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ScienceDirect
Marine Policy 31 (2007) 645–656
MARINE POLICY
www.elsevier.com/locate/marpol

Fish wars: Conflict and collaboration in fisheries management in Southeast Asia

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Received 15 January 2007; received in revised form 22 March 2007; accepted 24 March 2007

Abstract

As a result of declining and overfished small-scale nearshore fisheries in Southeast Asia, there are increasing conflicts and social tensions between and among different user groups, leading to coastal "fish wars". A challenge facing fishers, resource managers and national decision makers in the region is to identify more appropriate governance and public policy mechanisms to manage conflicts over fishery resources and to resolve them productively in the interests of both long-term sustainability and short-term economic feasibility. A quantitative analysis undertaken in selected coastal communities in Indonesia, the Philippines, Thailand and Vietnam with and without co-management indicate that co-management does lead to reduced resource conflict levels. The analysis has also shown that when resource conflicts are reduced, food security improves.

Keywords: Fisheries co-management; Conflict management; Peace and order; Southeast Asia

1. Introduction

The coastal waters of Southeast Asia are among the most productive and biologically diverse in the world. As a consequence, they are critical both for economic and food security, and as a global conservation priority. High rates of population growth, rapidly increasing food needs, as well as differing and uneven levels of economic development, resource use, and technological change, are putting enormous pressures on the region's coastal resources. These waters are now experiencing increased levels of conflict and social unrest, affecting both security and environmental sustainability [1].

Southeast Asians rely more heavily on fish as a primary source of dietary protein and income generation than any other people in the world [2,3]. It is now almost universally accepted that most of the nearshore fisheries in Southeast Asia are overfished [4,5]. It is also accepted that excess capacity is one of the leading causes of this overfishing. Silvestre et al. [6] state that, "The results of overfishing in South and Southeast Asia are that coastal fish stocks have been severely depleted and that resources have been fished down to 5–30 percent of their unexploited

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0308-597X/$ - see front matter
doi:10.1016/j.marpol.2007.03.012

levels. The trends are expected to worsen as coastal populations increase, unless remedial action is undertaken." Stobutzki et al. [7] state that, "... there is an urgent need to reduce fishing capacity in the region." Sugiyama et al. [8] state that, "Based on current trends, production from capture fisheries in the Asia-Pacific region will decline over the next 10–20 years unless excess capacity and fishing effort is greatly reduced." Overfishing is resulting in lower productivity of fisheries, high levels of conflict among different users, loss of economic rents, increasing impoverishment of fishers and erosion of food security in coastal communities that are highly dependent on fish supplies for protein, livelihoods and income.

It is becoming clear that the challenge for resource managers and national decision makers is to choose more appropriate governance and management approaches for these small-scale fisheries operating in nearshore waters. However, scientific understanding and informed guidance on how to identify new public policy mechanisms and institutions to manage fisheries and conflicts over fishery resources and to resolve them productively in the interests of both long-term sustainability and short-term economic feasibility remains to be elucidated. Addressing this issue is the primary objective of this paper. The purpose of this paper is to analyze the degree to which alternative institutional arrangements to centralized fisheries management, such as community-based management and co-management, have served to deter the incidence and severity of "fish wars", and to what degree has the threat of resource conflict been reduced as a result of these alternative management approaches.

2. "Fish wars"

Conflicts and wars related to the rights over the use of land and water have been important human issues throughout recorded history. Although many of us are probably more aware of wars fought over religious freedom, political ideologies and social issues, conflicts over fishing rights and resources are just as common, if less reported. Since the Exclusive Economic Zones (EEZ) were established in the 1970s, disputes have become more frequent and more violent than ever before. Due to the establishment of EEZs, access to the world's oceans has been radically reorganized and the access rights of foreign fishing vessels have been curtailed. Negotiations, international fisheries agreements (such as those between European and African countries), and recourse to an international tribunal have sometimes succeeded in resolving conflicts.

More often than not, however, foreign boats from territorial waters and EEZs or migrant fishermen from other locations in the country are expelled by force. Vessels are boarded and crew imprisoned. Occasionally, weapons are used and people are killed. Fights have broken out, for example, between Vietnam and Cambodia and between the Philippines and China over access to territorial waters. Thousands of Indonesian fishers have been incarcerated as a result of illegal fishing in Australian waters.

While sovereignty issues are generally at the root of such conflicts, they are also the manifestation of competition for access to fish stocks, in coastal waters as much as on the high seas. In addition, the use of flags of convenience serves to exacerbate the problem. The country where a boat is registered does not necessarily identify its country of origin, and this loophole enables fishing companies to flout international fishing and labor conventions with impunity.

The total number of reported piracy attacks globally reached 276 in 2005, with the majority of attacks occurring in the waters of Indonesia, Malacca Straits, Bangladesh and India. This estimate is believed to be low, as many ship-owners and masters hesitate to report incidents of attack. Many of the pirates are believed to be from rural fishing communities [9].

Such conflicts are not limited to the high seas of Southeast Asia. In fact, the most pronounced increases in user conflicts and rising levels of social unrest are occurring within the region's coastal waters where the majority of the fishery users are present. For example, tensions are being aggravated by conflicts between users of different fishing technologies. The right to use passive fishing equipment like hand and gill nets, long-lines, and fish traps (typically associated with small-scale fishers) is often contested by those who use active gear such as trawls and purse seine nets (often associated with industrial fishers). Part of this is because such passive equipment often gets caught and carried off by trawlers. But more importantly, modern industrial fishing fleets operating in coastal waters typically use high technology electronics, over-efficient fishing gear and power, and *in situ* commercial fish processing equipment. This level of power and technology may "vacuum", or monopolize, available fishery resources, taking all living organisms from coastal waters and leaving nothing behind for resident and other smaller-scale fishers. Moreover, it is well known in the region that industrial fishing operations illegally operate within a country's waters, both in the EEZ and near the coasts. Such competition and differences often ultimately divide small-scale and industrial fishers to such a degree that they become adversaries. In such cases, industrial fishers, using more modern or productive fishing gear, will enter and fish in near shore waters used by small-scale fishers, whose gear and boats limit them to these areas. Often already overfished fisheries, on which the small-scale fishers depend for food and livelihood, are further exploited. In India, for example, small-scale fishers have lately been very vociferous in condemning shrimp trawlers whose fishing methods jeopardize fish stocks. In this type of conflict, where industrial fishers often enjoy the benefits of government subsidies, negotiating a solution can be very difficult, as it involves working across totally

different social and economic sectors. In other situations, such as in the Philippines and Thailand, such competition is known to regularly lead to violence, and even fatalities [10,11].

The result of overfishing and multiple sources of fishing pressure in Southeast Asian coastal waters is the reduction or collapse of important fishery populations, leading to high levels of conflict among different users over remaining stocks [12]. A complex, negative feedback cycle is created in this situation, whereby rapid population growth paralleled by fewer economic opportunities and access to land increases the number of people living in the coastal zone dependent on fishery resources and thus the number of fishers. Increased fishing pressure results in fish population declines and stock collapses and increased resource competition, both between fishers and scales of fishing operation (e.g., small vs. commercial). The result is reduced income and food security, increased poverty, and a lower overall standard of living and national welfare. This in turn drives users to employ more destructive and over-efficient fishing technologies in the "rush" to catch what remains, thereby further depleting fishery populations. These factors lead to further increased user competition, and thus higher rates and probabilities of human conflict, over remaining stocks. This destructive cycle leads to a pattern of self-reinforcing "fish wars" with deteriorating social and environmental consequences. Decreasing fish stocks combined with increasing conflict are driving some people out of the fishery. This is leading to increasing unemployment in many rural areas. This added level of instability is thought to fuel national levels of social unrest and political instability, thereby acting as a powerful and destabilizing risk factor to regional and global security concerns.

As a consequence of this cycle, coastal "fish wars" over the remaining and limited *in situ* populations of important economic and dietary fishery resources are becoming commonplace in the region. Social tension in the coastal waters of many of the most productive and biologically diverse ecosystems is being aggravated today by declining or collapsed fishery populations and compounded by conflicts between users of different fishing technology and between small-scale and industrial fishers. Such conflicts are not always passive in nature and armed conflict and violence is increasingly being reported as a common issue in relation to increased coastal fisheries competition within nation states. Immediately reconciling the compounding needs for improving the ecological sustainability of fisheries consumption while also improving food security and reducing resource conflicts has recently begun to be widely acknowledged by the world community. As a priority outcome from the 2002 World Summit on Sustainable Development, understanding, resolving, and preventing the spread of this complex and deteriorating cycle has now become a global priority; see Resolution II, §30 through 32, of the Plan of Implementation of the WSSD [13]. But the question remains: exactly how do we meet this challenge?

2.1. Seeking potential solutions in new institutional arrangements

Clearly, in order to end this cycle, the appropriate incentives for sustainable resource use must be instituted and complied with by users. An overriding question and concern is to what degree this cycle influences or threatens human security and resource sustainability. Of particular interest is whether new public policy mechanisms, such as new governance and management arrangements for resource ownership, access and use, can provide solutions to resolve and manage conflicts over fishery resources.

Policymakers thus need alternative strategies for preventing and resolving these conflicts before they escalate into greater civil unrest and violence. An early solution was to use scientific advice on the state of the stock and institute national fisheries management plans through a centralized management agency and using command-and-control measures. Such solutions offered only partial answers.

Recent management experience [14,15] tells us that where a centralized, command-and-control marine resource management approach and authority has not been effective in policing or resolving user conflicts over fisheries extraction, new institutional arrangements, such as the use of collaborative and community-based management approaches, are showing potential for intervening on the negative feedback cycle of "fish wars" by reducing user conflicts while also addressing fisheries sustainability and food security needs. These new approaches are giving resource users and local citizens groups a greater voice and more responsibility in resource management. People are empowered and decisions are brought down to levels more appropriate to the functioning of the resource and social systems.

Collaboration among fishers can possibly serve to reduce conflict. Where centralized management authority has not been effective to resolve conflict over resource use, new approaches, such as local, collaborative (co-)management arrangements, are showing potential for conflict management. At Kayar, in Senegal, for instance, a local fishing committee was created which has managed to resolve a very long-standing feud between local and migrant fishers [16]. In San Salvador Island in the Philippines, a co-management arrangement was able to resolve conflict between local fishers who utilized traditional fishing gear and new migrants to the area who were using cyanide to collect ornamental fish for the aquarium trade [17]. Co-management is reshaping the institutions of governance for fisheries and coastal resources throughout Southeast Asia. Co-management has now become widely used as an alternative fisheries management policy in a number of countries in Southeast Asia, including Indonesia, the Philippines, Thailand, and Vietnam [18].

3. Methods

To address these issues, between 2003 and 2006 the authors worked together to undertake a collaborative,

multi-national research project to conduct an in-depth, country-level investigation and analysis of selected coastal areas in Indonesia, the Philippines, Thailand, and Vietnam.

Upon the completion of designing an applied research framework, the first step of our work consisted of a literature review to identify variables believed to impact user conflicts over fishery resources in Southeast Asia [19–25]. Warner [23] identifies four issues that may explain the emergence of conflict:

1. Demographic change (a sharp influx of newcomers into a community).
2. Natural resource competition (increased dependence upon the natural resources which increases competition for space and resources).
3. Developmental pressures (as government policy switches from livelihood protection to food production).
4. Structural injustices (changes in legislation that deny or severely restrict access to a resource by dependent groups of society).

Charles [20] organizes the wide range of fisheries conflicts into four interrelated headings:

1. *Fishery jurisdiction*: conflicts over who owns and controls access to what, the optimal form of management and the role of government in the fishing system.
2. *Management mechanisms*: conflicts over how policy is carried out, often short-term conflicts over harvest levels, enforcement and the consultative process.
3. *Internal allocation:* conflicts resulting from how different fishery stakeholders interact.
4. *External allocation*: conflicts resulting from how fishery groups and "outside" activities interact.

Bennett et al. [24] developed a revised typology to Charles which extended the four conflict categories into five categories:

1. Type 1: Who controls the fishery (Access issue on who among the fishers can fish).
2. Type 2: How the fisheries is controlled (Enforcement issues on how management systems are implemented; quota allocation, fishing seasons).
3. Type 3: Relations between the fishery users (User groups-related issues such as small- vs. large-scale fishers; ethnic and religious groups).
4. Type 4: Relations between fishers and other resource users (Conflicts arising from multiple use of resources: farmers, tourists, conservationists, industrial developers).
5. Type 5: Relations between fishers and non-fishery issues (Conflicts external to but affecting fisheries such as corruption, politics, elite groups, environmental concerns, and economic change).

Bennett et al. [24] concluded that institutional failure was a factor in fisheries conflicts. This included both informal institutions such as markets, communities and social capital (i.e., a set of *de facto* rules or norms that govern behavior and shape society) and formal institutions such as the state, the judiciary, the political system (i.e., a set of *de jure* rules enshrined in regulations and constitutions that govern behavior and shape society). The degree and success of conflict management is largely dictated by institutional capacity, and the ability of the formal and informal institutions to withstand and adapt to change.

3.1. Survey design and implementation

Next, the investigation team developed a comparative analysis framework composed of demographic, social, security, resource and governance variables that are believed to influence multiple aspects of user conflicts relating to coastal fishery resources in Southeast Asia. Several categories of independent variables that emerged from our literature review used within this framework include:

1. demographic characteristics,
2. social stratification,
3. security issues and civil tension,
4. resource condition and harvest activity,
5. community and resource conflict and resolution,
6. marine resource governance and tenurial arrangements, and
7. community organization.

Various states of these multiple component variables were hypothesized by the research team as impacting the level of user conflict over coastal fishery resources in Southeast Asia. To test these hypotheses, a data collection methodology was developed, field tested, and refined in 2004.

Data were collected by the project team during 2004 and 2005 at a total of 32 study sites across Indonesia, the Philippines, Thailand, and Vietnam. In Indonesia, study sites were selected in Bali, North Sulawesi (Manado), Maluku (Ambon and Kei) and Papua (Biak and Jayapura) Provinces. In the Philippines, study sites were in Palawan, Negros Oriental and Cebu Provinces. In Thailand, study sites were in Chumporn, Surat Thani, Nakhon Si Thammarat, Phuket, Krabi and Phang Nga provinces. In Vietnam, study sites were in Nam Dinh, Hai Phong, Khanh Hoa and Thue Thien Hue provinces.

The study relied on strictly comparable data collected by employing identical methods at all 32 sites in the sample. Three structured questionnaires were used to collect primary data from fishers, key informants and government officials (respectively) at each study site. Questionnaires were carefully translated from English into the national language of each country in close coordination with the principal investigators (first three authors), who worked with country teams on-site through survey method tutorial and field data collection.

The fisher questionnaire served as the foundation and primary focus of the data collection process, consisting of 58 questions that were grouped into five parts

- Part 1: demographic information (8 questions).
- Part 2: social stratification and security issues/tensions (15 questions).
- Part 3: coastal fishing and resource depletion (8 questions).
- Part 4: marine resource conflicts and resolution (14 questions).
- Part 5: co-management (13 questions).

Within each country, the team purposively selected eight coastal fishing communities as the sample. This included four communities with co-management/community-based coastal resource management, and four without co-management/community-based coastal resource management (or with centralized, command-and-control management). The planned minimum sample size in each community was ten fishers, three to five key informants, and one or two government officials. The fisher respondents were selected randomly in each village, whereas the key informants and government officials were purposively sampled.

The actual total sample size was 357 questionnaires, with 272 usable fisher questionnaires. The following sample size in each of the four countries was:

Indonesia: Total sample: 110; number of useable questionnaires: 96
Philippines: Total sample: 90; number of useable questionnaires: 80
Thailand: Total sample: 72; number of useable questionnaires: 62
Vietnam: Total sample: 85; number of useable questionnaires: 34 (This number is lower than the average for the other sample sites because of problems with data reliability for some of the sites.)

A translated codesheet and electronic spreadsheet template for raw data entry was developed and provided to each national team. Raw data collected from the field were coded, entered, and checked by each national team, and then sent to the University of Connecticut for data recoding, review, and entry into a master database for export to and use by SPSS statistical analysis software.

Descriptive and inferential statistics, both univariate and multivariate, were used to summarize and analyze primary data. For hypothesis testing ($\alpha = .10$) and quantitative analysis, inferential statistics were employed in the study, namely logistic regression. Both binary and ordinal logistical regression were undertaken to look at factors affecting resource use conflicts.

4. Results

The histogram in Fig. 1 summarizes the distribution of reported resource conflict levels in all four countries, for villages with and without co-management arrangements. The results provide a preliminary indication that villages with co-management arrangements present have lower levels of conflicts over coastal fishery resources.

4.1. Indonesia

Visual inspection of the histograms in Fig. 1 shows that the effect of co-management seems to be to move responses down the scale from 3 to 2 and 1; thus, the Indonesian data is analyzed with an ordered logistic regression.

The results of the regression are presented in Table 1. The model χ^2 (95.997, d.f. = 11) is statistically significant ($p = .000$). The Cox and Snell and Negelkerke R^2 values indicate that 63 or 72 percent, respectively, of the variation in resource conflict can be accounted for by this model. Overall, the results are statistically satisfactory as indicated by the signs and goodness of fit.

Significant determinants of resource conflict in Indonesia include socioeconomic stratification, peace and order (counter-intuitively, positive), high percentage of income from fishing, and good resource conditions, as well as high levels of village level conflict and the absence of co-management.

The existence of co-management in the village negatively affects resource conflict level. (As reported in this model, villages without co-management are more likely to report higher levels of resource conflict.) This observed result reflects what one might expect in that within communities where fisheries co-management is present, there is a decreased level in resource conflicts.

The negative coefficient on socioeconomic stratification indicates that the less respondents feel that "some people have more money than others", the more likely they are to perceive a higher level of conflict over resources. The positive coefficient of perceived peace and order in the area indicates that as the level of peace and order improves, there is a perception among respondents that resource conflict levels increase. While this appears counterintuitive, perhaps this reported relationship indicates that from within a more peaceful environment, the resident population becomes more attentive and sensitive to issues regarding resource conflict, rather than focusing on basic safety and security needs.

Resource conditions and activities were highly significant determinants of resource conflict levels in Indonesia. Specifically, the higher the reliance of the fisherman's household on fishing as a source of income, the more likely he was to report higher levels of resource conflict. Good resource conditions were also related to increased levels of conflict.

Finally, overall Indonesian village (civil) conflict levels were strongly correlated with marine resource conflict levels in waters adjacent to these villages.

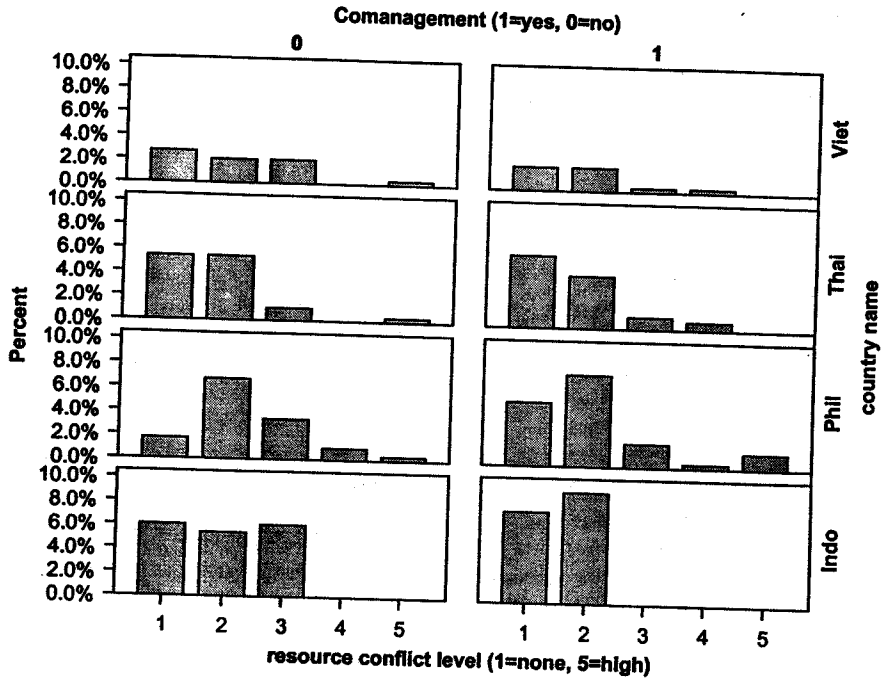

Fig. 1. Distribution of resource conflict levels for co-management vs. non-co-management villages, by country.

Table 1
Results of ordered logistic regression: Indonesia

	Parameter estimate	S.E.	Significance
Demographics			
No more than 9 years of education	.132	.618	.831
Household size	.102	.200	.611
Age	−.021	.032	.507
Years of residence	−.012	.022	.589
Stratification			
Socioeconomic stratification**	−1.953	.856	.022
Security			
Peace and order today*	1.974	1.094	.071
Food security	.733	.770	.341
Resource conditions/activities			
Percent of income from fishing**	1.266	.276	.000
Resource conditions today**	.858	.407	.035
Conflict			
Village-level conflict**	2.319	.489	.000
Management			
Co-management village**	−4.064	1.027	.000
Likelihood ratio (model χ^2)	95.997		
d.f.	11		
Cox and Snell R^2	.632		
Nagelkerke R^2	.721		
N	96		

*$p<.10$.
**$p<.05$.

4.2. Philippines

Visual inspection of the histograms in Fig. 1 shows that the effect of co-management in the Philippine villages is to move more responses to category 1 (no resource conflict). Therefore, a binary logistic regression (coding resource conflict as 0 = no conflict vs. 1 = some conflict) was undertaken.

The results of the regression are presented in Table 2. The model χ^2 (38.977, d.f. = 15) is statistically significant ($p = .001$). The Cox and Snell and Negelkerke R^2 values indicate that 38 or 57 percent, respectively, of the variation in resource conflict can be accounted for by this model. Overall, the results are statistically satisfactory as indicated by the signs and goodness of fit.

Significant determinants of resource conflict in the Philippines include education, socioeconomic and religious stratification, food security and improved resource conditions, as well as high levels of village conflict and the existence of co-management in the village.

The existence of co-management in the village negatively affects resource conflict level. The result is what is expected in that in communities with co-management there is a decrease in conflicts over resources.

Both socioeconomic stratification and religious stratification cause an increase in villagers' perception of the level of resource conflict. The more outsiders that are in the community, the more likely it is that there will be conflict over fishery resources. In the Philippines, especially in Palawan province, there is increasing immigration of people seeking resources and livelihoods. An improvement in local resource conditions is positively related to the levels

Table 2
Results of binary logistic regression: The Philippines

	Parameter estimate	S.E.	Significance
Demographics			
More than 9 years of education*	2.654	1.372	.053
Household size	−.205	.190	.282
Years of residence	.025	.044	.572
Stratification			
Ethnic stratification	.052	1.126	.963
Socioeconomic stratification**	3.016	1.483	.042
Religious stratification (no. of religions)**	1.650	.770	.032
Security			
Peace and order improved over last 5 years	−3.684	10.340	.722
Peace and order today	.711	.730	.331
Food security**	−2.933	1.353	.030
Resource conditions/activities			
Percent of income from fishing	.092	.986	.926
Years fishing in the area	−.037	.045	.417
Resource conditions improved in past 10 years**	3.036	1.407	.031
Conflict			
Village-level conflict**	1.594	.961	.097
Management			
Co-management village**	−3.673	1.664	.027
Fishers involved in management	−.118	.971	.904
Likelihood ratio (model χ^2)	38.977		
d.f.	15		
Cox and Snell R^2	.386		
Nagelkerke R^2	.571		
N	80		

*$p<.10$.
**$p<.05$.

of resource conflict. That is, if resource conditions have improved, it is likely that there will be higher levels of conflict, perhaps as outsiders are drawn in to the newly enhanced resource base. Similar findings were found by Pollnac et al. [26].

Food security in the village is negatively related to resource conflict. This is reasonable in that if everyone has enough food to eat, they are less likely to fight over access to food resources.

Finally, overall village conflict levels were strongly related to resource conflict levels in the Philippine villages.

4.3. Thailand

As with the Philippines, the effect of co-management in the Thai villages is to move the responses to category 1 (no resource conflict). (See Fig. 1.) Therefore, a binary logistic regression (coding resource conflict as 0 = no conflict vs. 1 = some conflict) was undertaken.

The results of the regression are presented in Table 3. The model χ^2 (40.096, d.f. = 14) is statistically significant ($p = .000$). The Cox and Snell and Negelkerke R^2 values indicate that 47 or 63 percent, respectively, of the variation in resource conflict can be accounted for by this model. Overall, the results are statistically satisfactory as indicated by the signs and goodness of fit.

Significant determinants of resource conflict in Thailand include ethnic stratification, peace and order and low crime rates, years fishing in the area, an improvement in resource conditions, co-management, and fisherman training in resource conflict and management.

In the case of Thailand, the "management" component of the analysis is complex. Fishermen who have been in the area for a long time, who are trained in resource conflict and who are involved in management are more likely to report higher levels of resource conflict. Taken together, these effects seem to imply that the more "invested" a fisherman is in his career and community, the more likely he is to notice conflicts over resources. Co-management does have a mitigating effect on these pressures toward

Table 3
Results of binary logistic regression: Thailand

	Parameter estimate	S.E.	Significance
Demographics			
More than 9 years of education	1.037	1.033	.316
Household size	−.445	.400	.267
Years of residence	.009	.034	.784
Stratification			
Ethnic stratification**	−3.452	1.465	.018
Socioeconomic stratification	.485	.932	.603
Religious stratification	−.439	1.412	.756
Security			
Peace and order improved over last 5 years**	−3.777	1.575	.016
"Good" level of crime**	−5.258	1.618	.001
Resource conditions/activities			
Years fishing in the area**	.130	.065	.046
Resource conditions improved in past 10 years*	2.524	1.421	.076
Management			
Co-management village*	−2.490	1.330	.061
Training in problem solving	−1.441	1.017	.157
Training in resource conflict**	3.466	1.615	.032
Fishers involved in management**	2.752	1.099	.012
Likelihood ratio (model χ^2)	40.096		
d.f.	14		
Cox and Snell R^2	.476		
Nagelkerke R^2	.635		
N	62		

*$p<.10$.
**$p<.05$.

increased conflict, as does improving peace and security and controlling crime.

In contrast to Indonesia and the Philippines, social stratification in Thailand (in this case, ethnic stratification) was negatively related to the levels of conflict over resources. This means that increasing the diversity in an area causes resource conflict levels to fall. This is an unexpected finding as greater resource conflict is usually associated with increasing ethnic diversity in an area. An explanation for this finding is based in the unique "hospitality" culture of the local Thai people in which there is a desire to maintain social harmony in the community, especially toward people of different backgrounds, and the feeling that it is more important to share the resources (even if there is more competition for resources and everyone has less), than to cause any social disruption.

Finally, as was the case in the Philippines, an improvement in local resource conditions leads to increases in resource conflict, although perhaps not via an influx of outsiders (as ethnic stratification is negatively related to conflict in Thailand).

4.4. Vietnam

The data for Vietnam was problematic. Missing values for many key variables and meaningless responses to stratification questions made analysis difficult. As a result, the number of cases included in the regression for this country was quite a bit lower than the total; 34 out of 85 total cases had all the required variables for the regression reported below.

As was the case with the data from Indonesia, the effect of co-management in Vietnam appeared to be to move the responses down the categories from 3 to 1 and 2 (Fig. 1). Therefore, an ordinal logistic regression was undertaken.

The results of the regression are presented in Table 4. The model χ^2 (21.852, d.f. = 8) is statistically significant ($p = .005$). The Cox and Snell and Negelkerke R^2 values indicate that 47 or 51 percent, respectively, of the variation in resource conflict can be accounted for by this model. Overall, the results are statistically satisfactory as indicated by the signs and goodness of fit.

Significant determinants of resource conflict in Vietnam include peace and order, food security, village level conflict and co-management. Unlike in the other samples, resource conditions were not significant.

The existence of co-management in the village negatively affects resource conflict level. (As reported in this model, villages without co-management are more likely to report higher levels of resource conflict.) The result is what is expected in that in communities with co-management there is a decrease in conflicts over resources.

In Vietnam, as in Indonesia, peace and order was positively related to resource conflict. That is, as the level of peace and order in the area increases, fishermen's perceptions of resource conflict levels increase. Food security was negatively related to resource conflict. Having some people in the area without enough food to eat leads to greater conflict over fishery resources.

Finally, as in most of the other areas, village-level conflict was positively related to resource conflict.

Table 4
Results of ordered logistic regression: Vietnam

	Parameter estimate	S.E.	Significance
Demographics			
Household size	.183	.213	.389
Years of education	.092	.148	.534
Stratification			
No useable data			
Security			
Peace and order today*	1.274	.712	.074
Food security**	−1.739	.881	.048
Resource conditions/activities			
Income from fishing	.090	.245	.136
Resource conditions today	−.748	.639	.242
Conflict			
Village-level conflict**	2.786	.892	.002
Management			
Co-management village**	−3.009	1.196	.012
Likelihood ratio (model χ^2)	21.852		
d.f.	8		
Cox and Snell R^2	.474		
Nagelkerke R^2	.515		
N	34		

*$p < .10$.
**$p < .05$.

4.5. Region-wide results

Following the country-specific analyses, data from all four countries were pooled and analyzed regionally. Across the region as a whole, there appears to be a trend for villages with fisheries co-management present to report lower levels of conflict (i.e., a higher percentage of responses in categories 1 and 2, rather than category 3; see Fig. 2). To test this hypothesis, an ordered logistic regression was performed on the aggregate data. Results of the regression are summarized in Table 5.

The model χ^2 (116.054, d.f. = 17) is statistically significant ($p = .000$). The Cox and Snell and Negelkerke R^2 values indicate that 34 or 38 percent, respectively, of the variation in resource conflict can be accounted for by this model. The results of this aggregate model are somewhat less conclusive than for those of any of the individual countries, which is not unexpected given the diversity represented across the four countries.

Significant determinants of resource conflict across the region as a whole include education, religious stratification, food security, crime levels, a *lack* of improvement in resource conditions, village level conflict and co-management.

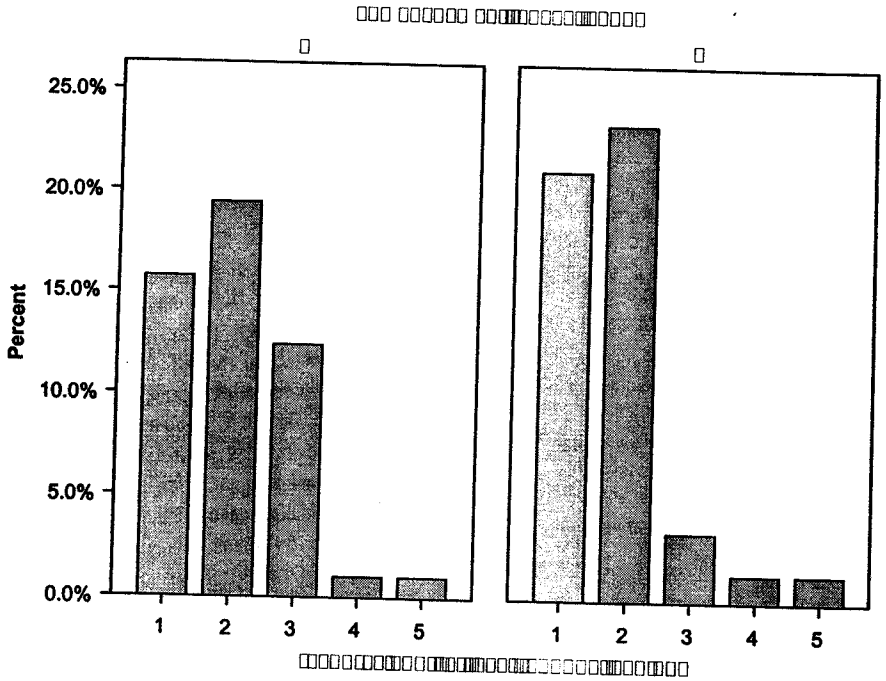

Fig. 2. Distribution of resource conflict levels for co-management vs. non-co-management villages, region-wide.

5. Discussion

As would be expected, a wide range of types of co-management exist in the four countries [27,28]. The Philippines, with the longest history of community-based coastal resource management and co-management (the oldest reported co-management being in 1984), has more "mature" types of co-management such as cooperative (where government and fishers cooperate together as equal partners in decision making), advisory (users advise government of decisions to be taken and government endorses these decisions), and informative (government has delegated authority to make decisions to user groups who are responsible for informing government of these decisions). Thailand, with the oldest reported coastal resource co-management being in 1994, has more consultative (where mechanisms exist for government to consult with fishers but all decisions are taken by government) and cooperative co-management arrangements. Indonesia, with the oldest reported coastal resource co-management being in 1997, reportedly has more consultative and cooperative type co-management arrangements. Vietnam, with coastal resource co-management being introduced more recently than in the other three countries, has more instructive and consultative co-management arrangements. Conflict management is not the primary reason for the introduction of co-management. The primary reasons for the establishment of co-management include the need for greater resource user participation or involvement in management, initiation through a project or program, and the need for a change or improvement in resource management due to increasing overfishing and resource degradation [28].

Results of the survey analysis conducted in Indonesia, the Philippines, Thailand, and Vietnam suggest that the existence of fisheries co-management in the community negatively affects resource conflict levels (see Fig. 3). This result is what one might expect in that within communities with co-management present, there is a reported decrease in the level of conflict over marine resources, and a corresponding increase in civil peace and order. This would be expected in countries where government, community members and non-governmental organizations have been active in implementing a process of co-management that provides for increased resource user engagement and participation, empowerment of local communities to become involved in the resource management and decision making process, and training opportunities on coastal management and conflict mitigation.

In the Philippines and Vietnam, food security was found to have a negative coefficient, indicating that food security improves as resource conflicts decrease. As described above, resource conflicts result from increasing competition for the resource, access issues, inadequate enforcement, and relationships between the resource users. As these conflicts are reduced through co-management arrangements, people feel more secure and are able to better manage the fishery resource for longer-term sustainability, resulting in more fish for the future.

In Thailand, peace and order and levels of crime were found to be statistically significant explanatory variables. The negative coefficients of the perceived peace and order and crime situations in the area indicate that as both variables improve, there is a decrease in the resource conflict levels. This suggests a critical link between how

Table 5
Results of ordered logistic regression: Regionwide

	Parameter estimate	S.E.	Significance
Demographics			
Age	.018	.013	.157
Years of schooling**	.094	.038	.014
Household Size	−.003	.067	.966
Years of residence	−.011	.009	.226
Stratification			
Ethnic stratification	.515	2.076	.804
Socioeconomic stratification	323	.292	.268
Religious stratification**	−.973	.349	.005
Security			
Food security*	−.568	.307	.064
"Good" levels of crime**	−.555	.258	.032
High levels of peace and order today	.233	.267	.383
Peace and order worse today than 5 years ago	.231	.337	.494
Resource conditions/activities			
Percent of income from fishing	.081	.077	.294
Improvement in resources*	.766	.453	.091
Resource levels today	−.226	.156	.148
General conflict			
Village level conflict**	1.373	.190	.000
Management			
Co-management village**	−.664	.288	.021
Likelihood ratio (model χ^2)	116.054		
d.f.	17		
Cox and Snell R^2	.343		
Nagelkerke R^2	.379		
N	276		

*$p<.10$.
**$p<.05$.

residents perceive a peace and order situation in their community and the impact on resource conflict levels in their community.

In both the Philippines and Thailand, the positive coefficient associated with a perceived improvement in resource conditions indicates that the more change respondents perceive in resource conditions, the more likely that there are resource conflicts. This would make sense in that if respondents perceive improvements in the condition of the resources, there would be more competition (perhaps via an influx of outsiders), and thus conflict, for the resources.

6. Conclusions and policy recommendations

As stated in the introduction of this paper, the objective of this research project was to identify new public policy mechanisms and institutions to manage conflicts over fishery resources caused by technological change, and to resolve them productively in the interests of both long-term sustainability and short-term economic feasibility. A specific focus was to determine if community-based management and co-management arrangements lead to a reduction in fishery conflicts.

Bennett et al. [24] conclude that, "It is likely that a close alliance between government and local stakeholders (e.g. co-management) is a pre-requisite for successful conflict management in tropical fisheries." (p. 374). They further state that, "In so far as such an arrangement can strengthen the links between those that use the resource and those that manage or control the resource, co-management of some form may be the best long-term solution to conflict management. Where co-management is able to redistribute power and responsibility in the fishery, potential conflicts related to power relations and allocation of resources might be mitigated." (p. 374).

Charles [20] states, "While not purporting to remove all conflict in fisheries, co-management does appear to deal successfully with certain major manifestations of conflict."

Pomeroy and Rivera-Guieb [28], in identifying the potential benefits of co-management, state that these include, "... increased communication and understanding among all concerned can minimize social conflict and maintain or improve social cohesion in the community." (p. 20).

This study presents quantitative support demonstrating the relationship between fisheries co-management and marine resource conflict, and between marine resource conflict and food and economic security. While further study and analysis of these relationships are needed to confirm these findings, results from selected communities in Indonesia, the Philippines, Thailand and Vietnam with and without co-management indicate that fisheries co-management arrangements can lead to reduced resource conflict levels and increased civil order. This study also demonstrates that when resource conflicts are reduced, food security may improve. In the Philippines, Thailand, and Vietnam, these findings further indicate that as peace and order improves and crime decreases in an area, the level of coastal resource conflict decreases.

These findings suggest that fisheries co-management can serve as a practical and effective fisheries management policy option for coastal nations with societal concerns regarding the maintenance of civil order, reducing levels of marine resource conflict, and enhancing or maintaining food security. This study also suggests that traceable, causal linkages may exist between how marine resources are managed in a particular nation with a high dependence on coastal fisheries, and the observed level of civil conflict and peace and order within the nation. Should additional, independent evidence supporting these quantitative findings be provided in the future, this suggests the need for increased policy support to be provided to explore the utility of fishery co-management arrangements in nations and coastal areas where they are not yet present but where resource conflicts are on the rise and peace and order is decreasing.

	Indonesia	Philippines	Thailand	Vietnam	All
Demographics					
Education		+			+
Household size					
Years of residence					
Stratification					
Ethnic stratification			-		
Socioeconomic stratification	-	+			
Religious stratification (number of religions)**		+			-
Security					
Crime ("good" levels)			-		-
Peace and order improved over last 5 years			-		
Peace and order today	+			+	
Food security		-		-	-
Resource conditions/activities					
Percent of income from fishing	+				
Years fishing in the area			+		
Resource conditions today	+				
Resource conditions improved in past 10 years		+	+		+
Conflict					
Village-level conflict	+	+		+	+
Management					
Co-management village	-	-	-	-	-
Fishers involved in management			+		
Training in resource conflict			+		
Nagelkerke R Square	0.721	0.571	0.635	0.515	0.379

Fig. 3. Summary of significant regression results.

During the last decade, there has been a shift in the governance of fisheries to a broader approach that recognizes fisher's participation, local stewardship, and shared decision-making in the management of fisheries. Through this process, fishers are empowered to become active members of the fisheries management team, balancing rights and responsibilities, and working in partnership, rather than antagonistically, with government. Conflict management is usually a central element and assumed benefit of the co-management process [28]. For the first time, this study provides strong, quantitative validation of this assumption as applied within a coastal fisheries management context in multiple countries.

Co-management has been shown to have a number of advantages for the management of fishery and marine resources. Co-management is now becoming more widely accepted around the world as an alternative fisheries management strategy to the top-down, centralized government management approach. This paper has been able, in a preliminary way, to quantitatively support another of these advantages, the reduction of conflict over fishery and marine resources. For those working in conflict management, co-management can serve as a process to develop the skills that can help people express their differences and solve problems in a collaborative way. The implied linkage out of this study between collaboratively managed marine resources and a safe and peaceful coastal community existence cannot be overlooked.

Acknowledgments

The authors would like to thank the John D. and Catherine T. MacArthur Foundation Program on Global Security and Sustainability for providing financial support for this project. Robert Pomeroy would like to thank the Oak Foundation for supporting some of his time on this project. We would like to thank all the research staff in Indonesia, Philippines, Thailand and Vietnam who worked

on the project. We also share our sincere thanks to the hundreds of government officials, key informants, and fishers across the four countries who participated in our study. We greatly appreciate their time, interest, and contributions. Finally, we would like to dedicate this work to the coastal fishing communities of the southwest Thailand peninsula, who only 2 months after our field work were devastated by the 2004 Indian Ocean tsunami. Their compassion, generosity, and wisdom will not be forgotten.

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