Living under the State and Storms: The History of Blood Cockle Aquaculture in Bandon Bay, Thailand

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Bandon Bay, on the east coast of peninsular Thailand, has seen rapid development of coastal aquaculture since the 1970s. It has also seen the emergence of conflict between fishermen and aquaculture farmers over competing claims on marine resources. This article examines the roles of state initiatives, environmental changes, and natural disasters in the development of these conflicts.

Blood cockle aquaculture was introduced to Bandon Bay through state policies that incentivized in-migration and the establishment of "cooperative communities." After significant damage due to natural disasters in the late 1980s, large-scale government-sponsored rehabilitation projects and an associated influx of capital gave aquaculture a "great leap forward." Environmental changes and government policies triggered adaptations by farmers that led to an expansion of cultivation into new—and illegal—areas, and a transformation of cultivation from small-scale to large-scale farms.

The expansion of the aquaculture area brought about conflicts over the use of coastal resources between aquaculture farmers and coastal fishermen. Yet these two communities that had developed from agricultural settlement in the early 1980s had no traditional means of negotiation and bargaining to resolve the conflicts and therefore relied on deep connections to the bureaucratic system rather than relations with each other.

Keywords: coastal aquaculture, Bandon Bay, natural disaster, blood cockle, pollution, climate change

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Introduction

Coastal aquaculture around Bandon Bay, in Surat Thani Province of Southern Thailand, developed in the context of state development projects implemented as part of the government's anti-Communism policies. The government further promoted intensive aquaculture when neighboring countries declared a 200-nautical-mile exclusive economic zone off their coasts at the end of the 1970s.[1] Since then, the Bay has become the main aquaculture area of Thailand and, according to 2000–04 aquaculture production statistics, one of the most concentrated aquaculture areas in Southeast Asia (Campbell 2011, 31). The main products of the Bay can be divided into two groups according to the method and area of cultivation. The first is intensive cultivation of marine shrimp, or prawns, in ponds constructed on land along the riversides and coast. Production depends on these controlled and artificial settings in order to ensure a stable supply for the export market. The second is extensive aquaculture in natural marine settings that relies not only on the local climate and water quality but also on natural food organisms (*ibid.*, 6). In Bandon Bay, this extensive aquaculture includes the cultivation of blood cockles (*hoi kraeng*, *Anadara nodifera*, *Anadara granosa*), oysters (*hoi takrom*, *hoi nangrom*), and green mussels (*hoi maeng phu*).

Pond cultivation of shrimp accounted for more than half of the total aquaculture area in Bandon Bay during 2000–10 (Fig. 1). Blood cockle production was ranked second after shrimp.[2] Unlike shrimp cultivation, which is an export-oriented industry, blood cockles are produced mainly for the domestic market. Although Surat Thani has a significant share of the domestic market, blood cockles are not a major product for the province,[3] and the government does not consider it significant because it is not an export product. As cockle cultivation relies heavily on local climate and water quality, cockle farmers have to adapt farm management to minimize the risks from climate variability and pollu-

1) The exclusive economic zone of India was declared in 1977 (James 2014, 100). The Socialist Republic of Vietnam issued a declaration on its territorial sea, contiguous zone, exclusive economic zone, and continental shelf in May 1977 (US Department of State 1983, 3). The Burmese government declared its territorial sea of 12 nautical miles and a zone of 24 nautical miles in 1977. Burma has also claimed an exclusive economic zone of 200 nautical miles since 1977 (Selth 2001, 5).

2) These official statistics were collected only in the areas legally defined as cultivable and only among registered cultivators, and hence do not reflect the exact situation. In 2009, for example, bivalve mollusk cultivation occupied 11,988 acres in the Bay according to official statistics but 31,685 acres (mostly blood cockle) according to a GIS survey by the Surat Thani Fisheries Office.

3) According to the Surat Thani Province Governor's Office Plan, agricultural products accounted for 30 percent of the province's total production. There are five categories of agricultural products: rubber, 71 percent; oil palm, 17 percent; coastal fisheries, 8 percent; and livestock and fruit, 2 percent (Samnakngan Changwat Surat Thani 2013).

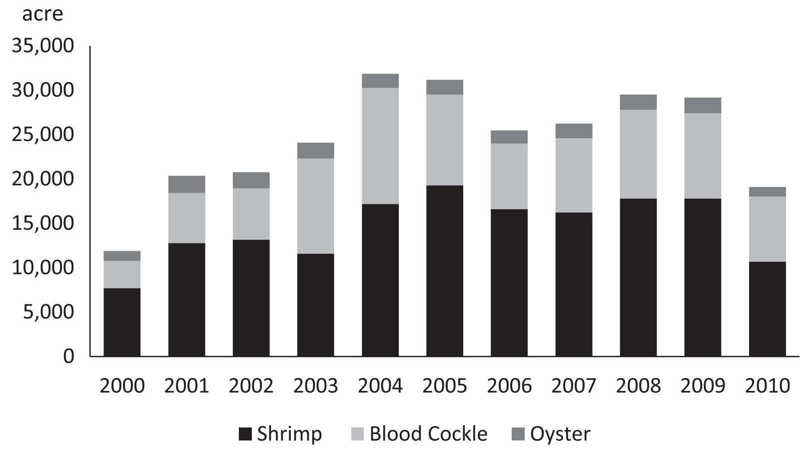

Fig. 1 Cultivation Area by Species in Bandon Bay, 2000–10
Sources: Computed from annual statistics from the Department of Fisheries.

tion. They have expanded their farms 3 kilometers out from the shore into areas outside the zone legally approved by the government. This expansion has challenged the marine usage rights of poor local fishermen, as rich local fishermen are able to illegally convert common marine areas into their own private assets thanks to their political influence. As a result, conflicts between artisanal fishermen and blood cockle farmers over the use of resources have repeatedly erupted in recent years, not only in Bandon Bay but also in the Bay of Pattani and Phetchaburi Province.

Studies on the development of coastal aquaculture in Thailand focus primarily on conflicts over coastal resource management. Thai academicians pay attention to the ways in which sociocultural norms of local communities can enhance the roles of local actors in dealing with resource conflicts. This analysis framework gained popularity as a tool in case studies of water and forest resource management in Northern Thailand. As for studies on coastal resources, most emphasize case studies of local fishery communities in the lower southern parts of Thailand, including the east (Gulf of Thailand) and west (Andaman Sea) sides. Such communities are found in Songkhla, Pattani, and Phagnga (Anan 2000; Chalita 2000; Watthana 2001; Lertchai *et al.* 2003; Lertchai and Narit 2009).

Among studies on coastal aquaculture, studies on coastal shrimp farming are extraordinarily ubiquitous. That is because shrimp is the most commonly farmed seafood in coastal Thailand, and shrimp has been the export item that triggered the most widespread attention on the standardization of food safety when compared with other kinds of coastal aquaculture. Notably, most studies on coastal shrimp farming emphasize sustainability. Since the origination of shrimp farming in the early 1970s and throughout the next four decades, shrimp farmers have employed various cultivation strategies and technical innovations to expand farms and products. However, these methods have not been able to cope with problems such as water pollution and land-use conflicts. As a result, current studies tend to focus on ways to manage structural problems within the Thai natural resource management system, such as aquaculture zoning and water resource management (Szuster 2006). Likewise, this analytical approach has been applied to the study of shellfish resources in Ban Don Bay, as can be seen from the study by A. Jarernpornnipat *et al.* (2004).

This study focuses on sociopolitical aspects of the conflicts over coastal resource management, based on the case study of blood cockle cultivation, which is highly dependent on natural factors. Due to its dependence on natural factors, blood cockle cultivation is vulnerable to environmental change. Understanding this vulnerability will help us ascertain ways to make blood cockle cultivation sustainable. Moreover, most aquaculture communities in the Bay are relatively new, having been established via state policies initiated in the 1970s. As a consequence, the sociopolitical organization of this particular area is dissimilar to that of long-established communities in Northern and lower Southern Thailand.

The few studies on resource conflict in the Bay argue that traditional economic activities and community culture have been destroyed by capitalism.[4] However, this argument oversimplifies the issue and does not sufficiently examine the political and economic conditions and historical context during the 1970s and 1980s, specifically the impact of state development projects on local communities. Through these projects, coastal lands were distributed to non-local and landless farmers, creating new aquaculture communities. This ignited new conflicts between established fishing communities and the newcomers.

A mixed-method approach was employed to examine the main object of this study. The main methodology of this study is the historical approach, which can help us understand the sociopolitical aspects of resource management through a local economic and environmental history. Thai national archives and official documents were perused to study state policies and environmental statistics. Natural science research reports on the environment of the Bay were reviewed to gauge environmental changes during four decades beginning in the 1970s. Basic field face-to-face interviews were conducted with 10 farmers in the Bay from 2011 to 2015 to find out their personal aquaculture experiences, farm operations, and strategies to reduce the effects of pollution and natural disasters.

4) Such as Mahawitthayalai Walailak (2006).

This study examines the dynamics of blood cockle cultivation in the Bay from 1979, the first year that the government assigned "cultivable areas" in the Bay, focusing on three factors: the state's aquaculture projects, environmental changes, and the adaptations by blood cockle farmers. The article is divided into four parts. The first traces the background of cockle production in the Bay. Historical statistics of the size of cultivated areas and yields are analyzed to ascertain trends in production. The second part examines government programs that have played a key role in triggering the production of cockles in the Bay and their results. The third section focuses on the construction of cockle seedbeds, as a result of government intervention, which sparked new conflicts in the Bay. The last part examines the adaptations of farmers to state regulations and environmental changes.

I Background of Blood Cockle Production in the Bay

History

According to the Cabinet minutes of March 1953, General Phibun Songkhram, the prime minister of Thailand at the time, ordered the minister of agriculture to start a project to promote intensive cultivation of crabs, shellfish, blood cockles, and oysters. Four coastal areas on the west and east sides of the peninsula were chosen as the pioneer sites (NA [3] SR 0201.31/56). Until the early 1970s, however, blood cockle cultivation was confined mostly to Phetchaburi and Samut Songkhram Provinces, where natural blood cockle seedbeds had formed around the mouth of the Mae Klong and Phetchaburi Rivers.

In the first half of the 1970s, the release of waste from sugar factories into these rivers made the natural cockle seedbeds unsuitable for production (Siri 1983). Due to the resulting decline in blood cockle production, a group of farmers in Satun Province, with the cooperation of Malaysian farmers, took the opportunity to introduce a Malaysian style of capital-intensive cockle farming by sowing cockle spat[5] in the Tam Malang Bay in Mueang District, Satun Province. This type of cockle farming was conducted on a large scale (farms of 80–350 acres) and was costly because of the need to purchase the spat and transport it from Perak, Malaysia. Despite the costs, the method expanded to other provinces in Southern Thailand, including Trang, Ranong, Nakhon Si Thammarat, and Surat Thani, on both sides of the peninsula (*ibid.*). The *1967 Thailand Marine Fishery Census* records one household in Bandon Bay cultivating blood cockles on 2.37 acres

5) Spat are young, immature bivalves.

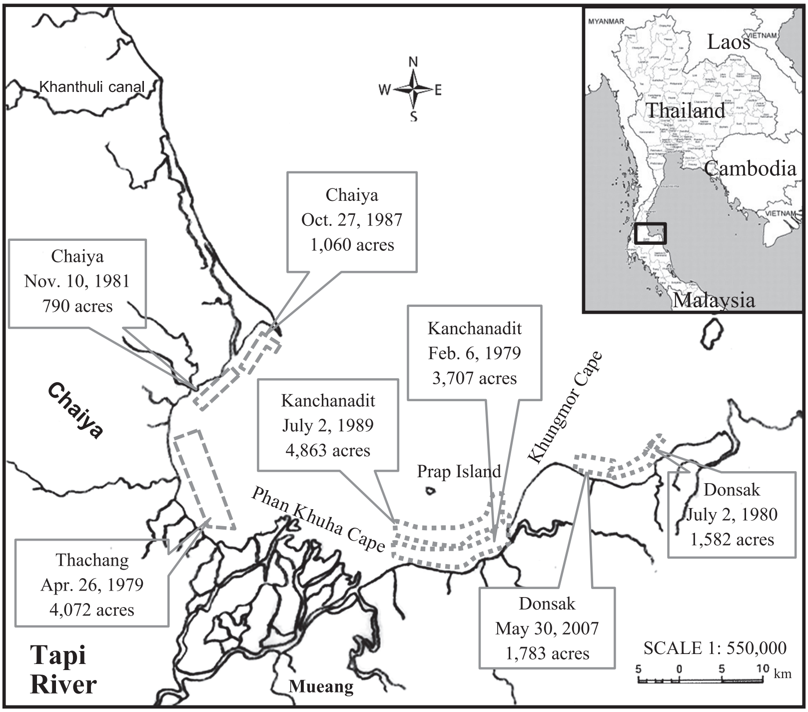

Fig. 2 Areas Declared as Cultivable in Bandon Bay
Source: Samnakngan Pramong Changwat Surat Thani (2010).

(Krom Pramong 1968, 150), indicating that the transfer of techniques did take place at the individual level even before 1970.

Scale

Although some farmers had experimented with the intensive method of blood cockle cultivation, only in 1979 did the Department of Fisheries (DOF) declare 7,779 acres of coastal waters in Kanchanadit and Thachang Districts as cultivable areas for aquaculture.[6] By 2007, the DOF had declared 17,857 acres in the Bay as cultivable areas for aquaculture (Fig. 2).

According to a 2010 survey by the Surat Thani Provincial Fisheries Office, however, a total of 31,685 acres of fish and shellfish were actually cultivated in the Bay, meaning

6) According to the 1947 Fisheries Act, the government may proclaim stretches of sea as cultivable areas for aquaculture. Prospective farmers must register and apply for a two-year cultivation permit. By law, cultivable areas may be reassigned; but in practice the first permit-holders apply for new permits to keep their rights and may rent out the farm to others.

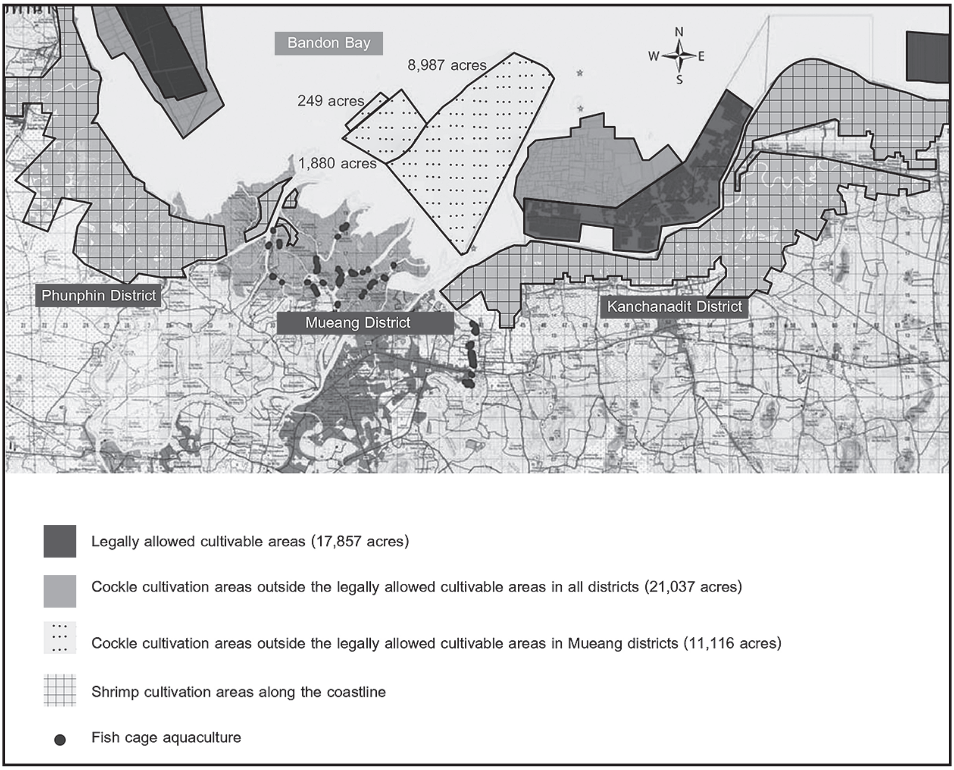

Fig. 3 Coastal Aquaculture in Bandon Bay, 2010
Source: Adapted from the Map of Samnakngan Pramong Changwat Surat Thani (2010).

that 21,037 acres were cultivated outside the legally allowed area of 17,857 acres (Fig. 3) (Samnakngan Pramong Changwat Surat Thani 2010).

The dark gray, light gray, and dot marine cultivated areas in Fig. 3 show bivalve mollusk cultivation. The dot area in Mueang District became a cultivated area after 2006, when artificial blood cockle seedbeds were successfully constructed. Figure 4 shows that blood cockle has had the major share of bivalve mollusk production in the Bay in terms of cultivated area since 1991 and in terms of yield since 1998. Figure 5 shows that over the period 1991–2010, blood cockle production increased more sharply in Surat Thani (Bandon Bay) than in the three other provinces. The figure also shows the year-to-year fluctuation in production.

Most cockle cultivation in the Bay is capital-intensive. According to interviews with farmers, they usually purchase the cockle seed from two main producing areas depending on the species (*Anadara nodifera* from Phetchaburi Province and *Anadara granosa* from northern Malaysia, especially Perak). Malaysia has occasionally prohibited cockle seed

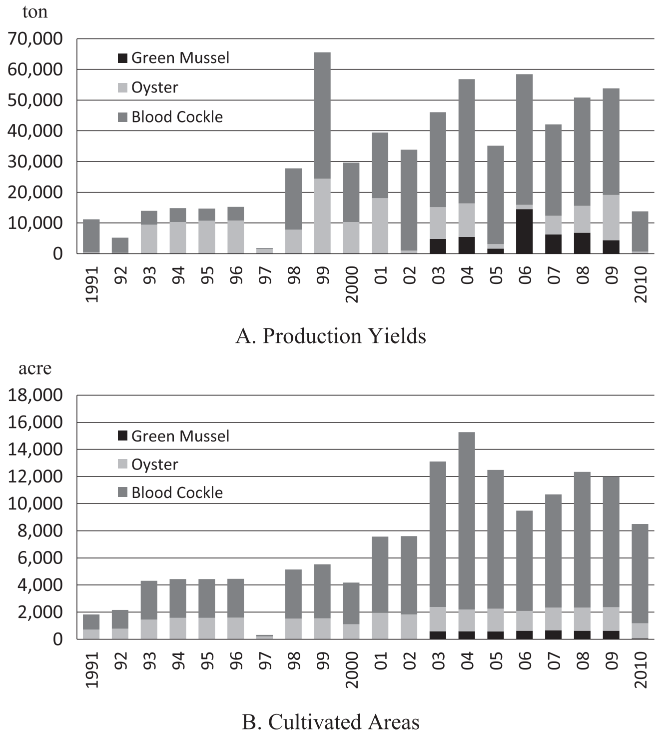

Fig. 4 Production Yields and Cultivated Areas by Species in the Bay, 1991–2010
Sources: Computed from annual statistics from the Department of Fisheries.

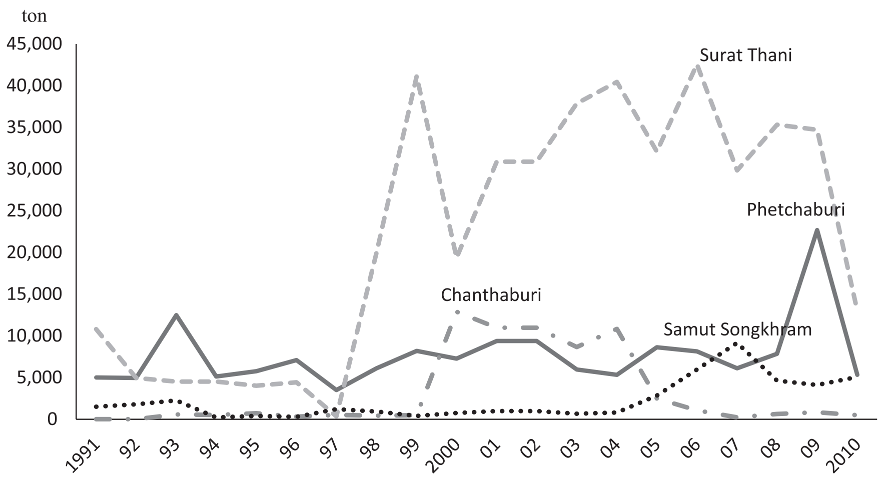

Fig. 5 Blood Cockle Production in Four Major Provinces in Thailand, 1991–2010
Source: Computed from annual statistics from the Department of Fisheries.

exports for local reasons, but Bay farmers are still able to purchase illegally imported seed from Malaysia through connections with local merchants.

Production Cycle

One cycle of cockle farming in the Bay lasts 18–24 months (Fig. 6). The beginning of the cycle depends on several conditions, such as the origin of the spat and the size of the sowing seed. Farmers decide on the seed size depending on their farm location, budget, cockle market prices, local climate, and so on. Seed sizes are measured by the number of seeds per kilogram. For example, a count of 10,000/kg means there are 10,000 cockle seeds per kilogram. A farmer can harvest 125 kilograms of market-size cockles (80 cockles per kilogram) from a farm sown with 10,000/kg seed and can harvest 3.75 kilograms of market-size cockles from 300/kg seed. Therefore, the large seed sizes are more economical. To cultivate the 10,000/kg seed, a farmer needs more capital and must have a nursery farm about 1–2 kilometers away from shore. A mortality rate of 30 percent is

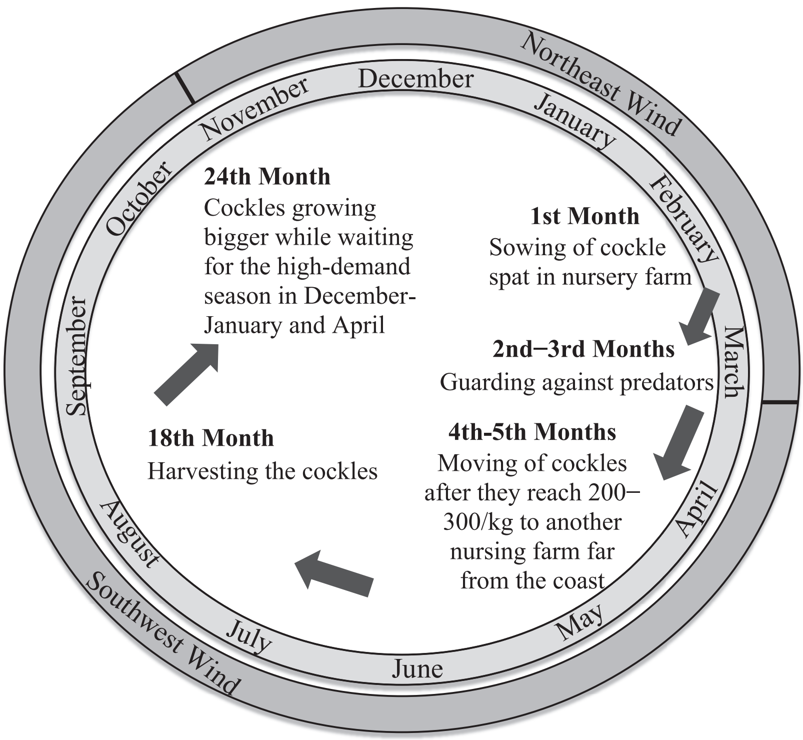

Fig. 6 Cycle of Blood Cockle Farming in Bandon Bay

Sources: Interviews with various people engaged in blood cockle farming in Bandon, August 2011, August 2012, September 2013, February 2014, September 2014, and August 2015.

normal for cockle cultivation in the Bay.

What factors contributed to the sharp fluctuation in yield and cultivated area in Bandon Bay? The next section examines the impact of government policies.

II Coastal Aquaculture Projects and the Settlement of Aquaculture Communities

The government's projects in the Bay result from two different yet interrelated policies. The first includes projects aimed to promote cockle cultivation through the organization of pilot farms, local coastal aquaculture cooperatives, and local aquaculture communities. The second, which will be discussed in the next section, includes projects designed to overcome production constraints such as the lack of cockle seed in the Bay, the lack of investment funds, and the resistance of local artisanal fishermen to cockle cultivation.

According to DOF reports, the promotion of blood cockle cultivation was originally a project of import substitution. In 1970, the DOF applied for a loan from the Asian Development Bank for fisheries development projects, including the development of brackish water aquaculture (NA. K/P 6/2513/20). In 1971 a shrimp experimental unit, today's Coastal Fisheries Research and Development Center, was established in Kanchanadit District, Surat Thani Province. In 1976, this center was promoted to the Brackish Water Fishery Station of Surat Thani. However, projects promoting blood cockle cultivation could not be launched immediately due to fear of local resistance. According to the 1947 Fisheries Act, artisanal fishermen had no rights to fish in areas that the DOF declared as cultivable for aquaculture, and hence fishermen often mounted opposition (*Government Gazette* 3, 64, 81–114). In practice, a person who wanted to apply for a cultivation permit needed to first negotiate with local residents. The final decision on the proclamation of cultivable areas was made by the DOF at the central government level (Siri 1983, 15). To avoid local resistance, in July 1976 a Land Settlement Cooperative was organized in Kanchanadit and Thachang Districts. The tenure of public lands, including the mangrove forest of these cooperatives, was transferred to the Cooperative Promotion Department (Krom Pramong 1980, 2). Under anti-Communism policies, numerous rural economic development projects were implemented in Southern Thailand at the same time.

Surat Thani in particular was a target area for development projects under the Fourth National Economic and Social Development Plan (1977–81). In an attempt to reduce local resistance, in 1976 cooperative communities (*nikhom sahakon*) were established in Thachang and Kanchanadit Districts and cooperative community lands were distributed both to local landless farmers and to newcomers (NA [8] MT 5.4.2.1/36). Coastal areas around the Bay were developed for aquaculture beginning in 1980, when shrimp farm projects were promoted jointly by the Ministry of Interior, the Ministry of Agriculture and Cooperatives, and the Fourth Army. This was the first time that shrimp cultivation was promoted to farmers through the Cooperative Communities Office in Kanchanadit District (*ibid.*).

The Ministry of Agriculture and Cooperatives started aquaculture development projects in the Bay with finance from a US$14 million loan agreement signed between the Asian Development Bank and the Ministry of Finance (*Government Gazette* 33, 96, 1067–1068). In February 1979, 7,779 acres of coastal land under land settlement cooperatives in Kanchanadit and Thachang Districts were declared as aquaculture cultivable areas. Any farmer who wanted to cultivate bivalve mollusks had to apply for a permit and pay a yearly cultivation tax of 80 baht per 0.4 acre. The permit gave the rights to cultivate and receive compensation for damages. However, because there was no natural seed supply in the locality, spat had to be purchased and transported from Phetchaburi and Malaysia at some expense. Although the mudflats of the Bay were suitable for blood cockle cultivation, the costs were high for local villagers because of the need to import spat. In late 1981, the DOF made available 958 acres of cultivable area for private investors to organize blood cockle pilot farms in Thachang District (Krom Pramong 1982, 9). A similar farm was set up in Chaiya District in 1982 after 791 acres were declared as cultivable for aquaculture (Thanasit 1994, 42). According to statistics from 1980 to 1987, between 958 and 1,085 acres of the cultivable areas were held by these pilot farms, which were used to study soil properties and ideal methods of cultivation (Chat *et al.* 1986). Almost all blood cockle cultivation in the Bay up until 1987 resulted from these DOF policies combined with funds from private investors.

Despite the promotion of blood cockle cultivation through the pilot farms, in 1987 only approximately 1,800 acres (oyster culture included) of the 8,567 acres of the declared areas were actually cultivated. In 1988, a Blood Cockle Cultivating Group Project was formed in 1988 through cooperation between the DOF, the Bank for Agriculture and Agricultural Cooperatives (BAAC), and local community leaders such as a village headman and an imam in Mueang District. The official objective of the project was to encourage artisanal fishermen to gain income from cultivating blood cockles. Because there were no natural seedbeds, blood cockle cultivation was not considered a natural fishery in the Bay at that time. According to the 1979 reports of the Community Development Department, the main income of villagers around the Bay came from agriculture. Villagers from seven subdistricts earned seasonal income from artisanal fishing. Only farmers in Thathong Subdistrict reported receiving income from oyster farming. In Phun Pin

Subdistrict and Patthana Tambon Lilet District, located at the mouth of the Tapi River, more people were primarily engaged in fisheries between February and July when they were free from rice cultivation and there was no monsoon (NA [8] MT 5.4.1.64/49, 54).

In 1988, 70 artisanal fishermen joined the blood cockle project and obtained a loan from BAAC to purchase spat from Phetchaburi. The DOF allocated 395 acres of cultivable land in Kanchanadit District to implement the project. As the culture areas in the Bay were expanded, the number of farms rose to 37 in 1989. The project was opposed by some groups of local artisanal fishermen, especially from Li Let Subdistrict at the mouth of the Tapi River. Bamboo fences around the cockle farms blocked the fishermen from fishing in the cultivated areas (*Thai Post*, October 9, 1997, 12). Conflict between the artisanal fishermen and the blood cockle cultivators in the Bay emerged in the late 1980s.

In June 1993, a group of fishermen was organized as the Surat Thani Province Coastal Aquaculture Cooperative in order to promote "eco-coastal" aquaculture and reduce illegal fisheries (Sahakon Phulieng Satnam Chaifang Surat Thani c.2012, 1). The cooperative operated under the Coastal Fisheries Research and Development Center, which provided guidance on cultivation techniques and the purchase of spat. New aquaculture cultivable areas were declared in the Bay in 1987, 1989, and 1990. A decade after the first declaration, the legally declared cultivable areas had increased from 10,152 to 16,075 acres. Perhaps due to the founding of the cooperative, in 1993 the area actually cultivated increased from 1,800 to 2,862 acres and the number of farms increased three times from the previous year to 302.

Disaster Response

Between 1997 and 2010 the area and yield of blood cockle production fluctuated sharply (see Fig. 7). Due to severe monsoon flooding in October and November 1996, the cultivated areas declined dramatically—from 2,861 acres the previous year to 110 acres—and the yield decreased from 4,421 tons to 339 tons. Consequently, in 1997 the government provided a 195-million-baht low-interest loan fund to organize a Blood Cockle and Oyster Sustainable Cultivation Career Development Project in order to rehabilitate cultivation in the Bay. This five-year project, which was implemented by the Surat Thani Provincial Fisheries Office and the Surat Thani Coastal Fisheries Research and Development Center, provided loans and training for cockle cultivation and arranged the purchase of spat. Because members of the cooperative could apply for loans of up to 300,000 baht, the number of members jumped from 641 in 1997 to 1,372 in 1999 (*ibid.*, 13). Most of the 35 cultivator groups were located in Kanchanadit District, with a few in Thachang and Chaiya Districts. The cultivated area increased from 3,070 acres in 2000 to 5,633 acres in 2001. The group expanded cultivation into public land outside the proclaimed

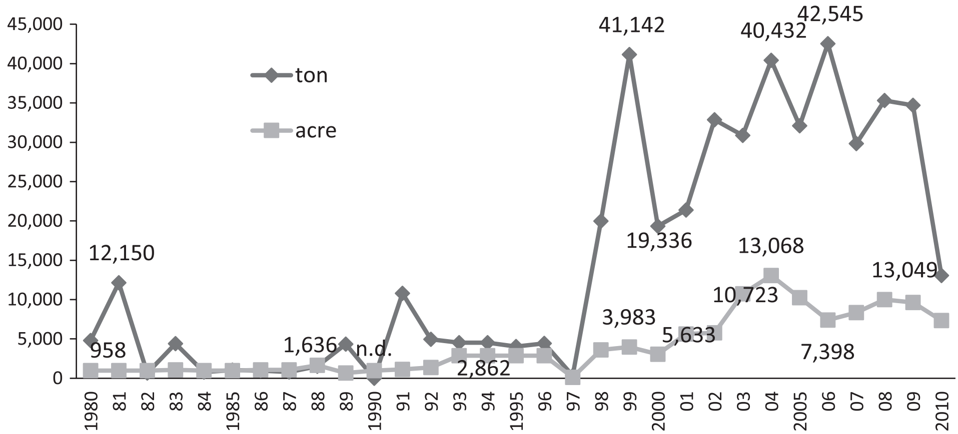

Fig. 7 Blood Cockle Production and Cultivation Areas in Bandon Bay, 1980–2010
Source: Computed from annual statistics from the Department of Fisheries.

cultivable areas. Local villagers objected and accused cultivators near the Research Center's farms of colluding with investors to encroach onto public land defined as natural reserves (*Khao Sot*, February 13, 2002, 29).

The expansion of cultivated areas continued, reaching 10,723 acres in 2003 and peaking at 13,068 acres in 2004. In 2004 the DOF launched a Seafood Bank Project in conjunction with several government organizations, including the BAAC and the new Assets Capitalization Bureau founded in 2003. Under this project, cockle farmers could apply for a loan using the cultivable land they held under permit as collateral. The project therefore added value to the permitted cultivable areas and transformed the rights of cultivation into an unofficial tenure of an asset that could be bought and sold.

From the official data, it is difficult to assess the impact of this project on the dynamics of aquaculture in the Bay. However, local NGOs and media argue that the project sparked the uncontrolled expansion of aquaculture beyond the proclaimed cultivable areas, which in turn affected the local management of natural resources in the Bay. Small-scale blood cockle farmers, such as ex-members of the cooperative, sold their cultivated areas to large-scale farmers who had a greater capacity to handle risk. Thus, ultimately large-scale farmers benefited from the government projects.

As noted above, the establishment of cooperative communities led to the settlement of newcomers along the coastal areas of Kanchanadit and Thachang districts. Initially they cultivated shrimp, but later they switched to blood cockles under the state-initiated Blood Cockle Cultivating Group Project. These farmers subsequently established the Surat Thani Province Coastal Aquaculture Cooperative. Thus, the social make-up and economic activity of these settler communities was significantly molded by government policies to promote aquaculture in the Bay.

III Man-made Seedbeds: Overcoming Constraints and the Birth of New Conflicts

Apart from the establishment of pilot farms and coastal aquaculture cooperatives, the government launched projects to overcome the constraints of cockle production in the Bay. The production of cockles decreased in 1984 and did not increase again until 1988, the first year that blood cockle cultivation was promoted to the local villagers (see Fig. 7). The decrease was related to the lack of cockle seed supply. To overcome this constraint, the DOF requested technical assistance from the International Center for Living Aquatic Resources Management. On December 14, 1980, a project named Technical Assistance for Applied Research for Coastal Aquaculture was initiated with an agreement between the center and DOF, and finance was arranged by the German Agency for Technical Cooperation (McCoy and Tanittha 1988, ix). Researchers examined the growth and mortality of cockle seed transplanted from Phetchaburi (*Anadara nodifera*) and Malaysia (*Anadara granosa*) to sites in Nakhon Si Thammarat and Chumphon Provinces (*ibid.*). Experimental sites were also created in Nakhon Si Thammarat, Phangnga, and Surat Thani Provinces for the study of cockle seed settlement and the farming of breeder cockles. The objective of the project was to create artificial seedbeds by sowing larvae in an area suitable for seed settlement and growth.

Similar projects supported by various funding sources continued from 1980 to 1987 (Samnakngan Setthakit Kankaset 1990, 53–69). As the experiments at the Surat Thani site proved successful, the DOF acquired funds from the Farmer's Aid Fund to pursue this project in 1987 (*ibid*., 59). Funding from United States Agency for International Development (USAID) under the Agriculture Technology Transfer project was used to implement projects such as cockle seed production at the Prachuap Khiri Khan Provincial Fisheries Station and the Surat Thani Brackish Water Fisheries Station (Songchai *et al.* 1987, 1).

A DOF survey of cockle seedbeds between April 1991 and March 1992 concluded that Kanchanadit and Thachang Districts were suitable areas for cockle cultivation but unsuitable for breeding cockle spat (Wichien and Thawisak 1992), hence cockle spat would still have to be purchased from Phetchaburi and Malaysia. On the basis of information from artisanal fishermen, the survey also identified a settling ground for natural cockle seed at Kungmo Cape on the east side of the Tapi River (*ibid.*). During January–December 2000, the Surat Thani Coastal Aquaculture Research and Development Center conducted a study on environmental factors and the spatfall[7] season of cockles (*Anadara granosa*) at two cultivation sites, one at Kungmo Cape and the other on the east side of the Tapi River's navigable channel (the center's site located inside the light gray area of Fig. 3) (Teeraya *et al.* 2004). The study found that the spatfall season in both locations occurred in December, contradicting a 1992 technical paper finding that cockles developed to the mature gonad stage all year round and spawned in July and November, but never developed into spat (Wichien and Thawisak 1992; Teeraya *et al.* 2004, 16–18).

During 2002–06, the center published some related papers on the diversity and distribution of plankton along the shoreline of the Bay. In October 2006, two Thai newspaper articles reported that a seedbed had been found on the west side of the Tapi navigable channel and that its economic value was equivalent to approximately US$1.4 million (*Delinew*, October 10, 2006, 10). In mid-2006, according to a survey conducted by the Coastal Habitats and Resource Management Project (CHARM), cockles were cultivated in Kanchanadit, Thachang, and Chaiya Districts but not at the mouth of the Tapi River. By 2010, according to the DOF survey of Surat Thani (see Fig. 3), new cockle cultivation areas had appeared on the west side of the Tapi River navigable channel. However, economically valuable seedbeds did not develop every year; according to newspaper interviews they were found only in May 2006, 2011, and 2012.

The DOF conducted studies in an attempt to understand what environmental changes had resulted in the Tapi River becoming a suitable natural site for cockle seedbeds. Several factors may have been in play. For two decades from the 1980s, cockle farms had expanded beyond the legally allowed cultivable areas, in particular moving away from the shore and closer to the Tapi navigable channel. In addition, due to severe flooding in Surat Thani at the end of 1988, the government had drawn up a master development plan to minimize the impact of natural disasters in the province. Under the Surat Thani Urban Land Use Plan of December 1991, areas on the west side of the Tapi River (dark gray in Fig. 8) were designated as agricultural areas. In 1994 the government introduced the Marine and Coastal Water Quality Standard of Thailand in order to control marine food safety (*Government Gazette* 16 ngo, 111, 64–72). Shellfish aquaculture in the Bay was now controlled by these food safety, environment, and land use measures. As a result of the changes in the landscape of the Tapi Delta and the surface layer of the sea over three decades, the west side of the Tapi navigable channel had somehow become a suitable area for the occurrence of seedbeds.

Even so, the DOF had temporarily overcome the constraints on seedbed cultivation. However, the discovery of the natural seedbeds resulted in conflict between cockle farm-

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7) The setting and attachment of young bivalves to the substrate.

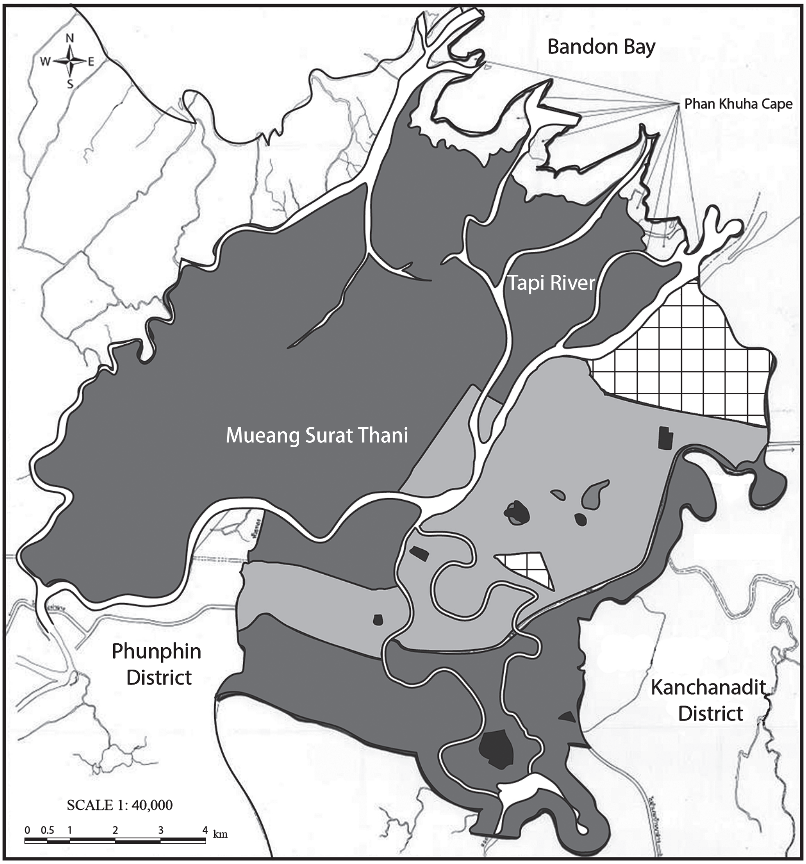

Fig. 8 Urban Land Use Plan for Surat Thani Province, 1991
Source: Adapted from the Map of *Government Gazette* 220m, 108 (December 14, 1991, 1–10).

ers and artisanal fishermen over usage rights. Since cockle cultivation was not traditionally practiced in the Bay, there was no local custom for communities along the coast to manage the seedbeds, unlike in Phetchaburi Province, where such customs were well established. In the absence of such customs, the conflict between communities on the west and east sides of the Tapi River over the tenure and usage rights of the seedbeds was difficult to resolve.

According to the land use plan, residential areas (light gray areas in Fig. 8) and a special industrial area (grid) were planned for the east side of the river. These land use changes affected the quality of marine water in the legally allowed aquaculture areas in Kanchanadit District located 3 kilometers from the coastline. How the farmers handled these environmental changes is discussed in the next section.

IV Farmers’ Survival Strategies: Adjusting to Pollution and Environment Changes

Blood cockle cultivation in the Bay can be categorized into two types according to the size of the cultivated area and the capital required. Large-scale capital-intensive farms are operated by individuals, households, or companies. Small-scale farms are operated by small households, mainly comprising artisanal fisherfolk who cultivate blood cockles as a means to diversify their income. Both groups cultivate under the same environmental conditions and must rely on the local climate and quality of marine water. However, each group adapts to state policies and environmental conditions in a unique way determined by its assets. This section examines the strategies employed by farmers to reduce the effects of pollution and natural disasters. Interviews were conducted with three large-scale capital-intensive farmers in Kanchanadit and Chaiya Districts and seven small-scale farmers in Kanchanadit, Mueang, and Chaiya Districts.[8] All of the interviewed farmers had experienced damage from long-term pollution and short-term climate variation, such as heavy rains outside the monsoon season, drought and strong waves and winds, and heavy rains in the monsoon season.

Pollution and Environmental Changes

Polluted water from the wastes of the residential and industrial areas on the east side of the Tapi River flows into the Bay and affects the water quality of the legally allowed cultivable areas in Kanchanadit District. The effects of pollution on marine water fluctuate according to the season. In the rainy season, the large volume of water flowing from the rivers and canals brings more pollution into the Bay. A 1999–2001 marine water quality survey conducted by the center found that some areas one kilometer away from the coast became unsuitable for aquaculture, especially for the cultivation of oysters to be consumed raw. In this near-shore area, because land was more expensive, a large-scale, more capital-intensive operation was more economical. As a result of this economic factor and the pollution, some oyster farmers in the area sold the official rights of their farms to large-scale cockle farmers who had the capital to finance a 10,000/kg size cockle spat nursery. Then, to combat the impact of the pollution, the large-scale farmers expanded their farms beyond the legally cultivable areas. Some of the large-scale farmers were newcomers who were attracted by the profits and had the strong economic-socio-political assets to override the legal restrictions on the cultivable area. Some

8) Fieldwork was conducted in August 2011, August 2012, September 2013, February 2014, September 2014, and August 2015.

artisanal fishermen who lost their fishing areas due to the expansion of aquaculture farms decided to adopt cockle cultivation to compensate for their lost income. Now it has become difficult to clearly distinguish between artisanal fisherman and aquaculture cultivators. Many farmers run an aquaculture farm for their main income yet also fish to obtain supplementary cash for daily expenses.

Cockle farmers worry about climate variability more than water pollution, because damage from the former is more costly. The monsoons bring heavy rains in November and December (Fig. 9). Farmers understand this season well and protect their assets from the monsoon rains.

Damage to cockle cultivation from natural disasters was not recorded until the end of the 1980s, when the government's Blood Cockle Cultivating Group Project began to promote cockle cultivation. According to interviews and personal and official records, the natural disasters that affected blood cockle cultivation in the Bay until 2011 can be categorized into three types. The first type is the heavy rain that fell in Surat Thani in November 1988 and December 1996. In 1988 the DOF had just begun to promote cockle cultivation among villagers. The Cultivating Group Project distributed cockle spat to the member groups according to the government's fiscal calendar, so the farmers sowed the spat in September, the last month of the fiscal year and the middle of the monsoon season. Heavy rainfall at the end of November (Fig. 9) destroyed the spat and reduced the salinity of the marine water in cultivated areas. As a result, member farmers became indebted and had to take out more loans from the BAAC (Samnakngan Setthakit Kankaset 1990). However, the cockle cultivation groups continued the project.

The economic loss in bivalve mollusk cultivation in the Bay due to the heavy rainfall of December 1996 was valued by DOF at US$10 million (Sahakon Phulieng Satnam Chaifang Surat Thani c.2012, 20–29). The rainfall was less than that in 1988 and 1993, but the loss was greater because the areas under cockle cultivation had increased—from 3,070 acres in 2000 to 5,633 acres in 2001, largely due to the Sustainable Cultivation Career Development Project and the provision of US$5.04 million worth of low-interest loans (Sahakon Phulieng Satnam Chaifang Surat Thani c.2012). In December 2008, as can be seen from the comparison of daily rainfall in Surat Thani Province in Fig. 9, heavy rain again resulted in a loss, this time estimated at US$170 million.[9)]

The second type of disaster is a result of drought or strong waves and winds, and it is not as severe as heavy rainfall. This type of disaster slows the growth rate of shellfish and increases mortality, decreasing farmers' profits but not causing bankruptcy. Accord-

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9) Unpublished dataset of Special Projects and Alleviation Sub-Division, Department of Fisheries, Thailand.

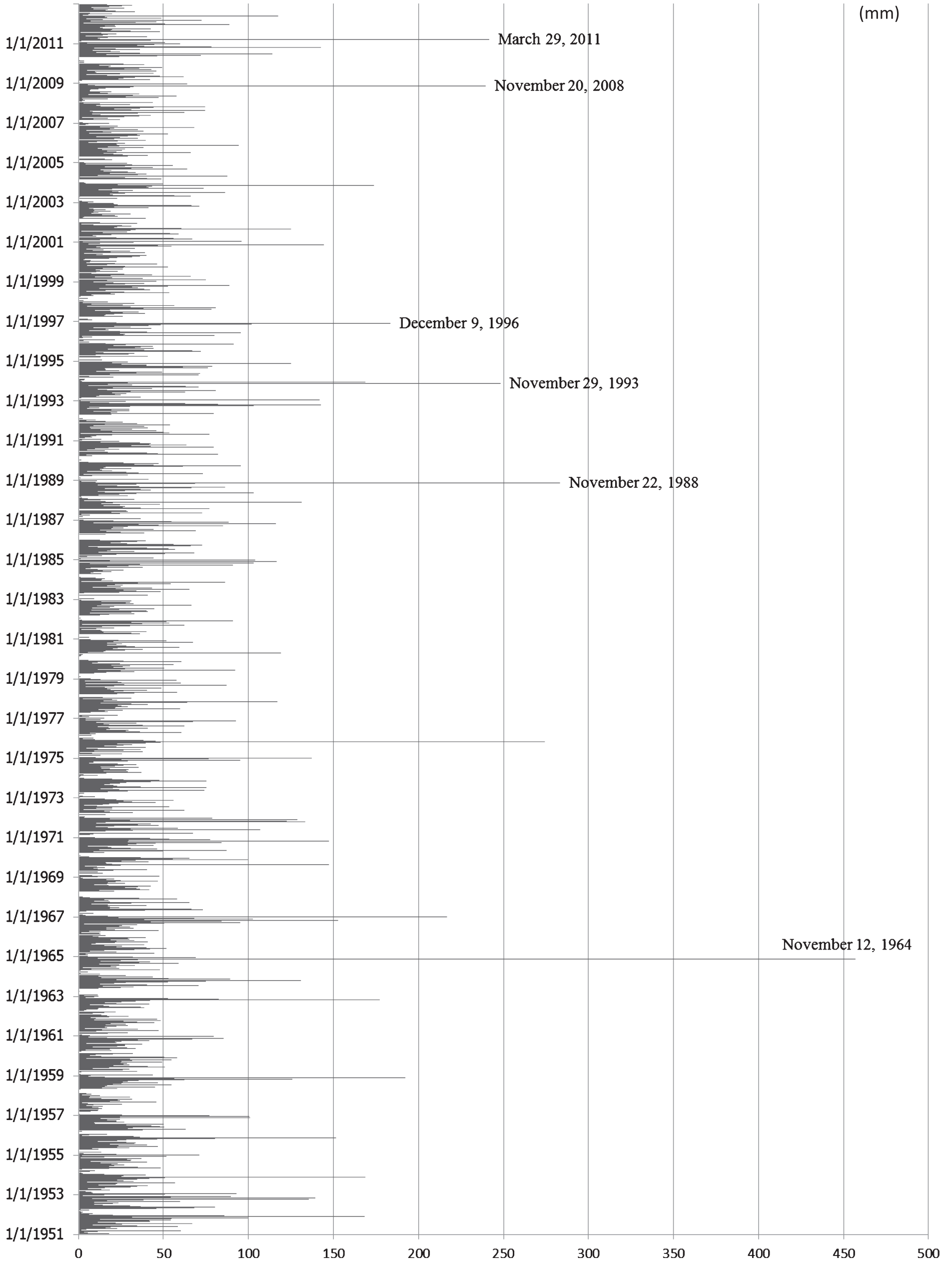

Fig. 9 Daily Rainfall in Surat Thani Province, 1951–2012

Source: Computed from daily statistics from the Thai Meteorological Department, Surat Thani Provincial Meteorological Station.

ing to a report of the Surat Thani Coastal Aquaculture Cooperative, a drought linked to El Nino occurred in 1999. In the same year, there were strong waves and winds in December. Some farmers who had cultivated within the officially allowed areas decided to sell their permits to other farmers. This happened during the time the Assets Capitalization Bureau implemented its projects.

The third type of disaster is heavy rain in the dry season. Figure 9 shows that the daily rainfall on March 29, 2011 was equivalent to the level during the monsoon. Nothing like this had occurred since the first year that meteorological records were kept in the Bay. The 2011 disaster caused significant damage because the storm hit during spat-sowing time. In order to reduce the effects of fresh water from the Tapi River, the spat needed to be moved from the nursery farm to other farms far from the coast, but both groups were unable to do this in time. The massive amount of water flowing in from the river and canals reduced the salinity level of all cultivated areas, making it impossible for the cockles to survive. Both types of farmers were affected by the disaster.

Despite the frequency of natural disasters and their impact on cockle production, the DOF's rules for disaster compensation have not been adjusted. For disaster relief in the form of finance or equipment, the DOF categorizes fisheries into three types: (1) all species of fish; (2) shellfish (shrimp, crabs, and bivalve mollusks); and (3) ponds and fish cages. Since cockle farms are included in the same group as shrimp farms (the main target of the assistance), in the 2011 disaster they were provided with dolomitic limestone, which is used to improve the water quality of shrimp and fishpond farms but is unsuitable for cockle farms in the sea. The outdated rules clearly illustrate the low status of bivalve mollusk cultivation compared to the export-oriented shrimp industry.

Farmers' Survival Strategies

As the three types of natural disasters caused unprecedented damage to blood cockle cultivation in the Bay, the DOF's regulations for disaster compensation were not adequate; they were neither timely nor efficient in responding to the environmental changes. Both small-scale and large-scale farmers had little confidence in the official rules or local climate. Thus, they tried to create individual solutions appropriate for their situation.

Small-scale farmers in particular have some common risk management strategies. First, most of them prefer a short period of cultivation due to their worry about unprecedented disasters and shortage of financial assets. They therefore harvest and sell their cockles to large-scale farmers before they reach market size. They gain less profit, but they do not have to worry about any disaster occurring during the extra months before the cockles reach market size. Some farmers reduce the area of cockles in favor of green mussels, which fetch less profit than cockles but can be harvested within six months.

Some have also tried to cultivate clams from wild spat gathered in the Bay.

G and A were small-scale farm owners in the Bay. G lived in the Muslim coastal community in the special industrial area of Mueang District (grid area in Fig. 8). G's father had moved from a Muslim community along the Saen Saep canal in Bangkok to the Bay in the 1950s. He was one of three pioneer families who settled the Muslim community in this area. Most of the inhabitants in this community had moved from the Muslim community along Saen Saep canal in Bangkok and Chachoengsao Province. Most of them identified themselves as relatives of one another. G had worked as a fisherman all his life. Due to the expansion of cockle farming at the end of the 1990s, fishing areas shrank; and this made G decide to try cockle farming to generate a new source of income after 2003 to replace the income that he used to get from working on a fishing trawler.

During the heavy rains in March 2011, G decided to do nothing because he could not afford to hire a boat. Because his farm was located outside the cultivable area, he did not receive disaster compensation from the DOF. This disaster deprived him of the ability to repay the loans that he had taken from BAAC as capital for cockle farming. He sold his land in Prachuap Khiri Khan Province to settle his debts. He started to accumulate capital by not only offering services to build and repair small fishing boats but also catching fish along the coastal areas. In addition, he invested in cockle farming by purchasing cockle babies from Malaysia for US$5,672. In 2013, he reaped a good profit from the cockle farm. Currently, G has changed his farming strategy by reducing areas of cockle farming and turning to green mussel farming.

The situation is similar with A, a small-scale farmer in Kanchanadit District. According to her memory, heavy rains occurred in November 1993 and considerably affected the business of oyster farmers. Consequently, many of them quit cockle farming and sold their farms. A purchased 16-acre oyster farm located in the cultivable area from her relative who was affected by the 1993 rains. Her father was an oyster farmer and had a small oyster stall near her home. As cockle farming was more lucrative, she decided to cultivate blood cockles instead. Because of the disaster in 2011, her blood cockle farms were completely destroyed. She received US$5,600 in compensation from the government, which she used as capital for the next cultivation. After that, she decided to operate her farm using a new strategy applied by many farmers. A purchased 1,600/kg seed for the equivalent of US$5,672 and sowed it in the farm in June 2011. The cockles would reach marketable size in 8–10 months, so she planned to harvest and sell them the following April during the long Songkran Festival vacation. She also purchased 20,000/kg seed for US$2,828 to sow in her nursery farm. These reached marketable size in the next two years. Since there were no disasters, she reaped a handsome profit.

Large-scale farmers have different strategies for managing risks. Some purchase

100–300/kg size spat from small farmers to shorten the cultivation period. They cultivate the 100–300/kg size spat in farms located away from the shore, outside the legal cultivable area, in order to reduce the effects of fresh water flowing from the river and canals. In this way they can fulfill their contracts and maintain their long-term relationships with seafood wholesalers in Samut Sakhon Province, even though their profit is reduced.

K and S were owners of large-scale capital-intensive farms that covered an area of 790 acres. They started operating their farms in the early period of blood cockle cultivation in the Bay. They knew each other and learned the way of cultivation at the same time in the late 1980s. Their cockle farms were located in Kanchanadit District, both inside and outside the legal cultivation zones. K was a member of a shrimp-farming family in a province in the Upper Gulf of Thailand. He had moved to Surat Thani in the mid-1980s to work as a manager of a shrimp farm. He started blood cockle cultivation in 1987–88. In 1997, he worked as a secretary of the Surat Thani Province Coastal Aquaculture Cooperative and as a key person of the Blood Cockle and Oyster Sustainable Cultivation Career Development Project.

S was an operator of his family's fishery and aquaculture business. He assisted his parents on an oyster farm from 1979. His family switched from oysters to blood cockles in 1987 due to the declining price of oysters. Fishermen who used to do oyster farming in the legal zones began selling their cultivation rights to others. S's family had other business lines, including owning a large fishing boat with 50 crew members. They bought coastal areas that became nursery farms for cockle seed.

K and S shared a similar experience of cockle farming. The most important capital in this business was cockle seed from Malaysia. After years passed and seedbeds became available in the Bandon Gulf, they started to purchase cockle babies born in the gulf instead. They sold the cockles to seafood wholesalers in Samut Sakhon Province. A wholesaler offered them a loan and asked them to use it for cockle farming and send the products to her. However, they both declined her offer as they were worried about environmental factors, which they could not control. For instance, because of heavy rains in the dry season in March 2011, K and S said, they could not move the spat since the continuous heavy rainfall made it too dangerous to sail. Besides, S had denied a contract offer from an international hypermarket chain in Thailand. S emphasized that he could not predict environmental changes. Unlike the wholesaler in Samut Prakan Province, with whom he had the personal relationship to negotiate in case he could not fulfill their contract, he could not do the same with the international hypermarket chain.

V Conclusion

State development projects were the driving force behind the growth of cockle cultivation in Bandon Bay from 1980 onward. The declaration of cultivable areas, promotion of pilot farms, and establishment of cooperatives led to new settlements of aquaculture farmers in the Bay. After major natural disasters caused significant destruction in the late 1980s, the government approved large budgets for rehabilitating affected areas. After that, the influx of capital supported by the state increased the area under aquaculture in a great leap forward.

Cockle cultivation in the Bay is a costly form of aquaculture that is vulnerable to climate variability and pollution. Some farmers are attracted to the high potential returns in comparison to green mussel and oyster farming. The state's readiness to provide relief in case of natural disasters is limited because cockles are not an export product, and the costs of compensating for disasters may exceed the benefits accruing to the state. Farmers must develop their own survival strategies in response to natural disasters. These strategies differ according to the scale of cultivation, location of the farm, and personal situation of the farm owner. Medium and large-scale farms have a higher ability to handle the risks from climate variability. Small-scale farmers have switched to safer crops that involve fewer risks but deliver lower profits. Many have abandoned cockle cultivation and sold their farms to large-scale farmers.

In 1979 the Department of Fishery promulgated a law, succeeding the Fishery Act 1947, which enabled local people to temporarily utilize some offshore areas for private aquaculture. Although the state's proclamation in 1979 legally allowed the use of common marine resources for private farms, conflicts between artisanal fishermen and cultivators did not emerge until the late 1980s, when cockle cultivation expanded outside the officially allowed areas and common marine resources on the west side of the Tapi River channel were illegally converted to private farms. Artisanal fishermen whose usage rights are being challenged have opposed cockle cultivators since that time. Fishery communities regard the aquaculture farmers as proxies of the state.

The conflict is more complex than a confrontation between fisheries and aquaculture, between customary practice and innovation. Some fishermen are primarily agriculturists who fish to earn extra income during periods when they cannot practice rice cultivation. Among the artisanal fishery communities, some local people have adopted aquaculture as a secondary means of income.

The aquaculture communities in Kanchanadit were settled by the cooperative communities projects in the second half of the 1970s (NA [8] MT 5.4.2.1/36). Some in the community are newcomers from outside the locality, while some are former local agriculturists who have switched to artisanal fishing or aquaculture. There is no sociocultural foundation for negotiation and bargaining.

Due to their harsh geography and tropical monsoon climate, some areas of Southern Thailand were sparsely populated prior to 1950. However, these areas were a potential frontier for making a living by farming. As a result of the nationwide population boom from the 1940s to 1970s, outsiders began to move into these areas. This settlement was supported by the state through policies to establish cooperative communities and develop new forms of production such as aquaculture. The society of coastal Southern Thailand is not only made up of villagers who have long subsisted on fishery—before 1970—but has a large admixture of new communities constructed within the framework of state-led development. Vulnerability to natural disasters has added to tensions over conflicting claims on marine resources. Different segments of local society share a common connection to the bureaucratic systems of the state, yet they lack the ability to negotiate and bargain with each other.

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