AQUACULTURE CRSP 21ST ANNUAL TECHNICAL REPORT

A STUDY OF AQUACULTURE BROWNFIELDS: ABANDONED AND CONVERTED SHRIMP PONDS IN THAILAND

Tenth Work Plan, GIS: Planning, Policy, and Global Data Analysis Research 1 (10GISR1)
Final Report

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ABSTRACT

This study examined the current state of abandonment and conversion of shrimp ponds in several areas of Thailand and identified patterns in conversion activities. A semi-structured questionnaire was used to gather data from farmers, head villagers, and stakeholders in villages throughout Chanthaburi, Chachoengsao, and Samut Sakhon provinces. These areas were selected because they had experienced a rapid growth in shrimp culture followed by a period of collapse.

Interviews were conducted with farmers, head villagers, and other stakeholders. Quantitative data generated through the questionnaire was supplemented by qualitative data obtained through informal questioning during interviews. The distributions of responses were compared statistically to a random distribution using a chi square test (alpha = 0.05), and results with significant values higher or lower than random were considered to demonstrate preference or lack of preference for a response, respectively. Data were compared by informant group within each site, by informant group across sites, across informant group by site, and aggregated as one sample.

An average of 54% of identified shrimp ponds were abandoned or converted to other uses at the time of study. This varied strongly by region, with 87% abandoned or converted at Samut Sakhon, 63% at Chachoengsao, and only 12% at Chanthaburi. Conversion options were numerous, including polyculture (36% of all conversions), fish monoculture (15%), rice culture (9%), and a variety of other changes (40%). Abandoned land was estimated to be 14% of the area occupied by shrimp culture, while 30% was in polyculture, 25% remained in shrimp culture, 17% was in urban development, 9% in fish culture, and 5% in salt pans. Results for housing were inflated by the occurrence of two large developments in Samut Sakhon.

Responses to 11 questions indicated that informants felt their communities had grown and developed in positive ways during the period of the shrimp boom and subsequent bust. A significant majority of respondents agreed there was more opportunity for children, people were happier, and there was less illness than in the past in their community. Over all respondents, these answers indicated positive community development.

Employment preference indicated that land ownership and self-employment were more desirable than off-farm employment. There was very strong statistical agreement among all areas and all groups that people with their own land were less subject to economic problems and that communities would be better off if more people owned their land.

There was no indication that respondents felt shrimp pond abandonment or land dereliction were problems for their communities. Despite 70% of respondents recognizing that farmers had changed culture practices or left their land, 87% did not feel abandoned ponds were a problem.

We expected to find a linear process of converting from other agriculture to shrimp aquaculture and then to a new use after collapse occurred. The process was actually cyclic with some farmers opting to rent their land to new farmers after collapse, or temporarily convert while waiting to return to shrimp when conditions permit.

This study evaluates barriers to converting ponds to shrimp culture. Perhaps the single largest barrier to reclamation the perception locally that there is no problem with abandoned or idle land.

INTRODUCTION

In many cases, intensive shrimp culture results in abandonment of poorly functioning farms. A great deal of research has been conducted on shrimp aquaculture with abandonment being mentioned as the end result of failed culture (Flaherty and Vandergeest, 1999; Quarto et al., 1996; Hambrey, 1996; Flaherty and Karnjanakesorn, 1995). Little has been written about land use options following shrimp culture. The research presented in this paper describes some social factors that impact how ponds are reclaimed or converted by examining the current state of abandonment and conversion in several areas of Thailand.

The social environment of shrimp farming is different in Latin America, Africa, Asia, and the United States. This study was expressly concerned with issues in central Thailand. The Thailand context is unique in several ways. Unlike Latin America, where shrimp operations managed by large corporations displaced small landholders, the development of Thailand's

shrimp industry has relied on proliferation of small producers. Thailand is more heavily dependent on high input, high impact, intensive shrimp culture than other Asian producers (Vandergeest et al., 1999). These factors combine to cause an ongoing problem of land abandonment in many areas of Thailand. Environmental degradation and simultaneous economic collapse cause migration, land transfer, reallocation of resources, and other changes that can profoundly affect social conditions.

The first objective of the study was to quantify and examine the extent of pond abandonment in three areas of Thailand, including descriptions of the types of conversions that took place. Secondly, local concerns about pond abandonment and conversion were assessed in order to describe which alternatives to shrimp culture were most desirable at the village level. Finally, perceptions of abandonment and conversion were assessed to determine how they impacted the likelihood for adoption and diffusion of alternative uses for failed shrimp ponds.

METHODS AND MATERIALS

This study was the result of field research using interviews with shrimp farmers, government officials, industry staff, village leaders, and other stakeholders in three shrimp culture areas of central Thailand. In August and September 2002, semi-structured interviews were conducted in Chanthaburi, Chachoengsao, and Samut Sakhon provinces. In addition to questionnaires, field observations were made at the time of the interviews. Interviews were conducted with conversant national government officials and national and international researchers. After field data collection, additional information on demographic and cultural characteristics was gathered from government agencies and publications.

Shrimp farming has been undertaken in 25 of 76 Thai administrative units (changwats). For this research, it was necessary to find areas where there had been a large shrimp industry that was faltering or failed and to be able to identify farmers and farmland that had been in shrimp production. Selected sites were to be representative of different demographic profiles and aquaculture experience. Chachoengsao, Chanthaburi, and Samut Sakhon had the second, third and fifth largest number of shrimp culture establishments in the country in 2000 (NSO, 2001). The development of shrimp culture universal was different in nature at the three sites. Chachoengsao had experienced a large degree of inland shrimp culture that presented a unique set of impacts due to importation of salt water to freshwater areas. Although shrimp is grown in coastal areas of Samut Sakhon and Chanthaburi, the former was one of the first areas to experience catastrophic crop failure and abandonment and presented a longer-term picture of evolution of the industry. Together, the sites represented a diversity of shrimp culture experience.

Chachoengsao is a province in eastern Thailand with 14 km of coastal access. The province is 82 km from Bangkok, encompasses approximately 5,351 km^2, and in 2000 had a population of 632,533. The resulting density was 118 people per km^2 and grew at a rate of 1.36% between 1990 and 2000 (NSO, 2001). In 2000, 91.5% of coastal land was used for agricultural purposes, dominated by rice culture (85.8%), orchard garden (3.9%), and coastal aquaculture (2%). Of coastal aquaculture establishments, shrimp accounted for 96%, with a total of 6,655 sites in 2000 (NSO, 2001).

Chanthaburi is on the eastern side of the Gulf of Thailand, encompassing 6,338 km^2. It is approximately 245 km from Bangkok and has 68 km of coastline that once supported extensive mangrove areas. The population in 2000 was 474,221 with a density of 75 people per km^2. Of the 259,508 rai (1 rai = 1,600 m^2) dedicated to agriculture in the coastal zone, 8.8% was rice paddy, 3.5% orchard, 2.9% coconut grove, 15.5% rubber palm plantation, and 12.72% coastal aquaculture. There were 3,239 shrimp farms in 2000, comprising 87.7% of the total aquaculture establishments (NSO, 2001).

Samut Sakhon is situated in the northern most part of the Gulf of Thailand, approximately 30 km from Bangkok. It is 840 km^2 in area and has 41 km of coastline. Salt pans and shrimp farms once dominated the area, but recently, there has been a remarkable increase in industrial development. The population in 2000 was 457,078 with a density of 524 people per km^2. A majority of coastal land (55.9%) was used for agriculture; specifically rice paddies (13.5%), orchard garden (15.3%), coconut garden (15.4%), and coastal aquaculture (16.1%). In 2000, 1,371 shrimp farms remained, comprising 90% of coastal aquaculture in the area (NSO, 2001). Although a large number of farms were physically present, an extremely small number of them were still active.

A semi-structured questionnaire provided opportunity to develop a standardized set of questions that could be used to compare among study sites and interview groups. Few expectations about possible outcomes could be articulated in advance. The questionnaires were therefore designed to gather information from a diverse sample on a variety of topics. The questionnaires were drafted in English and translated to Thai by a native Thai speaker.

Data were analyzed comparing frequency distributions using chi square tests. To evaluate approval or disapproval for a response, observed frequencies were compared to expected frequencies, constructed using a random distribution of answers (20% in each category for 5-category answers, 50% in each category for yes or no answers). Observed distributions significantly different from random were considered positive if response bias was in the positive direction, and vice-versa. When overall results were significant, differences among response groups, provinces, or other categories were evaluated using the overall frequency distribution as expected and the group frequencies as observed. For all statistical tests, alpha was set at 0.05.

Three separate questionnaires were developed to gather information from farmers, head villagers, and other stakeholders. A common set of questions regarding general social perception was asked of all groups. The farmer group included farmers who were currently engaged in shrimp culture, as well as those who had abandoned and converted land. Head villagers were local elected government officials who had responsibility for maintenance of certain local demographic records. In many cases, head villagers were also shrimp farmers. Other stakeholders were informants in ancillary industries, such as feed companies, or those unrelated to the shrimp industry. This group was included to assess perceptions of shrimp culture from those not directly involved, in order to determine if infor-

mation gathered from farmers and head villagers differed from that of other members of the community.

Information was collected from a variety of sources on where there had once been shrimp farms, and signs of abandonment were used to generate farmer interviews. Head villagers and other stakeholders were identified based on farmer information and knowledge of the local industry.

The spatial extent of various land uses in each study site was derived from two sources. When respondents could be located at places such as housing developments, active shrimp ponds, or sites of other aquaculture production, they were asked to provide estimates of the area of land used for each purpose. When no respondents could be found, the size of abandoned ponds was quantified using Geographic Positioning Satellite (GPS). During these site visits, GPS points were collected at each corner of an abandoned pond. These points were transcribed to a Geographic Information System (GIS) using ArcView, and the area of each abandoned pond was estimated.

RESULTS

A total of 147 surveys were conducted, with the majority of interviews completed for farmers, and fewest for head villagers (Table 1). The distribution of interviews was fairly even across the three sites.

In all study sites, transitions from one form of aquaculture to another were made easily. Of the 109 farmers surveyed, 69% indicated they had ceased to farm shrimp at some time. In Chanthaburi, an additional six farmers had changed locations because of crop difficulties, bringing the total number of farmers who had temporarily converted or abandoned ponds to 74% of the sample. Slightly over one third of the farmers who had stopped at some point had returned to shrimp culture by the time of survey. These numbers demonstrated the prevalence of shifts in aquaculture production, as well as the difficulty in quantifying land dereliction at any point in time.

Table 1. Number of surveys collected from each interest group in each study area.

Changwat	Farmers	Head Villagers	Others	Total
Chanthaburi	44	7	10	61
Chachoengsao	39	5	10	54
Samut Sakhon	26	2	4	32
Total	**109**	**14**	**24**	**147**

Multiple concepts of abandonment complicated the evaluation. From the researcher's perspective, abandonment occurred whenever a farmer ceased to seed shrimp into their pond for an indefinite period of time. Often, farmers did not consider their land abandoned or converted, even if they were not using it or were using it for alternate purposes. Therefore, it was difficult to assess which ponds were essentially fallow, temporarily converted, or truly abandoned.

For the purpose of this study, ponds were considered abandoned if they appeared to have been left for a significant amount of time with no activity or residents. Unused ponds were similar in that they were inactive, but resident farmers indicated they had indefinite plans for future uses. Fallow ponds were those inactive for a matter of weeks or months between crops, while truly converted ponds were being used for something other than shrimp culture, and the owner indicated no intention to return to shrimp. Land dereliction was used to refer generally to all types of abandonment or under use from the perspective of the researcher.

Classification of ponds was further complicated by adoption of rotational cropping. For example, three farmers in Chachoengsao and eight in Chanthaburi indicated they rotated shrimp crops with crops of other aquatic organisms. These multi-use ponds were neither strictly dedicated to intensive shrimp culture, nor were they completely converted. Pond classification was therefore based on use of the pond on the day of site visit. At another time, the same pond could be classified another way.

A number of farmers indicated they had not ceased to be shrimp farmers, even when they had not seeded shrimp for a number of seasons or had converted to other aquaculture. For example, Mr. Chaiya of Chachoengsao indicated on the questionnaire that shrimp and fish were main sources of income. He explained the majority of his income was from fish, but also stated he had never stopped shrimp culture. Although his income was from another product, he still considered himself in the shrimp industry, and his ponds, although full of fish, were still shrimp ponds.

Land uses measured at the time of this study offered a snapshot of the relative levels of abandonment and conversion. The study identified the uses of 3240 rai (547 ha) of former shrimp ponds. An estimated 77 ha (14%) of recorded ponds across all study areas were abandoned. Nearly twice as much area was still being used for intensive shrimp culture (140 ha), and more still had been converted to polyculture (161 ha). Two housing developments constructed on former shrimp ponds totaled 93 ha of the measured area. Fish culture was practiced on 9% of the area and salt pans represented 4%.

Interviews and observation in individual study areas provided more information about land dereliction. In Chachoengsao, when shrimp crops began to fail, farmers converted to fishponds. These farmers often returned to shrimp culture, or rented land to others for that purpose. The net result was a 5–10% decrease in the number of shrimp farmers over the past 12–13 years. In Samut Sakhon, however, it was difficult to find active farmers. Approximately 95% of ponds appeared to be unused. A former employee of a feed company identified several locations where many square kilometers of shrimp ponds had been converted to other uses, mainly industrial or housing developments and salt pans. In Chanthaburi, the majority of abandoned ponds seemed to be owned by absentee companies, and these represented approximately 5–10% of current ponds.

A wide variety of activities were being conducted on land that had formerly been intensive shrimp ponds (Table 2). The perception in the literature that abandoning ponds results in barren and unproductive land was not supported by field observations. Many farmers used banks of the ponds to grow crops such as lemongrass, flowers, and squash varieties for additional income. In some cases, however, environmental

Table 2. Number of main income generating activities and observed land conversions of farmers at the time of survey.

Activity	Chachoengsao	Chanthaburi	Samut Sakhon	Total
Shrimp Culture (Unconverted)	17	36	4	57
Polyculture	10	3	11	24
Fish Monoculture	6	2	2	10
Other Aquaculture	2	2	3	7
Rice Culture	5	1	0	6
Fruit Grove	2	1	2	5
Salt	0	0	3	3
Housing	0	0	3	3
Mangrove	0	0	1	1
Other	4	1	2	7
Conversion Totals	29	10	27	66

Table 3. Number of ponds and farms with various types of polyculture conversions. (1 rai = 1,603m^2).

Polyculture System	Farms	Ponds	Area (rai)
Fish and Shrimp	17	80	762.0
Multiple Fish Species	3	12	67.0
Shrimp and Mussels	2	3	160.0
Shrimp and Prawns	1	7	17.5
Fish and Crab	1	1	4.0
Shrimp and Crab	1	1	2.0
Fish and Frog	1	1	1.5

conditions made it impossible to grow terrestrial crops in former shrimp ponds, and alternate forms of aquaculture were practiced. The sample included a large number of fallow ponds that owners indicated were still primarily used for shrimp production.

With sites aggregated, the most popular conversion was adoption of polyculture (39% of farmers and 26% of ponds). The most popular polyculture was fish with shrimp (Table 3). Fifteen percent of farmers had converted to fish monoculture with the species of choice being tilapia (4 farms) and sea bass (3 farms). Some of these farms used fish to improve pond water and soil quality in order to return to intensive shrimp culture. The category of land use labeled "other" included a number of farms that returned to rice culture or coconut plantations. Crab culture and vegetable farming were also observed in a number of former shrimp ponds.

Presence or absence, and the proportions of various land-use activities, demonstrated distinct conversion options within study sites (Table 4). Intensive shrimp farms dominated Chanthaburi (58% of area), while conversions were more difficult to identify. The sample included only eight former shrimp farmers; seven had converted to other aquatic species (fish and crabs) while one was planning to rent land for shrimp culture. Thirteen current farmers moved from one farm to another when production declined, indicating a slight preference for relocation over conversion. In the other two study areas combined, only three active shrimp farmers had relocated. Almost

Table 4. Estimated areas of each land use for current and former shrimp ponds, based on interview and GPS results. (1 rai = 1,603m^2).

Land Use	Area (rai)	Percent of Area (%)
CHACHOENGSAO		
Polyculture	595.5	58.9
Shrimp	279.3	27.7
Fish	125.0	12.3
Abandoned	12.1	1.2
Total	**1,009.9**	
CHANTHABURI		
Shrimp	509.0	58.1
Abandoned	300.0	35.2
Polyculture	48.5	5.5
Fish	19.0	2.2
Total	**876.5**	
SAMUT SAKHON		
Housing	583.0	38.0
Polyculture	367.0	23.9
Abandoned	166.3	10.8
Fish	165.0	10.8
Salt	160.0	10.4
Shrimp	93.0	6.1
Total	**1,535.3**	

the entire area classified as abandoned in Chanthaburi was a single large company that had failed in its attempt to practice intensive culture on an industrial scale.

A much higher percentage of conversion was observed in Chachoengsao. Only 27% of the area surveyed was still dedicated to shrimp culture, while over 71% had been converted to other forms of aquaculture. Farmers clearly had opted for conversion over abandonment or sale of land. Very few people relied on only one source of income, and few individuals had moved away from agricultural pursuits.

In Samut Sakhon, conversion was much higher compared to the other study sites, reaching 84%. Many different types of

Table 5. Questions from surveys and the theme to which each belonged.

Survey Themes and Questions
PERCEPTION OF COMMUNITY WELL-BEING
4) In general the environment in the village is better now than in the past.
5) There is more opportunity for the children in the village now than in the past.
6) There is less crime in the village now than in the past.
7) People earn more money than in the past.
8) People in the village are happier than in the past.
9) People in the village work more than in the past.
10) There is less illness in the village than in the past.
12) The village has grown in the last 10 years.
13) There is more pollution in the village than in the past.
14) I see fewer sick people now than 10 years ago.
15) Local people have more representation in the government than 10 years ago.
EMPLOYMENT PREFERENCE
1) It is better to work on a farm than work in a factory.
2) It is better to work in a shop than in a factory.
3) It is better to work on a farm than in a shop.
11) Shrimp farmers have a better life than factory workers.
16) It is better to work for someone else than to work your own land.
17) People with their own land are less subject to economic problems.
18) Shrimp farmers have a better life than salt farmers.
19) Factory workers have a better life than shrimp farmers.
20) Salt farmers have a better life than factory workers.
21) The community would be better if there were more employment in factories.
22) The community would be better if more people owned their own land.
PROBLEM PERCEPTION
23) Have farmers had to change culture practices or leave land?
24) In your opinion, is there a problem with abandoned shrimp ponds?
25) In your opinion, is there a problem with under used land?

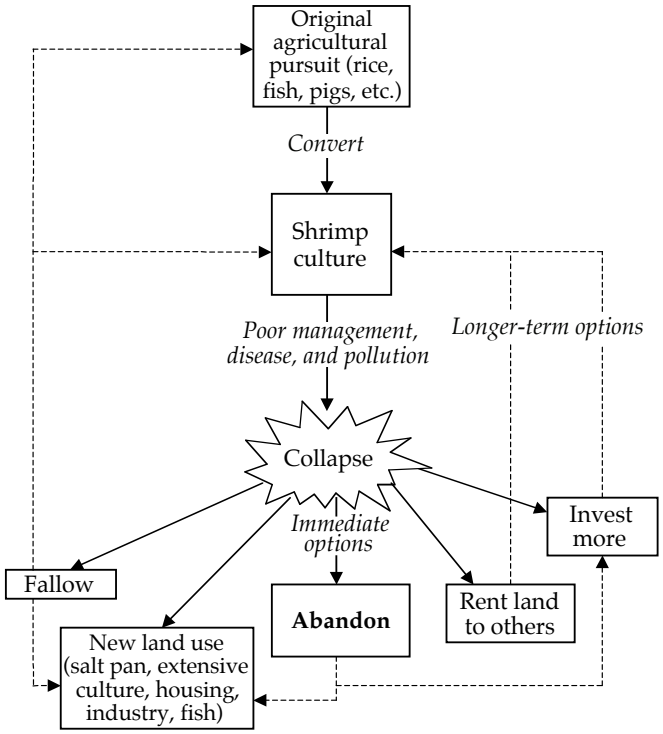

Figure 1 Shows the possibilities for a farmer to convert their land from agricultural pursuit of intensive shrimp culture, to another use, once shrimp production failed.

conversion were observed, and a larger portion of conversion involved land sale. Two housing developments accounted for the highest portion of conversion in area. Each of these had displaced approximately 200 farmers. Conversion to extensive systems using natural seed stock and no inputs was the most commonly observed aquacultural conversion in Samut Sakhon.

The interviews used to evaluate conversion options had common question sets broken down into three themes: perceptions of community well-being, employment preference, and problem perception. The former two themes were quantified using a five-point Likert scale, and the latter simply yes or no. Table 5 outlines questions from the survey and the theme to which each belonged.

Perceptions of community well-being indicate how respondents believed the community had developed through the evolution of shrimp culture. There was a perception of positive change in communities during the shrimp boom. Positive development was expressed by agreement with statements 4, 5, 6, 7, 8, 10, 14, and 15, and disagreement with statement 13. There was a strong agreement that villages had grown, that people worked more, and they earned more money. Respondents agreed children had more opportunity and defined this by explaining that education was better and there were more options for employment and mobility. There was a general sense that people were happier than in the past, and very strong agreement that there was more government representation for local people. In general, respondents believed there was less illness and fewer sick people. They also agreed there was more pollution than in the past. Despite experiencing more pollution, there was a sense that the environment in general was better. The only nonsignificant response was on question 6. Therefore, in general, respondents felt their communities had grown and developed in positive ways.

When data were grouped for individual study sites, the only significant difference occurred on the question of pollution. In Samut Sakhon, there was significantly stronger agreement than at the other sites that there was more pollution. When grouped by informant type, there were no significant differences.

Responses on employment preference indicated that land ownership and self-employment were more desirable than off-farm employment. There was very strong agreement for aggregate data that people with their own land are less subject to economic problems, and that communities would be better off if more people owned land. There was very strong disagreement that it is better to work for someone else than to own your own land. Respondents demonstrated a preference for shrimp farming over factory or retail work, and a preference for work in shops over factories. Respondents also preferred shrimp farming over salt farming, and salt farming over factory work.

When sites were compared to the aggregated total, respondents in Samut Sakhon differed significantly in opinion from the other two sites on a number of questions in the employment preference theme. They agreed more strongly that people with their own land were less subject to economic problems. They slightly disagreed that shrimp farmers had a better life than salt farmers, but they were stronger in agreement that salt farmers had a better life than factory workers.

Very few respondents identified any problems with shrimp culture or abandoned land. Over 70% of those sampled agreed farmers had to change practices or leave their land. When asked about abandoned or underutilized land, however, there was no sense that it was a problem at the local level. Eighty-

seven percent of the sample indicated there was no problem with abandoned shrimp ponds in the village. The opinions regarding underutilized land were not as clear. Overall, 71% of respondents stated there was no problem with underutilized land, but the responses from Chachoengsao and Samut Sakhon were not significantly different from random.

DISCUSSION

Three general statements about shrimp farm abandonment and conversion can be derived from this study. First, assessing the extent of abandonment was complicated by a high level of fluidity in land-use change. Second, local perception could be an important factor in adoption of sustainable land uses, and there was no perceived damage caused by shrimp culture and no perception of land dereliction being a problem. Third, there were clear preferences for the types of employment across all sites.

The design of this study was based on the concept that a farmer would convert his or her land from another agricultural pursuit to intensive shrimp culture, and then convert to another use when shrimp production failed. The process we found was not linear, but rather cyclic (Figure 1). The number of farmers that had failed at shrimp farming and had returned, either by relocating or by waiting for a period of time, indicated that land use decisions were not permanent, and failure at one time did not diminish the allure shrimp farming generated for future economic return.

The cyclical pattern of abandonment complicated quantification of abandoned, converted, or underused land as the extent of dereliction varied regionally and temporally. At times and in certain locations, shrimp culture may appear to be completely successful and sustainable. This assessment could lead to the erroneous conclusion that there was no problem with land dereliction in that area. Interviews and field observations indicated there were large areas of shrimp ponds not in use, and at any point, they could be brought back into use and just as quickly become idle again. Although land dereliction was difficult to precisely quantify, there were large areas of former shrimp ponds with little or no production of any sort. Given the importance of the agricultural sector in Thailand and its limitation by cultivable area, land dereliction on any scale presents a barrier to development.

Solving the land dereliction problem requires that the conversion cycle be broken. This study identified two factors that influenced the type of interventions likely to arrest rapid and unsustainable land-use change. First, issues that motivate a community to participate in an intervention, adopt technology, or make lasting changes must be considered. Secondly, the intervention should have its foundation in desires of the community and build on activities that are acceptable locally. Success of development activities has been linked to inclusion of local opinions (Blanchet, 2001; GESAMP, 2001; Barg, 1992).

Two important results related to how communities mobilize to address locally defined problems. The "perceptions of community development" theme was developed to offer insight into social impacts of shrimp culture. We assumed that perception of social degradation would provide impetus for a community to stop unsustainable shrimp culture and create pressure to move to other forms of income generation that had less severe effects. There must be local perception of a problem in order to facilitate local action. Therefore, the problem perception theme for questions inquired about local views of shrimp culture, pond conversion and land dereliction. Strong local perception of a problem would be another motivator to break the conversion cycle.

Many references on shrimp aquaculture predict that shrimp farming communities will experience dramatically negative social impacts from shrimp farming (Scott, 1998; Gujja and Finger-Stich, 1996; Quatro et al., 1996). Though this may occur in some locations, these impacts were not detected by this study. Respondents felt their communities were better off in a number of ways than they had been in the past. This study did not establish a causal link between shrimp culture and positive community development, but from the perspective of community members, it demonstrated improvement in some indicators of quality of life during the shrimp boom. However, it was possible that villagers did not recognize, or were unwilling to discuss, negative social impacts.

Data from all three study sites supported a trend toward further marginalization of the poorest shrimp farmers. The debt cycle created through shrimp culture caused farmers who failed to convert or sell land. In many cases, conversion required that farmers accept lower incomes (e.g., culture of fish or other aquatic species), or make additional capital investment (e.g., rice culture, housing, or industry). Poorest farmers are often unable to accept these conditions, and land sale is the most economically sensible option for them. After repaying debt, these farmers remain impoverished, landless laborers (Flaherty and Karnjanakesorn, 1995) left to seek employment outside the village where they farmed.

The perception that the community was better off than in the past may simply be an artifact of further marginalization of the poorest people. Conditions for these people may not have improved, but since they could have been forced out of the community by debt and need for employment, they would not be included in interviews.

There was no perception that communities were harmed by displacement of people, nor that the social legacy of shrimp culture was fundamentally negative. Therefore, social concerns were not sufficient by themselves to cause conversion of abandoned or poorly functioning farms.

There was no perception that land dereliction was a problem in any study site. The definition of "abandonment" played a role in how land dereliction was perceived. Land for which there were future intended uses was not perceived as derelict, regardless of time of fallow or uncertainty about when it would be brought back into production. Decisions regarding land conversion appeared to be made individually. Despite the amount of abandoned and unused land observed during data collection, respondents did not feel there was a problem, and therefore, there was little impetus for change.

Communities that recognize problems are often able to identify internal and external mechanisms to solve them. In the case of shrimp farming, respondents did not believe shrimp farming had caused a decline in quality of life or community well-being.

Informants from all sites preferred land-use options that permitted land owners to derive income from in situ activities. On-farm employment and land ownership were viewed as more economically secure and beneficial to the entire community. This indicated it was preferable to develop alternatives that allowed farmers to continue to produce, rather than sell land and seek employment elsewhere.

Informal interviews during the initial phase of research design resulted in the expectation that there were a limited number of uses for poorly functioning or abandoned ponds because of the environmental degradation caused by shrimp farming. These options were believed to be fish culture, salt production, mangrove restoration, housing development, and industrial development. The surprising diversity of observed land uses indicated that environmental conditions did not degrade as badly as expected. Further research should be conducted into how shrimp culture intensity and duration affects the land, in order to support more generalized discussion of environmentally viable conversion options.

In addition to promoting and researching desirable alternatives, the willingness of farmers to attempt and fail repeatedly at shrimp culture should be further examined. This research indicates, while farmers considered shrimp farming risky, the potential benefits far outweighed the potential losses. Recent advances in management practices such as effluent treatment, crop rotation, and better feeding practices have increased the likelihood of shrimp farming success and provided incentives for struggling farmers to continue. The incentives to continue shrimp farming are disincentives for conversion, and when shrimp culture is not successful, the land remains idle.

Environmental conditions, demographic factors, and historic employment impacted conversion options. Clear conversion trends existed in the three study sites. A larger percentage of farmers sampled in Chanthaburi had relocated and continued shrimp culture compared to other areas. Chanthaburi had much stronger infrastructure to support shrimp farming. Land intended for industrial development was available for rent as shrimp farms, and land availability allowed farmers to relocate when production declined. Additionally, farmers in Chanthaburi could take advantage of an active private sector, which provided advice on pond management and market conditions. Additional infrastructure made relocation to continued high-income generation preferable to conversion in this changwat.

In Chachoengsao, farmers were likely to diversify income sources and maintain land ownership. Much more area was dedicated to other forms of aquaculture than to any other type of conversion, and farmers indicated they had more than one source of income. Preference for on-farm income combined with decreasing land availability compelled farmers to diversify income sources.

In Samut Sakhon, more options were observed that required transfer of land ownership, such as housing and industrial development. Industry was rapidly growing in this changwat, providing a strong market for land. Respondents indicated that land speculation had become prevalent. The combination of industry and increases in associated land and water pollution combined with the land market leads many farmers to sell land rather than convert.

Despite commonalities in employment preferences and problem identification, the case studies indicated that other factors impacted land-use choices. Some of these factors include availability of land, infrastructure, environmental conditions, urban growth pressure, population density, and historic employment. These factors also must play a role in land-use change. The current study did not discover strong relationships between these factors, but field experience did indicate that this is an area that could also influence success of shrimp culture or conversion.

ANTICIPATED BENEFITS

The generalizations made above have important implications for programs seeking to reclaim abandoned shrimp ponds. The results also presented a number of questions that should be addressed in future research.

The cyclical model of conversion impacts how reclamation and rehabilitation activities must be structured. Shrimp farming continues to provide strong incentives for participation, and even perpetual crop failure did not seem to diminish the expectations of a great return on investment. Therefore, for the cycle of shrimp culture, conversion, and return to shrimp culture to be broken, incentives for appropriate land uses must be identified and promoted.

At the time of the study, regional trends in conversion indicated that more research should be conducted to link land price and availability, population growth and density, changing environmental conditions and proximity to urban centers to land-use decision-making. The interaction of these factors and their relative impact on individual decision-making are important in modeling future land-use trends. A stronger understanding of these dynamics can support policy development that can lead to more sustainable land uses.

This study demonstrated that conversion and abandonment did occur. Interventions, research, and policy should strongly consider the income generation preferences of local people. Inclusion of these preferences into reclamation or rehabilitation activities could strongly increase the likelihood of success for those activities. A wide variety of land-use options are environmentally and economically viable for abandoned shrimp ponds. Local preference should serve to limit proposed land-use options in order to increase likelihood of adoption and decrease social impact.

Adoption and dissemination of shrimp culture alternatives would be greatly enhanced by designing programs based on a thorough understanding of the local context. This study indicated that some commonalities could be drawn among areas in central Thailand, where shrimp culture had begun to fail on a large scale. These commonalities should play a role in how land dereliction is addressed on a regional level. At the same time, local variation in conversion patterns should be considered to help understand the specific dynamics of practice adoption. Development of programs based on a solid understanding of commonalities, but sensitive to local divergence, can contribute positively to remediation of derelict land and support the promotion of more sustainable land uses.

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Cite as: [Author(s), 2004. Title.] In: R. Harris, I. Courter, and H. Egna (Editors), Twenty-First Annual Technical Report. Aquaculture CRSP, Oregon State University, Corvallis, Oregon, [pp. ___.]