

Sustainable Small-scale Mariculture Ventures as a Comparative Climate Friendly Livelihood Alternative in Pohnpei, Federated States of Micronesia

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Abstract Like most Pacific island nations, the Federated States of Micronesia (FSM) faces threats to livelihoods, food security, and health from the impacts of climate change. The island of Pohnpei faces specific climate related threats linked to over fishing, sedimentation from deforestation, and a poorly developed economy, which restricts rural residents access to livelihood alternatives. With assistance from the Pacific American Climate Fund (PACAM); and funding from United States Agency of International Development (USAID), the Marine and Environmental Research Institute of Pohnpei (MERIP) is more than half way through a three-year program to reduce climate impacts in Pohnpei. The project goal is to reduce vulnerabilities associated with climate change faced by Pohnpei's coastal communities, inshore reefs and Marine Protected Areas (MPA). One of the primary strategies employed is reducing dependency on fishing and unsustainable farming practices by increasing number and sizes of aquaculture farms growing sponges and marine ornamentals. Engaging rural fishers and farmers in alternative livelihoods will reduce pressure on natural resources and make communities less vulnerable to the effects of climate change on these resources over time. This paper examines the benefits and constraints of the introduced livelihood alternatives—farming of sponges and marine ornamental invertebrates and their impact on traditional fishing activities. In addition, comparisons are made with the growing of *Piper methysticum*, or sakau, a narcotic root crop. Growing of sakau is Pohnpei's most widespread, but comparatively environmentally destructive, form of rural income generation and is widely recognized as the main cause of the islands upland deforestation and resulting lagoon sedimentation. Results show that growing the new adaptive commodities provide similar or greater incomes than the less climate friendly traditional activities of fishing or growing sakau. However, expansion of these activities or additional livelihood alternatives need to be developed, to further reduce environmental degradation.

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Introduction

The geographic focus of this project is Pohnpei Island in the Federated States of Micronesia (FSM). The FSM has a vast ocean EEZ (2.9 million km²) but only 700 km² of landmass. Pohnpei is the capitol island of the FSM with 35,000 residents and Pohnpei Island is the third largest island in Micronesia. Per capita GDP is a low USD3000 (192nd in the world) while unemployment is 16.2% (CIA World Factbook 2016). The FSM is an extremely difficult place to do business, and this has dire effects on the less educated and fortunate members of its society. The World Bank ranks the FSM as fourth from last out of 26 East Asian and Pacific Island nations in ease of doing business and 152nd in the world, out of 190 nations (World Bank 2017). Poor governance and immense geographical separation are the primary contributors to this status, a problem shared by many small-island developing states, or SIDS. The FSM ranks particularly badly in the following categories: registering property; protecting investors; enforcing contracts and resolving insolvency. Economic development lags far behind the latent potential of their aquaculture, agriculture and agro-forestry resources and skills. Manifold factors affect commercial business development in these islands, including: non-Western values; geographic separation; poor infrastructure and transportation; and poor business and technical capacity. Climate change is likely to drive per capita GDP lower when compounded with these development constraints.

The lack of income earning opportunities for coastal communities relegates many members of society to a semi-subsistence lifestyle with almost no access to the cash economy other than fishing and farming. The result has been increasing pressure on inshore fisheries leading to declines in fish stocks (Rhodes and Tupper 2007; Rhodes et al. 2008; Hopkins and Rhodes 2010; Rhodes et al. 2016) and increasing concerns about food security. In a household survey of fishing communities around Pohnpei (Hopkins and Rhodes 2010) the mean number of people per household were 8.3 while only 1.4 people per household were employed in any way. A preliminary follow up report, on their initial market survey in 2006, by Rhodes et al. (2016), showed sharp declines in diversity of species caught and a shift toward catching fish which feed in the lower trophic levels, both indicators of over fishing.

Climate change is an increasingly growing threat to livelihoods in Pohnpei and the FSM. According to predictions from the Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAPP 2015) there is a very high statistical confidence of increases in the following climatic areas, by 2030, for the FSM: surface air temperatures; sea surface temperatures; annual and seasonal rainfall; intensity and frequency of extreme heat days; intensity and frequency of extreme rainfall days; ocean acidification; and mean sea level rise. Incidence of drought and tropical cyclones are not predicted to increase and may even decrease but may be more severe when they occur. The Secretariat of the Pacific Community (Bell et al. 2011) also predicts that these changes will lead to a 40% decrease in coral cover and 65% decrease in fish abundance and diversity by 2100. Given the

already decreasing fish stocks in Pohnpei, from overfishing, it will be key for coastal communities to have viable options to fishing, and a robust and healthy marine environment, to build resiliency to the effects of climate change in the coming years.

One particular threat to Pohnpei's environment is farming *Piper methysticum*, a root crop with narcotic properties, known locally as sakau, but better known globally as "kava". This root based drink is enjoyed in many areas of the Pacific such as Fiji, Vanuatu and the US state of Hawaii. Kava or sakau is a significant plant for the people of Pohnpei (Scrimgeour and Gallen 2003). It is used in ceremonial feasts, settling of family disputes, and more recently as a recreational pastime where people gather to drink and exchange news. The latter activity has led to a large increase in sakau cultivation around the island. Traditionally, sakau is planted in upland forests, which are cleared for growing the crop. So intense is the demand for sakau that between 1976 and 1996 the upland forests of Pohnpei shrank by 42% to just 15% of the total land area of the island (Trustum 1996). Introduction of alternative methods for growing sakau in the lowlands and the establishment of a watershed line protecting the upland forest in some of Pohnpei's municipalities has slowed the rate of deforestation (Dahl and Raynor 1996). In municipalities where the watershed line was not implemented, deforestation continues and the demand for sakau continues to grow (Jasmine Mendiola, personal communication). Most farmers still prefer to plant in upland areas due to a lower incidence of insect pests and a higher potency end product (Merlin and Raynor 2005). This deforestation often results in landslides and soil erosion (Victor et al. 2006) with subsequent sedimentation of rivers, mangroves and inshore coral reefs. This has led to substantial coral mortality in the lagoon (Victor et al. 2006), impacting fisheries habitat. The combination of forest clearing and sedimentation makes the upland growing of sakau the most environmentally destructive activity in Pohnpei, and one of the most destructive activities for inshore fisheries. The cultural and recreational importance of sakau combined with a high local and foreign demand is a major hindrance to establishing more environmentally sustainable alternative livelihoods in Pohnpei.

Since 2005, the Marine and Environmental Research Institute of Pohnpei (MERIP) has been working with coastal communities in Pohnpei to develop alternative income generating forms of aquaculture and to protect their fish stocks through community-based marine protected areas (MPA's). MERIP works with rural fishing communities based around five Marine Protected Areas (MPA's) in Pohnpei, to promote marine conservation and climate change adaptation through coral, giant clam and sponge farming. The premise behind these activities is that engaging communities will reduce stress on over exploited inshore fisheries and upland forests and will also make communities less vulnerable to the effects of climate change in the long run. Corals and giant clams are grown for export to the marine ornamental trade while sponges are grown for export to the bath and beauty industry. All methods of rearing are highly sustainable and have very low impact on the environment. Communities learn about marine and coral conservation and make income from selling their products. Only community members that have engaged seriously with protected areas and other conservation activities are invited to

become part of the farming program. In addition, the links between farming opportunities and MPA and marine conservation are also stressed during community meeting so that people are aware of the origin of the opportunity being presented. Income from sales of products stimulates the communities to fish less and to respect the MPA regulations. MERIP has been very successful in developing export markets for products being farmed and presently exports to more than 10 locations globally. Since 2015, MERIP has been receiving support for these activities from the Pacific American Climate Fund (PACAM) with funds originating from the United States Assistance for International Development (USAID). One of the main purposes of this grant is to increase the number of people on Pohnpei engaged in climate friendly aquaculture activities in the form of giant clam, coral and sponge farming. Using PACAM funds MERIP has expanded the number of farmers engaged in sustainable aquaculture practices to 63 individuals.

This paper examines the climate change adaptation benefits and constraints of the introduced livelihood alternatives—farming of sponges and marine ornamental invertebrates. In addition, socioeconomic comparisons are made with inshore fishing and the growing of sakau.

Methods

MERIP employs the nucleus estate model for working with local farmers for farming all the commodities grown. The farmers receive all materials and assistance necessary to start their farm at no cost. In return they receive a lower price for their harvested products. MERIP also maintains central farms for some of the commodities grown which guarantees throughput and provides a place to conduct applied research on new species and farming techniques. Post-harvest handling, marketing and export also take place through MERIP. Descriptions of farming methods are as follows.

Sponge Farming

Farmers currently grow two species of natural sponges for the bath and beauty trade—the Micronesian wool species (*Cosinoderma matthewsi*) which is used for body bathing and the smaller, softer *Spongia matamata* used primarily for facial cleaning. Wool sponge and facial sponge farming is based on sustainable fragmentation of sponge explants (Ellis et al. 2005). Farms are started using wild collected broodstock colonies, which are sustainably collected by cutting just the top half of the sponge and leaving the bottom half to regenerate. Farmers then set aside one third of their explants for grow-out as future cutting stock. Farm structure is simple, consisting of submerged mainlines 6 mm in diameter that are anchored to rocks some 2–3 m below the surface. Mainlines are generally about 30 m long and

the farm may be made up of anywhere from 2 to 5 mainlines. Lighter grow-out lines are then strung perpendicular to the mainlines about 1.5 m apart. Onto these grow-out lines, explants are individually hung about 30 cm apart. The mainlines have sufficient slack to allow them sag about 8–10 m below the surface, also allowing them to also be raised close to the surface using floats so that the farmers can work without repeated free diving. Sponge farms need intermittent cleaning approximately every 4–6 weeks and grow-out time is about 2.5 years for the wool sponge and 9–12 months for the facial sponge. Processed sponges are sold to a variety of customers primarily in New Zealand, the United States, Australia, Singapore, Malaysia and Hong Kong. Sponges are sold without any chemical whitening and most customers are retailers of eco-friendly products.

Coral Farming

Farmers currently grow 31 species of hard and soft corals for export to the marine ornamental trade. All corals are grown using sustainable fragmentation techniques. Broodstock colonies are started from wild collected stock and explants are then sustainably cropped from these colonies. Grow-out time ranges from 2–6 months depending on the species being grown and the corals require very little maintenance during that time. Corals are grown on metal tables equipped with steel mesh trays or flat plastic mesh sheets, which house the explants. The tables are placed at a depth of 3–7 m depending on the site location and the species being grown. Harvested explants are exported live to two wholesalers in the region, one in Kosrae, FSM, and one in Majuro, Republic of the Marshall Islands. These wholesalers then combine these products with their own for further export, primarily to the United States and European Union. MERIP handles all export of products from Pohnpei.

Giant Clams

One species of giant clam is raised for export, the colorful *Tridacna maxima*. This species does not grow much larger than 40 cm in the wild and has a minimum market size for the marine ornamental trade of just 4–5 cm. *T. maxima* are spawned at the MERIP facility and larvae reared to a size of 2 cm using raceways receiving flow-through seawater. At a size of about 2 cm the clams are allowed to attach to concrete plates for lagoon-based grow-out. The concrete plates are placed into plastic cages designed primarily for grow-out of edible oysters in Southern Australia. These cages are resistant to almost all giant clam predators except for the Ranellid snail *Cymatium spp.*, which settle onto the clams from the plankton. Cages are placed on metal trestles in the lagoon in about 2–3 m of water so the clams receive sufficient sunlight. To reduce predation from *Cymatium* snails the cages and clams must be cleaned and inspected every 3 weeks. Grow-out time, in the lagoon,

for the *T. maxima* ranges from 6–9 months. The giant clams are exported live to the same wholesalers in Kosrae and Majuro for onward shipping to markets in the United States and European Union.

Data regarding number of hours worked by farmers was collected from interviews with MERIP extension agents and farmers themselves. Income earned by farmers was collected from records of payments by MERIP to farmers over a two-year period from January 2015 through December 2016. Information on farmer's other livelihood activities and perceptions on conservation and the marine environment were gathered from socioeconomic surveys conducted in May 2016.

Limitations

Grow-out methods for sponges and corals are well understood, as these commodities have been adopted by farmers since, or before 2010. Research by MERIP on lagoon culture methods for the giant clam, *T. maxima*, has been ongoing for a number of years but only carried out by local farmers since 2015. Therefore, results for this commodity may not be as robust as for the sponges and corals, which have been established for much longer. Data for farmers engaged for less than 6 months was not included in the data analysis.

Results

Income and Time Commitment

Monthly earnings (USD), number of months engaged, and earnings per hour (USD) for the four main commodities being farmed (giant clams, hard corals, soft corals and sponges) are presented in Table 1.

Soft and hard coral farmers had the highest monthly income of all the commodities. However, mean monthly income was almost twice as high for soft coral farmers at \$83.81 than hard coral farmers at \$43.21. Sponge farmer and giant clam farmer incomes were approximately a quarter of soft coral farmers and half of hard coral farmers at \$24.65 and \$16.95 respectively. When hourly income was calculated hard and soft coral farmers had similar incomes at \$7.23 and \$8.38 respectively. Likewise sponge and giant clam farmers had similar hourly incomes of \$3.08 and \$2.83 respectively, but these returns were both less than half of the coral farmers.

Mean number of hours worked monthly by farmers was highest for soft coral (10 h) and sponge farmers (8 h). Hard coral and giant clam farmers worked lower hours at 6.2 and 6 h/month respectively. Mean engagement time of hard coral, soft coral and sponge farmers were similar ranging from 15.22 to 17.53 months. Giant clam farmer average engagement time was lower at a mean of 12.85 months.

Table 1 Income and time commitment data for farmers engaged in mariculture activities in Pohnpei, FSM (n = number of farmers)

	Commodity			
	Giant Clams (n = 10)	Hard Corals (n = 12)	Soft Corals (n = 16)	Sponges (n = 14)
Average Number of Hours Worked Monthly	6	6.2	10	8
Mean Monthly Income (\pm St. Dev.)	\$16.95 \pm 10.34 Range \$6.35–\$38.18	\$43.21 \pm 25.78 Range \$21.42–\$102.77	\$83.81 \pm 36.82 Range \$11.11–\$134.78	\$24.65 \pm 10.44 Range \$7.77–\$42.57
Mean Hourly Income (\pm St. Dev)	\$2.83 \pm 1.72 Range \$1.06–\$6.36	\$7.23 \pm 2.53 Range \$4.29–\$15.36	\$8.38 \pm 3.68 Range \$1.11–\$13.48	\$3.08 \pm 1.31 Range \$1.55–\$4.52
Mean Number of Months Engaged in Farming (\pm St. Dev)	12.85 \pm 5.02 Range 7–20	15.22 \pm 6.48 Range 7–24	17.53 \pm 5.44 Range 7–24	16.93 \pm 7.11 Range 6–24

Socioeconomic Data

A total of 38 aquaculture farmers were interviewed in May 2016 to gather data on their sources of income, livelihood activities and outlook on fisheries/coral reef conservation.

Following are the main outcomes of the surveys:

- There were 16 coral farmers, 13 sponge farmers and 9 giant clam farmers interviewed
- Mean number of people per farmer household was 7
- Primary occupations of aquaculture farmers are: farming sakau and other crops—42%; fishing—38%; paid employment—9.3%; home maker 10.7%
- Since starting aquaculture farming: 66% fish less; 17% fish about the same; and 17% fish more
- 60% of respondents claimed aquaculture farming had brought about the change in their fishing habits
- 75% of respondents felt it was harder to catch fish than in the recent past
- 70% of respondents felt fish are smaller than in the recent past
- 100% of respondents felt having a marine protected area was important and that fisheries management was essential to a healthy future
- 97% of respondents felt that coral reefs are important in protecting the land from storm activity.

Discussion

The main point of discussion of this paper is the efficacy of sponge, coral and giant clam farming as climate friendly adaptations and alternatives to fishing and sakau farming. In terms of income, corals present the best option for farmers with an annual income of between \$500–\$1000. Sponge and giant clam farming are less attractive with an annual income of \$200–300. However, it should be noted that none of these activities take up more 12% of a typical working week of 40 h. In Pohnpei, as in many areas of the Pacific and developing world, many rural residents do not have a full-time occupation but rather subsist or make income from a range of different activities. In this regard, climate friendly aquaculture farming is an ideal alternative to provide a supplemental income, or in some case a replacement income, for rural residents of Pohnpei.

Average earnings per hour for all the new commodities are above the Pohnpei State minimum wage of \$1.75 per h. For coral farmers, average earnings per hour are more than 4 times the minimum wage of \$1.75. Estimated annual income from fishing in Pohnpei was estimated in 2011 to range from \$535 to \$780 (Jeff Kinch personal communication) and fishers on average worked 1.8 days per week on this activity (Hopkins and Rhodes 2010). This equates to an hourly income of \$0.71 to \$1.04, much lower than even the giant clam farmers in this study, who earn \$2.83 per h.

It is harder to get an estimate of average income for sakau farmers as the industry is very informal and many people only grow sakau for personal consumption and cultural purposes. In 1996, it was estimated that more than 450,000 kg of sakau, worth around \$3 million, entered the commercial economy in Pohnpei (Merlin and Raynor 2005) and that around 4000–5000 people were engaged in the industry by the year 2000 (Merlin and Raynor 2005). Extrapolating these numbers indicates that average annual income per farmer would be around \$600–\$750. In a 2003 study of the use value of forests in Pohnpei, Scrimgeour and Gallen estimated that households from two typical villages in Pohnpei spent an average of 18 h per month in the forest looking for land and planting and tending to sakau. This equates to an hourly income of between \$2.78 and \$3.47. This is much higher than fishers or the Pohnpei state minimum wage but only equivalent to giant clam and sponge farmers, but much lower than farmers who grow corals.

Average annual per capita income for Pohnpei was \$2093 in 2005; the last time a household survey was conducted in the FSM (FSM 2005). However, farming and fishing tend to be the occupation of members of society with lower levels of education and less opportunity so annual incomes of less than \$1000 are to be expected. Scrimgeour and Gallen (2003) stated, “most of the (sakau) farmers are young without any formal education”. This is also indicated in the FSM Household Income Survey of 2005 where 33% of households in Pohnpei had per capita income of less than \$1300 (FSM 2005). The same survey also showed data that per capita income dropped as the number of people per household increased. The mean number of people per household of sponge, giant clam and coral farmers is seven.

It is clear that in terms of hourly income rates, sponge, giant clam and coral farming can provide an equivalent or greater income to people engaging in the more environmentally harmful activities of fishing and sakau farming. However, to date only 63 farmers have been engaged in farming of these climate friendly commodities. By comparison estimates of sakau farmers in Pohnpei ranges from 4000–5000 (Merlin and Raynor 2005) and fishers who sell at least a part of their catch from 2500–3000 (Hopkins and Rhodes 2010). Constraining the growth of these climate friendly sustainable commodities is the demand for corals and giant clams and the need to upscale production of sponges. Giant clam and coral demand from Pohnpei, based on MERIP exports, are estimated at approximately 1000 and 2000 pieces per month respectively. Corals exports from MERIP averaged 2150 pieces per month during the calendar years of 2015 and 2016. Giant clam farming demand has not yet been met and could be as high as 1000 pieces per month (Jacob Applebaum and Martin Selch personal communication). Because of this the number of giant clam and coral farmers is unlikely to increase by more than 10 individuals in the coming 2–3 years. Demand for sponges on the other hand, remains high and more farmers could be engaged. Farm production of sponges could expand greatly. In 2015 and 2016, 3867 sponges were exported by MERIP. ClearSight Consultants, MERIP's biggest customer for sponges, based in New Zealand, estimated just their demand for sponges to exceed 18,000 pieces per year (Carina Sim-Smith personal communication). It is estimated a further 20–30 sponge farmers could be engaged before market demand was met. In total a maximum number of around 100 farmers could be engaged for these 3 commodities.

Socioeconomic data gathered from interviews in 2016 show that there is an impact in reduced fishing and increased income among aquaculture farmers, although no data was collected on the impact on sakau farming. In addition, aquaculture farmers displayed a good understanding of environmental issues through training they had received from MERIP staff during semi-annual meetings held during 2015 and 2016.

The value or gaining qualifications, either formally or informally, as a means of adapting to, and reducing vulnerability to, climate change is clearly demonstrated by the work undertaken by MERIP. Community members who engaged as aquaculture farmers were not only well informed about how the effects of climate change will affect their lives in the future, but are also making valuable income from their activities. Even the lower paying activities of giant clam and sponge farming make approximately the same per hour as sakau farmers and more than fishers in Pohnpei, while coral farmers can make 3–4 times more per h.

Best Practices

Key to the development of new climate friendly economic and livelihood adaptations in Pohnpei and the rest of the Pacific region is adherence to sustainable best practices for development. In the context of this paper it is useful to look at the

lessons learned from a review of government led livelihood diversification projects in the Pacific by Gillett et al. (2008). In this report 22 livelihoods projects, were analyzed for valuable lessons. Many of these findings have been adopted by MERIP and can equally apply to just about any sustainable development project in the Pacific, especially those relating to climate change, as follows.

Strong Private Sector Involvement. MERIP has sought to make strong linkages with private sector wholesalers and buyers. This has helped the development and long-term sustainability of climate friendly aquaculture farming because prices obtained for products are realistic and based on world market prices. This gives the farming operations a much better chance of long-term viability.

Long Term Support by a Local NGO. There is strong evidence that livelihood diversification initiatives that are successful in the Pacific require a long time to achieve profitability and eventual profits are characteristically modest rather than spectacular (Gillett et al. 2008). MERIP has sought not to treat the development of climate friendly aquaculture farming as a “project” but rather a long-term investment toward a more sustainable future. The future of MERIP’s support for the activity is not linked to a finite funding cycle but is ongoing. Additionally, MERIP plays the role of an “honest broker” between private sector interests and the communities. Businesses are generally better than fisheries or other government departments or NGO’s at identifying and/or developing opportunities, but often have difficulties in spreading benefits. They are also better at community relations, hence the need for somebody to smooth the interface between business and community (Gillett et al. 2008).

Community Training, Awareness and Education. Awareness raising on climate change, environmental education and technical training for community members is essential to the long-term success of any climate change adaptive development. Without this, participants will not be able to understand the context of their involvement versus less sustainable activities. In addition, it helps participants to understand their business better and make the link between their own activities and conservation and climate change. Constant communication with the involved communities also helps to dispel mistrust of the intentions of outside assistance providers.

Sustainability and Continuity. Heavily subsidized livelihood diversification activities run the risk of failing once the subsidy is reduced or removed (Gillett et al. 2008). In addition, promotion of climate friendly livelihoods that do not have a plan for transitioning of activities into an entirely local business structure from the outset run this same risk of failure. Therefore, interventions should be planned to slowly transition out subsidies and to ensure local businesses are involved from the outset. Because MERIP is a locally based corporation it can provide both long-term extension and export support to ensure farmers transition smoothly to self-sufficiency over an appropriate time frame.

Conclusions and Future Prospects

The development of climate friendly aquaculture farming has provided a comparative income for 63 rural residents of Pohnpei and a viable alternative to the less environmentally friendly activities of fishing and sakau farming. Coral farming provides an hourly income of 3–4 times that of sakau farming or fishing, while sponge and giant clam farming are provided comparable, or greater, hourly incomes. All the aquaculture commodities provide an hourly income greater than the Pohnpei state minimum wage while allowing farmers to pursue other cultural and subsistence activities.

There is potential for these types of aquaculture to accommodate another 30–40 individuals before market constraints are met. However, the sheer scale of people involved in these less sustainable activities accentuates the need for development of more climate friendly alternatives. In addition, the traditional and recreational demand locally for fish and sakau continue to make them attractive commodities to disadvantaged and less educated members of Pohnpeian society. However, these resource-based activities are increasingly under threat from the combined effects of over exploitation and climate change. Equipping community members with formal or informal qualifications in alternative livelihoods and knowledge of how climate change will affect them, will greatly increase their resilience and reduce vulnerability in the long run.

Lessons learned from this work have broad scale application across the Pacific. In general, there is environmental degradation of some sort and the effects of climate change are reasonably uniform among these tropical and subtropical island nations. In addition, the development and cultural constraints are also fairly constant across the Pacific. Applying some of the best practices learned from this work may assist other organizations working on climate change adaptation and reducing vulnerability in other Pacific Island nations.

Given the predicted changes to Pohnpei's inshore fisheries and forests because of climate change, the need for sustainable alternative livelihoods is greater than ever. Future climate change adaptation projects should therefore focus on providing alternatives to fishing and sakau farming such as niche agriculture products and development of finished, easily exportable high value commodities. In addition, value adding for existing fishery and forest products can help in increasing per unit revenues. The presence of community and environmentally minded businesses or non-state actors with business and marketing capacity can greatly enhance the success of small-scale climate friendly sustainable ventures in the future.

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