# 行政院國家科學委員會專題研究計畫 成果報告

## 養殖土地利用變遷及對地區經濟發展的影響：雲林及宜蘭地區的比較研究（II）
## 研究成果報告(精簡版)

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## 1. Introduction

Aquaculture, especially shrimp farming, can be a quick and important source of income and foreign exchange earnings. It can bring social and economic benefits to coastal areas that, for example, do not have the options of growing agricultural crops. The Food and Agriculture Organization (FAO) reports that aquaculture is probably the fastest growing food-producing sector (FAO 2006). But aquaculture can be a cause for social conflicts by competing with other coastal land uses such as mangroves, rice paddies, tourism, and preservation of nature (Martinez-Alier 2001; Lebel et al. 2002; Cheong 2003; Stead 2005). It can also lose its export competitiveness because of global competition (Tsai et al. 2006). More seriously, aquaculture has been linked to various regional and local environmental problems such as conversion of mangroves, salinization of groundwater and agricultural land, and pollution of coastal waters due to pond effluents (Flaherty and Karnjanakesorn 1995; Dierberg and Kiattisimkul 1996; Tisdell 1999; Senarath and Visvanathan 2001; FAO et al. 2006).

Taiwan’s aquaculture faces economic and environmental threats. Once a lead exporter, Taiwan has gradually lost its export competitiveness (Traesupap et al. 1999; Lee et al. 2003; Tsai et al. 2006) for the past two decades. As a result, production of shrimp and eel has decreased remarkably (Fig. 1). Taiwan has also been confronted with acute aquaculture-related environmental problems such as fish diseases, land subsidence, and flooding (Lin 1989; Chen 1990). As part of a solution to these environmental problems, government agencies have proposed plans that include conversion of aquaculture areas into wetlands, ecotourism, and adoption of new and refined aquaculture technologies (e.g., CEPD 2006). But the reality is that many aquaculture farmers are struggling to preserve their livelihoods, which have existed for several generations for some of them. Wetland and ecotourism are therefore not viable options at least at present. This leaves technology as an option that can accommodate both government agencies and aquaculture farmers.

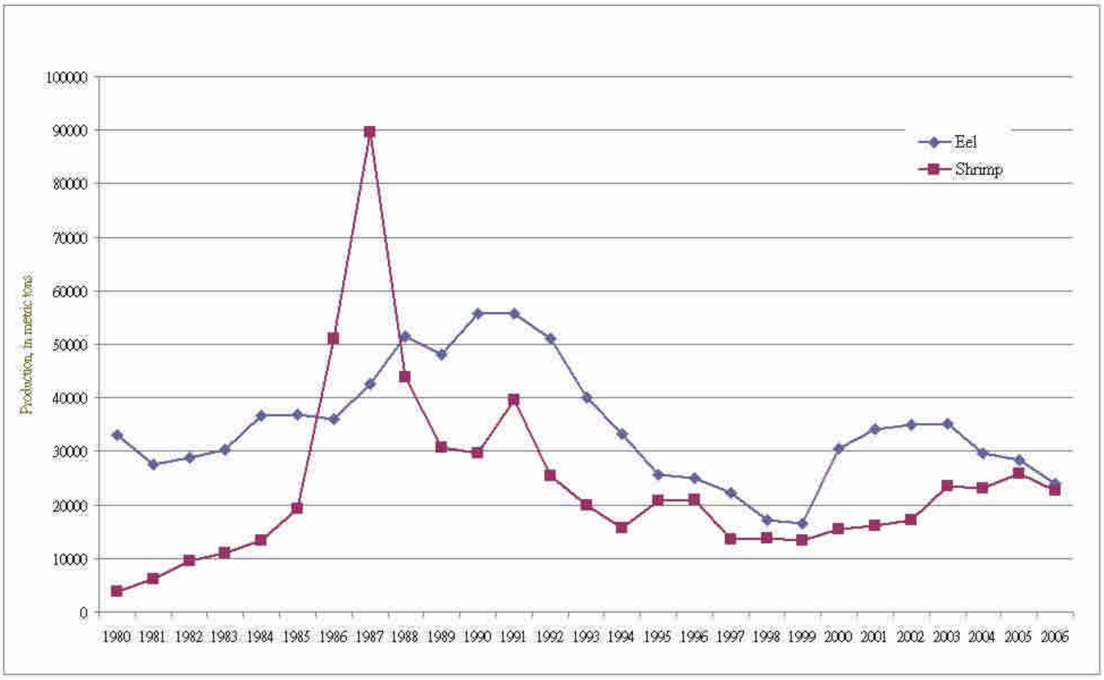


Fig. 1. Eel and shrimp production in Taiwan, 1980-2006. Data source: 2006 Taiwan Fishery Yearbook.

Previous studies have stated that agents (e.g., aquaculture farmers in this study) must be willing to accept new technologies before adopting them (Iyer-Raniga and Treloar 2000; Gordon et al. 2001; Lambin 2005; Stead 2005). However, few comprehensive studies have been made as to which types of agents are more likely to accept new technologies. Unless these “willing” agents can be identified, it will be difficult for planners to target their efforts and to succeed in their promotion of technology transfer.

Using Taiwan as a case study, this study attempts to find who are more willing to accept new aquaculture technologies. Because knowledge of local tradition, local history, and local circumstances is required for successful technology transfer (Ostrom 1990; Irvine and Kaplan 2001; Armitage 2005), this study also tries to gain a better understanding of local conditions such as who have abandoned aquaculture in the past and who are more likely to switch job or land use. We interviewed 224 aquaculture farmers in the field, and used logistic regression to find characteristics of these farmers that could explain their willingness to accept new technology, their previous abandonment experience, and their propensity to switch job or land use. It is hoped that results from this study can help planners of sustainable aquaculture identify potential adopters of environmentally friendly technologies.

## 2. Study Area

The study area consists of the coastal townships in Yunlin and Ilan Counties (Fig. 2). Four coastal townships in Yunlin are part of Taiwan’s core aquaculture area on the west coast. Clam has been the dominant species in the north, eel in the south, and shrimp along the coast in monoculture or polyculture (e.g., with clam) (Richards 1986; Tsai et al. 2006). In recent years, because of the government’s heavy promotion and favorable export markets, tilapia has also become a popular species in inland locations. Located in northeastern Taiwan, Ilan’s aquaculture grew rapidly in the 1970s with eel exports to Japan, followed by shrimp farming in the 1980s. Ilan has abundant precipitation and fresh water supply, which was instrumental to the initial expansion of aquaculture. But the cooler temperature accompanied by the northeast winter monsoon presents a limiting factor for Ilan’s aquaculture. Shrimp (white, black tiger, and grass shrimp) is still the dominant species.

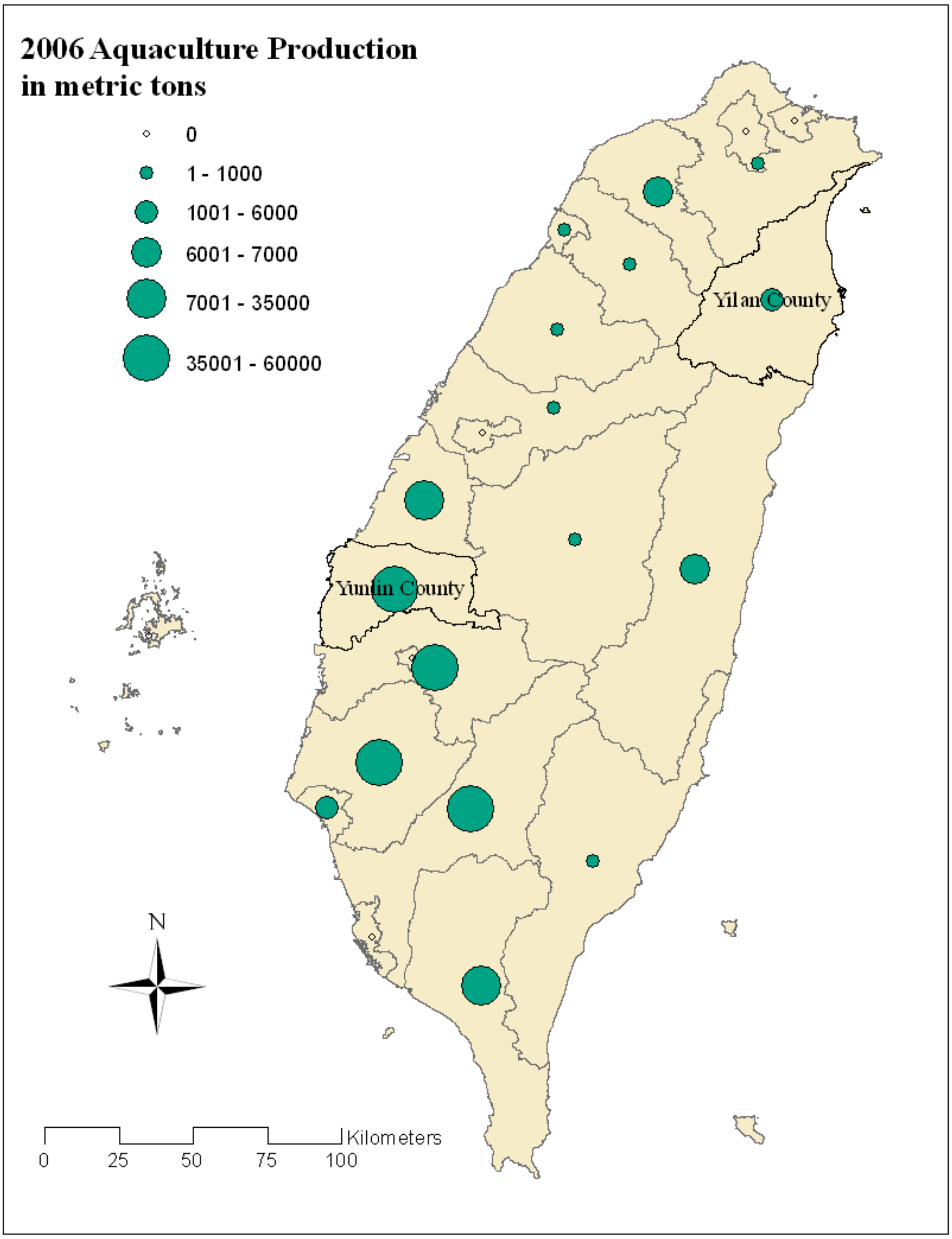


Fig. 2. Aquaculture production by county in Taiwan in 2006. Yunlin and Ilan Counties, which are included in the study area, are labeled. Data source: 2006 Taiwan Fishery Yearbook.

In 2005, the average household income in Yunlin County was 71% of Taiwan's average, making Yunlin the second poorest county in Taiwan. Ilan County fared better at 92% of Taiwan's average. Ilan is a one-hour drive from the Taipei metropolis, the largest metropolis in Taiwan with a population of three million. In contrast, Yunlin is far away from any major city. Overall, Ilan has a more diverse and vigorous economy than Yunlin.

**3. New and Refined Aquaculture Technologies**

This section describes new and refined aquaculture technologies that are relevant to the study area. Eel farmers in Taiwan have known the inland super-intensive recirculating eel culture system since the 1990s (Shyu 1998). The system consumes less than 10% fresh water of conventional eel culture and offers antibiotics-free features. The main hurdle for its adoption has been the high cost. Researchers have been looking for ways to lower its cost, such as building the system outdoors without the greenhouse (Shyu and Liao 2004).

Fish diseases continue to be a major problem for shrimp farmers. The reliance of antibiotics or other drugs to combat diseases has led to drug-resistant bacteria, which, when contained in the shrimp products with antibiotic residues or discharged with waste water, can have harmful effects on the consumers or the environment (Shyu and Liao 2004). To minimize the use of antibiotics, researchers have been working on disease diagnoses and prevention, treatment of pond effluents, and development of disease free stocks (Liao and Chao 1997).

Inspection of the antibiotic residues in the eel products for export to Japan has been enforced in Taiwan since the 1990s. Increasingly, domestic consumers are also willing to pay higher prices for authenticated (safe) shrimp, clam, and other aquaculture products (Lee et al. 2006). Researchers are now in favor of adopting a Hazard Analysis Critical Control Point system to provide traceability in the Taiwanese aquaculture industry (Lee et al. 2006).

Taiwanese researchers have reported that de-hulled soybean meal can effectively replace fishmeal in diets for tilapia reared in a water re-circulating system without reduced growth rates (Wu et al. 2003; Lin et al. 2004). Because fishmeal in diets essentially converts low-cost fish species into a high-value species, soybean meal is highly favored as a cost efficient and sustainable substitute (FAO 2006; Deutsch et al. 2007).

## 4. Method

### *4.1 Questionnaire Survey*

Surveys are a common tool for gathering information in social sciences. They can be used to measure things such as attitudes, beliefs including predictions and assessments of importance, and facts including past behavioral experiences (Weisberg et al. 1996). The design of a questionnaire survey must be guided by previous studies. Economic studies of technology transfer have shown that farmers are more inclined to adopt new technologies that can cut production cost, increase profit, and reduce risk (MacLeod and Taylor 1994; Frank 1995; Ruttan 1996). Characterization studies of farmers have found that education level, age, available resources, and past experience tend to influence farmers' behaviors (Rogers 1995; Wadsworth 1995; Moseley 2000; Solano et al. 2000; Bergevoet et al. 2004). Finally, extension agencies, network membership, and perceived social pressures may also be important for adoption of farm technology (Wadsworth 1995; Bergevoet et al. 2004; Lockie 2006; Rehman et al. 2007).

Based on the literature review, the questionnaire for this study included 22 fixed choice questions. They covered three general categories: (1) background information on the farmer such as age, education level, farming experience, and size of his aquaculture operation; (2) risk factors such as fish diseases, land subsidence, typhoon, water supply, and impact of local industrial plants on aquaculture operations; and (3) economic aspects of aquaculture farming as well as of external factors such as market prices and government policies that might influence the farmer's decision-making.

Two surveys were conducted, one in Yunlin and the other in Ilan. The survey in Yunlin was conducted in September and October of 2004. Using a stratified sampling method and a target sample size of 100, we derived a number of persons for each township that was proportional to the size of the aquaculture area within the township. Aquaculture farmers for the survey were then randomly selected from each township. In the field, we were able to conduct the survey with 87 of the intended 100 farmers. The survey in Ilan was conducted in September 2005 and July 2006. Using a target sample size of 140 and the stratified sampling method, we were able to conduct the survey with 137 farmers in the field.

*4.2 Interview*

Informal interviews were conducted with government officials and aquaculture farmer association officials in Ilan in September 2005 and in Yunlin in September 2006 and March 2007. These interviews were primarily designed to obtain information on aquaculture technologies.

*4.3 Logistic Regression*

Logistic regression is useful when the dependent variable is category (e.g., presence or absence) and the explanatory (independent) variables are categorical, numeric, or both (Menard 2002). The logit model from a logistic regression has the following form:

$$\text{logit}\,(y) = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots$$

where the logit of *y* is the dependent variable, $x_i$ is the explanatory variable *i*, *a* is a constant, and $b_i$ is the regression coefficient *i*.

The logit of *y* is the natural logarithm of the odds:

logit (*y*) = $\ln(p/(1-p))$

where *p* is the probability of the occurrence of *y* and *p*/(1 - *p*) is the odds. To convert logit (*y*) back to the probability *p*, the above equation can be rewritten as:

$$p = \frac{\exp(a + b_1x_1 + b_2x_2 + b_3x_3 + ...)}{1 + \exp(a + b_1x_1 + b_2x_2 + b_3x_3 + ...)}$$

A logit model can be evaluated by the receiver operating characteristic (ROC). The ROC measures the fitness of a model or model accuracy on the basis of true positive (proportion of incidences correctly reported as positive) and false positive (proportion of incidences erroneously reported as positive) (Pontius and Batchu 2003). Typically, a probability value of 0.5 is used to determine whether the model has made a correct prediction (> 0.5) or not (< 0.5). Additionally, Cox and Snell $R^2$ and Nagelkerke $R^2$ measure how well the explanatory variables can predict and explain the dependent variable. Cox and Snell $R^2$ cannot achieve a maximum of 1, whereas Nagelkerke $R^2$ stretches the $R^2$ value to range from 0 to 1.

This study ran a series of logistic regression analyses at the general (combining the samples from Yunlin and Ilan) and local (treating Yunlin and Ilan separately) levels. The dependent variables were abandonment experience, switching job, switching land use, and willingness to accept new technology. Explanatory variables came from the farmer's responses to the questionnaire, which represented his background data and his views on risk factors and economic conditions. A number of explanatory variables such as age and the seriousness of fish diseases contained ordinal data. They were converted to binary data for the analysis. For example, fish_disease_34 separated farmers, who viewed the fish disease problem to be moderate or serious, from those, who did not. Two water supply questions were not used in the analysis because of missing data caused by some farmers using only brackish water or fresh water.

Logit models were first developed at the general level. Then explanatory variables selected for the abandonment experience and willingness to accept new technology models were used to develop the local models. If local differences did not exist between Yunlin and Ilan, then the local models should be similar to the general models.

## 5. Result

### *5.1 Questionnaire Survey*

Appendix 1 itemizes responses to the survey questions from 224 aquaculture farmers. It shows that 75% have a minimum of 11 years of experience in aquaculture farming, and 34% have abandoned aquaculture at least once during the past 10 years.

Compared to the general population in Taiwan, these farmers are older (only 8% are younger than 40 years old) and less educated (93% have <= 12 years of education). Almost 60% of those surveyed own the aquaculture farm, but 83% have fishponds that are smaller than three hectares.

With respect to the risk factors, 87% describe the fish disease problem as either moderate or serious, 70% complain about serious impacts from nearby industrial plants, and 59% suffer frequent damages from typhoons.

63% of the surveyed farmers do not have enough income to pay for the household expenses, 46% do not have enough capital to cover the farming costs, 64% are willing to switch to a different land use, and 55% are willing to switch to a different job if given the opportunity. Market price affects 54% of the surveyed farmers in their decision making and government policies 25%.

*5.2 Abandonment Experience*

Using the dependent variable that separates farmers who have, or have not, abandoned aquaculture within the past 10 years, the logit model includes five explanatory variables that are significant at the 0.1 level: fishpond_size, other_income, capital, age, and fish_disease (Table 1). The model is significant at 1% level (ROC = 74.5%, Cox & Snell $R^2$ = 0.171, Nagelkerke $R^2$ = 0.236, n = 224). A farmer is more likely to have abandoned aquaculture if he has a small fishpond (< 2 ha); has no income from other sources; has insufficient capital to pay for farming costs; is older in age (> 50); and considers the problem of fish diseases to be moderate or serious.

[Table 1]

*5.3 Switching Job*

Using the dependent variable that separates farmers who are, or are not, willing to switch to other jobs, the logit model includes two explanatory variables that are significant at the 0.1 level: edu_level, and capital (Table 2). The model is significant at the 1% level (ROC = 69.4%, Cox & Snell $R^2$ = 0.133, Nagelkerke $R^2$ = 0.178, n = 224). A farmer is more likely to switch job if he has years of education > 9 and has insufficient capital for farming costs.

[Table 2]

*5.4 Switching Land Use*

Using the dependent variable that separates farmers who are, or are not, willing to switch to different land uses, the logit model includes edu_level as the only explanatory variable that is significant at the 0.1 level (Table 3). The model is significant at the 1% level (ROC = 60.4%, Cox & Snell $R^2$ = 0.040, Nagelkerke $R^2$ = 0.055, n = 224). A farmer is more likely to switch to a different land use if he has > 9 years of education.

[Table 3]

*5.5 Willingness to Accept New Technology*

The logit model, which separates farmers who are, or are not, willing to accept new technologies, includes five explanatory variables that are significant at the 0.1 level: fish_disease, abandonment_exp, fishpond_size, edu_level, and other_income (Table 4). The model is significant at 1% level (ROC = 72.1%, Cox & Snell $R^2$ = 0.137, Nagelkerke $R^2$ = 0.193, n = 224). The result shows that a farmer is more willing to accept new technologies if he considers the problem of fish diseases to be moderate or serious, has not had abandonment experience, has fishpond size > 2 ha, has > 9 years of education, and has income from other sources.

[Table 4]

*5.6 Yunlin Models*

Of the five explanatory variables selected for abandonment of aquaculture in the general model, the Yunlin model includes fishpond_size and other_income that are significant at the 0.1 level. Two other variables, fish_disease and capital, are close to the 0.1 level. This local model is significant at the 0.1 level (ROC = 88.8%, Cox & Snell $R^2$ = 0.394, Nagelkerke $R^2$ = 0.547, n = 87).

Of the five explanatory variables selected for willingness to accept new technology in the general model, the Yunlin model includes only abandonment_exp that is significant at the 0.1 level. Three other variables are close to the 0.15 level.

This local model is significant at the 0.1 level (ROC = 75.0%, Cox & Snell $R^2$ = 0.172, Nagelkerke $R^2$ = 0.238, n = 87).

*5.7 Ilan Models*

The Ilan model for abandonment of aquaculture includes capital that is significant at the 0.1 level. Two other variables, fishpond_size and other_income, are close to the 0.1 level. The model is significant at the 0.1 level (ROC = 64.4%, Cox & Snell $R^2$ = 0.071, Nagelkerke $R^2$ = 0.098, n = 137).

The Ilan model for willingness to accept new technology includes fish_disease and fishpond_size that are significant at the 0.1 level. The other three explanatory variables in the general model all have probabilities close to 0.1. The Ilan model is significant at the 0.1 level (ROC = 72.4%, Cox & Snell $R^2$ = 0.147, Nagelkerke $R^2$ = 0.211, n = 137).

## 6. Discussion

*6.1 Abandonment Experience and Willingness to Accept New Technology*

Interestingly, abandonment experience is a significant explanatory variable for willingness to accept new technology. Farmers who have abandoned aquaculture within the past 10 years are those who have small fishponds, insufficient capital for farming costs, and no income from other sources. In other words, these are poorer farmers in the sample who have given up aquaculture in the past and may do so again in the future. They are not willing to accept new technology because they probably cannot afford the additional cost and are not really committed to aquaculture for making a living.

Moderate or serious fish disease problem is the only significant explanatory variable for both the abandonment experience model and the willingness to accept new technology model. This result is not contradictory as it appears to be. Nearly 90% of farmers in the survey have experienced moderate or serious fish diseases; therefore, the fish disease problem becomes a factor for abandoning aquaculture as well as for being willing to accept new technology. Farmers, who do not have enough income or capital, are likely to abandon aquaculture when facing the additional fish disease problem. On the other hand, farmers, who are better-off financially, probably hope that new technology can reduce or even solve the fish disease problem.

The model for willingness to accept new technology has a significant, positive relationship with education level. This result is consistent with studies of diffusion of innovations that suggest that earlier adopters of technologies tend to have more years of formal education (Rogers 1995; Moseley 2000; Solano et al. 2000; Bergevoet et al. 2004). This study, however, also shows that farmers with a higher level of education (> 9 years) are more likely to switch to a different job or a different land use. Therefore, it is important for government planners to encourage these farmers to remain in aquaculture so that they can help promote new or refined technologies for achieving sustainable aquaculture.

*6.2 Local Difference*

For willingness to accept new technology, the local model has a ROC value of 75.0% for Yunlin and 72.4% for Ilan, suggesting that farmers in these two counties have similar views on the technology issue. For abandonment experience, the local model has a ROC value of 88.8% for Yunlin and 64.4% for Ilan; in other words, the explanatory variables selected for the general model perform poorly for Ilan. A series of runs with different combinations of explanatory variables were tried for Ilan, but none produced a ROC value of greater than 67%. There are two possible reasons for this poor model performance. First, the questionnaire did not include enough questions that are relevant to abandonment of aquaculture in Ilan. Second, abandonment of aquaculture is a more complicated issue in Ilan than Yunlin. Related to the second possible reason is the close proximity of Ilan to the Taipei metropolis, which not only creates a more diverse economy but may also create a more unstable condition for aquaculture, meaning that farmers may have many more different reasons for abandonment. A more detailed study is needed to better understand abandonment of aquaculture in Ilan.

*6.3 What's next?*

This study has identified the type of farmer, who is more willing to accept new technologies. What is next? Besides having new or refined technologies available for farmers to adopt, appropriate physical and institutional infrastructure must be in place to implement a technological change (Berkhout 2002; Tompkins and Adger 2002; Dietz et al. 2003; Lambin 2005; van der Brugge et al. 2005). For example, if an outdoor recirculation system becomes feasible, how should it be implemented in Yunlin? The cost is probably still too high for individual farmers to adopt their own systems. Should it be run by a farmer association? Or, should it be run by an extension office? Regardless of what final decision is reached, it should be made with inputs from all stakeholders for a technological change to be implemented successfully (Iyer-Raniga and Treloar 2000; Gordon et al. 2001; Stead 2005).

## 7. Conclusion

New or refined technologies may help solve aquaculture-related environmental problems. Based on a questionnaire survey, this study has found that farmers, who have larger fishponds, income from other sources, and higher levels of education but have not had abandonment experience, are more willing to accept new technologies. These farmers can serve as earlier adopters of technologies and promoters of technology transfer. However, some of these farmers with higher levels of education may also leave aquaculture for a new job or switch to a different land use. Therefore, for technology transfer to succeed, government planners must encourage these more highly educated farmers to remain in aquaculture.

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Appendix 1. Questionnaire questions and responses

Questions are in italic, with the variable name in bold in front of each question.

Responses to each question are presented in three sets of parentheses, from left to right: the total sample, the Yunlin sample, and the Ilan sample.

**Category 1:**

**Abandonment_exp.** *Have you abandoned aquaculture farming during the past 10 years? Yes, No*

(77, 147) (29, 58) (48, 89)

**Age.** *Age? <=39, 40-49, 50-59, >=60*

(18, 40, 67, 99) (11, 27, 27, 22) (7, 13, 40, 77)

**Edu_level.** *Education level? Illiterate, <=6 years of education, 6-9, 9-12, >12*

(31, 93, 56, 29, 15) (8, 29, 25, 18, 7) (23, 64, 31, 11, 8)

**Years_aqua.** *Years in aquaculture farming? <=5, 6-10, 11-15, 16-20, >20*

(22, 33, 41, 28, 100) (3, 24, 29, 8, 23) (19, 9, 12, 20, 77)

**Man_power.** *Other than the harvesting time, can you take care of aquaculture farming by yourself? Yes, No*

(176, 48) (72, 15) (104, 33)

**Ownership.** *Land ownership? Sole owner, Joint owner, Renter, A mix of the above*

(134, 4, 48, 38) (63, 2, 12, 10) (71, 2, 36, 28)

**Findpond_size.** *Size of fishpond? <=0.9 chia*, 1-1.9 chia, 2-2.9 chia, >=3 chia*

(70, 74, 43, 37) (17, 30, 23, 17) (53, 44, 20, 20)

**Category 2:**

**Operation_type**. *Have you raised, or do you raise, fish in brackish water, or fresh water, or both? Brackish water, Fresh water, Both*

(102, 32, 90) (53, 28, 6) (49, 4, 84)

**Fresh_water.** *Is it easy to get fresh water in your farming area? Easy, Fairly easy, Difficult*

(88, 39, 49) (22, 26, 39) (66, 13, 10)

**Salt_water.** *Is it easy to get salt water in your farming area? Easy, Fairly easy, Difficult*

(158, 22, 12) (52, 7, 0) (106, 15, 12)

**Fish_disease.** *How serious is the fish disease problem locally? Not serious, Fairly serious, Serious*

(29, 73, 122) (10, 36, 41) (19, 37, 81)

**Subsidence.** *How serious is the land subsidence problem locally? Not serious, Fairly serious, Serious*

(140, 30, 54) (9, 26, 52) (131, 4, 2)

**Typhoon.** *How often has your fishpond been damaged by typhoon? Often, Occasionally, Never*

(133, 67, 24) (40, 39, 8) (93, 28, 16)

**Ind_plant.** *What is the extent of impact that the new Formosa Petrochemical Corporation has brought to your local environment? No impact, Some impact, Serious impact*

(133, 67, 24) (8, 35, 44) (3, 21, 113)

**Category 3:**

**Household_exp.** *Is the income from aquaculture farming enough to cover your household expenses? Enough, Usually enough, Not enough*

(34, 48, 142) (13, 18, 56) (21, 30, 86)

**Capital.** *Do you have enough capital to pay for the farming costs? Enough, Usually enough, Not enough*

(101, 21, 102) (18, 9, 60) (83, 12, 42)

**Other_income.** *Income from other sources? Yes, No*

(122, 102) (50, 37) (72, 65)

**Switch_lu.** *Will you consider switching from aquaculture to a more profitable land use type? Yes, No*

(144, 80) (60, 27) (84, 53)

**Switch_job.** *Will you consider switching from aquaculture to a different, higher-income job? Yes, No*

(124, 100) (57, 30) (67, 70)

**Accept_NT.** *Are you willing to experiment with new aquaculture farming technologies? Yes, No*

(155, 69) (57, 30) (98, 39)

**Market_price.** *Does the market price influence your decision-making in aquaculture farming? Yes, No*

(120, 104) (76, 11) (44, 93)

**Gov_policy.** *Does the government policy affect your decision-making in aquaculture farming? Yes, No*

(55, 169) (29, 58) (26, 111)

From my NSC project, I developed a sustainable aquaculture project, which was later sponsored by the Global Land Project, a joint project for land systems for the International Geosphere-Biosphere Programme and the International Human Dimensions Programme.

I went to the University of Copenhagen in February 2007 to meet with Prof. Anette Reenberg, chair of the GLP, and Dr. Tobias Langanke, executive director of the GLP. We discussed about the working relationship between the sustainable aquaculture project and the GLP.

Appendix 1

GLP – a joint research agenda of IGBP and IHDP

# GLP newsletter

Newsletter of the Global Land Project International Project Office

June 2007 Issue No. 2

## Editorial

Welcome to this second Newsletter of the Global Land Project. After establishing the International Project Office (IPO) in Copenhagen in September 2006 and a meeting of the Scientific Steering Committee (SSC) in Beijing (November 2006), the GLP begins to take shape. In the past months we have focused on networking and planning for activities such as workshops.

GLP has no budget to contract and conduct research as such. GLP lives almost exclusively through the efforts and cooperation of individuals and (endorsed) projects that have funding from other sources, but who see a mutual interest in placing their project (or part of it) in the context of the Global Land Project.

We hope to be able to demonstrate the added value and synergies that GLP will provide in return. Workshops and other activities organized by GLP could lead to new cooperation's and networking and open new venues for publications. In a more general sense, being part of GLP could enable scientists to place their local or regional studies in a global context. GLP also hopes to initiate a stronger integration between the natural and the social sciences, not only in its synthesis activities, but also among existing and planned projects.

In this second GLP newsletter we provide you with an overview of the emerging GLP network by presenting the projects, activities and networks we have endorsed so far. The 3 nodal offices that GLP has set up in Japan (Sapporo), China (Beijing) and the UK (Aberdeen) will take a lead in initiating GLP activities in the form of workshops and educational activities and will be introduced in more detail in the next newsletter.

### Contents of this issue:

# Overview: Endorsed Research Projects and Programmes

The following list of projects reflects a wide ranging interest in contributing to the GLP. These projects, networks, programmes or PhD projects have applied for endorsement status within the last months and after a short review process have been granted GLP endorsement by GLP. This formal recognition of mutual interest in cooperation is a first step in establishing the practical details of a real cooperation. Some of these projects introduce themselves with a short summary of their work below.

- **Rationalising Biodiversity Conservation in Dynamic Ecosystems (RUBICODE).** *Paula Harrison, Environmental Change Institute, Oxford University, UK.*
- **North American Land Change: Decision Making in Coupled Human-Environment Systems.** *Steven M. Manson, Department of Geography, University of Minnesota, Minneapolis, USA.*
- **Fire-Land-Atmosphere Modeling and Evaluation for Southeast Asia (FLAMES).** *Darla K. Munroe, Department of Geography, Ohio State University, Columbus, USA.*
- **Sustainable Aquaculture Project.** *Kang-tsung (Karl) Chang, Department of Geography, National Taiwan University, Taipei, Taiwan.*
- **The Boston-Area Climate Experiment.** *Jeffrey Dukes, Department. of Biology, University of Massachusetts, Boston, USA.*
- **Refining plant functional classifications for earth system modelling.** *Sandra Lavorel, Colin Prentice, Sandra Diaz, Paul Leadley.*
- **Sustainable resource use or imminent collapse? Climate, livelihoods and production in the Southwest Pacific (CLIP).** *Department of Geography and Geology, University of Copenhagen and the Danish Meteorological Institute.*
- **History Database of the Global Environment (HYDE).** *Kees Klein Goldewijk, Netherlands Environmental Assessment Agency (MNP).*
- **The southern Yucatan peninsular region (SYPR) project. Landscape Vulnerability-Resilience in the SYPR**. *B. L. Turner II, Geography, Clark University*.
- **Monitoring Land Use/Land Cover Changes and its Envionmental Impacts in Karst Mountain Ecosystem: a spatial analysis integrating RS, GIS, social survey and climate data.** *Huang Qiuhao, Department of Resources, Environment & Geography, Peking University, Beijing, China.*
- **A Political Ecology of Postsocialist Land Use Change.** *Johannes Stahl, Institute for Agricultural Economics and Social Sciences, Humboldt University, Berlin, Germany.*
- **Tools for management and Sustainable Use of Natural vegetation in West Africa (SUN).** *Anne Mette Lykke, Department. of Systematic Botany, Aarhus University, Denmark.*

- **ARIDnet** (A Research Network for Studies of Global Desertification).
- **TERACC** (Terrestrial Ecosystem Response to Atmospheric and Climatic Change).
- **NEESPI** (Northern Eurasia Earth Science Partnership Initiative).
- **MRI** (Mountain Research Initiative).

## Sustainable Aquaculture Project

*Kang-tsung (Karl) Chang, Department of Geography, National Taiwan University, Taipei, Taiwan.*

Taiwan's aquaculture faces economic and environmental threats. Once a lead exporter, Taiwan has gradually lost its competitiveness due to globalization since the early 1990s. It is also confronted with acute aquaculture-related environmental problems such as land subsidence and flooding. This project attempts to tackle these challenges and find sustainable alternatives for Taiwan's aquaculture.

At present, the project is looking at a three-pronged solution: conversion to wetland, adoption of biotechnology, and introduction of ecotourism. Recently, we have used a system of rainfall runoff models, SOBEK, to assess the benefits of conversion of aquaculture area to wetland. We have also analyzed a questionnaire survey of aquaculture farmers to determine the characteristics of farmers who are more likely to accept new technologies.

Taiwan's experience is not unique; we invite aquaculture researchers from other countries to contact us and to participate in this important project.

http://www.geog.ntu.edu.tw/research/SAP/index.htm

*Ilan, Taiwan. Harvesting of white shrimp (Penaeus vannamei). Photograph: Karl Chang.*