Economic Value of Coral Reef and Management Effectiveness in Trao Reef Locally Managed Marine Reserve

By
Do Hung Nguyen

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**The Norwegian College of Fishery Science
University of Tromso, Norway
&
Nha Trang University, Vietnam**

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Abbreviations

AIG	Alternative income generation
CBD	Convention on Biological Diversity
DANIDA	Danish International Development Agency
GEF	Global Environment Facility
GRi	Gross revenues
IMA	International Marine-life Alliance Vietnam
IUCN	International Union Conservation Union of Nature
IWC	The International Whaling Commission
MCD	Centre for Marinelife Conservation and Community Development
MCPA	Marine and Coastal Protected Area
MPAs `	Marine Protected Areas
NGOs	Non-governmental organizations
NRi	Net revenue of economic activity ith
NTAs	No-Take Areas or Marine Reserves
NTB	Nha Trang Bay
Pi	Price of products
PRA	Participatory Rural Appraisal
Qi	Quantity of products
REA	Rapid Ecological Assessment
TEV	Total economic value
TCi	Total cost of each economic activity
USD	United States Dollars
WB	World Bank

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Abstract

Trao Reef Locally Managed Marine Reserve was established in 2001 to protect coral reef being under threat because of human activities. However, the economic value of coral reef represents an important sight to help local people and resource managers in using and managing the resource effectively in the marine reserve has not been seen. By using financial analysis to calculate producer surplus of resource users, this study evaluated the direct use value consisting of fishery and aquaculture values of coral reef in the marine reserve. The findings show that the direct use value of coral reef is US$207,819 in which aquaculture is an important contribution. This study also investigated the evaluation of effectiveness of the marine reserve management under the context of community based management approach by contrasting with Nha Trang Bay MPA management which follows top-down management approach. The results show that community in Trao Reef marine has higher awareness, higher compliance, and higher participation to the marine reserve management. These indicators imply that Trao Reef management is performing better than Nha Trang Bay MPA management.

Key word: economic value of coral reefs, direct use value, community- based management, MPA.

1. Introduction

Coral reefs ecosystem is characterized as the most productive and high biodiversity marine ecosystem (Moberg, F. *et* al., 1999, Cesar, 2002). Goods and services provided by coral reef ecosystem benefit a vast number of people. Reef -based economic activities such as fishing, aquaculture, tourism etc generate sources of income for communities around reef areas. Communities also get benefits from costal protection, aesthetic and cultural values which are provided by reefs ecosystem. The benefits of coral reefs have evaluated in term of money show impressive numbers. Estimated potential net benefits of global coral reefs are about US$29.8 billion (Cesar, Burke and Pet-Soede, 2003) and in Southeast Asia is US$2.4 billion (Burke *et* al., 2002).

Although having significant roles, coral reef now is under threats (Goreau *et* al., 2000, Westmacott *et* al., 2000, Cesar 2002, Burke *et* al., 2002). There are many factors pushing reefs being in danger. Threat to coral reefs is mainly regarded to human activities (recreational and tourism industry, coastal development, intensive fishing, etc) (Sebens, 1994, Arjan Rajasuriya *et* al., 1995, Burke *et* al., 2004). Environment factors such as global warming (Burke *et* al., 2004), natural events (hurricanes, predator outbreaks and periods of high temperature) also contribute to the risk of coral reefs. In Southeast Asia, the use of destructive fishing methods (blast fishing, poison fishing) is seriously affecting to coral reefs ecosystem (Burke, 2002).

The coral reefs crisis is happening all over the world and coral reefs management issues now become a global concern (Bellwood *et* al., 2004). There are many efforts to looking for solution to deal with these problems internationally (Mora *et al*., 2006)
MPAs play important roles in coral reefs conservation (Westmacott *et al*., 2000) and they are evaluated as an appropriate and effective tool for marine reserve conservation (Villa *et al*., 2002, Salm RV *et al*., 2000).

The need to evaluate economic value of coral reef in the coral reef management field has been perceived, that is the reason why many studies have investigated the evaluation of

economic value of coral reef in many countries (Cesar, 2003; Cesar *et al.*, 2004; Pham *et al.*, 2005; Spurgeon *et al.*, 2004; Giselle *et al.*, 2007, Gustavson, K, 2000, White *et al.*, 2000).

MPAs represents as a tool of natural resource management; the success of this management arrangement depends on the process of establishment and development. Now a day, numerous MPAs have been set up with different management approaches. Among various approaches of MPA management, co-management and community base management approaches which follow bottom-up model of management are applied widely for costal resource management in many countries .

Trao Reef locally managed marine resource is established with the main purpose to preserve coral reef which has been under degradation due to the overexploitation of local residents. However the value of coral reef in this area has not been evaluated to aware the local community and managers about the importance of coral reef in the economic sight.

Trao reef marine reserve is the first locally managed marine reserve in Vietnam and has been expected to be the model for other community based managed marine reserves. However, how it has done in comparison with different marine protected area which follows an opposite management approach has not been investigated.

With the aims to address these issues, this study is going to deal with two objectives divided into two parts. In the first part, the study will evaluate the direct use value from biodiversity of coral reefs ecosystem in Trao Reef locally managed marine reserve. The second part, the study will evaluate the effectiveness of Trao Reef marine reserve as community base management approach by contrasting it with the Hon Mun MPA management that follows a top-down management approach.

2. Literature review

2.1. Coral reef value

2.1.1. The classification of economic benefits of coral reef

By the functions of coral reef ecosystem as the most productivity and highest biodiversity ecosystem on Earth, variety of goods and services are provided (Moberg and Folke, 1999). As a classification of Morberg and Folke (1999), the goods generated from the support of coral reef ecosystem belong to two categories; those are renewable resources and mining of reef. Renewable resource includes sea food products, raw material for medicine, other raw material (seaweed, algae ,etc), curio and jewellery , live fish and coral for aquarium trade. Goods from mining of reefs are coral block, ruble, sand, raw material for construction industry, oil etc. Services of coral reefs ecosystem are also classified into five categories; those are physical structure service (shoreline protection, build up of land etc), biotic services (maintenance habitat and biodiversity, ideological support, etc) , biogeochemical services (e.g., waste assimilation) , information services (e.g., climate report) , social and cultural services (e.g., esthetic and artistic values) (Moberg and Folke, 1999). All of these goods and services are benefits for human life.

2.1.2. Economic values of coral reefs

According to environmental economic literature, economic value of natural resource consists of use value and non use value (Pearce, D & D. Moran, 1994). Use values refer to value obtained by actual use goods or services provided by resource ecosystem. It consists of direct use value and indirect use value. In some case, direct use value can be sub-divided into extractive direct use value and non extractive direct use value. In context of coral reef resource, typical direct use values are capture fisheries, Mari culture, aquarium trade, pharmaceutical, tourism, recreation, research, education etc; indirect use values are biological support, coastal ecosystem, global life support (Barton, 1994)

Non use value refers to future value, in coral reef context; non use values include option value, quasi-option value, bequest value and existence value. The Figure 1 represents a general picture of economic value of coral reefs.

Making distinction of these values is to use appreciate method to evaluate these values in term of money. The combination of these values forms total economic value (TEV) of coral reef. Evaluation of coral reefs is important to improve coastal resource management because this value provides economic sight for manager in making decision.
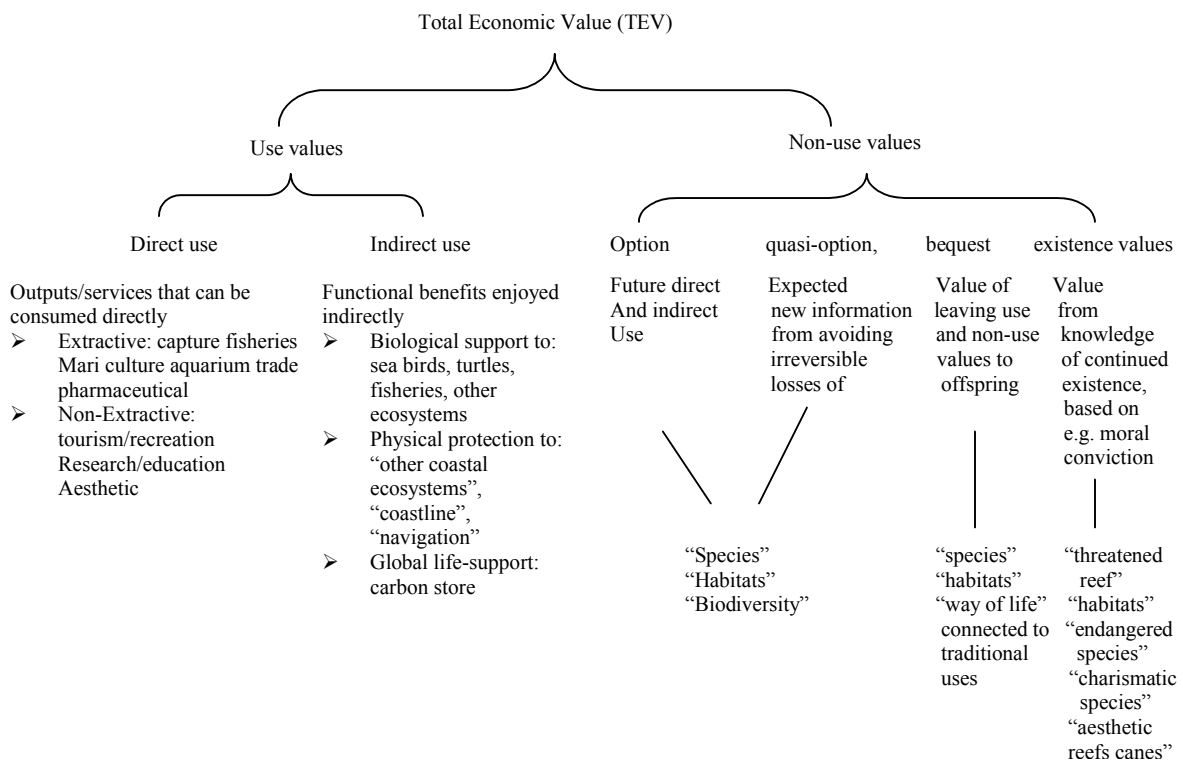
Figure 1: Total Economic Value and Attributes of Economic Values for Coral Reefs
Source: Adapted from Barton, 1994)

2.1.3. Fisheries and Aquaculture values of coral reefs

Fisheries and Mariculture are two of typical direct use values of coral reefs and have been investigated in many studies (Spurgeon *et* al, 2004, Cesar *et* al 2002, Cesar, 2003, Giselle *et* al, 2007, Pham *et* al, 2005).

Fishery value of coral reef is understood as values generated from reef based fisheries. In study of Spurgeon *et* al , 2004, they include two types of fisheries in the categories of coral reef economic value; those are subsistence fishery and artisanal fishery. In this study, artisanal fishery is in the category of direct use value and refers to products directly harvested from coral reef ecosystem; it is not include the associated reef fishery from offshore water. However offshore associated reef fishery is included in indirect benefit category of coral reefs. This makes a difference with the study of Cesar *et* al, 2004 and Cesar 2003, in these studies both reef based fishery from offshore and inshore are included in direct use value attribute of coral reef. Aquaculture operating in coral reef ecosystem is considered as reef based economic activity and its value contributes to direct use value attribute of coral reef. In the study of Pham et al, 2005, they consider the net revenue of lobster and grouper farming operating in Nha Trang Bay MPA as a part of direct use value of coral reefs in this area.

2.1.4. Methods to evaluate benefits of coral reefs

When evaluating economic value of coral reef, most studies investigate to the economic benefits of coral reefs ecosystem (Cesar, 2003; Cesar et al, 2004; Pham et al, 2005; Spurgeon et al, 2004; Giselle et al 2007, Gustavson, K, 2000, White et al, 2000, in Coastal Resources Management Project) while some studies explore the economic values of coral reefs at the site of economic loss due to the degradation of coral reefs (White et al, 2000 in Marine Pollution Bulletin; Pet-Soede et al, 1999).

The common method used to evaluate direct use values including fisheries values of coral reefs is productivity change method (Cesar and Chong, 2004). Numerous studies use the production approach to estimate fisheries values (Cesar, 2003; Cesar et al, 2004; Pham et al, 2005; Spurgeon et al, 2004). In these studies, market price technique was used to calculate

producer's surplus. Producer surplus can be found by deducting production cost from market price revenue (Spurgeon et al, 2004), so it can be understood as a term of value added or net benefit.

There are different ways to estimate gross revenues. In the study of economic valuation of the coral reefs of Hawaii, Cesar et al use commercial fisheries data to estimate total fisheries value (Cesar *et* al., 2004) while Pham *et* al., directly use the potential fish yield and price of fish to estimate the gross fisheries values (Pham *et* al., 2005). To carry out these calculations, the information about fish stock or the statistic commercial fishery data need to be available. However it is not easy to get these data in some areas.

In other way, Giselle *et* al. in 2007 used data from interviewing municipal fisher and seaweed farmer to calculate the gross revenue and average net revenue per fisher and seaweed farmer then multiplied with the total number of fisher and seaweed farmers respectively to get total net revenue (Giselle *et* al., 2007).

Costs need to be deducted from gross revenue to find net revenue. Cesar has assumed cost of fishing activities as a portion of gross revenue (Cesar *et* al., 2004). Further details, Giselle considers costs as a sum of fixed costs and variable costs. Fixed costs include depreciation of vessel, reparation and maintenance, variable costs consist of fuel, supplies, packing cost and labor share) (Giselle *et* al., 2007). In the study "Value associated with the local use of the Montego Bay Marine Park", Gustavson considers the costs' elements as costs of utilities, operating service, reparation and maintenance, good and material etc but does not include the depreciation and bank interest payment (Gustavson, K., 2000).

Reef fisheries

In order to estimated the actual fisheries value of coral reef, the concept of reef fisheries is considered The classifications of fisheries estimated values are different among different studies. Cesar *et* al., in 2004 subdivided fisheries sector into four types: commercial fisheries, subsistence fisheries, aquarium fisheries and recreational fisheries. The dependences of these

fisheries on coral reefs ecosystem are different. Therefore in this study, the reef dependency of each fishery are multiplied with the net revenue to derive reef-associated fisheries values. Similarly Spurgeon *et* al., in 2004 gave the classification of direct and indirect artisanal fishery benefits. In their classification, the direct artisanal benefit is reef fish species and lobster caught on or in the vicinity of coral reefs while indirect artisanal benefit is reef-associated species, these species are bottom fish species which depend on the reef environment at some point in their life. Only a portion of indirect artisanal fishery benefit is considered reef-associated fishery value (Spurgeon *et* al., 2004).

2.2. MPA management

MPA became a tool for natural resource conservation and fisheries management. Numerous MPAs have been established during last two decade of 20th century. Although many MPAs have been successful in conservation aspects, large potion of MPAs have failed due to problems appeared in management. This is motivation for many researchers in evaluating the effectiveness of MPAs management.

In particular areas, MPAs are managed under a variety of management models. In Southeast Asia, three models of MPAs management have been applied: centralized, community-based, and collaborative managements (Burke et al, 2002). By reviewing the governance and management of MPAs in Eastern Africa, Francis *et al*. (2002), has identified that there are four different generations of MPAs according to different management approaches in this region. Those are 1) small areas centrally managed by government; 2) large multiple use MPAs operated under cooperate management; 3) MPAs managed by private companies or nongovernmental organization with the agreement of respective goverment, and 4) MPAs managed by communities which are called community based management (Francis *et* al., 2002). Although there are various types under the different names in the different regions, their managements generally follow two different approaches which are top-down and bottom-up approaches.

Presenting for top-down approach is MPAs which are centrally managed by the government in Southeast Asia or MPAs which are small areas centrally managed by government and MPAs are managed by private company or non-government organization in Eastern Africa. This model

has advantage of strong power of government for enforcement, financial capacity. However the limitation of this model is the restriction to community involvement in the management process. The second is bottom-up approach represented by the form of community-based management which focuses on public participation of the community involvement in management process The strength of this approach is having higher compliance and supports of community from their involvement which is a vital element for success of MPAs (Kazan, S.1988). However this model has experienced some weakness such as weak institution; lack of finance and human resources that results in many unsuccessful MPAs (Cristie *et al*, 2002). This is the reason for the existent of the third model which stands on the middle ground of top-down and bottom-up models. Presenting for this model is collaborative management MPAs in Southeast Asia or large MPAs operated under cooperative management in Eastern Africa. Collaborative management as a definition is entitled to share responsibilities among stakeholders; these stakeholders could be particularly the community itself, governmental entities, and educational institutions even non governmental organizations (Burke et al, 2002) to reduce the limitations of both models.

Whether MPAs management follows top-down or bottom-up approach, there are evidence that the community involvement is important for success of MPAs management. By comparison of all types of MPAs, Francis *et al*. (2002) indicated factors contributing to the success of MPAs in Eastern Africa in management context, they are the involvement of local people in planning and management, successful alternative income projects and involvement of NGOs and private sector. By contrasting two MPAs under two different management models in The Philippines, White *et* al. (2002) showed that both community based MPAs and National Marine Park have been successful. Further more studies indicate advantages of each model that are suitably operated with the conditions in each sites. They also mentioned that the most important factor for the success of both management approaches is the participation of the community. The role of community in MPA management are gradually recognized, this is illustrated by the facts there are many community based management MPAs have been established

3. Studz Sites

3.1. Trao Reef locally managed marine reserve

Trao Reef marine reserve is a small near shore reserve located in Xuan Tu Sea, a coastal sea of Van Phong Bay. The municipal community in this area relies heavily on the sea for their livelihood. For a long time, Xuan Tu Sea is known as a treasure for the local community, thirteen coral reefs of more than fifty all over Van Phong Bay are found in this area. Coral reefs here are presented as a high biodiversity ecosystem with a highly diversity of fauna and flora species. The number of coral reef species and reef fish species in this area are higher comparing to others in Van Phong Bay. There are 59 coral reef species (64% of total species), reef fish species are 69 (69% of total number species) in Van Phong Bay (Hoang X.B., 2005). Coral reefs here are also harbors of many kinds of fish which spend a period of their life time for feeding and breeding. About twenty years before, fishery resource here was so abundant that local people just spent few hours for fishing; they could yield about 15 to 20 kg of fish for their catches (as the local fishers estimation).
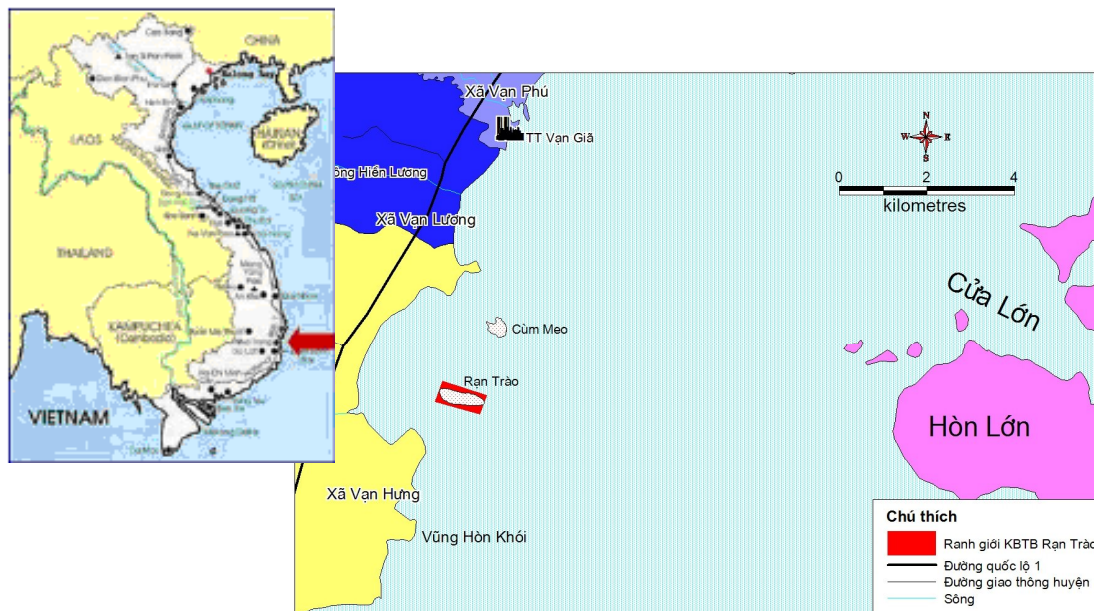
Figure 2: Trao Reef Marine Reserve Position

(Source : Adapted from Proposition of Trao Reef Marine Reserve Project, 2008)

The problems and issues related to resource use and resource management in the community

Together with the increasing population, the number of marine resource users has been increased. A part of local people whose livelihood relied on agriculture for long time has turned to fishing to make their living. In addition to the increase in resources extractors, many destructive fishing methods such as poison fishing, trawling, diving, fishing with light etc have been used by local fishermen. Overexploitation led to depletion in fish stock and degradation of coral reefs in this area. Fish yield now is just about 10% compared to 10 years before (IMA, 2001). Many issues related resource management and resource use existed in this area such as conflicts among the user groups, lack of community participation in resource management, lack of integration between resource management and economic development. All these problems lead to vicious circle (overexploitation- natural resources decreases-poverty – increasing in fishing and overexploitation) (IMA, 2004)

Perceived losses due to the degradation of coral reefs for a long period of time, a part of the local people have aim to conserve the coral reefs in this area. The aim to set up a marine reserve emerged among the local community. With the permission of people community of Khanh Hoa Province and the financial support of IMA-Vietnam (now is MCD- Vietnam) and local Agriculture and Rural Development Bank, Trao Reefs marine reserve was established on 25th of March, 2001 under the project ***Trao Reef Locally Managed Marine Reserve Project.*** The goal of Trao Reef Marine Reserve management is "*To conserve and manage coastal coral reefs ecosystems and resources in Van Hung commune, Van Ninh district Khanh Hoa province through improving local socio – economic conditions and enhancing participation of various stakeholders*" (McDonald, 2005).

With the aim to deal with the problems and issues of resource use and resource management in Xuan Tu sea, the model selected for Trao Reef marine reserve is a model of community- based management marine reserve in which local community is allowed to highly involve in the management process. The marine reserve has been established and managed by local community with the supports of municipal authority and other agencies (IMA and local Agriculture and Rural Development Bank). In organizational structure of marine reserve management, core group has important role and stands in the central. The core groups includes

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nine members, they are selected by and presented for community to be in charge in doing conservation activities.

Together with the core group, in management board there are representatives of municipal finance department, the border station, and municipal people commune. They are in charge of supporting finance and give higher power for enforcement.

According to explanation of a representative of Trao Reef marine reserve management board, community participates in all management process. From the starting time of marine reserve establishment, PRA has been done among community to collect economic condition information and the aims of local community for the conservation, the meeting with all member of community to discuss and select the reef entitled for conservation also had done. All activities of Trao Reef management have been proposed by management board then introduce to community to received feedbacks. Adjustments in these activities are made to meet the aims of community

The regulation of Trao Reef marine reserve have been proposed by local community and adopted with capacity and resource using customs of local community. The regulation of Trao Reef management is associated with zoning scheme of the marine reserve. The total core zone area of Trao reef marine reserve is 54 ha (Proposition to Trao Reef Locally Managed Marine Reserve, 2008), within this area, all fishing activities are forbidden.

In order to achieve management goal of the marine reserve, together with the regulation, many programs with relevant activities have been introduced to the community. Education and awareness program , capacity building program by which technique training, workshop, study tours and pilot model of environmental friendly aquaculture have been introduced (IMA, 2004),

After three year of implementation, the assessment of Trao Reef Marine Reserve Project showed achievements in biological aspects. The evidence of this improvement can see through the increasing live substrate covered by hard coral, soft coral, fleshy seaweed and abundance of reef fish (McDonald, 2005).

A clear evidence for the improvement of fish stock is the increasing in density of certain species of fish and the size of fish within the protected area comparing to adjacent sites. The comparison of fish stocks in Trao Reef and two adjacent sites in figure 2 shows big differences in number of fish observed between these areas. The number of small size fish (< 10 cm) as well as large size fish (>30 cm) within Trao Reef are higher compare to those of other sites (McDonald, 2005). This is a clear evidence for the effects of less fishing pressure within Trao Reef area.
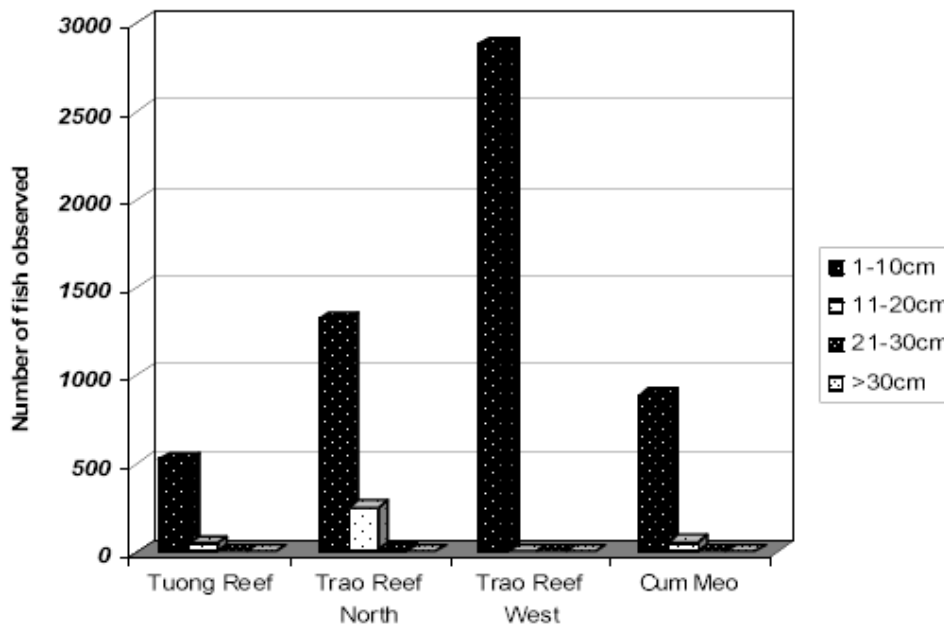
Figure 3: Observed reef fish (Cited from McDonald, 2005)

The averaged density of reef fish showed the positive trend over time. Over three years 2001, 2003 and 2004, the density of fish measured by number of individuals per 400m^2 is 315, 555 and 835 respectively.

The percentage substrate cover by soft coral reef has been increased from 10 % in 2001 to 15% in 2004 (Hoang, X.B *et* al., 2005). Trao Reef has a highly variety of coral reef composition

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comparing to other reefs outside the marine reserve on Xuan Tu Sea, there are 59 kinds of coral among 82 kinds of coral in Xuan Tu Sea.

3.2. Nha Trang Bay Marine Protected Area

Nha Trang Bay MPA consists of nine islands corresponding to a total area of about 13,000 Ha. In addition, Nha Trang Bay MPA is an ocean MPA located in the Southern of Nha Trang Bay within 1 to 15 km from mainland. This area is isolated from the coastal communities, but there are island communities living all over this MPA. (Hon Mun MPA Pilot Project, 2009[a]).

Figure 4: Nha Trang Bay MPA position (From Internet)

With approximately a total of 3,000 flora and fauna species, the marine ecosystem in this area is considered as the highest biodiversity compared to the one of other coastal marine water areas in Vietnam. In this area, more than 200 coral species have been identified (Vo *et* al., 2002) accounting a high percentage of coral species in the world (Ho *et al*., 2004).

The richness and biodiversity of fish species are also very high comparing to other areas, 800 fish species registered nearly 336 coral reef fish have been found (Vo *et al*., 2002). This

characteristic shows that the marine ecosystem in Nha Trang Bay is important both nationally and internationally.

Coral reefs have significant contribution to the biodiversity of marine ecosystem in Nha Trang Bay which supports fishing, aquaculture as well as tourism activitites. Nha Trang Bay is a fishing ground for a major part of local islands' fishermen (Ho, *et* al, 2004) and for a part of fishermen from the shore and adjacent areas (Doan, 2002). In recent years, aquaculture is increasing and become an important source of income for local people (Ho, *et* al, 2004). Tourism sector also has increased dramatically (Lindsey, G & A. Holmes, 2002), there is about 300,000 tourists visite Nha Trang annually (Ho, et al 2005) and tourism became the main contribution for the economy of Khanh Hoa province.

However coral reef ecosystem in Nha Trang Bay was under threats due to variety of human activities (Doan, 2002) . The side-effect in the growth of population density has been a trigger for the increasing number of fishermen which lead to overexploitation in fishery, during only three years from 2002 to 2005, the population in Nha Trang Bay MPA has increased 14.83% (Ho *et* al, 2005) . The use of destructive fishing methods (trawling, cyanide fishing, dynamite fishing) have affected to coral reef seriously (Hon Mun Proposed MPA,2004). Uncontrolled development of Aquaculture and tourism activities have caused water pollution problem. The anchoring from tourism boats and activities of divers damage directly to coral reef communities (Hon Mun Proposed MPA, 2004) .

In context of the government plan to set up certain number of MPAs in Vietnam, Nha Trang Bay has been selected to establish a MPA and expected to be a model for other MPAs all over the country. This priority is due to the international importance of the biodiversity of marine habitat and coral reef ecosystems in this area.

With the financial support from WB/ GEF, DANIDA and IUCN, People committee of Khanh Hoa Province and Ministry of Fishery and IUCN have operated the Hon Mun MPA pilot project since 2001. The objectives of Hon Mun MPA and the project is: "*To protect Marine biodiversity environment and to enable local island communities to improve their livelihoods and*

in partnership with other stakeholders to effectively protect and manage the marine biodiversity in Nha Trang Bay, as a model for collaborative MPA management in Vietnam" (Hon Mun MPA Pilot Project, 2009)[a]. The project has lasted for four years from 2001 to 2005, during that period; the MPA was named Hon Mun MPA. When the project finished, the MPA have been renamed to Nha Trang Bay MPA (Le, 2007).

The Hon Mun MPA follows the top down management system which implies that the main organization relies on governmental entities. Ministry of Fishery and Khanh Hoa People's Province Committee are both in charge to manage the MPA. To manage the MPA, one provincial entity has been established called Hon Mun Marine Protected Area Authority (Hon Mun MPA Newsletter No.1, 2002)

The reasons for choosing this top-down management approach can be explained based on the reality and issues of using the resource, the number of stakeholders, the size of the MPA and the goal itself .Nha Trang Bay MPA has variety and large number of stakeholders including island fishermen, and adjacent fishermen, aquaculture farmers, tourists. These groups of resource user will be affected after the establishment of MPA, so there will be potentially complicated conflicts among various resource user groups. To deal with this problem it is required a well-planned management system for the MPA.. Additional reason for the importance of government role in MPA management in Nha Trang Bay is regard to the large size of MPA. To control all economic activities within this MPA, it is required sufficient financial and human resources and the high powerful enforcement. These requirements will be full filled by the participation of the government.

The regulations of the MPA

To achieve the objective of biodiversity conservation, the People's Committee of Khanh Hoa Province has determined certain regulations within the Hon Mun MPA Management System established through the decree 26/2002/QD-UB. On these regulatory statements it is been quoted the importance to restore fish stocks in Nha Trang Bay to guarantee a well managed protected area (Hon Mun MPA Newsletter No.1, 2002).

Among the temporary regulations entitled for this MPA, the most important represents the intention of stopping the illegal fishing practices for example the use of dynamite and cyanide. At the same time, to forbid the anchoring of boats on corals and throwing away trash into the sea. These regulations are entitled to manage in a responsible and sustainable way the whole area.(Hon Mun MPA Newsletter No.1,2002)

The regulations of MPA are based on a zone system approach: core, buffer and transition zones. The core zone represents the prohibited area to all activities which are harmful to coral reefs. Trawling and destructive fishing and polluting activities are forbidden in all three zones (Hon Mun MPA Newsletter No.1, 2002).

Activities

To achieve the objectives of the MPA related to improving livelihood of local communities, together with the implementation of regulations, the educational programs and alternative income generation programs have been operated through various activities.

The aim of promoting sustainable Aquaculture activities is to develop alternative income generation (AIG) within the area. Relying on these sustainable aquaculture activities the community will relieve the fishing pressure on wild stocks.

Other activities entitled to improve the livelihood of the community, it can be mentioned the following: the provision of 20 technical training courses, the delivery of credit programs introduced already to the community, and the implementation of ecotourism initiatives introduced to the local villagers, which includes glass-bottom basket boats and cooking (Hon Mun Marine Protected Area pilot project, 2009)[a].

Additional efforts have been focused in improving the understanding of local people about the benefits of conservation schemes through comprehensive educational programs developed specifically for schools in Nha Trang Bay.

The achievements of MPA.

After for years of establishment, the results of the MPA in biological aspect has not showed the improvement. In table 1, the changes in some typical groups of coral reef ecosystem are seen as in negative trend.

Table 1: Taxonomic composition of four groups of organism in the four stations sampled by REA in 2002 and 2005 and trends in taxonomic richness.

Organism groups	Locations	**Family**		**Genera**		*Species*		Trend	Change (%)
		2002	*2005*	*2002*	*2005*	*2002*	*2005*		
Macro-algae	MPA	4	4	21	19	26	26	Stable	0.00
Invertebrates	MPA	26	29	36	37	52	42	Down	-19.23
Fish	MPA	31	31	77	75	162	140	Down	-13.58
Hard corals	MPA	15	15	59	53	274	256	Down	-6.57

Source: (Adapted from Le, 2007)

In order to achieve the goals to improve livelihoods for local communities, the project has implemented several programs through which many activities have been operated.

After three years of project's implementation, all the efforts have resulted the considerable improvements in socioeconomic conditions of the communities in this area. There is an increasing in income per capital in communities, from 2002 to 2005 the average monthly income per capital increase about 27.53% (Ho *et* al, 2005). The increasing in income may be explained due to the high contribution (54%) of aquaculture activity which is more developed after the implementing the project .in the household income source (Ho *et* al, 2005) The wealth status in communities have been change positively, the number of poor households have been reduced 16.3% during 3 years after the implementation of the project (Ho *et* al., 2005). Living conditions of the people in the communities also have been improved, the percentage of concrete houses increased from 12 % in 2002 to 24% in 2005. (Ho *et* al, 2005)

Communities in Nha Trang Bay have percieived the effects of establishment of the MPA both in biological and social-economic aspects. High percentage of local people have perceived

positive effects of project in coral reef (68.9%), fish density (67%) and water quality (67%) Positive effects of project in income, awareness also were perceived by 48% and 54.4% of local people respectively. (Ho *et* al, 2005). Communities have participated in various project activities (meeting at villages , gender activities, clean up events, AIGs activities, training course, study tours and workshops). Among these activities the villages' meetings and clean up events have been participated by large part of people (about 61.17% and 49.51% respectively). The participation of community over all these activities is 61.17% (Ho *et* al, 2005). Beside the positive perception, local community also stated that problems in Nha Trang Bay such as uncontrolled aquaculture, illegal fishing, waste disposal and over-fishing are still existed (Ho *et* al, 2005).

4. Data and Methods

4.1. Data collection

In order to obtain information to evaluate net benefits of fisheries and aquaculture activities in Trao Reef marine reserve, a socioeconomic survey for fishing and marine-culturing households was carried out at two villages called Xuan Tu No.1 and Xuan Tu No.2 in Van Hung commune where the livelihood of the majority of people depend on fishing and aquaculture. The convenience sampling method (Bunce, L et al, 2000) was used for this survey by which interviewer passed to any fishery and aquaculture household at two villages to make an interview if the household header willing to participate. The sample size is 36 households taken among 250 households participating in fishery and aquaculture in these two villages. This is a face to face interview with household that I conducted in March, 2009.

The main purpose of the survey is to collect data to estimate the value of the coral reef of the Trao reef. Relevant questions to fishing and aquaculture activities such as fish season, fishing gear, species of aquaculture and the costs, prices of fish and productivity per fishing trip and Aquaculture cycle are prepared in the questionnaire. This information is needed to calculate the total cost and income and then annual net benefits for each household. The questionnaires also include a question related to fishing location. This question is used to estimate the percentage of fishing households supported by Trao Reef marine reserve. This is important information in calculating the true fishing value of the reef. In addition, the survey also involves the questions about perceptions of local people to Trao Reef marine reserve such as perceived changes of natural source, awareness of protected area, success of marine reserve, etc. The full questionnaire is presented in Appendix 1.

In order to collect information to evaluate net benefit of fishery and aquaculture, the relevant questions to costs of fishing such as maintenance cost, labor cost, fuel cost, insurance, costs included bait and food for fishermen during fishing trip were asked. Questionnaire also asked for fish yield per day and fish price to get information to calculated income of fishing trip. Information to costs of aquaculture such as cost of cage maintenance, feed cost, cost of seed etc as well as the information to productivity and price of aquaculture species were asked, In

addition, questionnaires also include a question related to fishing location. This question is used to estimate the percentage of fishing households supported by Trao Reef marine reserve; this is important information in calculating the true fishing value of the reef.

In order to get some social indicators to evaluate the effectiveness of Trao Reef marine reserve, the information about perception of local people to the change of resource, the participation of community in activities of marine reserve management and effectiveness of marine reserve were collected by asking questions as following: "What benefit have you perceived from the establishment of Trao Reef marine reserve" "Have your family received financial or technique support to improve the livelihood of your family from the Trao Reef marine reserve project?" "Have you ever participated in making decision related Trao Reef marine reserve management" "How do you participate to marine conservation activities? "Do you believe in the current management and regulation of the marine reserve" "How is your evaluation about the effectiveness of the marine reserve management"

Sample size and the distribution of households according to the economic activities are presented in the table 2

Table 2: Sample description

Items	No	% of sample size
Sample size	36	100
Households participate in fishery	32	88.9
Households participate in aquaculture	17	47.2
Households participate in both fishery and aquaculture	14	38.9
Households participate in fishery surrounding Trao Reef marine reserve	9	25

In order to evaluate the effectiveness of Trao Reef marine reserve and Nha Trang Bay MPA (Hon Mun MPA), the data of coral reef condition, reef fish population in two study sites were collected from the relevant reports and other studies.

4.2. Method of calculating coral reef value

Fisheries and aquaculture values

The net revenues from production of lobster farming and fishing are estimated based on data collected form households interviews. In case of fishing activity, net revenue is net income from fishing. Net revenues are calculated as formula (1).

$$NRi \quad = \quad GR_i \quad - \quad TC_I \qquad (1)$$

Where: NRi is net revenue of economic activity i^{th} (fishing and lobster farming)

GR$_i$ and TC$_i$ are gross revenues and total cost of each economic activity respectively.

$$GRi \quad = \quad Q_i* P_i \qquad (2)$$

P$_i$ is the price of products. It is the local market price of fish caught or farm-gate price of lobster. Q$_i$ is the quantity of products. It is amount of fish caught or lobster production. TC$_i$ is total cost

Total cost of fishing activity includes expenditures for fuel, labor, and maintenance. Total cost of lobster culture includes expenditure for feed, fuel, labor, cage depreciation and maintenance, as well as interest of loan.

Because Trao Reef is a very small area compared to the total reefs areas in Van Phong Bay, only net revenue of fishing household operating surrounding Trao Reef are determined as value supported by Trao Reef and they will be calculated.

To calculate the total fisheries benefit of coral reef in Trao Reef marine reserve, the total number of fishing households operating around Trao Reef in two villages is needed. This number is determined from multiplying the total fishing households of two villages by the portion of households doing fishing near Trao Reef.

The average annual net revenues per fishing household and per lobster farming household are calculated. Total net benefit of each economic sector will be computed by multiplying the net

revenue with total number of fishing households and lobster farming households..The fishery and aquaculture value of coral reef is the sum of total net revenues of these economic activities.

5. Results of the survey at Trao Reef Marine Reserve

5.1. Socioeconomic profile

5.1.1. General information

The survey at Trao Reef marine reserve with the questionnaire presented in the appendix gives some socioeconomic characteristics of local fishing and aquaculture households showed in the table 3.

Table 3: Socioeconomic profile of fishers and lobster farmers

Socioeconomic profile		Fishers and lobster farmers (n=36)
1.Gender	%Female	2.8 %
	% Male	97.2 %
2.Age	Max	79
	Min	24
	Average	49
3.Number of people living in household	Max	8
	Min	2
	Average	5
4.Monhtly income from fishing (USD)		163
5.Monthly income from aquaculture (USD)		106
6.Anual income per capital (USD)		450
7. Income structure		
Poor group (%)		30.56%
Medium and high income group (%)		69.44%
8.Education	% No Education	2.78 %
	% Elementary level	66.67 %
	% Secondary School	27.78 %
	% High School	2.78 %

In fishing and aquaculture farming households, a family header usually is the man who makes main income for the whole family. In fishing households, women have less responsibility in making income; they solely play a role as housewives. The result from survey of this study showed that approximately 2.8 % of fishers are female and 97.2 % are male. Age of fishermen is in the range of 24 to 79 years old, the average age is 49 years old. The number of family member in each household is from two to eight members, and in average, it is about five members per household. The majority of fishers have education at elementary and secondary school levels (94.45%). Two main sources of income of these households are fishing and aquaculture farming. Fishing and aquaculture activities generate income about US$165 and US$106 monthly respectively.

With the total number of fishing and aquaculture farming households is 250; it can be calculated about 222 households doing fishing and 118 households doing aquaculture in these two villages.

5.1.2 Reef based economic activities

The fishing habits of the community in Trao Reef mariner reserve are briefly described in Table 4.

Table 4: Fishing methods

Fishing methods	Participating households		The average number of fishing days per month (days)	Average catch per day (kg)	Main species of fish caught
	No	%			
1.Diving	6	18.75	21	11.1	Sea cucumber, shell, grouper, crabs, Haliotis diversicolor, Lutraria rhynchaena
2.Neting	16	50	21	11.6	Large head hairtail, Ponyfish, etc, Japanese jack mackerel
3.Fishing with light	1	3.125	15	15	Cardinalfish ,Jarbua terapon
4. Traping	9	28.125	22	4.3	Craps
Total	**32**	**100**			

The main fishing methods used by fishermen in Xuan Tu 1 and Xuan Tu 2 villages are diving, inshore gill netting, traditional fishing with light and trapping. Inshore grill netting and trapping are the most common fishing methods used by fishermen, about 80% of total households are using these methods. Also those are main fishing methods used by fishers who operate fishing surrounding Trao Reef marine reserve. The species of fish caught by gill net are mainly near shore species. Traps are used only to catch crabs and by fishermen operating in the vicinity of Trao Reef marine reserve and near the shore. Diving and traditional fishing with light do not appear around Trao Reef marine reserve. The average number of fishing days carried out per month is more than a half of month; this demonstrates that fishermen still highly depend on fishing for generating income.

Table 5: Fishing results by location

Fishing locations	Participating households (n=32)		Total catch amount per year (kg)	Average catch per household per day (kg)	Annual income per household (USD)
	Number of households	%			
Surrounding Trao Reef	9	28	12568	5.7	1378
Far away Trao Reef	23	72	57796	11.5	1907
Total	**32**	**100**	**70364**		

As the results showed in table 5 by fishing location, there is 28 %f fishing households operating surround Trao Reef marine reserve. Their average catch per day is about 5.7 kg which is lower compared to the average catch of households operating far away Trao Reef (about 11.5kg). The reason explains for this difference is that the majority of fishers doing fishing surround Trao Reef are using traps to catch crabs, so the amount of their yield is lower compared to the yields of fishers using other fishing gears. This also explains the lower annual income from fishing of this group (US$1,378) compared to groups of households fishing far away Trao Reef.

Table 6: Cost structure for fishing activities per year

Type of cost	Surround Trao Reef		Far away Trao Reef	
	Value(USD)	%	Value (USD)	%
Depreciation of fishing boat	5	1.2	65	5.5
Maintenance cost	10	2.2	123	10.4
Fuel cost	0	0	678	57.4
Labor cost	0	0	90	7.63
Insurance	0	0	1	0.07
Costs for bait, food	426	96.6	224	19.0
Total *In which:* - Operating cost - Fixed cost	**441** 426 15	**100** 96.6% 3.4%	**1181** 992 189	**100** 84% 16%

Table 6 presents the costs of fishing activity. Costs of fishing activities in Xuan Tu 1 and Xuan Tu 2 villages consist of two categories operating cost and fixed cost. Fixed costs are related to depreciation of fishing boats and fishing gear, expenditures for maintenance of fishing boats and fishing gears, it also includes the insurance payment since for some new boats, owners can buy insurance. Operating cost consists of expenditure for fuel, bait, and food for fishermen fishing for many hours. Compared to the fishing households operating far away Trao Reef, the cost of fishing households operating surround Trao Reef are lower in both fixed cost and operating costs. In fixed cost it can be explained that some fishing households fishing along the shore, they can just use the metal boat without engines to go fishing; this makes lower expenditures for depreciation and fuel which are the main composition of costs. The operating cost of households fishing far away Trao Reef (US$992) is more than two times compared to the households fishing surround Trao Reef (US$426), this due to the high expenditure for fuel.

Table 7: Lobster farming characteristics

Species	Panulirus ornatus, P.hormarus P.stimpsoni
Cycle duration	15.6
Number of cages per households	14
Average production per households (kg)	411

Another reef-dependence economic activity in this area is lobster cage farming. Lobster farming had existed in this area before the establishment of Trao Reef marine reserve and has been expanded in recent years. This activity becomes additional and main source of income for many households. The table 7   describes some characteristic of lobster farming in this area. The main lobster species being raised are Panulirus ornatus, P.hormarus and P.stimpsoni. One culture cycle lasts from 12 to 18 months, in average the duration for once cycle is about 15 months

Table 8: Financial analysis for lobster farming households

Indicators	Value (USD)
Average fixed cost per cycle	682
Variable cost per cycle	15632
Average cost per cycle	16314
Average revenue per cycle	18164
Average net revenue per cycle	1850
Average net revenue per year	**1269**

The table 8 shows that the average revenues is quite high (about US$18,164) , but the average net revenue is US$1850 and only accounts for 10.2 % of average revenue. Explanation for this is the loss in production mainly due to the low water quality, this cause the disease for lobster species.

Table 9: Lobster farming costs per cycle

Indicators	Value (USD)	%
Cost of cage maintenance	472	2.89
Cost of lobster seed	6598	40.44
Cost of feed	7301	44.75
Fuel cost	394	2.42
Labor cost	282	1.73
Interest	1057	6.48
Cost of cage repairing	210	1.29
Total	**16314**	**100**

It is can be seen in the table 9 that the main costs in lobster farming is for feed and seed maintaining about more than 80% of total production costs. The labor cost is only nearly 2% of total cost. The high cost is also an characteristics of lobster farming, this species is not suitable for poor households. In fact almost lobster farming household had to borrow bank loan to operate this economic activity.

5.1.3. Income and income structure

The household income in the communities is quite low of about 38 millions VND per year. The structure of the income is presented in Table 10.

Table 10: Household income structure

Income sources	1000 VND/year	Percentage (%)
From fishing	26,565	69.30
From aquaculture	5,994	15.64
Seasonally hired work	1,823	4.76
Small business	1,250	3.26
Official working	1,333	3.48
Others	1,367	3.57
Total	**38,332**	**100**

Table 10 shows that the main income of families is mainly from fishing (about 69.3% of total income), aquaculture account for 15.64%, the other sources only maintains only 15.06%. These results imply that the diversification in income sources for fishing and aquaculture households still at low level

5.2. Evaluation of coral reef value

Fishery value

Reef caught by local fishermen surrounding Trao Reef is considered the direct benefit of coral reef. In the table 11, the total net income of fishing households operating surrounding TRao Reef is considered as the fishery value of coral reef. The average annual net income is US$937 per household, multiply with the total households fishing surrounding Trao Reef is 62 (25% of the 250 total fishing and aquaculture households) derive the total annual net income is US$58,077. This is the fishery value of coral reef in Trao Reef marine reserve.

Table 11: Total annual net income of households fishing surrounding Trao Reef marine reserve (USD)

Average annual income	1378
Average annual cost	441
Average annual net income	937
Total households fishing surround Trao Reef in two villages	62
Total annual net income	**58,077**

Aquaculture value

Lobster farming operating surrounding Trao Reef is the main aquaculture activity in Trao Reef area and is supported by coral reef ecosystem. The net revenue yielded from lobster farming is considered as the aquaculture value of coral reef.. Results of financial analysis for lobster farming showed annual net revenue per household per year of US$1269 (in the table 12). Multiplying this value by total aquaculture household in two villages (118 households) yields the total annual net benefit for reef-based lobster farming is US$149,742.

Table 12: Total net revenue of aquaculture (USD)

Average net revenue per year	1,269
The total aquacuture households	118
Total net revenue	149,742

Total direct use value

The total direct use value of coral reef in Trao Reef marine reserve is combining of fishery and aquaculture values present in table 13.

Table 13: Total net value of fishery and aquaculture in Trao Reef marine reserve

Ecosystem	Resource use	Annual net revenue	
		USD	USD per ha of marine reserve
Coral reef	DIRECT		
	Fishery	58,077	1,076
	Aquaculture	149,742	2,773
Total		**207,819**	**3,894**

In the table 13, the direct use value of coral reef in Trao Reef marine reserve includes fishery value and aquaculture value. Combining these values results the total direct use value for coral reef in Trao Reef marine reserve is about US$207,819.. With the total area of marine reserve is 54 ha, the direct use value of coral reef is US$3,894 per hectare.

5.3. Community participation and awareness

5.3.1.Local community Participation

Levels of local participation to activities of Trao Reef marine reserve are presented in table 14.

Table 14: Participation of local people in the marine reserve management activities (No = 36 household)

Items	Yes		No		Total	
	Number	%	Number	%	Number	%
Respondents said their households have received financial support and technique training from project	5	13.89	31	86.11	36	100
Respondents have been informed and received promotion about marine reserve	22	61.11	14	38.89	36	100
Respondents have been informed the purpose of the marine reserve	31	86.11	5	13.89	36	100
Respondents have been aware of regulation and zoning scheme of marine reserve	31	86.11	5	13.89	36	100

Respondents have participated in making decision of the marine reserve management	16	44.44	20	55.56	36	100
Respondents have participated in cleaning up the beach	36	100	0	0	36	100
Fishermen do not use destructive fishing methods	32	100	0	0	32	100
Aquaculture farmers have collected waste to process in inland	17	100	0	0	17	100

The results in the table 14 show that: The percentage of household have received support from Trao Reef marine reserve management activity is only 13.89 % , this shows that limitation of financial and human resource of the Trao Reef project for supporting local community

The high percentage of people participated in the different activities of Trao Reef marine reserve illustrate that high community involvement in management process. More than 44% of respondents said that they have chance to participate in decision making of Trao Reef marine reserve. It is the evidence that communities have highly allowed to involve in important process of management. All respondent said that they have been participated in cleaning up the beach.

The awareness of local community is high, there is more than 86% of respondent said that they have been aware and informed about regulations and zoning scheme of marine reserve as well as the purpose of marine reserve.

The compliance of local community to the conservation activities is also high (100% of people participate to cleaning up the beach activity, 100% of fishermen said they do not use destructive fishing methods after they be aware of regulation, 100% of lobster farmer said they usually take the waste from aquaculture farming to in land to process)

5.3.2. The stated compliance

In order to see the benefits of Trao Reef marine reserve to local community, perceptions of local fishermen and aquaculture farmers are used as evidences for the effect of Trao Reef marine reserve to their economic activities as well as the living environment.

Table 15: Change in fishing activity due to the establishment of the marine reserve

Items	Fishing position		Fishing gears	
	Number	%	Number	%
Fishermen said that they have changed	14	43.75	6	18.75
Fishermen said that they have not changed	18	56.25	26	81.25
Total	**32**	**100**	**32**	**100**

In the table 15, there is 43.75% of fishers has changed there fishing location , most of fishermen said that they are not allowed to fish in Trao Reef as before, they have to go further for fishing. The percentage of fishers has to change fishing gear is 18.75% and they state that they are not allowed to use destructive fishing methods so they had to change fishing gear. This illustrates for the awareness of fishers with the regulation of Trao Reef marine reserve.

Table 16: Perception of fishermen about the change in fish stock and fish yield

Items	Fish stock		Fish catch		Size of fish	
	Number	%	Number	%	Number	%
Fishermen perceived there is an increase in	14	43.75	6	18.75	6	18.75
Fishermen perceived there is no change in	13	40.63	22	68.75	21	65.63
Fishermen perceived there is a decrease	5	15.63	4	12.5	5	15.63
Total	**32**	**100**	**32**	**100**	**32**	**100**

The results in the table 16 shows that the high portion of fishermen have perceived the increasing in fish stock (about 43.75%) however only 18.75% of them said there is increase in their catch, the reason for this is only fishermen operating surround Trao Reef they benefit from the higher catch, the others go further to fish so they have perceived that change, some fishers state that although there is an increasing in fish stock but the number of fishermen increase over time, this consequently led to the lower yield. The higher size of fish also perceived by 18.75% of fishermen, most of them are crabs trapping fishermen who operated surrounding Trao Reef.

Table 17: Perception of aquaculture farmers about the change in productivity after the establishment of marine reserve

Items	Number	%
Respondents perceived increase in production	4	23.53
Respondents perceived no change in production	9	52.94
Respondents perceived decrease in production	4	23.53
Total	**17**	**100**

It can be seen in the table 17 that the perceptions of aquaculture farmer to the change in productivity after the marine reserve established are different. 23.53% said that their production increase, they give the reason that because the patrolling activity has taken place every day, so the benefit from this it is the reduction of stolen products comparing to what it was before. Large part of of lobster farmers (about 53%) said their production has not change and 23.53 % said there is a decrease in productivity, the reason is the pollution of water is worst due to the higher lobster farming density.

By asking the aquaculture farmers "Does aquaculture activity of your family change after the establishment of Trao Reef marine reserve?", there are 17 respondents (100% of total aquaculture farmers) said that there are no changes in their cultivated species or their aquaculture model This illustrate that although there are some technique training activities have been done but not broadly so it has not created any influence in aquaculture activity.

Table 18: Perception about the benefits of the marine reserve

Items	Coral reefs condition		Fish density		Water quality		Living condition	
	Number	%	Number	%	Number	%	Number	%
Respondents said there are an improvement	36	100	23	63.89	15	41.67	12	33.33
Respondents said there are not improvement	0	0	11	30.56	16	44.4	24	66.67
Respondents did not give the answer	0	0	2	5.56	5	13.9		
Tong	**36**	**100**	**36**	**100**	**36**	**100**	**36**	**100**

The results in the table 18 shows that there is 100 % of respondent said they perceved the improvement in coral reefs condition and 63.89% perceived the increasing in fish desitiy. This imply that the improvement in biological aspect of coral reef are so clear that local community can perceived, this may help to strengthen   their believe and their approval for the conservation activities. However about the water quality, living condition improvement have been perceive by lower percentage of local people (about 41% and 33% respectively).

6. Discussion

Following the attribute of direct use value of coral reef presented in figure 1, there are two components in direct use value of coral reef in Trao Reef marine reserve currently, those values are fishery value and aquaculture value.

Table 19: Comparison direct use value of coral reef at two sites

Ecosystem	Resource use	Trao Reef marine reserve			Nha Trang Bay MPA		
Coral reef	Direct use Value	Annual net value (USD)	Annual net value per hectare of marine reserve	Total area (hectares)	Annual net value (USD)	Annual net value per hectare of MPA (USD)	Total area (hectares)
	Fishery	58,077	1,076		1,740,256	134	
	Aquaculture	149,742	2,773		1,254,078	96	
	Tourism	0	0		4,248,690	327	
Total		**207,819**	**3,894**	**54**	**7,243,024**	**557**	**13,000**
Source of data		Survey		Proposition of Trao Reef Locally managed marine reserve, 2008	Pham *et al*, 2005		Hon Mun MPA Pilot Project (2009[a]).

Category of direct use value of coral reef in Trao Reef marine reserve shows that the aquaculture value (US$149,742) is much higher than fishery value (US$58,077). This is due to the number of aquaculture households (118) higher than the number of fishing households (62) operating surrounding Trao Reef.

Compare to the study of Pham *et* al, the fishery and aquaculture value of coral reef in Nha Trang Bay MPA is totally about US$2,994,334, this value is much higher than in Trao Reef marine reserve (as in the table 19). An explanation for this different is that Nha Trang Bay marine protected area encompasses the large are of sea water in which the number of people operating fishing and aquaculture is much higher than in small area as Trao Reef marine reserve, so the total net value of these reef base economic activity is higher than in Trao Reef area. However when taking the these value per hectare of marine reserve, the result in Trao Reef marine reserve is US$3,894 per ha (presented in table 19), and in Nha Trang Bay MPA with 13,000 Has in total MPA area (Hon Mun MPA Pilot Project, 2009[a]) results US$ 230 per ha. This is the big difference between two areas. It can be explained that the community in Trao Reef marine reserve is coastal community, the resource user density is much higher than resource user density in Nha Trang Bay MPA which is established in the ocean. This result implies that the coral reef resource exploitation in Trao Reef area is much higher than in Nha Trang Bay MPA.

In study of Pham et al, 2005, they consider also the tourism value in attribute of direct use value of coral reefs, this value estimated about US$ 4,248,690 is the most important direct use value of coral reefs in Nha Trang Bay MPA (Pham *et* al, 2005). However in Trao Reef marine reserve, tourism value is not possible to measure currently since the feature of marine ecosystem in this area is different with the one in Nha Trang Bay MPA. The water in Trao Reef area is coastal sea water, it is not as transparent as in ocean water in Nha Trang Bay MPA to see coral reef clearly, so this place is not really attractive for tourists who like to enjoy observing coral reefs. That is the reason for the fact that tourism still has not been available in Trao Reef marine reserve. However the eco-tourism is a potential economic activity in this area, so direct use value of coral reef in this area may evaluated at higher value in the future. This potential value also contributes to the total economic value of coral reef recently as representative of an option value.

The effectiveness of Trao Reef marine reserve management

The effectiveness of Trao Reef management can be seen by the high participation of local community in the activities of projects, 100% respondents said they have been participated in the clean up the beach events, the meeting in communities also have been participated by more than 86% of local people. These indicators showed at higher values than those of Nha Trang Bay MPA. In Nha Trang Bay MPA, the participation of local community in clean up event and villages' meeting are 48.54% and 61.17% respectively (Ho *et* al, 2005). The higher involvement of community in Trao Reef mariner reserve imply that the high support and compliance of community to activities of marine reserve. This is an evidence for the advantage of community based management.

Their compliance with the regulation of marine reserve is very high, 100% fishermen said that they do not use destructive fishing methods, 100% of lobster farmer said the waste from aquaculture activity have been collected to process in land. In the different side, in Nha Trang Bay MPA illegal fishing still happens and this problem is perceived by 50% of local people. This difference refer to the compliance, the awareness of regulation is higher in Trao Reef as well as controlling and monitoring activities in more effectiveness comparing in Nha Trang Bay MPA

Positive perceptions such as higher catch, higher fish size from fishermen imply that a part of fishermen have benefited from Trao Reef marine reserve. This is an illustration of the positive ecological outcomes of Trao Reef marine reserve This may make a high believe of people for conservation if more people perceived benefit over time.

Other economic indicator and perceptions about the economic activity of local people also illustrate for the effectiveness of management activities. Income structure of households in Trao Reef marine reserve shows a high percentage from fishing (69.3%), aquaculture and other sources contribute only about 30% in total household income., This illustrates that the diversification of income sources in the community is still at low level. The high percentage (100%) of aquaculture farmers said that there is not any change in the aquaculture species and models after Trao Reef establishment. This implies that the effects of capacity building programs

of the project have not been perceived. On the other side, communities in Nha Trang Bay presented much improvement in their economic condition by the effect of AIGs programs (income from aquaculture account for 54 % of household income sources). This difference in the economic conditions in two sites gives evidence for the fact that the lack of financial and human resources lead to the lower effects of improving livelihood program in Trao Reef marine reserve than in Nha Trang Bay MPA

7. **Conclusion**

This study has investigate in evaluating the direct use value of coral reef in Trao Reef marine reserve by using financial analysis to estimate producer surplus of fishery and aquaculture economic activities in Trao Reef mariner reserve, the findings show an importance of coral reef ecosystem in economic sight in the marine reserve. Although the tourism have not been included in this direct use value attribute since at this area tourism sector has not been developed, the value per hectare of marine reserve show at higher value comparing to coral reef in Nha Trang Bay. This can be an indicator to take attention of community and resource manager improve the policies for conservation of coral reef resource in this area.

Addition to the evaluation of coral reef ecosystem, this study address to the management effectiveness of Trao Reef marine reserve by comparing with the case of Nha Trang Bay MPA, the results show the higher perception of local community of benefits, higher participation to management activities than in Nha Trang Bay MPA. Take these findings together with the evidence in the positive trend of coral reef ecosystem after the establishment of marine reserve, this study improves for the advantages of community based management as high participation and involvement of community that make the high compliance , high awareness of regulation, and the high effectiveness in controlling activities.

This research have done with limited resources, so there are many limitations which can not be avoided in in this study.

The first is regarding to approach of this study in evaluate the effectiveness of Trao Reef marine reserve management, The evaluation mainly based on the perceptions and attitudes of local people which rely much on the accuracy of answer of respondents, so if the respondents gave the biased information, this the results of study probably does not represent for the facts.

The survey for this study was taken with small sample size and focused in only on fishing and aquaculture households, so this sample is not preventative of the community.

In the comparison between two MPA, the author used some data taken from report of Ho *et al*, 2005 which were measured four years earlier compare to this survey, so the accuracy of the comparisons is not high.

The lack of resource to collect data in both sites at the same time period, this study has not make comparison the management effectiveness of these MPAs by using variety of economic indicators for instant income per capital, the sources of credits, the contribution of project in sources of credit, expenses and expense distribution of family etc which could make the comparison more exactly in socioeconomic outcome and the effects of MPA management..

In conclusion, it is difficult to conclude which type of management is better than the other because of lack of information related to available data, the longevity of these two MPAs and differences between them for instant the size and positions. However, some indicators found from this study such as higher awareness, higher participation, higher compliance, higher perception of benefits of resource conservation imply that Trao Reef marine reserve management is performing better than Nha Trang Bay MPA management.system.

For future studies, it is necessary to go deeper on the following aspects: extend the number of economic indicators in comparison, the larger and more representative survey to make the analysis more accurate. The questionnaire also should include more questions to ask people whether they agree or disagree with the rules and regulations.

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Appendix

FISHERY AND AQUACULTURE HOUSEHOLD SURVEY QUESTIONNAIRE

1. GENERAL INFORMATION

a) Household information

Name of respondent: Gender:……………….

Age: …………………………….

Address:……………………………   Phone:………………

b) Family composition

No	Name	Relationship with household header	Age	Occupation		Education level
				Main	Additional	
1						
2						
3						

2. ECONOMIC ACTIVITIES

a) Fishing activity

2.1 Fishing equipment? …………………………………………………………..

Equipment		Length (m)	Capacity (CV)	Year of purchase	Value (thousand VND)		How many years do you use it?
					At purchasing time	At present	
Fishing boat/ metal boat	1.						
	2.						

Fishing gear						

2.2 Where is your fishing position?

2.3 Fishing methods

Fishing methods	Fishing seasons	
	High season	Low season
1.		
2.		

2.4 How many labors work on every fishing trip?..

2.5. How many hours do you spend for fishing trip? (h):…………………………………..

2.6 Species caught:…………………………………………………………………….

2.7 What is your purpose for fishing?

       a. For selling (%)

       b. Subsistence (%)

2.8 Calculation for fishing activities

	Fishing method 1	Fishing method 1	Total
High season			
Fishing position			
Fishing time (From………….to ……..….)			
The number of fishing days per month			
Fish yield per day (kg)			
Fish price (thousand VND/kg)			
Fishing income per day (thousand VND)			
Low season			
Fishing position			
Fishing time (From………….to………)			
The number of fishing days per month			
Fishing yield per month (kg)			
Fish price (thousand VND/kg)			
Fishing income per days (thousand VND)			

Expense for maintenance per year (Thousand VND)			
Expense for fuel per year (thousand VND)			
Labor payment (thousand VND)			
Insurance per year ( )			
Expense for bait, food and others			
Total cost per fishing trip (thousand VND)			
Where do you sell the fish?			

b) Lobster farming activity:

2.9.

Lobster species	**The number of lobster cage**	**Expense of making cage (thousand VND)**	**How many years do you use?**
1.			
2.			

2.10 Financial calculation for lobster farming (*previous cycle)*

Duration of one cycle (From ……………..to …………..)	
The number of seeds	
The price of lobster seed	
Feed cost	Per one cycle (thousand VND)	
	Per individual per cycle (thousand VND)	
Cost for fuel	
Labor cost per month (thousand VND)	
Loan • The total amount of loan: • Duration • Interest rate	
Expense for cage maintenance	

Other expense		
Production	Loss(% or number of animal)	
	Average weight of individual (kg)	
	Total productivity (Kg)	
Price (thousand /kg)		

3. HOUSEHOLD ECONOMIC CONDITION.

3.1 Sources of income

Sources of income	What family member participates in?	Income per month or per year (thousand VND)
1. Fishing		
2.Aquaculture		
3. Work for hire		
4.Small business		
5. Officer		
7. Others		

3.2 Type of dwelling

    (1)   Concrete house

    (2)   Walls: brick + roof: iron sheet/ fibrocement

    (3)   Wall: bamboo mat + roof : leaves

3.3. Expenses for the family?...

	Expenses	Remarks	Total per year
For food			
Health care			
Education			
Others			
Total			

3.4 According to local classification for poor household level, does your family belong to poor group?

(a) Yes   (b) No

4. PERCEPTION ABOUT MARINE RESOURCE AND CONSERVATION

a. Change related to fishing activity

4.1. Compare to the time before the establishment of Ran Trao marine reserve, how do you perceive the change on this Marine Reserve?

	Increase	Same	Decrease	Remark/ explanation
Fish stock				
Yield				
Number of species				
Size of species				

4.2. Does the establishment of Trao Reef marine reserve influence to your fishing activity?

(1) Fishing position?

(2) Fishing gear?

b. Change related to aquaculture activity

4.3 Does aquaculture activity of your family change after the establishment of Trao Reef marine reserve?

(a) Productivity ☐ Increase ☐ No change ☐ Decrease

(b) Cultivated species ☐ Yes ☐ No

(c) Model of aquaculture ☐ Yes ☐ No

c. Perception about marine conservation

4.4 What benefit do you perceive from the establishment of Trao Reef marine reserve?

a. Improvement in coral reefs population   1- Yes   2- No
b. Increase fish density   1- Yes   2- No
c. Higher biodiversity of ecosystem   1- Yes   2- No
d. Improve water quality   1- Yes   2- No
e. Improve living condition for community   1-Yes   2- No

4.5. Have your family received financial or technical support to improve the livelihood of your family from the Trao Reef marine reserve project?

(a) Yes   (b) No

4.6. Have you received any information or promotion about marine reserve?

(a) Yes   (from whom)   (b) No

4.7. Have you be informed about the purposes of marine reserve?

(a) Yes   (b) No

4.8 Have you be aware of regulation, and zoning of marine reserve?

. (a) Yes   (b) No

4.9. Did you have the chance to participate in decision making related to Trao Reef marine reserve management?

   (a) Yes   (b) No

4.10 How is your participation in community meetings related to Trao Reef marine reserve?

   (a) Usually   (b) Rarely   (c) Never

4.11 Which of the following marine conservation activities have you participated in?

      (a)Cleaning up the beach

      (b)Collecting waste from aquaculture activities to process in land

      (c)Do not use destructive fishing methods

      (d)Other activities

4.12 Do you believe in the current management and regulation of the marine reserve?

      (a) Yes   (b) No

4.13 How is your evaluation about the effectiveness of the marine reserve management?

   1- Good   2 - Adequate   3- Bad

Thank you very much for your participation!