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# Societal Cost of Fishing Activities Comparison for Three Southeast Asia Delta Regions Base on Ecost Model

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***Abstract***

*Coastal fisheries are important components of fisheries sector in Southeast Asia. However, conflicts are arising from excessive fishing effort due to increasing economic and social motivation. The purpose of this article is to present the application of an integrated approach to assess the societal cost and fishing policies of fishing activities in three delta regions of Southeast Asia by constructing ECOST model. Here, the Pearl River Delta, the Gulf of Thailand and the Mekong Delta have been chosen to carry out comparative analysis from economic, ecological and social aspects. The results indicate that overfishing in three South Asia delta regions has brought out the great ecological cost which causes net benefit of whole fisheries community falls to be negative.*

**Keywords:** Societal Cost of Fishing Activities, Pearl River Delta, Mekong River Delta, Gulf of Thailand, ECOST Model.

## Introduction

Most fisheries in Southeast Asia have been experiencing a biological decline due to growing fishing pressure. The fisheries marine economists and ecologists have begun to recognize the assessment of fishing activities and public policy should not only consider the economic and social benefit but also need to consider the ecological cost. The ECOST model is developed to put social, economic and ecological system into an integrated assessment [1]. Society includes the social system, economic system and ecological system interacting with each other, thus the mention to the "societal" cost. The linkage between social and economic systems is made through income distribution. The linkage between economic and ecological systems is made through changes in biomass stock while the one between social and ecological systems is made through environmental problems and protections. The paper must be seen from the wider perspective of equipping public decision-makers and society with the appropriate tools and methods needed to consider, not only immediate economic and social profits, but also the costs engendered by fishing activities which relate as much to ecosystems as to societies [2].

Fishing activity has been increasing drastically during the last 20 years on the East Asian littoral zones, particularly near the delta of important rivers. This paper geographical coverage is spread over three delta regions in southeast Asia, namely Pearl River Delta (PRD) in China, the Gulf of Thailand (GT) in Thailand and the Mekong River Delta (MRD) in Vietnam. They have been regarded as representative of typical Delta ecosystem in global fishing activities. The main aim of this paper is thus to present the development of the ECOST model and its application to assess the societal cost of fishing activities, which can reflect the reality of their ecosystems and societies and contrasting in three coastal regions.

In China, the Pearl River is the second largest river (2200 km) in terms of water discharge, after the Yangtze. Currently, the coastal region of the PRE-is a significantly and quickly devel-

oping economic zone in China [3]. As a result of rapid economic development in recent decades, the whole region has experienced rapid industrialization and urbanization. The high population density and rapid development of industry and agriculture have resulted in severe stress to the aquatic environment [4].

Thailand had been one of the top tenth exporters of fishery products. The Gulf of Thailand and Andaman Sea are two major fishing grounds of Thailand. Catches from the Gulf of Thailand shared more than 70% of the total marine catches [5]. However, due to over fishing and fishery resource degradation, the capture has been reached a plateau, a rapid decline of catch/effort and massive changes in catch composition, including an increase of the proportion of small size fishes, such as "trash fish".

In the past decade, the Mekong delta fisheries sector has achieved considerable growth. After 1985, Vietnam applied the Doi Moi Policy, which relied on market mechanisms and encouraged private business. This motivated the development of fisheries, contributing to increasing number of fishing boats and fishing effort [6]. However, the sector suffers from several problems that need to be resolved to ensure their sustainable development. Over-fishing, resources degradation and marine pollution are the major problems faced in the coastal resource management of Vietnam.

A delta is a landform that is formed at the mouth of a river where that river flows into an ocean, sea, estuary, lake, etc. These three regions are selected as representative of delta fishing activities with the characteristics of estuary coastal waters driven by gradients due to the combined influence of river flow and sea. The resultant nutrient-enriched waters provide large biological productivity and sustain the most important commercial fisheries. They play a role of natural refuge and nursery area for hundreds of species. Therefore, this study will facilitate the comparison of fishing activities' societal cost under similar environment while it also provides a comparison of fishing methods and management policy among different countries.

## Study Area

### The Pearl River Estuary

The coastal ecosystem of the Pear River Estuary (PRE) extends from 112°30′E to 115°30′E, 21°00′N to 23°00′N, is a typical ecosystem of China's coastal sea with 72 600 km2 (Fig. 1). The PRE-waters are subjected to the influence of three water sources: The Pearl River discharge, the oceanic waters from the South China Sea and the coastal waters from the South China Coastal Current [7]. The Pearl River Delta in China refers to six municipal cities, including Guangzhou, Foshan, Zhongshan, Dongguan, Shenzhen and Jiangmen.

The PRE-is also an important fishing ground in the South China Sea. Because of special hydological features of PRD, fish species in the Pearl River is complex while large variety of species are involved [8]. The main gear types in PRE-are trawlers (demersal, pelagic and shrimp), gillnet, hook and line, purse seine and other fishing gears such as fish pots and traps with the results of the large increase in the number of fishing boats and improvement in the fishing technology [9].

### Gulf of Thailand

The Gulf of Thailand is situated from 99°00′E to 104°00′E, 6°00′N to 13°30′N, and has a total seabed area of 304,000km2 (Fig.1). It is relatively shallow, with a mean depth of around 58m [10]. Four major rivers discharge into the gulf, whose basin is enclosed by underwater ridges that cause the inadequate interchange of water between the gulf and the South China Sea, thus it is treated as an ecological distinct subset of the South China Sea.

Main fishing grounds for Thai fisheries could be divided into two, one in the Gulf of Thailand and the other in the Andaman Sea. Catches from the Gulf of Thailand accounted for 69% of the total catches in 2004. Thai fisheries, like other tropical fisheries were multi-species and multi-gears. Main fleets could be grouped into eight groups; i.e. trawlers, purse seiners, gill netters, falling netters, other mobile netters, hook and liners, stationary fishing, and miscellaneous.

### The Mekong Delta

The Mekong is the longest river in Southeast Asia. The Lower Mekong Basin comprises the four counties, Cambodia, Lao PDR, Thailand and Vietnam. The littoral marine zone near the Mekong Delta is 4286.41 km2 and extends from 105°46 E to 106°18 E, 8°55 N to 9°21 N. has a 700 km coastline and a sea territory of 360,000 km2(Fig.1). The river splits into the Mekong proper and the much smaller basin to form a large estuarine delta, called the nine dragons in Vietnam, before it empties in the South China Sea.

Numerous fishing gears are use: littoral trawls targeting benthic fish and crustaceans, pelagic trawl for pelagic small Clupeids, gill nets for pelagic species in general, drags for crustaceans. Fish biodiversity is high as recorded in other areas in the region but it is clearly threatened by the increasing fishing pressure and other deteriorations of the habitat. The Mekong delta is known for its abundant potential in marine resources. Marine fisheries production consists mainly of pelagic and demersal fish, which contribute 80 to 90% of fisheries yield [11].

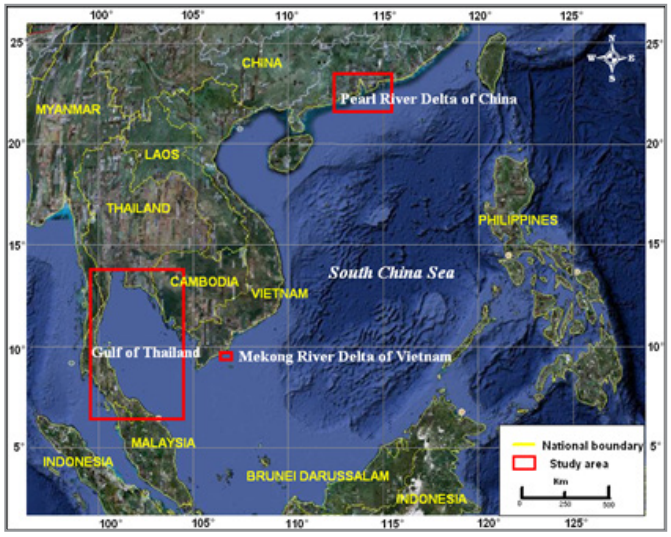


**Figure 1:** Study area of Three Delta Regions

## Methods

In this study we apply an integrated approach to value the societal cost and benefit of fishing activity [2]. The society refers to three systems, namely ecology system, economic system and social system. Here we construct trophic mass-balance ecosystem models based on the dynamic simulation software: Ecopath and Ecosim [12]. The economy consists of PRE-fishery sectors including marine capture and fish procession, households, linked to the rest of the world thought commodity and factor (labor and capital) market. The species in the food web are represented by predator-prey relationships and several function groups are commercial fishes which provide inputs to economics system. Meanwhile the linkage between the social and economic system is made through income distribution, moreover the social and ecological systems are connected though environmental problems and pretention. Theoretical and mathematical backgrounds of ECOST model are detailed elsewhere [13].

### Economic Costs and Benefits

In ECOST mode, the economic costs and benefits of fishing activity include the costs and benefits of three fisheries sectors, namely harvesting, processing and marketing sectors. We assume that the production cost of each metier has the Leontief form, which means that each input is proportionally fixed to output. The model contains both supply-push and demand-pull input-output mechanism at the core to trace full impact of marine fishing on the economy.

Social Accounting Matrix (SAM) drawn up for the fishing sector in three delta regions provide a consistent database that allows details analysis of economic structure of three delta regions.

### Ecological Costs and Benefits

One link between the ecosystem and the economic system involves the supply of ecosystem resources, goods, and services to the economy, such as fish stock as input to the fish harvesting. We simulated the biomass dynamic though EwE approach, which is the most widely applied ecological model software in the world. Since the benefits through the fishing activities have been calculated into economic benefit, the ecological benefits are assumed as zero in this study to avoid the repeated counting. Here, we define that the ecological cost exists when fisheries are economic overfished. As we known, several forms of overfishing were defined by fishery biologists, such as growth overfishing, recruitment overfishing, and ecosystem overfishing and economic overfishing [14]. Economic overfishing occurs when less than maximum economic yield is obtained from fishing activities.

Let el refer to ecological system, X indicate total catch of a species (s), P_s and MSY_s be their price and growth of biomass, we consider ecological benefit is zero, and the potential growth of the biomass stock is $GB_s = f(B_{s,t-1}, X_s)$ The Schaefer model was applied to estimate the maximum sustainable yield□MSY□for fishes in Delta regions.

Then, the ecological cost of species s is

$$C_s^{el} = P_s \cdot X_s - P_s \cdot GB_s - MSY_s$$

Social Costs and Benefits

The personal income distribution is commonly regarded as one of the main forces determining the social cost and benefit. The ECOST model focuses on social costs and benefit of basic material needs and health, and leave all other social service to the other category. Let BMN, HLH and OTH represent basic material needs, health care and other social services, respectively. PIF is personal income for fisheries household, and α is the share of each spending in personal income. Hence, the social benefit of social services can be calculated as

$$B^{sc} = \sum_{i}^{n} \alpha_i \cdot PIF, \quad i \in (BMN, HLH, OTH)$$

The social cost is the difference between national average expense and fisheries household. Let PEN represent personal expense for national average level, then the social costs for fisheries community are

$C^{sc}$=PEN-PEH

**Societal Costs and Benefits**

As mentioned above, the societal cost and benefit are accounted for the sum of social, economic and ecological costs and benefits. Let st indicate the society, while en, el and sc indicate economic and ecological and social, respectively. B, C and NB indicate benefit, cost and net benefit, respectively; then the societal cost and benefit and net benefit can be calculated by $(B,C)^{st} = ("B,C)^{en} + (B,C)^{el} + (B,C)^{sc}$, hence the net societal benefit is $NB^{st}=B^{st}-C^{st}$.

## Results

The ECOST model can assess the societal costs and benefit of fishing activities at métier level. The ECOST model was applied to compare and analyze the economic, social and ecological cost and benefit of fisheries activities in the PRD of China, Gulf of Thailand and Mekong Delta of Vietnam. The unit of "Euro/ton" is used to analyze the cost and benefit of fishing activities in these three delta regions within a unified framework, which means how much we gained or lost from every ton capture. Euro is considered as a unit of currency in ECOST project.

**Economic Cost and Benefit**

Economy contributes to fishery industry, in term of value-added, employment, wage and consumption. The economic costs and benefits of fishing activities include the costs and benefits of three fisheries sectors, including harvesting, processing and marketing sector.

The benefit of fishing activities is the output of the fleets, meanwhile the cost of each fleet is assumed follows the Leontief function, which means that input is proportionally fixed to output. Therefore the net economic benefit is the economic benefit minus the economic cost. The Fig.2 describes the net economic benefit of harvesting, processing and marketing sectors in 2004 for three cases. Apparently, number of the harvesting sector and marketing sector in China and Vietnam were both higher than the processing sector, in particular in the Pearl River Delta of China. On the contrary, the processing sector in Thailand was a little bit higher than harvesting sector but less than marketing sector. Main reasons for this phenomenon are the total output of fisheries in China and Vietnam is much less than Thailand, the landings are usually consumed by local people, and they prefer the fresh seafood instead of processed product, however, the processed seafood export plays a significant role in Thailand fishing industry.

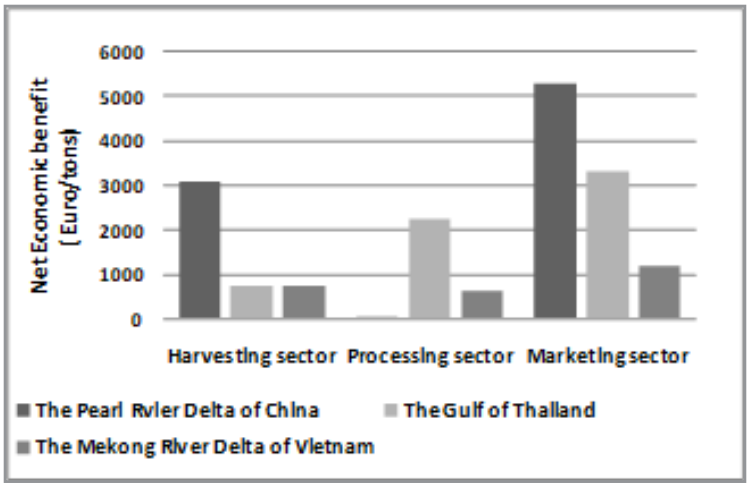


**Figure 2:** Comparison from Fishing Harvesting, Processing and Marketing Sector in 2004 (Euro/tons)

The total net economic benefits of three delta regions are represented in Fig.3. The results are simulated based on the reference year 2004 and extended from 2004 to 2014. For the economic impact there is the still a net gain from the fishing, there was 1987.18 Euro/tons in China which is a little higher than Thailand 1869.20 Euro/tons and about two times more than Vietnam (732.48 Euro/tons) in the year of 2004. According to the net economic benefit in China shows an obviously decline in the first three years, after a modest fluctuation, it remains stable at the level of about 1900 Euro/tons. The net economic benefit in Thailand experienced a slight downward trend, the number of economic benefits gradually declined to 1806.52 Euro/tons in the next ten years. As for the Mekong Delta of Vietnam also shows a steady fall, however, the number of economic benefits remained at around 689 Euro/tons throughout.

Therefore, it can be clearly seen from the curves that the net economic benefit in the Pearl River Delta of China were substantially higher than the gulf of Thailand and the Mekong River Delta of Vietnam, and all of these three regions shows a declined trend although positive net economic benefit can be gained from the fishing activities (Fig.3).

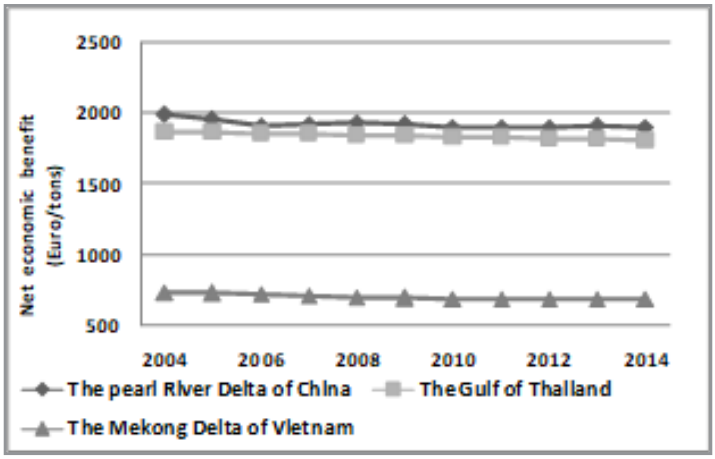


**Figure 3:** Net Economic Benefits of Fishing Activities in Three Delta Regions

**Ecological Cost and Benefit**

The concept of ecosystem service value can be a useful tool for valuing ecological benefit and cost. Ecosystem service to human being can be simply assessed, as in the case of fish harvested from the ocean, although in other cases maybe indirectly and difficult to determine, such as gas and climate regulation, leisure and recreation, nutrient cycling, etc.

Here the ecological benefit of fisheries activities is defined as the landing value of fish harvested which is equal to the economic benefit, hence the ecological benefits are considered to be zero to avoid double counting. On the other hand, positive ecological cost is caused by overfishing. We adopt economic overfishing to calculate the ecological cost in this study that means if economic capture of marine fish is beyond maximum sustainable yield.

The ecological costs are the different between the landing value and the maximum sustainable value. The Figs. 4.1-3 show the ecological costs by species in three regions.

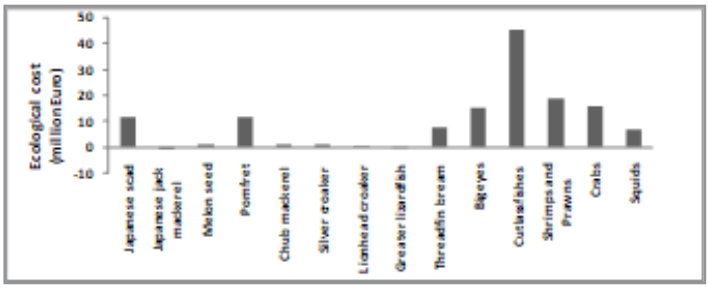


**Figure 4-1:** Ecological Costs by Species in the Pearl River Delta of China

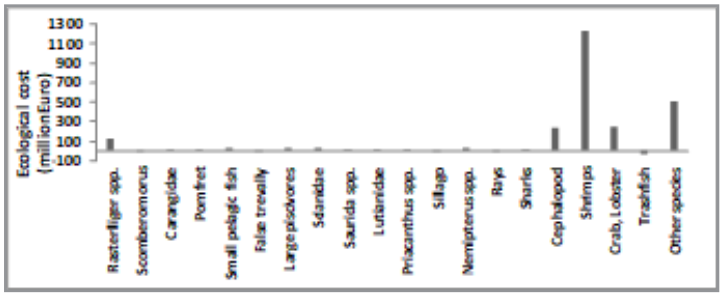


**Figure 4-2:** Ecological costs by species in the Gulf of Thailand

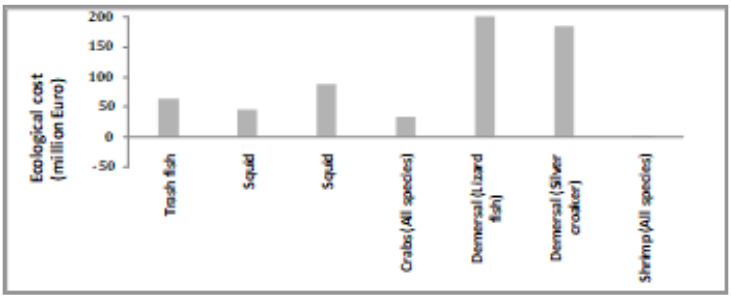


**Figure 4-3:** Ecological costs by species in the Mekong Pearl River Delta in Vietnam

According to the charts, cutlass fishes, shrimps and demersal species Lizard fish are the most dangerous species in the Pearl River Delta of China, Gulf of Thailand, and Mekong Pearl River Delta in Vietnam, respectively. Moreover, most species in this study show a significant ecological cost, which means most marine fishes have been over-exploitation and increasingly serious. The present level of exploitation of fisheries resources is higher than the estimated maximum sustainable yield MSY for these three delta regions. It's clear that this over-fishing is brought about by intensive trawl operations and that it is the root cause of the current difficult fisheries situation. The current situation is clearly reflected in the index of catch per unit effort (CPUE), which has measurably decreased in China, Thailand and Vietnam [15-17]. The numbers of fishing vessels thus their fishing effort have far exceeded the carrying capacity of the fishing ground. To reduce fishing effort, number of vessels should be cut off.

The net ecological benefits of different regions are compared in Fig.5. All of numbers are negative indicates that the fishing efforts have exceeded the maximum sustainable effort of some fish species harvested. And in this sense, it can be considered the marine resource is overfishing in this three delta regions, particularly in the Gulf of Thailand. Reported that by 1995, the trawlable biomass in the Thailand Gulf has declined to only 2.8% of the biomass level in 1961, and the fishing effort was about twice as much as the level of maximum sustainable yield [18]. The net ecological benefits in the Pearl River Delta in China face a dramatically drop from 2004 to 2008 and then stable at a level of round -3600 Euro/tons. However, the net benefits in Vietnam make a steady decrease in the simulation year.


**Figure 5:** Net ecological benefits of fishing activities in three delta regions

**Social Cost and Benefit**

ECOST model develops a method to value the basic material need and health. It assumes the linkage between social and economic system is made thought income distribution, and the personal income distribution is regarded as one of main forces determining the social costs and benefits. Fishery household expenses can be classified into basically material needs, health, social relations, personal security, freedom and choice. The personal security refers to saving of personal expense. Obviously, the basic material needs and household saving is dominant in the personal expenses of these three regions, followed by health care, social relations and freedom and choice (Fig.6). The basic material needs account for 40~50% in study areas.

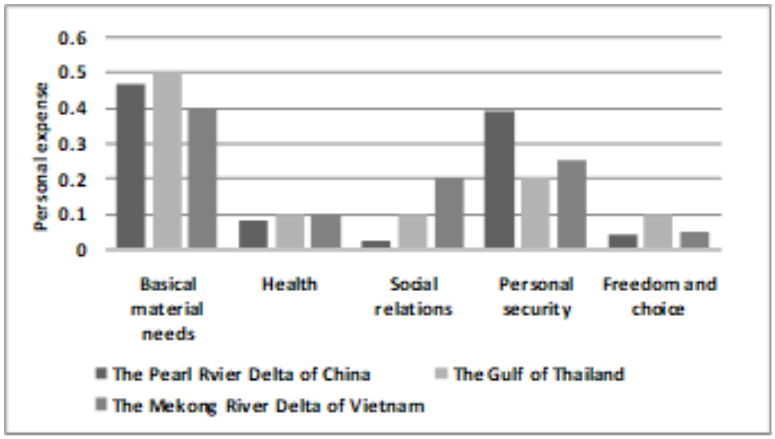


**Figure 6:** Composition of Personal Expenses in Three Delta Regions

The net social benefits of fisheries in different regions are shown in Fig.7. As we can see from the curves, the net benefits of social in Thailand experience a dramatic drop in the simulation years. Moreover, the benefits in China show a slight decline in the first two years then tend to go up gently from 2008. However, the line mostly goes straight with a steady decrease in Vietnam indicated that lesser net social benefits gained from fishing activities with time.

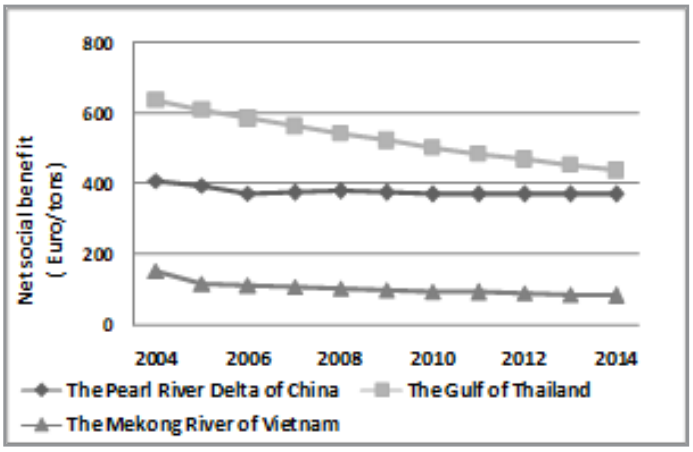


**Figure 7:** Net social Benefits of Fishing Activities in Three Delta Regions

**The societal Cost and Benefit**

The societal cost and benefit accounts for the sum of social, economic and ecological costs and benefits. ECOST model develops an integrated framework where the economic, ecological and social system are interactive each other.

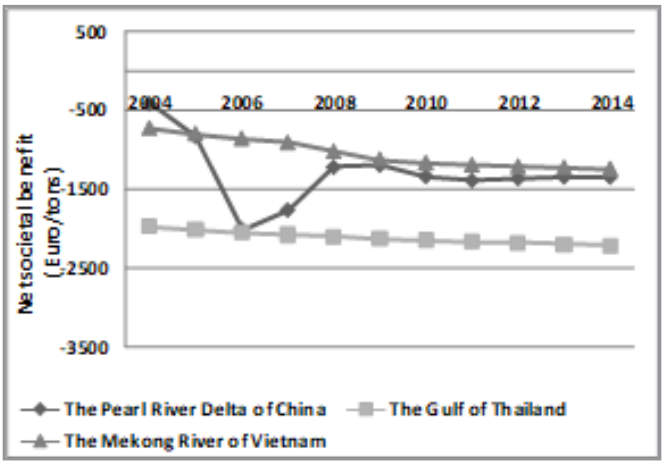


**Figure 7:** Net societal Benefits of Whole Fisheries Community in Three Delta Regions

Here, we also make a comparison for net societal benefits of fisheries in different regions (Fig.8). The net societal benefits in Thailand fall to be negative illustrate the huge ecological costs have exceeded the economic and social benefit, the number shows a gradual declined in the simulation year. The net societal benefits in China started a downward plunge, and in the period between 2006 and 2008 experience a slight growth and a modest decrease from 2008 to 2010 after that the number tend to be stable. Delta region of Vietnam shows a gentle decline trend as usually.

In this study, we defined particular fleet with a particular gear and targeting a particular species as métier. Hence, fishing harvesting sector can be considered as consists of various producers. In this study, China defined trash fish trawling, shrimps trawling, Japanese scad purse seiner, threadfin bream gill net and squid hook&line five métier as main fishing method. For the Gulf of Thailand, five métiers are selected for they are trashfish otter board trawling, squid pair trawling, shrimps beam trawling, small pelagic fish purse seiner, and shrimps push net five métier. In the Vietnam defined trash fish pair trawling, squid pair trawling, squid single trawling, crabs single trawling, demersal (Lizard fish) single trawling, demersal (silver croaker) trammel net and shrimp trammel net seven métier.

Several métiers are chosen to facilitate the comparison of fishing methods and management in different regions, such as same métier in different regions or the same species are seized by different gears or the same gear catch different species. Fig.9.1-4 present the comparative analysis between métiers in different

regions. Here, the trashes fish trawling appear are in all these three regions, Fig.9-1 shows trash fish trawling in the Mekong River Delta is much less cost than Gulf of Thailand and Pearl River Delta. At the same time, the net benefit in Vietnam fall to be negative and go down gradually over time. The Trash fish trawling in Thailand experiencing a dramatic fall between 2004 and 2006, then steady drop from 2006 to 2014. On the other hands, for China, there was a sudden rise in the first three years and then plunge sharply even more cost than Thailand, due to the rapid marine capture fishery development. The results indicate that Trawl fleet use non-selective gears, leading to high proportion of juvenile economic species to be sold as trash fish at low price for future processing in to fish meal.

Trawlers especially otter board trawler were the main fishing vessels in the delta regions. Small otter board trawlers fish along the coastline, competing with small scale fishing vessels especially drift gill netter in resource utilization. Trawlers were not allowed to fish within 3 km from shoreline. Whenever they fished along the shoreline, there were conflicts with coastal fisheries especially those small-scale fisheries. When coastal resources had been degraded, many small otter board trawlers turned to beam trawl targeting for shrimp, with a better price thus higher return.

Shrimp fishing is important in these three delta regions, the shrimp trawling in China gained 131.94 Euro/tons in 2004 but fall dramatically in the follow years. Shrimp fishing in Vietnam and Thailand showed a slightly similar trend, them were all negative and shows a steady decline in the simulation years. Fig.9-2 reflects the simulation results from 2004 to 2014.

We can see from Fig. 9-3, the squids trawling is dominant fishing activities in coastal fishing of Vietnam, however, it makes a steady decrease from 2004 to 2009 then remained stable at -620 Euro/tons. As in China, it reached a peak in 2005 then declined slightly, the number remained unchanged while it mostly approaches -620 Euro/tons, on the other hands, the net societal benefit in Thailand are also under zero and declined steadily which means the squids fishing are overexploitation.

Fig.9-4 gives the métier of purse seiner in China and Thailand clearly the Japanese scad purse seiner dropped markedly in 2006 and fluctuated around -108 Euro/tons in china. However, small pelagic fishing in Thailand obtained much more benefit than in China, although it takes on a downward trend over time.

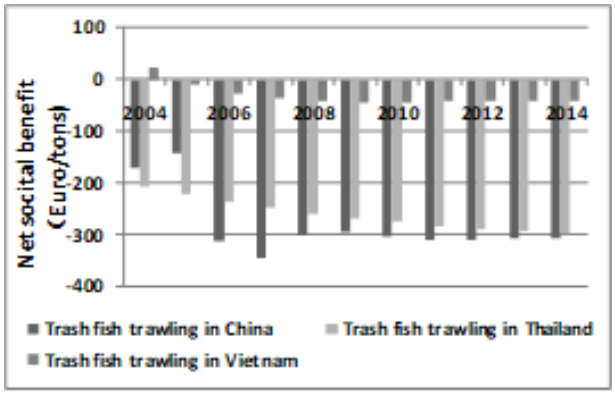


**Figure 9-1:** Net societal benefit simulation of Trash fishing trawling in three regions 2004-2014

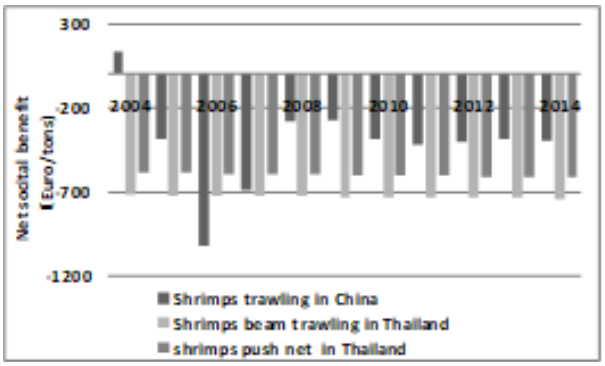


**Figure 9-2:** Net societal benefit simulation of Shrimps Capture in Three Regions 2004-2014

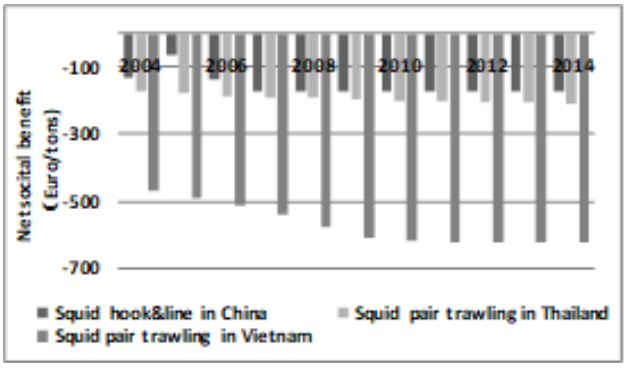


**Figure 9-3:** Net Societal Benefit Simulation of Squids Capture in Three Regions 2004-2014

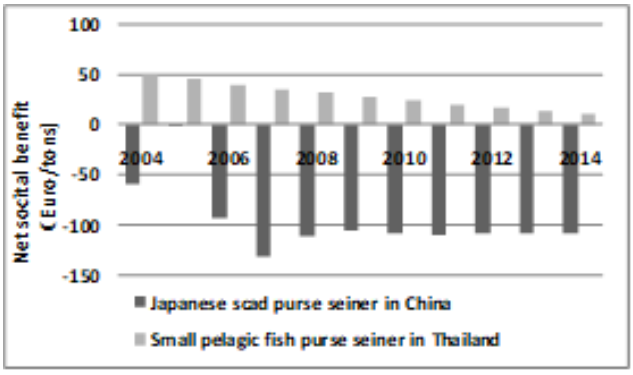


**Figure 9-4:** Net societal Benefit Simulation of Purse Seiner in China and Thailand

## Discussion and Conclusion

ECOST model develops a methodology to assess the society costs and benefits of fishing activity for three delta regions of Southeast Asia at métier level. However, from policy makers' point, it is more convenient and desirable to have a tool to compare all fishery related costs and benefits in a common unit. The costs and benefits of the social, economic and ecological systems in different area are all analyzed and compared in this paper.

Understanding the trade-off relationship among ecological, economic and social objective is important in designing fishery policies to manage or restore ecosystem. Using the Pearl River Delta in China, the Gulf of Thailand in Thailand and the Mekong River Delta in Vietnam as case studies and comparative analysis we explore the trade-off between conversation and socio-economic objectives in management fisheries in delta regions.

Gross domestic product (GDP) of Pearl River Delta in China, Gulf of Thailand in Thailand and the Mekong River Delta in Vietnam were estimated at 106848.79, 129878.70 and 35765.35 million Euros in 2004 of which the fishing industry contributed 1.42%, 2.50% and 3.84% of GDP, respectively. Furthermore, although the fisheries sector makes a relatively small contribution to delta regions' GDP, it makes an important contribution to export earnings and employment, and provides the people with the principal source of animal protein in their diet. It is clear that in all three delta regions, the rapid increase in fishing capacity has leaded to the decline of the fisheries resources so that fishing activities become less profitable. This study shows that almost all types and size of operation could gain positive economic benefit from marine capture, but the net benefit of whole fisheries community falls to be negative due to the great ecological cost (Table 1). It's obvious that great negative societal benefit of Thailand brought by huge ecological cost although it gains net economic and social benefit from fishing activities, which illustrates that overfishing leads to societal cost of whole fishing community. As in MRD of Vietnam, it also suffers serious over-exploitation in coastal area as Gulf of Thailand, and the situation will become worse if no corresponding measures to be executed (Fig.8). The PRD is considered as economically developed areas in China, where capture of marine stocks dominated fishery production statistics in the past. However, culture fisheries expanded rapidly and the rate of marine fishery gradually declined. Therefore, the net societal cost is relatively small and the fishing activities tend to be rational.

**Table 1: Summary of Economic, Ecological and Social Indices of Three Delta Regions in 2004**

| Regions (unitmillion Euro) | GDP | Fisheries industry | Net Economic benefit | Net Ecological benefit | Net Social benefit | Net societal benefit |
|---|---|---|---|---|---|---|
| PRD in China | 106848.79 | 1512.25 | 1987.18 | -2814.80 | 408.22 | -419.40 |
| GT in Thailand | 129878.70 | 3246.97 | 1869.20 | -4491.93 | 637.16 | -1985.58 |
| MRD in Vietnam | 35765.35 | 1373.7 | 732.48 | -2099.09 | 152.20 | -828.68 |

**Date resourc:** Guangdong Statistical Yearbook 2004; Guangdong Fisheries Yearbook 2004; World Bank, Total GDP 2005, World Development Indicators Database. 1-1 pp. Review of the State of the world marine capture fisheries management: Indian Ocean. De Young, C. (ed.) FAO Fisheries Technical Paper. No. 488. Rome, FAO. 2006. 458 p; Prof. Nguyen Sinh Cuc 2003 – International Monetary Fund 2006, Vietnam: Statistical Appendix-Web: www.imf.org/external/pubs/ft/scr/2006/cr0652.pdf. Calculated by ECOST model.

The aim of this study is to quantify the potential trade-offs between conservation and other socio-economic objectives. The ecological system of these three delta regions has been greatly depleted by fishing and is considered to be currently in a sub-optimal state both with ecological and socio-economic objectives. We believe that the findings in this paper should be generally applicable to other marine ecosystem as characterised respectively by coastal upwelling (West Africa) and coral reef (Caribbean). To prevent more degradation and improve societal benefit from exploiting ecosystem, restructuring the fishing fleets is urgently needed. As we know, the fishing communities might oppose the policy of reduces fishing capacity. Understanding the trade-off among the economic, ecological and social system can help government and stakeholders to conduct informed discussions on future management and policy from the whole fishing communities.


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