.0 on the Richter scale, which triggered a 4.5-metre tsunami and caused at least 113 deaths. Several villages and holiday resorts were devastated (Wang, 2009).

Effects of environmental pollution and resource degradation

There are multiple reasons for extreme environmental pollution in South Pacific Island economies. First, South Pacific islands constitute a vital communication line connecting Asia, Oceania, and the Americas, and comprise an important fishing area in the world; thus it is easily prone to pollution damage from oil spills and waste dumping from ships and fishing boats. Second, island tourism is an important driver for

socioeconomic development in South Pacific island economies; therefore the construction of tourism facilities might erode island topography, invade habitats, and cause biomass losses. For instance, Vanuatu and Fiji have severely damaged the ecosystems in mangroves and estuaries through deforestation and reclamation for the purpose of tourism (Lu, 2007). Third, due to limited land area, these islands lack the space and facilities to dispose of domestic and industrial solid wastes, thus causing harm to the ecological environment. Fourth, the exploitation of mineral resources seriously strains the ecological environment. In Nauru, for example, trees and plant wastes are burned in landfill zones during the exploitation of phosphates, and topsoil is not replaced. Such an irresponsible approach has wreaked havoc on the ecological environment. Fifth, it is hard to clear up the pollution resulting from nuclear tests carried out by western powers in the Pacific region. Statistics suggest that from the 1940s to the

1990s, the United States conducted 23 and 43 nuclear tests on the Bikini Atoll and Eniwetok Island of the Marshall Islands, respectively, and the pollution and damage from the tests still remain a serious problem to the local environment (Xu, 2003).

PROBLEMS AFFLICING South Pacific island economies, including pollution of the marine environment, abuse of marine resources, fragile natural environments, and vulnerability to natural disasters, have drawn close attention from other islands and the international community.

Despite rich fishing resources in the South Pacific island economies, interest-driven local fishermen have adopted unsustainable ways of operation. They use boats with large power engines to maximize the catch; fishing methods have changed from traditional free diving to diving with the assistance of underwater breathing apparatuses; they fish through destructive means, such as the use of explosives and toxicants, and through gill nets and other damaging tools. Such ways of operation have led to severe degradation of local fishing resources.

Moreover, most economies in the region do not have armed forces, and their police forces are rather weak. For instance, there are only about 100 police officers in Nauru, 110 in the Cook Islands, 300 in Kiribati, and 400 in Tonga (MFA, PRC, n.d.). Economies with stronger enforcement, such as Samoa and the Solomon Islands, only have about 500 and 800 police officers, respectively (MFA, PRC, n.d.). Therefore, despite the existence of a licensing system for foreign fishing boats, it is difficult for the South Pacific island economies to exercise effective control over environmental pollution and illegal fishing given the hundreds of thousands or even millions of square kilometres of sea area under their jurisdiction.

MAJOR RESPONSE MEASURES FROM THE INTERNATIONAL COMMUNITY AND SOUTH PACIFIC ISLAND ECONOMIES

Problems afflicting South Pacific island economies, including pollution of the marine environment, abuse of marine resources, fragile natural environments, and vulnerability to natural disasters, have drawn close attention from other islands and the international community.

The United Nations Conference on Trade and Development in 1972 specifically addressed the unique problems facing island developing countries for the first time (Qi et al., 2013). To advance the interests of small island residents, the first Global Conference on the Sustainable Development of Small Island Developing States was held in Barbados in 1994, which adopted the Barbados Declaration and a Programme of Action for the Sustainable Development of Small Island Developing States. The International Meeting to Review the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States was held on 10 January 2015 in Mauritius to discuss such issues as global warming, rising sea levels, environmental pollution, and sustainable development. It also sought international aid to prepare for such natural disasters as earthquakes and tsunamis. A dedicated UN fund was set up on 15 February 2008 to help small island states address the impact of climate change on their social and economic development. The government of Greece provided one million Euros as a start-up fund (Qi et al., 2013). Private academic groups have also intensified research on island issues. Since 1986, the International Small Islands Studies Association has hosted a biennial academic conference to discuss common environmental problems and response strategies of island states and jurisdictions (Qi et al., 2013).

Regional cooperation

Pacific island economies depend heavily upon fishing resources as a major source of income and an important guarantee of food security. Tuna is the most valuable fishing resource for most Pacific island economies. In recent years, tuna resources have witnessed a declining trend due to overfishing, which poses a serious threat to the sustainable development of the major fish resources in the region. To protect and sustainably develop fishery resources, Micronesia, the Marshall Islands, Kiribati, Nauru, Palau, Papua New Guinea, and the Solomon Islands signed the Nauru Agreement in 1982 and the Palau Agreement in 1992 on coordinated management of purse seine fishing in the Western and Central Pacific. The agreements stipulate that the total number of foreign purse seine fishing boats in the region should not exceed 205 and quotas are allocated to each country (Wang & Wu, 2014). On 23 April 2010, it was announced at the Conference of Parties to the Nauru Agreement held in the Marshall Islands that starting 1 January 2011, purse seine fishing of tuna is prohibited in the 4.555 million km² of sea area between 10°N-20°S and 170°-150°E (MFC, PRC, n.d.). An observer

mechanism was instituted by relevant countries to supervise the fishing ban. Parties to the Nauru Agreement also stipulate that fishing boats are prohibited from using fish-aggregating devices for three months a year. Dedicated bodies such as the Pacific Islands Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Community (SPC) provide technical consulting, professional services, and support for the parties.

Improved environmental protection mechanisms

The Solomon Islands has made offshore fishery and marine resource management a national strategy. Given the fact that tribes and clans are in charge of land and sea areas, the country adopted a community-based approach in the management and utilization of marine resources. For instance, Tetepare Island established the Tetepare Descendants Association (TDA), the largest association of island owners in the Solomon Islands, to protect resources and the environment on the island through management plans to ban development of Tetepare Island and its water resources. A TDA patrol was also formed to monitor resource development on the island.

In 2015, Fiji launched the Green Growth Framework to protect its primeval natural environment. In addition, the Fiji government also called on tourism organizations

around the world to raise the environmental awareness of tourists in collaboration with Tourism Fiji, so that tourists could have a better knowledge and understanding of the country and learn to respect and protect the local natural environment while appreciating its beauty. In order to protect the marine ecosystem, enable fish stocks to grow and reproduce, and to bring the coral reefs back to life, the Fiji government has made the commitment that, by 2020, with the World Wildlife Fund (WWF) support, it will establish the world's largest management network of marine protection zones in 30% of its sea areas.

Palau established a national marine protection zone in 2015, becoming the first country in the world to set up a shark protection zone in the national sea, and the first to ban bottom trawling. With the increase of inter-

national tourists, in order to prevent Palau's pristine environment and culture from being damaged by tourists' negligent behaviours, the Palau government introduced the Palau Pledge on 8 December 2017, which stipulates that all tourists, before entry, must make a pledge to protect the ecology. Palau's immigration officials will stamp the "Palau Pledge" on the inner pages of all foreign visitors' passports upon entry. Only those who express a commitment to local ecological protection, with their signatures, are allowed to enter the country. Moreover, the Palau government has developed policies to penalize violators who may face a maximum fine of one million dollars.

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Wooden pier at Savusavu Harbour, Vanua Levu Island, Fiji

CONCLUSION

Far away from the centre of world economic development, South Pacific island economies, with their small land territories and vast sea areas, suffer from uneven distribution of resources, specialized economic structures, and great economic and ecological vulnerability. Accelerated development of marine resources may compensate for the lack of terrestrial resources and drive economic growth. But taken too far, it will cause irrevocable harm to the weak ecological environment and forestall sustainable development of the economy. Therefore, these island economies should prioritize an inclusive development strategy to foster the circular economy and green industries. Environmental issues, for all their complexities and interconnectedness, require extensive and inclusive participation to form a strong synergy. For instance, global warming and rising sea levels cannot be effectively addressed through the efforts of a single state or jurisdiction; only collaboration within the international community will work. Ecological problems within individual economies can only be fixed through a series of measures including stronger legislation and industrial restructuring. Although South Pacific states have had challenges in developing their economies, regional economic integration, trade connectivity, and stronger communication can promote resources complementarity among the economies and boost faster development. At present, due to a severe shortage of funds, technology, and human capacity, South Pacific island economies lack drivers for endogenous growth. It is therefore critical for them to enhance their cooperation with countries outside the region.

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