Mangrove Dependency and the Livelihoods of Coastal Communities in Thailand

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Abstract

Between 1961 and 1996, Thailand lost 50-60% of its mangrove forests, mainly due to conversion to shrimp aquaculture. The speed and scale of deforestation has affected many coastal communities. This paper highlights the importance of mangroves to four case study villages. Households depend directly on mangrove forests for fish and wood collection and/or benefit indirectly from the mangroves' support to coastal fisheries. Mangrove loss therefore affects the decision of households to look for outside employment. In response to deforestation, female household members allocate more hours to employment relative to mangrove-dependent activities whereas males will allocate less hours to outside work. Awareness of community conservation efforts and of the environmental damages imposed by shrimp farms also motivates households to participate in replanting activities. Efforts to control mangrove deforestation and promote community-based management of remaining mangrove forests as well as replanting would help to mitigate some of the worst impacts on coastal villages. By developing institutions to support local community management, the Government of Thailand could help avoid excessive mangrove deforestation and conflicts over uses. Such a framework could also provide important lessons in coastal resource management for other countries in Southeast Asia and elsewhere

Introduction: Shrimp Farm Expansion and Mangrove Loss in Thailand

The issue of coastal land conversion for commercial shrimp farming is a highly debated and controversial topic in Thailand. Frozen shrimps are a major export product of Thailand, earning more than $1.6 billion each year, and the government has been keen to expand these exports (Barbier and Sathirathai 2004; Tokrisna 1998). Yet, expansion of shrimp exports has caused much devastation to Thailand's coastline and has impacted other valuable commercial sectors, such as fisheries.

Thailand's coastline is vast, stretching for 2,815 kilometers (km), of which 1,878 km is on the Gulf of Thailand and 937 km on the Andaman Sea (Indian Ocean) (Kaosa-ard and Pednekar 1998). In recent decades, the expansion of intensive shrimp farming in the coastal areas of Southern Thailand has led to rapid conversion of mangroves (Barbier and Sathirathai 2004). Over 1961-96, Thailand has lost around 20,500 km^2 of mangrove forests, or about 56% of the original area, mainly due to shrimp aquaculture and other coastal developments (Charuppat and Charuppat 1997). Estimates of the amount of mangrove conversion due to shrimp farming vary, but recent studies suggest that up to 50-65% of Thailand's mangroves have been lost to shrimp farm conversion since 1975 (Aksornkoae and Tokrisna 2004; Charuppat and Charuppat 1997; Dierberg and Kiattisimkul 1996). The rate of mangrove deforestation slowed in the 1990s, but in the mid-1990s the annual loss was estimated to be around 3,000 ha/year (Sathirathai 1998).

Although mangrove conversion for aquaculture began in Thailand as early as 1974, the boom in intensive shrimp farming through mangrove clearing took off in 1985 when the increasing demand for shrimps in Japan pushed up the border-equivalent price to $100 per kilogram (kg) (Barbier and Sathirathai 2004). For example, from 1981

to 1985 in Thailand, annual shrimp production through aquaculture was around 15 thousand metric tons (KMT), but by 1991 it had risen to over 162 KMT and by 1994 to over 264 KMT (Kaosa-ard and Pednekar 1998).

Shrimp farm area has expanded from 31,906 ha to 66,027 ha between 1983 and 1996. A more startling figure is the increase in the number of farms during that period, from 3,779 to 21,917. In general, this reflects a rapid shift from more extensive to more small-scale, intensive and highly productive aquaculture systems averaging 2-3 ponds with each pond comprising up to 1 hectare (ha) in size (Goss et al 2001; Kongkeo 1997; Tokrisna 1998). However, much of the semi-intensive and intensive shrimp farming in Thailand is short-term and "unsustainable", i.e. water quality and disease problems mean that yields decline rapidly and farms are routinely abandoned after 5-6 years of production (Dierberg and Kiattisimkul 1996; Flaherty and Karnjanakesorn 1995; Thongrak et al 1997; Tokrisna 1998; Vandergeest et al 1999).

Although shrimp farm expansion has slowed in recent years, unsustainable production methods and lack of know-how have meant that more expansion still takes place every year simply to replace unproductive and abandoned farms. Estimates of the amount of mangrove conversion due to shrimp farming vary, but recent studies suggest that up to 50-65% of Thailand's mangroves have been lost to shrimp farm conversion since 1975 (Dierberg and Kiattisimkul 1996; Tokrisna 1998). In provinces close to Bangkok, such as Chanthaburi, mangrove areas have been devastated by shrimp farm developments (Raine 1994). More recently, Thailand's shrimp output has been maintained by the expansion of shrimp farming activities to the far Southern and Eastern parts of the Gulf of Thailand, and across to the Andaman Sea (Indian Ocean) Coast (Flaherty and Karnjanakesorn 1995; Sathirathai 1998; Vandergeest et al 1999).

Moreover, conversion of mangroves by shrimp farm is irreversible. Without careful ecosystem restoration and manual replanting efforts, mangroves do not regenerate even in abandoned shrimp farm areas. In Thailand, most of the estimated 11,000 or more hectares (ha) of replanted areas over 1991-95 have occurred on previously unvegetated tidal mudflats (Lewis et al 2000). Such "afforestation" efforts have been strongly criticized as being ecologically unsound (Ertemeijer and Lewis 2000; Stevenson et al 1999). However, more recent efforts at mangrove replanting in Southern Thailand have focused on ecological restoration of mangrove areas destroyed by both legal and illegal shrimp ponds, although the total area restored is very small relative to the natural mangrove forest area that has been converted (Lewis et al 2000). Currently in Thailand there is no legal requirement that shrimp farm owners invest in replanting and restoring mangroves, once farming operations have ceased and the ponds are abandoned.

Shrimp farming does not necessarily have to pose any environmental threat, provided that wastewater from the farm has been treated before being released. In addition, it is possible to design shrimp aquaculture systems in coastal areas that do not involve removal of vegetation and areas naturally fed by tidal conditions. However, the establishment of these farm systems is too expensive for the type of small-scale pond operations found in much of Thailand, which are dependent on highly intensive and untreated systems through rapid conversion of mangrove and coastal resources (Thongrak et al 1997; Tokrisna 1998). Much of the financial investment in coastal shrimp farms is from wealthy individual investors and business enterprises from outside of the local community (Flaherty and Karnjanakesorn 1995; Goss et al 2000 and 2001). Although some hiring of local labor occurs, it is reported that many shrimp farm owners in coastal areas have hired Burmese workers as their wage rates are much lower.

Ill-defined property rights have accelerated the rapid conversion of mangroves to shrimp farms in Thailand. Historically, this has been a common problem for all forested areas in Thailand (Feder et al 1988; Feeny 1988, Feeny 2002; Thomson et al 1992). Although the state though the Royal Forestry Department ostensibly owns and controls mangrove areas, in practice they are *de facto* open access areas onto which anyone can encroach. This has had three impacts on mangrove deforestation attributable to shrimp farms. First, the open access conditions have allowed illegal occupation of mangrove areas for establishing shrimp farms, in response to the rising prices and profits from shrimp aquaculture (Barbier and Sathirathai 2004). This process has been a frequent occurrence historically on all of Thailand's forest lands, as noted by Feeny (2002). Second, in Thailand insecure property rights in cleared forest areas have been associated with under-investment in land quality and farm productivity (Feder et al 1987 and 1988; Feeny 1988 and Thomson et al 1992). The lack of tenure security for shrimp farms in Southern Thailand appears also to be a major factor in the lack of investment in improving productivity and adopting better aquaculture methods, leading to more mangrove areas being cleared than necessary (Barbier and Sathirathai 2004). Third, several studies have pointed out how open access forest lands in Thailand are more vulnerable to rapid deforestation and conversion to agricultural and other commercial uses as the development of roads and the highway network make these lands more "accessible" (Cropper et al 1999; Feeny 2002). Similar problems exist for the open access coastal mangrove areas in Southern Thailand. In particular, the geographical "spread" of shrimp farm expansion and accompanying mangrove deforestation has also proceeded from the more to less accessible areas: initially in the coastal provinces near Bangkok, spreading down the southern Gulf of Thailand Coast towards Malaysia, and

more recently beginning on the Andaman Sea (Indian Ocean) Coast (Flaherty and Karnjanakesorn 1995; Raine 1994; Sathirathai 1998; Vandergeest et al 1999).

Despite the lack of secure property rights and the frequently illegal occupation of mangrove areas, owners have an incentive to register their shrimp farms and converted land with the Department of Fisheries. In doing so, the farms become eligible for the preferential subsidies for key production inputs, such as shrimp larvae, chemicals and machinery, and for preferential commercial loans for land clearing and pond establishment (Tokrisna 1998; Barbier and Sathirathai 2004). Such subsidies inflate artificially the commercial profitability of shrimp farming, thus leading to more mangrove conversion, even though estimates of the economic returns to shrimp aquaculture in Thailand suggest that such conversion is not always justified (Sathirathai and Barbier 2001). Combined with insecure property rights, the subsidies also put further emphasis on shrimp aquaculture as a commercial activity for short-term exploitative financial gains rather than a long-term sustainable activity.

Case Study: Mangrove Use and Labor Allocation in Four Coastal Villages

To illustrate the importance of mangroves to the livelihoods of coastal communities in Thailand, we now draw on a case study of the labor allocation decisions of rural households from four representative villages in coastal areas of Thailand. The four case study villages are Ban Khlong Khut and Ban Gong Khong in Nakhon Si Thammarat Province on the Gulf of Thailand and Ban Sam Chong Tai and Ban Bang Pat in Phang-nga Province on the Andaman Sea (See Figure 1). These four villages have experienced similar rates of mangrove loss, again mainly due to conversion to shrimp ponds, as have occurred nationally in Thailand (Aksornkoae et al 2004). Such

mangrove deforestation has had important, albeit varying, impacts on the livelihoods of villagers. Some households in these four communities derive their income and subsistence directly from mangrove forests, in terms of fish collection, wood products and firewood. Other households benefit indirectly from the protection and support the mangroves give to coastal fisheries. A few engage in aquaculture.

A randomly stratified survey at the four village study sites was conducted during April-July 2000. Personal interviews of the head of the household were conducted by trained enumerators speaking the local language under the supervision of a team of Thailand based researchers, using a pre-tested survey designed by the author. Pre-testing of the questionnaires was conducted in February 2000. The first stage of the survey was conducted in Phang-nga from 17 to 23 April 2000. The second stage of the survey in Nakhon Si Thammarat was carried out from 2 to 8 July 2000.

The survey gathered information on household involvement in outside employment and important household characteristics such as age, education, household composition, number of children, debt and size of land holding, and various production/income characteristics. The survey also collected detailed information on the mangrove-based activities of households, including the area of mangrove utilized by the household for such activities. Details on household labor allocation were also obtained to establish if the household was undertaking other activities that were not dependent on mangroves.

At each site households in two different villages were surveyed, Ban Sam Chong Tai and Ban Bang Pat in Phang-nga and Ban Khong Khut and Ban Gong Khong in Nakhon Si Thammarat. Further background details on these four case study villages can be found in Aksornkoae et al (2004), which unless otherwise indicated, is the main reference for this section.

Ban Sam Chong Tai and Ban Bang Pat are located on Phang-nga Bay, the former having only poor road access and consisting mainly of traditional fishing households that also collect many products from the mangroves. Ban Bang Pat is quite different. The village is located on the main highway and is highly commercialized and relatively modern. Although the villagers here still engage in coastal fishing, they generally do less traditional collection from the mangrove areas. Some female villagers also conduct various agricultural activities, including tending any rubber plantations owned by the household. The Nakhon Si Thammarat villages, Ban Gong Khong and Ban Khlong Khut, have relatively high levels of urbanization and commercialization. As both villages are located on the coast, fishing is still a major activity for many households. Villagers in Ban Gong Khong still engage in traditional collection activities from the mangrove areas, but households in Ban Khlong Khut do much less collection. In Ban Khlong Khut some households have their own shrimp ponds, which occupy much of the female labor of the household. A large percentage of household members in both villages in Nakhon Si Thammarat turn to outside employment. The main source of employment for female villagers is nearby factories, whereas male villagers often work in commercial shrimp farms owned by outsiders.

The mangrove areas in Ban Sam Chong Tai have been degraded mainly due to forest concessions. According to Thai law, forest concessionaires are required to replant but in reality, reforestation has never taken place. Although the forests have not been completely cleared, extensive damage has occurred in much of the forest areas. In Ban Bang Pat the mangrove forests were first cleared by tin mining concessions. These activities not only destroyed the forests but also created extensive water pollution in the area. After the prices of the mineral fell drastically coupled with the severe decline of mangroves, the Cabinet resolution on 23 July 1991 abolished tin mining in mangrove

forests throughout Thailand. However, the unintended consequence was that the forests became open-access areas and became susceptible for conversion into shrimp farming, which is the current threat to the mangroves near Ban Bang Pat.

There are few remaining large areas of mangroves in Nakhon Si Thammarat Province. The major cause of the conversion of the mangroves along the east coast of Thailand has been shrimp farming. Historically, commercial shrimp aquaculture was established on the Gulf of Thailand because road access was better than on the Andaman Coast, and the mangrove areas were more easily converted to shrimp ponds (Flaherty and Karnjanakesorn 1995; Raine 1994; Vandergeest et al 1999). Mangrove areas in Nakhon Si Thammarat have in fact decreased by as much as 53,811 hectares (ha), or 87.93%, during the period of 1961-1996 (Charuppat and Charuppat 1997). This mangrove loss was much higher than the deforestation rate of 19,742 ha, or 33.56%, in Phang-nga over the same period. At present in Phang-nga there are still 38,138 ha of remaining mangrove area compared to only 7,389 ha in Nakhon Si Thammarat.

In Ban Sam Chong Tai Village in Phang-nga, the local community is very active in the conservation of mangroves. They consider an area of around 60 ha, which is legally owned by the state, as their own community forest. These villagers are small-scale fishermen, who when questioned during our survey, expressed knowledge that their local mangrove areas serve as breeding grounds and fry nurseries for coastal fisheries. In Ban Bang Pat, the local community also participates actively in the replanting of mangroves, but less so than in Ban Sam Chong Tai. The replanting projects in Ban Bang Pat were not initiated originally by the community but by outside non-governmental organizations (NGOs). The situation is similar in the two villages surveyed in Nakhon Si Thammarat where local re-planting schemes were started by NGOs or the Royal Forestry Department.

As noted, the survey of the four villages elicited from households their allocation of male and female labor to their main income-producing and other activities, as well as the key socio-economic characteristics for each household. Information on the employment of male and female labor in work outside of the household also included wage rates and detailed time allocations. In total 201 households were surveyed, although two households reported no direct or indirect income-producing activities that depend on mangroves and were excluded from the sample, leaving a total of 199 households. Of the latter households, 61 reported having at least one male member undertaking outside employment, and 33 have at least one female member participating in paid outside work.

Table 1.A provides a brief set of summary statistics for the entire sample split by the type of mangrove activities the household was predominately involved in. The table shows that 32 households were fishers involved in offshore fishing but did not collect mangrove products. 61 households were involved in direct use collection activities only and 104 households did a combination of both. From those three groups the collect only group had the greatest percentage of households devoting time to outside employment (49% of males and 32% of females). The households involved in both activities had the lowest percentages of households participating in outside employment (males 17% and females 7%). As might be expected the need to supplement income in the households only involved in collection activities is paramount. This result is reinforced by the figures for percentage of income that is mangrove based. The households that are solely involved in collection activities have the lowest proportion of mangrove-dependent income. At the other end of the scale for those households involved in both direct and indirect mangrove-based activities almost all of their income comes from these activities.

Table 1.B reports similar data by village. An interesting pattern also emerges here, in that the villages in Nakhon Si Thammarat have a lower proportion of income coming from mangrove-based activities and a higher percentage of households working in outside employment. Households in Phang-nga, on the other hand, obtain a much higher percentage of their income from mangrove-related activities and engage less outside employment, with the majority of households choosing to devote their time to both direct collection and indirect mangrove production activities.

Table 2 summarizes by village the household male and female labor allocation, in terms of average hours per year, for mangrove-dependent activities, agriculture, replanting and outside employment. For all four villages surveyed, collection of fish (mainly shellfish and crabs) from the mangrove swamps and coastal fishing are the principle sources of mangrove-dependent employment for male and female labor. Across the entire 199 surveyed households, both male and female household members devote a substantial number of hours each year to mangrove-dependent activities. This is not surprising, given that in the sample mangrove-based income accounts on average for 83% of all household income, with a relatively small deviation across households.

However, mangrove-based activities appear to require more male than female household labor. The exceptions are that females spend more making shrimp paste in Ban Sam Chong Tai and in producing dried fish in Ban Gong Khong. However, as Table 2 indicates, these two activities do not require a considerable amount of labor compared to the other mangrove-dependent activities conducted by the households. In the two Phang-nga villages, households allocate on average almost three times as many male hours to female hours per year to all mangrove-dependent fishing and collection activities. In the Nakhon Si Thammarat villages, the ratio of total male to female hours spent per year on these activities is around 3.7 for Ban Gong Khong and 4.3 for Ban

Khlong Khut. On average across all four villages, males spend over three times as many hours on mangrove-dependent activities as females.

In contrast, compared to males on average females spend proportionately much more of their time in outside employment relative to mangrove-based activities. Across all households, the ratio of the average hours in outside employment to hours in all mangrove-based activities ranges from 41% to 74% for females, whereas the ratio for males ranges from 11% to 28%. The difference between male and females is even more striking in comparing average labor allocation rates for only those households whose members participate in outside work. For the latter households, with the exception of Ban Sam Chong Tai village, males spend proportionately more of their time on mangrove-dependent activities relative to outside employment. For females, the number of hours in outside work relative to the hours in mangrove-based activities is 1.6 times greater in Ban Gong Khong, 4.9 times greater in Ban Khlong Khut and 5.4 times greater in Ban Bang Pat. For the four households in Ban Sam Chong Tai who report female members working in outside employment, none of the females engage in any mangrove-dependent activities. In all four villages, for those households reporting individuals engage in outside work, the total number of average hours per year spent in outside employment by females exceeds that of males.

However, males clearly receive higher wages for outside work compared to females. For the 32 households whose female members participated in outside employment, the average hourly wage received was 22.8 Baht/hour ($0.57/hour).[1] For the 60 households whose male members participated in outside work, the average hourly wage received was 44.5 Baht/hour ($1.11/hour).

Mangrove Loss and Labor Allocation in the Case Study Villages

The above case study survey of four coastal villages is ideal for analyzing the impacts of mangrove loss on labor allocation decisions in several respects. First, the livelihoods of the surveyed households from these villages clearly depend on the surrounding mangrove ecosystems (Aksornkoae et al 2004). Second, although a few households in these four villages also engage in agriculture, the main alternative to mangrove-dependent activities is employment as wage earners outside of the household. Thus, any depletion or degradation of local mangrove forests will affect the income earned by villagers from mangrove-dependent activities and influence their decision to participate in and supply labor to outside employment. Finally, as discussed above, the local mangrove systems near these four villages are continually threatened with further depletion.

Utilizing a three-step Heckman selection model, Barbier (2004) estimates the total effect of a change in mangrove area on the supply of labor to outside employment by mangrove-dependent households in the survey.[2] The results are reported in Table 3 in terms of both marginal effects (a one-hectare change in mangrove area) and elasticities (a one-percent change in mangrove area). Two interesting findings emerge from the analysis.

First, both males and females appear to have "backward-bending" supply curves with respect to the number of hours spent in outside employment, implying that higher wages lead to income effects that are greater than the substitution effects. The result is that as males and females receive higher wages for outside employment, the total number of hours that they spend engaged in such work actually declines. Such a negative "own-wage effect" is also found in other household outside employment

studies in developing countries (Hernández-Licona 1997; Rosenzweig 1980), and is consistent with the situation where households receive sufficiently low market wages yet its minimum subjective requirement of income for subsistence cannot be achieved without outside employment. It is very likely that these conditions hold for the mangrove-dependent households surveyed in coastal Thailand.

Second, a change in mangrove area may affect the amount of labor supplied to outside employment in two ways: through a direct effect on hours worked and through an indirect impact on hours worked via the wage rate. Table 3 indicates that there is a direct effect of a change in mangrove area on the number hours worked in outside employment for females, but not for males. Instead, mangrove changes influence the labor supplied by males for outside work indirectly through influencing the "own-wage effect" described above and a "cross-wage effect " via female wages. The latter effect indicates the extent to which household males adjust their hours devoted to outside employment as the wage paid to female household members for outside work changes. Both of these indirect wage effects of changes in mangrove area are therefore shown in Table 3, and the sum of these two effects equal the total effect of a change in mangrove area on labor supply by males. In contrast, only the own-wage indirect effect is significant in affecting the hours worked in outside jobs by females. As shown in Table 3, the latter indirect effect plus the direct impact of a change in mangrove area equal the total effect of a change in natural capital on female labor supply to outside employment.

The results reported in Table 3 suggest that for the surveyed mangrove-dependent households the dominant impacts of loss of natural capital on the supply of both male and female labor to outside employment arises through indirect own-wage effects. As noted above, both males and females appear to have backward-bending labor supply curves, where higher wages lead to income effects greater than any

substitution effects thus resulting in less hours worked. Because mangrove loss leads to a reduction in the wages that females will receive from outside employment, the result is that females will increase the hours that they work. In contrast, mangrove deforestation increases the wages that males receive from casual work, and as a result, they will work less hours in such employment.

Thus, the total effect of a loss in mangrove area is to reduce the supply of male labor to outside employment but to increase the supply by female members. Across the 199 surveyed households, a 1% decline in the local mangrove forests will cause the numbers of hours that males work in outside employment to decline by 0.7% while increasing the number of hours worked by females by 1.88%. Given the large losses in mangrove forests that have occurred in the two case study sites, e.g. each new shrimp farm established in these areas can deforest between 2 to 27 ha of mangroves at a time, such deforestation clearly has had a significant impact on the allocation of household labor in these coastal communities. In particular, an important response of the mangrove-dependent households to such deforestation appears to be to increase the division of labor between male and female members of these households: the supply of labor from female members to outside employment opportunities increases while the supply from males decreases. As indicated in Table 2, the result is that, for those households whose members participate in some outside work, females will continue to spend more hours in such employment relative to mangrove-dependent activities compared to males.

Case Study: Mangrove Dependency and Participation in Conservation Efforts

Barbier et al (2004) also test the hypothesis that the degree of mangrove-dependency is a major causative factor in the active participation of households from the four case study villages in conservation efforts. The hypothesis is that, once households realize that as mangrove area declines they will experience impacts on their livelihoods leading to income losses, the households will participate in the replanting of mangroves. Whether households choose to be involved in mangrove conservation is also likely to vary with the characteristics of the household and its location, land ownership and tenure considerations, awareness of and attitudes to community conservation efforts, including the replanting programs sponsored by non-governmental organizations and some international organizations, and concerns over the threat of the environmental impacts of shrimp farms. In addition, the decision to participate in mangrove conservation may vary between the male and female members of the household.

As indicated in Table 2, all mangrove-dependent households in the four case study villages allocate some time to replanting activities. However, the average hours per year spent replanting varies considerably across the villages. Males generally spend more time replanting than females.

Barbier et al (2004) depict a mangrove-dependent household's choice whether or not to participate in mangrove conservation as a binary decision, which can be empirically estimated through a bivariate probit estimation for household males and females. The regression results are depicted in Table 4.

The results show that the male decision to participate is most greatly influenced by household awareness of community conservation efforts and utilization rules, as shown by the positive coefficient and highest marginal probability. The degree of

mangrove-dependent income is the second most important positive influence, with a marginal probability of 0.28. The household's awareness of the environmental impact of shrimp farming is the other significant variable in the male equation. The positive coefficient and marginal probability of 0.13 suggest that males from households that are aware of the negative environmental impact of shrimp farms are more likely to participate in replanting.

For females, the degree of dependence of the household on mangrove-based income is significant at the 10 % level and is the most important variable influencing their participation. Distance to the mangroves from the household is the next most important influence. The negative coefficient suggests that females from households that live increasing distances from the mangroves are less likely to participate in replanting. The area of mangrove utilized by the household is also important in the female decision. The result suggests that females from households that collect and fish in larger mangrove areas are less likely to participate in conservation. This might reflect that the household recognizes that smaller mangrove areas require more replanting effort. The number of children under 6 years of age, as might be expected, also influences the female decision to participate. Finally the household awareness of community conservation and utilization rules positively affects female participation in replanting.

Finally, the variable RHO measures the degree to which a household determines simultaneously, or jointly, whether males and females should participate in mangrove conservation. This variable is positive and significant, suggesting that the participation decision is jointly determined.

Policy Implications

Drawing on a case study of four coastal villages surveyed in Thailand, this paper has shown that continuing mangrove deforestation not only has a significant impact on the allocation of household labor in Thai coastal villages that are traditionally dependent on directly or indirectly exploiting these forests but also affects considerably the intra-household division of labor. In response to such deforestation, for those households whose members participate in some outside work, females will continue to allocate more hours in such employment relative to mangrove-dependent activities whereas males will allocate less hours to such work. One might also expect other mangrove-dependent households to send their females who do not currently work out looking for outside employment.

There are two concerns arising from this intra-household allocation of labor in response to mangrove deforestation. First, for the households in the case study survey, the average hourly wage received by females ($0.57) is almost half that received by males ($1.11). If the households require income from outside employment to meet overall needs, then they may fall short of their outside income target if the households increasingly rely on female members to participate in such employment. Even if the households do achieve their target through supplying more female labor to outside work, there may be an impact on other non-income activities important to the welfare of the household that are traditionally undertaken by females, such as child rearing, food preparation, care of the elderly and housecleaning. Second, the decline in the number of hours spent by males in outside employment accompanying deforestation presumably means that the males will be more productively employed at the margin in mangrove-based activities. If this is the case, then household income from these

activities should increase. However, as noted above, the loss of mangrove area in the four case-study sites have been far from marginal. The large-scale land use changes that have occurred have already led to substantial losses to the local mangrove forests. Any large, and decidedly non-marginal, losses in the remaining mangrove areas, such as the current threat posed by conversion to commercial shrimp farms, would have devastating consequences for the livelihoods of the mangrove-dependent households. The current mangrove-based collection and fishing activities conducted by these households would be in danger of collapsing, and the amount of time that males spend in such activities would not increase but be drastically reduced.

Finally, the analysis of the decision by male and female members of mangrove-dependent households to participate in replanting activities suggests that awareness of community conservation efforts and of the environmental damages imposed by shrimp farms are powerful motivating forces. The degree of dependence of the household on mangrove-based income is also an important factor. However, participation in replanting by females appears to face additional considerations, such as the distance of the household to mangroves, the number of children under 6 in the household, and the size of the mangrove area.

The insights from the case study analysis of mangrove-dependent households in Thailand suggest two main policy implications.

First, there is an urgent need to address the main institutional failure concerning management of local mangrove resources in coastal areas of Thailand. The present law and formal institutional structures of resource management in Thailand do not allow coastal communities to establish and enforce their local rules effectively. This has an important impact on the ability and willingness of these communities to conserve and protect their local mangrove forests. For example, in Ban Sam Chong Tai Village in

Phang-nga, the local community is very active in the conservation of mangroves. They consider an area of around 60 ha as their own community forest, even though it is legally owned by the state and still faces threat from possible conversion to shrimp farming by outside investors. In the other three surveyed villages, replanting projects were not initiated by the community but by outside non-governmental organizations (NGOs) or the Royal Forestry Department. These villagers are less motivated to participate in these replanting schemes and also have less say in the management of the remaining mangrove forests.

A new institutional framework for coastal mangrove management in Thailand that could make a difference to these and other coastal communities might contain the following features (Barbier and Sathirathai 2004). First, remaining mangrove areas should be designated into conservation (i.e. preservation) and economic zones. Shrimp farming and other extractive commercial uses (e.g., wood concessions) should be restricted to the economic zones only. However, local communities who depend on the collection of forest and fishery products from mangrove forests should be allowed access to both zones, as long as such harvesting activities are conducted on a sustainable basis. Second, the establishment of community mangrove forests should also occur in both the economic and conservation zones. However, the decision to allow such local management efforts should be based on the capability of communities to effectively enforce their local rules and manage the forest sustainably. Moreover, such community rights should not involve full ownership of the forest but be in the form of user rights. Third, the community mangrove forests should be co-managed by the government and local communities. Such effective co-management will require the active participation of existing coastal community organizations, and will allow the representatives of such organizations to have the right to express opinions and make

decisions regarding the management plan and regulations related to the utilization of mangrove resources. Finally, the government must provide technical, educational and financial support for the local community organizations participating in managing the mangrove forests. For example, if only user rights (but not full ownership rights) are granted to local communities, then the latter's access to formal credit markets for initiatives such as investment in mangrove conservation and replanting may be restricted. The government may need to provide special lines of credit to support such community-based activities.

A second policy initiative would be to focus on improvements in education and skills training, especially for females. Of the surveyed households, over two thirds of the households with female members employed in outside work are from the two villages in Nakhon Si Thammarat (see Table 1.B), where the main source of employment is near-by factories hiring relatively unskilled and young female workers in textiles and other light manufacturing occupations. The very low average female wage rate across all households suggests that outside employment for all females involves little or no skills. Given the current reliance of mangrove-dependent households on their female members participating in outside employment, and that this reliance will only increase as mangrove deforestation continues, then improved education and skills training for young females in the households may be increasingly important for the future income-earning potential and welfare of these households.

References

Abdulai A, Delgado C. 1999. Determinants of non-farm earnings of farm-based husbands and wives in northern Ghana. American J. of Agri. Econ. (81): 117-130.

Aksornkoae S, Sugunnasil W, Sathirathai S. 2004. Analytical background of the case studies and research sites: ecological, historical and social perspectives. In Barbier E.B. Sathirathai S., editors, .Shrimp farming and mangrove loss in Thailand. London: Edward Elgar. p 73-95.

Aksornkoae S, Tokrisna R. 2004. Overview of shrimp farming and mangrove loss in thailand. In Barbier EB, Sathirathai S, editors. Shrimp farming and mangrove loss in Thailand. London: Edward Elgar. p 37-51.

Barbier EB. 2004. Natural capital and labor allocation: mangrove-dependent households in Thailand. *mimeo.* Department of Economics and Finance, University of Wyoming, Laramie, Wyoming.

Barbier EB, Cox M. 2004. An economic analysis of shrimp farm expansion and mangrove conversion in Thailand. Land Economics 80(3):389-407.

Barbier EB, Suthawan S, editors. 2004. Shrimp Farming and Mangrove Loss in Thailand. London: Edward Elgar.

Barbier EB, Cox M, Sarntisart I. 2004. Household use of mangrove and mangrove conservation decisions. In Barbier EB and Suthawan S, editors. 2004. Shrimp farming and mangrove loss in Thailand. London: Edward Elgar. p. 115-130.

Charuppat T, Charuppat J. 1997. The use of Landsat-5 (TM) satellite images for tracing the changes of mangrove forest areas of Thailand. Bangkok: Royal Forestry Department.

Coxhead I, and Jayasuriya S. 2003. The open economy and the environment: development, trade and resources in Asia. Northampton, MA: Edward Elgar.

Cropper M, Griffiths C, Mani M. 1999. Roads, population pressures, and deforestation in Thailand, 1976-1989. Land Econ. 75(1):58-73.

Dierberg F.E. Kiattisimkul W. 1996. Issues, impacts and implications of shrimp aquaculture in Thailand. Environ. Manag. 20(5):649-666.

Erftemeijer PLA, Lewis RR III. 2000. Planting mangroves on intertidal mudflats: habitat restoration or habitat Conversion? In Sumantakul V, et al, editors. Enhancing coastal ecosystem restoration for the 21st century. proceedings of the regional seminar for east and southeast Asian countries: ECOTONE VIII. Ranong and Phuket, Thailand, 23-28 May 1999. Bangkok, Thailand: Royal Forestry Department. p 156-165.

Feder G, Feeny D. 1991. Land Tenure and Property Rights: Theory and Implications for Development Policy. World Bank Econom. Rev. 5(1):135-153.

Feder G, Onchan T. 1987. Land ownership security and farm investment in Thailand. American Journal of Agricultural Economics 69:311-320

Feder G, Onchan T, Chalamwong Y, Hongladarom C. 1988. Land policies and farm performance in Thailand's forest reserve areas. Econ, Devel. and Cult. Change 36 (3): 483-501.

Feeny D. 1988. Agricultural expansion and forest depletion in Thailand, 1900-1975. In Richards JF, Tucker R, editors. World deforestation in the twentieth century. Durham, NC: Duke University Press. p. 112-143.

Feeny D. 2002. The co-evolution of property rights regimes for man, land, and forests in Thailand, 1790-1990. In. Richards JF, editor. Land property and the environment. San Francisco: Institute for Contemporary Studies Press. p 179-221.

Flaherty M, Karnjanakesorn C. 1995. Marine shrimp aquaculture and natural resource degradation in Thailand. Environmental Management 19(1):27-37.

Goss J, Burch D, Rickson RE. 2000. Agri-food restructuring and third world transnationals: Thailand, the CP Group and the Global Shrimp Industry. World Dev. 28 (3): 513-530.

Goss J, Skladany M, Middendorf G. 2001. Dialogue: shrimp aquaculture in Thailand: a response to Vandergeest, Flaherty and Miller. Rural Sociology 66 (3): 451-460.

Hernández-Licona G, .1997. Oferta laboral familiar y desempleo en Mexico. *Trimestre Económico* (64): 531-568.

Kaosa-ard M, Pednekar SS. 1998. Background report for the Thai Marine Rehabilitation Plan 1997-2001. Report submitted to the Joint Research Centre of the Commission of the European Communities and the Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand Development Research Institute, Bangkok.

Kongkeo H, 1997. Comparison of intensive shrimp farming systems in Indonesia, Philippines, Taiwan and Thailand. Aquacul. Res. 28: 89-796.

Lass DA, Findeis JL, Hallberg MC. 1991. Factors affecting the supply of off-farm labor: a review of empirical evidence. In Hallberg MC, Findeis JL, Lass DA, editors. Multiple job-holding among farm families. Ames, IA: Iowa State University Press.

Lewis RR III, Erftemeijer PLA, Sayaka A, Kethkaew P. 2000. Mangrove rehabilitation after shrimp aquaculture: a case study in progress at the Don Sak National Forest Reserves, Surat Thani, Southern Thailand. Mimeo, Mangrove Forest Management Unit, Surat Thani Regional Forest Office, Royal Forest Department, Surat Thani, Thailand.

Raine RM. 1994. Current land use and changes in land use over time in the coastal zone of Chathaburi Province, Thailand. Biological Conservation 67:201-204.

Rosenzweig MR. 1980. Neoclassical theory and the optimizing peasant: an econometric analysis of market family labor supply in a developing country. Quart. J, of Econ. 94:31-55.

Sarnitsart I, Sathirathai S. 2004. Mangrove dependency, income distribution and conservation decisions. In Barbier E.B. and Sathirathai S., editors. Shrimp Farming and Mangrove Loss in Thailand. London: Edward Elgar. p 96-114.

Sathirathai S. 1998. Economic valuation of mangroves and the roles of local communities in the conservation of the resources: case study of Surat Thani, South of Thailand. Final report submitted to the Economy and Environment Program for Southest Asia (EEPSEA), Singapore.

Sathirathai, S. and Barbier, E.B., 2001. "Valuing Mangrove Conservation, Southern Thailand," Contem. Econ, Pol. 19(2):109-122.

Stevenson NJ, Lewis RR III, Burbridge PR. 1999. Disused shrimp ponds and mangrove rehabilitation. In. Streever W, editor. An International perspective on wetland rehabilitation. Dordrecht, The Netherlands: Kluwer Academic Publishers. p. 277-297.

Thomson JT, Feeny DH, Oakerson RJ. 1992. Institutional dynamics: the evolution and eissolution of common property resource management. In Daniel W Bromley. Editor. Making the commons work: theory, practice, and policy. San Francisco: San Francisico, Institute for Contemporary Studies Press. p. 129-160.

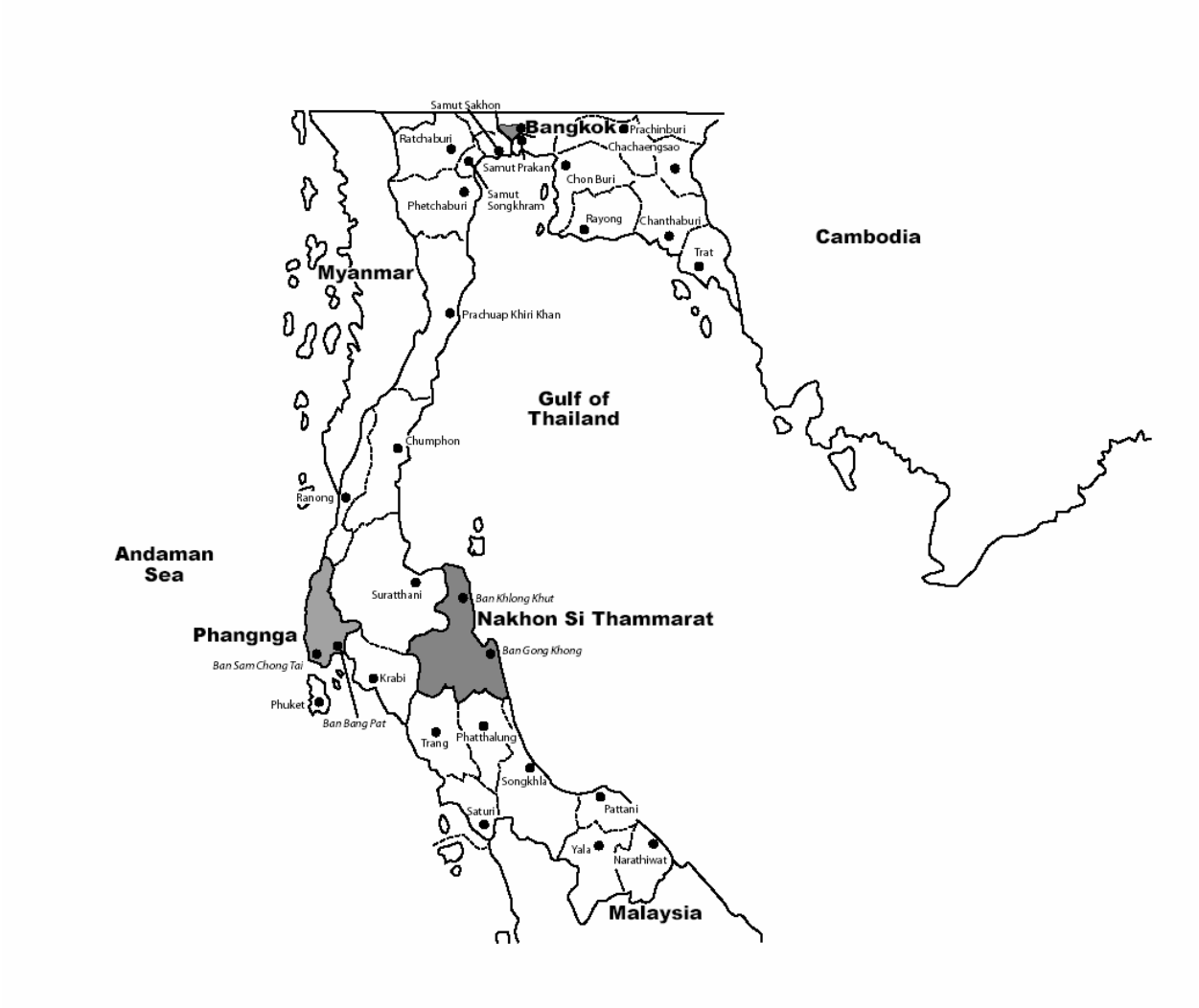
Thongrak S, Prato T, Chiayvareesajja S, Kurtz W. 1997. Economic and water quality evaluation of intensive shrimp production systems in Thailand. Agric. Syst. 53: 121-141.

Tokrisna R. 1998. The use of economic analysis in support of development and investment decision in Thai aquaculture: with particular reference to marine shrimp

culture. A paper submitted to the Food and Agriculture Organization of the United Nations.

Vandergeest P, Flaherty M, Miller P. 1999. A political ecology of shrimp aquaculture in Thailand. Rural Sociology 64(4):573-596.

Figure 1. Case Study Villages, Thailand



Source: Barbier and Sathirathai (2004).

Table 1. Summary Statistics for Outside Employment

A. By Household Type

	Fish Only N = 32		Collect Only N = 63		Fish and Collect N = 104	
	Male	Female	Male	Female	Male	Female
Outside employment						
Number (N)	12	6	31	20	18	7
(% of total)	(38%)	(19%)	(49%)	(32%)	(17%)	(7%)
Mangrove-dependent income share of total income	82%		75%		93%	

B. By Village

	Phang-nga				Nakhon Si Thammarat			
	Ban Sam Chong Tai N = 55		Ban Bang Pat N = 41		Ban Gong Khong N = 52		Ban Khlong Khut N = 51	
	M	F	M	F	M	F	M	F
Outside employment								
Number (N)	8	4	7	7	31	12	15	10
(% of total)	(15%)	(7%)	(17%)	(17%)	(60%)	(23%)	(29%)	(20%)
Mangrove-dependent income share of total income	95%		89%		66%		83%	
Fish only	1		5		3		23	
Collect only	19		3		34		7	
Fish and Collect	35		33		15		21	

Table 2. Summary Statistics for Labor Allocation - By Village
(Average hours per year)

	Phang-nga				Nakhon Si Thammarat			
	Ban Sam Chong Tai N = 55		Ban Bang Pat N = 41		Ban Gong Khong N = 52		Ban Khlong Khut N = 51	
	Male	Female	Male	Female	Male	Female	Male	Female
Wood collection	5.18	0.84	3.76	0.05	10.67	4.41	10.57	0.76
Fuelwood and charcoal	5.82	0.00	0.00	0.00	3.96	2.56	0.00	0.47
Fish Collection	610.85	218.89	125.73	110.41	1,367.73	386.88	324.02	35.22
Shrimp paste	28.87	123.35	23.27	2.93	4.35	4.73	0.00	0.00
Dried fish	0.00	0.00	0.00	0.00	9.81	12.23	1.73	1.12
All collection	**650.73**	**343.07**	**152.76**	**113.39**	**1,396.51**	**410.82**	**336.31**	**37.57**
Coastal fishing	783.20	194.09	965.20	279.73	857.50	195.69	2,231.98	520.27
Aquaculture	37.07	12.75	19.46	14.66	0.00	4.65	19.96	47.65
All fishing	**820.27**	**206.84**	**984.66**	**294.39**	**857.50**	**200.35**	**2,251.94**	**567.92**
All mangrove-based activities	**1,471.00**	**549.91**	**1,137.41**	**407.78**	**2,254.01**	**611.16**	**2,588.25**	**605.49**
Agriculture	**0.00**	**0.00**	**0.00**	**35.12**	**452.69**	**253.15**	**82.37**	**33.02**
Replanting mangroves	**22.69**	**14.07**	**18.94**	**9.43**	**61.69**	**18.77**	**2.37**	**0.31**
Outside work a/	**157.56**	**225.64**	**176.66**	**301.68**	**621.67**	**361.52**	**541.67**	**393.41**
(% of mangrove-based hours) b/	(11%)	(41%)	(16%)	(74%)	(28%)	(59%)	(21%)	(65%)
Adjusted outside work c/	**1,083.25**	**3,102.50**	**1,034.71**	**1,767.00**	**1,042.81**	**1,566.58**	**1,841.67**	**2,006.40**
(% of mangrove-based hours) b/	(130%)	--	(86%)	(542%)	(61%)	(155%)	(59%)	(490%)

Notes: a/ Hours in outside employment averaged across all households.
b/ Ratio of average hours in outside employment to average hours in all mangrove-based activities.
c/ Hours in outside employment averaged across households whose members participate in such work.

Table 3. The Effect of a Change in Mangrove Area on the Supply of Outside Labor

		Males		
	Direct Effect	**Indirect Effect (via male wages)**	**Indirect Effect (via female wages)**	**Total Effect**
Marginal effects	--	0.13	-0.09	**0.04**
Elasticities	--	2.30%	-1.60%	**0.70%**
		Females		
	Direct Effect	**Indirect Effect (via male wages)**	**Indirect Effect (via female wages)**	**Total Effect**
Marginal effects	0.26	--	-0.35	**-0.09**
Elasticities	5.36%	--	-7.25%	**-1.88%**

Source: Barbier (2004).

Table 4. Male and Female Participation in Mangrove Replanting Efforts

Variable	Males			Females		
	Coeff.	t-ratio	Marginal Prob	Coeff.	t-ratio	Marginal Prob
Constant	-2.4374	-2.4800	-0.6146	-1.9948	-1.6098	0.2741
Mangrove dependent income as a proportion of total income	1.1070	1.9772	0.2792	1.5465	1.7843	-0.2125
Area of mangrove used by household (ha)	-0.0002	-0.1428	0.0000	-0.0057	-2.2296	0.0008
If household is aware of community conservation efforts and utilization rules AWARE =1, otherwise = 0.	1.1357	4.3000	0.2864	0.8765	2.6493	-0.1204
If household believes shrimp farming has a negative environmental impact ATSFARM=1, otherwise = 0	0.5012	1.6316	0.1264	0.8173	1.4319	-0.1123
Average age of household	0.0131	0.7055	0.0033	-0.0093	-0.6093	0.0013
Number of children < 6	-0.0308	-0.1129	-0.0078	-0.6560	-2.5976	0.0901
Number of children 6-12	0.1048	0.5644	0.0264	-0.1447	-0.7812	0.0199
Distance of household to mangroves	-0.0307	-1.4999	-0.0077	-0.0484	-2.1469	-0.0066
Average years of male education	0.0043	0.0982	0.0011			
Number of adult males in household	0.2142	1.3659	0.0540			
If any household males participate in outside employment DM=1, otherwise =0	0.1334	0.4194	0.0336			
Average years of female education				0.0412	0.5620	-0.0057
Number of adult females in household				0.0369	0.2810	-0.0051
If any household females participate in outside employment DF=1, otherwise =0				0.2451	0.4069	-0.0337
RHO(1,2)	0.6817	4.2975				

McFadden $R^2 = 0.40$

Log-Likelihood Ratio Statistic = 194.54

Log-Likelihood Ratio Test for Homoskedasticity = -21.46

Note: The McFadden R^2 is calculated as $R^2 = 1 - L_{UR}/L_R$ where L_{UR} is the unrestricted maximum likelihood and L_R is the restricted maximum likelihood with all slope coefficients set equal to zero (Maddala 1983). The log-likelihood ratio statistic is given by $2(L_{UR} - L_R)$ and is asymptotically distributed as a χ^2 random variable. The log-likelihood ratio test for homoskedasticity was computed by $\chi^2 = -2(LR_{HOMO} - LR_{HETO})$, where LR_{HOMO} is the maximum likelihood in the homoskedastic regression and LR_{HETO} is the maximum likelihood in a regression corrected for heteroskedasticity.

Source: Barbier et al (2004).

Notes

[1] The exchange rate at the time of the survey (July 2000) was 40Baht/US$.

[2] Applying stand ordinary least squares (OLS) regression analysis to estimate this relationship would yield biased parameter estimates, since an OLS regression cannot take into account the censored nature of the labor allocation decision of the mangrove-dependent household. Although the household always engages in some form of mangrove-based activity, it may not participate in outside employment. This means in turn that the market wage rate and the amount of hours in paid work will be observed only if the household decides to participate in outside employment; if the household decides not to undertake outside work, then no wages or hours worked will be observed. To avoid sample selection bias arising from this participation decision, a standard approach adopted in the off-farm labor supply literature is to utilize a three-step Heckman procedure for conditioning the estimations of wages and hours supplied (see Abdulai and Delgado 1999, Barbier 2004 and Lass et al 1991 for further discussion).