STATUS OF AQUACULTURE

AND ASSOCIATED ENVIRONMENTAL MANAGEMENT ISSUES

IN VIETNAM

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ABSTRACT

1 Introduction

Aquaculture has been practiced for millennia together with the establishment and development of the Vietnam country. However, aquaculture with the application of the scientific method to aquacultural production has developed since the 1960s in Vietnam. The development of aquaculture underwent different stages related to the political and economic circumstances of the country.

Many freshwater and some brackish-water fish species such as mullet, milkfish and Asian seabass has been cultured in ponds since the 1960s (Son, 1996[b]). Freshwater cage culture in the Mekong delta has originated from Cambodia also in the beginning of 1960s (Phuong, 1998). Marine cage culture began to develop in the early 1980s when the Department of Fisheries (DoFI) in Binh Tri Thien province (Thua Thien-Hue Province now) initiated shrimp culture (*Metapenaeus ensis*) in pens in Tam Giang lagoon. However, actual marine cage culture developed in the form of lobster culture in Khanh Hoa province based on the study conducted by Ho Thu Cuc (UoF) in collaboration with Khanh Hoa DoFI in the early of 1990s (Tuan et al., 2000).

Aquaculture has great potential to develop in Vietnam. It has a 3,260km coastline, 12 lagoons, straits and bays, 112 estuaries, canals and thousands of small and big islands scattering along the coast. In the inland area, an interlacing network of rivers, canals, irrigation and hydro electric reservoirs has created a great potential of water surface with an area of about 1,700,000 ha, in which:

- 120,000 ha are small ponds, lakes, canals, gardens;
- 340,000 ha are large water surface reservoirs;
- 580,000 ha are paddy fields which can be used for aquaculture; and
- 660,000 ha are tidal zones.

The above figures are not included the water surface of rivers and about 300,000 - 400,000 ha of straits, bays and lagoons along the coast, which can be used for

aquaculture activities but have not been planned yet (MoFI, 1994[a]). In addition, Vietnam has various species of which many are high valued and suitable for culture. The number of freshwater fish species, brackish- and salt-water fish species are 544 and 186, respectively. Sixteen major shrimp species of high economic value have been recorded, and the following species have been cultured*: P.monodon, P.merguiensis, P.indicus, Metapenaeus ensis, P.orientalis, Panulirus ornatus, Macrobrachium rosenbergii*.: Some major molluscs species include pearl oyster, oyster, scallop, clam, cockle, snail, of these pearl oyster, clam and cockle have been put under culture. Among 90 high valued seawead species, *Gracilaria spp* (11 species), *Sargassum , Kappapsycus alvaresii* are the most noticeable. In the future when Vietnam can produce hatchery seed, aquaculture is predicted to develop strongly.

Regarding the management structure operating in the country, the Central Government is the highest executive organ. It is responsible for the issues related to politics, economy, culture, society, national defense, and foreign policy. The government administers all affairs of the national fishery development mainly via the Ministry of Fisheries (MoFI). The MoFI controls all institutions in its sector in order to fulfil annual, five-year, and long-term plans, which are handed by the national assembly or the central government. It has the right to issue legal documents in order to implement decisions made by the national assembly and the central government. The MoFI's stipulations affect all ministries, People's committees, institutions, and citizens in the whole country (National Institute for Administration, 1995). The Central Government in general, the MoFI in particular has paid much attention on aquaculture (Tuan et al., 2000).

The Central Government or the MoFI manages all big projects (normally more than US$ 5 million) related to the development of aquaculture/fisheries of the country. Other institutions such as the Ministry of Planning and Investment (MPI), the Ministry of Agriculture and Rural Development (MOARD), the Ministry of Education and Trainning (MOET), the Ministry of Science, Technology and Environment (MOSTE) or its National Center for Natural Science and Technology (NCNST) play a role as consultant units for the government or collaborating partners of the MoFI. Institutions in the fisheries sector such as research institutes for aquaculture (RIA) No I, II, and III and in other sector such as universities, oceanographic institutes, etc are implementation units through scientific contracts/research projects (fig. 1).

Based on the MoFI's direction, provincial Departments of Fisheries (DoFI) were making plans for the development of aquaculture in each province in order to fulfil their tasks at lower levels. The management system at the provincial and district levels is similar to that at the national level. However, provinces and districts normally manage projects at lower values.

The DoFIs have its agencies such as Agency for Resources Management (ARM), Center for Aquaculture Extension (CAE). Those are implementation units at the local levels.

The management structure looks well organized. However, at local government levels, there were some constraints as follows (Tuan et al., 2000):

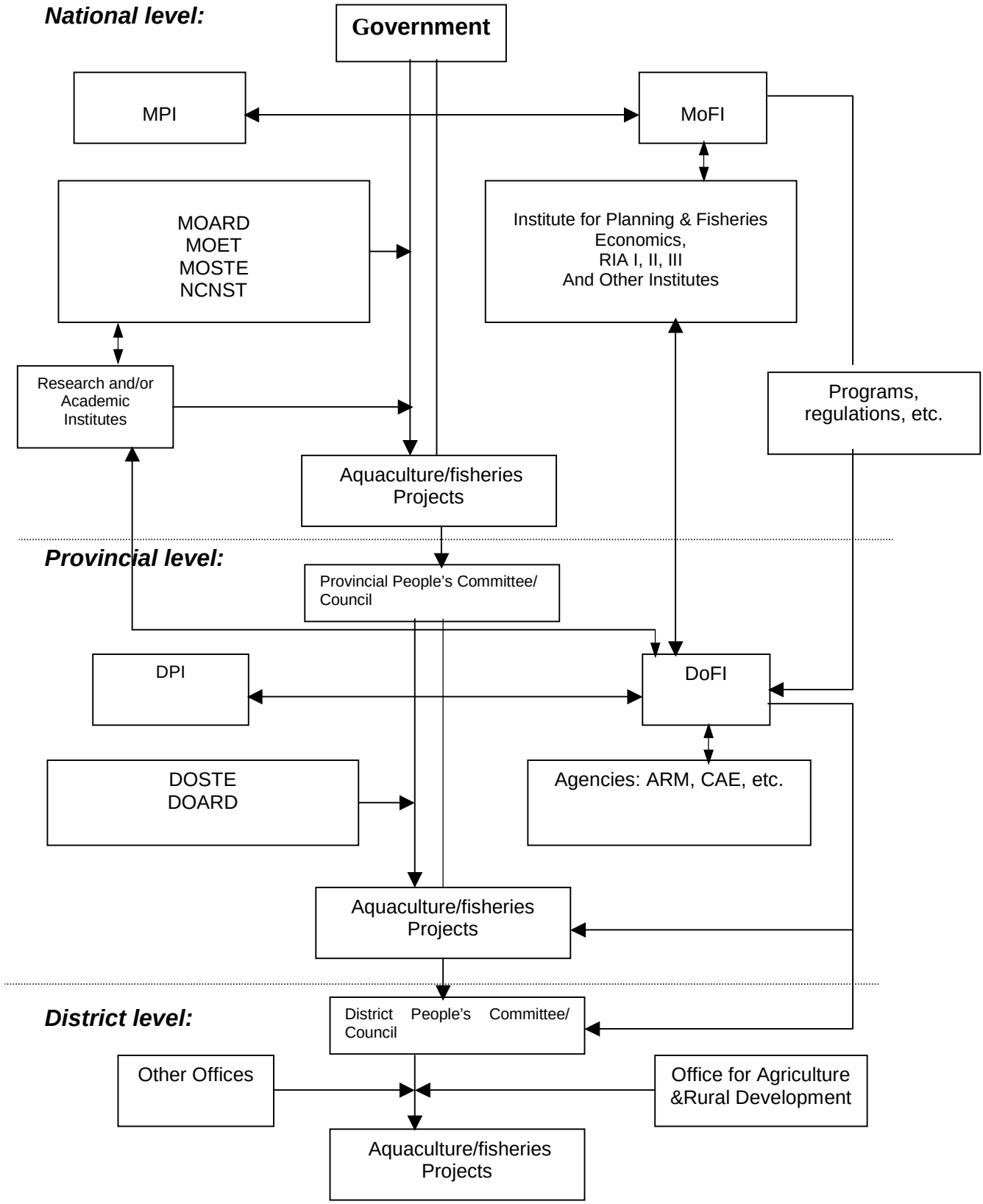

Figure 1. Management framework for aquaculture/fisheries development in Vietnam.

- DoFI has not enough power to manage all issues related to the development of aquaculture and fisheries in its province. The DoFI is not the final decision-maker. It works as a consultancy unit for the Provincial People's Committee. Its documents sent to districts are not mandatory.

- At district level, there is no fishery office. Only one person in agriculture office is responsible for fisheries. Therefore, there is a shortage of manpower to implement DoFI's plans at district and commune levels.

2 Current Aquaculture Activities

2.1 Aquaculture production

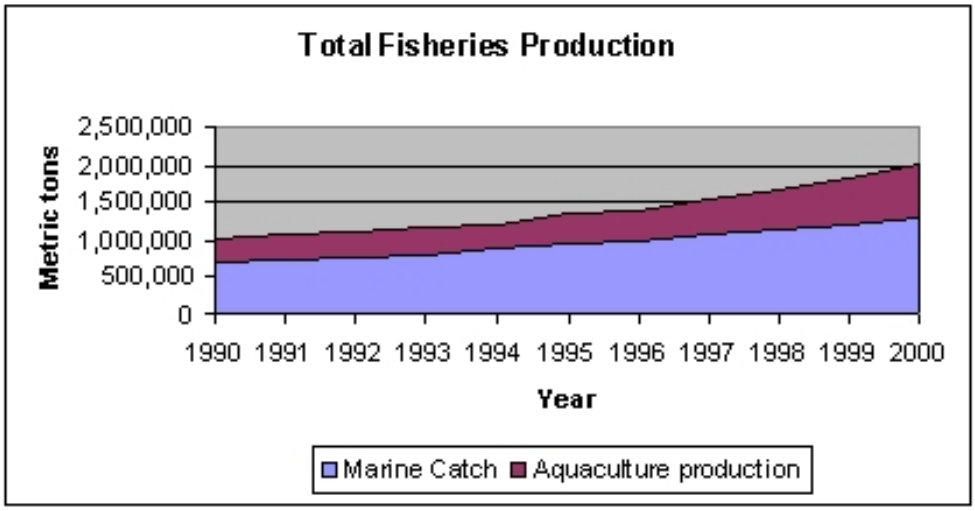

Figure 2. Total fisheries production of Vietnam
(Source: MoFI's annual reports)

The aquaculture production of Vietnam has increased more than twice for ten years since 1990 (fig.2). The production tends to increase in the future.

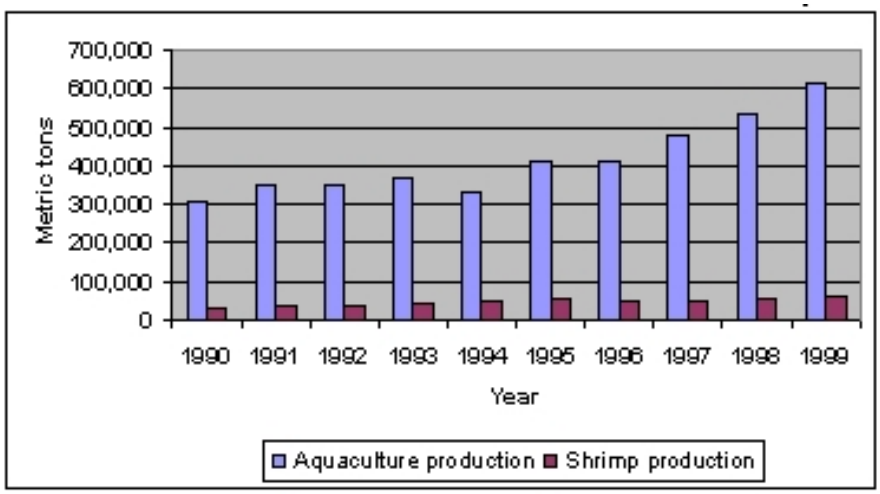

Figure 3. Shrimp production compared with aquaculture production
(Source: MoFI,)

Although shrimp production accounted for 10% of the total aquaculture production (fig. 3) and about 3% of the total fisheries production, it contributed to the exports approximately 30% and 50% of the volume and the value, respectively (figs. 4&5).

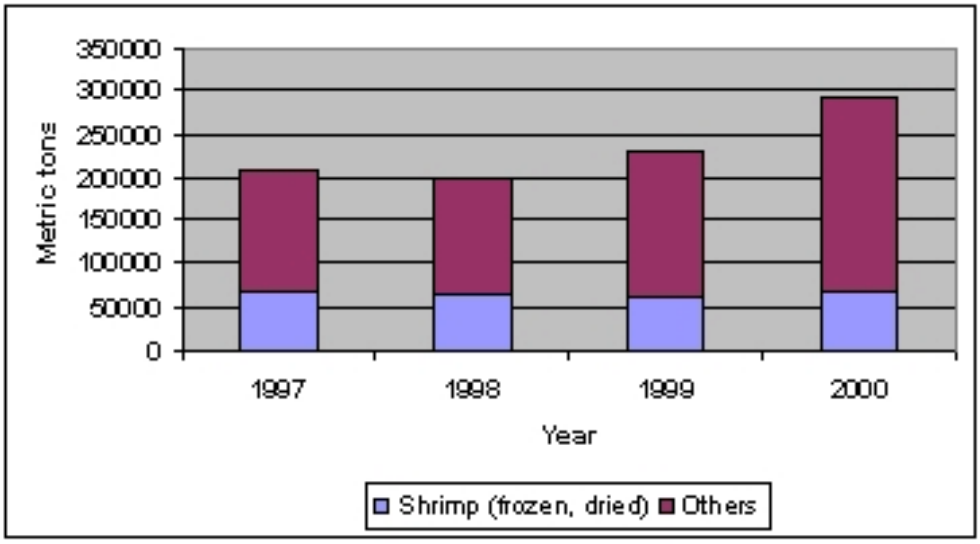

Figure 4. Shrimp and other seafood exports by year

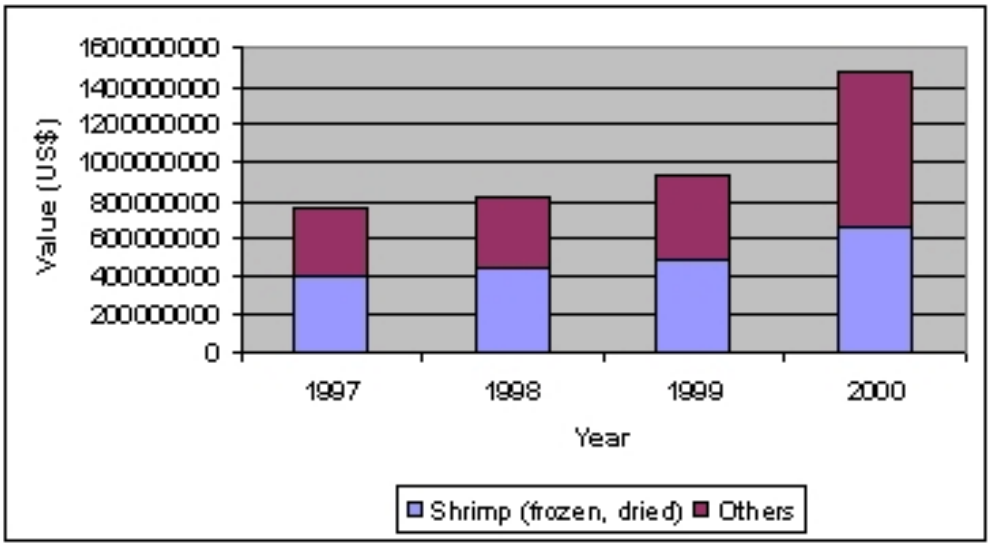

Figure 5. Export value of shrimp and other seafood by year

Because of high profit, shrimp farming continued to be expanded, though it faced with the disease outbreak in the years of 1996 and 1997 that caused 10% of the total production lost.

2.2 Culture areas and species cultured

The main culture types and areas as follows (fig. 6):

- Inland aquaculture:

- ✓ Pond culture: common in the delta of the North and the Middle. The main culture species are common carp *(Cyprinus carpio)*, bighead carp *(Aristichthys nobilis)*, silver carp *(Hypophthalmichthys molitrix)*, grass carp *(Ctenopharyngodon idellus)*, and tilapia *(Tilapia mossambica, T. nilotica)*.
- ✓ Cage culture: in reservoirs in the mountainous areas and along the Mekong river in the South. Most reservoirs were impounded after 1954 for various purposes such as irrigation, hydro-electricity, flood control and water supply. The reservoirs may be classified into large (more than 10,000 ha of water surface), medium (1000 – 10,000 ha), and small ones (less than 1000 ha). There are very few large reservoirs including Hoa Binh (19,000 ha), Thac Ba (18,000 ha), Tri An (32,400 ha), Thac Mo (10, 600 ha), and Dau Tieng (18,000 ha). Most are medium (460 reservoirs) and small. In some medium and large reservoirs, cage culture is commonly practiced. Grass carp (*Ctenopharyngodon idellus*), sand goby (?), snakehead (*Ophiocephalus spp*), common carp (*cyprinus carpio*), and catfish (*Clarias spp*) are the major culture species (Van and Luu, 2001). While Catfishes (*Pangasius bocourti* Sauvage 1880, *P. hypophthalmus* Sauvage 1878, *P. micronemus* Bleeker 1862, *Clarias macrocephalus* (Gunther 1864) and *C. gariepinus* (Burchell 1822) are commonly cultured in the Mekong delta. (Phuong, 1998).

- Coastal aquaculture:
  - ✓ Pond culture: tiger shrimp *Penaeus monodon* is the major species cultured along the coast of Vietnam, especially in the Mekong delta.
  - ✓ Cage culture: the major culture areas are Quang Ninh, Phu Yen, and Khanh Hoa provinces. The main species cultured are lobster (*Panulirus ornatus, P. hormarus, P. timpsoni,* and *P. longipes*), groupers (*Epinephelus bleekeri, E. akaara, sexfasciatus, E. malabaricus, E. coioides, E. merra* and *Cephalopholis miniata).* In addition, some other species such as Seabass *Lates calcarifer*, Yellowtail *Seriola dumerilli*, Sea bream *Parargyrops edita*, Snapper *Lutjanus spp*., Sea-horse *Hippocampus*, Pearl oyster (*Pinctada maxima*, and *P. martensii*), and ornamental fishes were also cultured in cages (An 1993; Tuan 1998).

Figure 6. Major Aquaculture Areas in Vietnam

Table 1. Summary of the commonly cultured species in Vietnam

Scientific name & synonyms	Common names	Distribution	Habitat	Seed supply	Culture form	Culture Area
Epinephelus akaara	Hong Kong grouper, Red spotted grouper, Red grouper	Ton Kin gulf, Southern Central Sea	Marine, demersal; common in rocky areas	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E. malabaricus	Malabar grouper, Estuarine grouper	Ton Kin gulf, Southern Central Sea	Marine and brackishwater. Coral, rocky reefs, sandy and muddy bottoms, tidepools, estuaries, mangrove; juveniles occur in shallow coastal waters and estuaries	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E. merra	Honeycomb grouper	Ton Kin gulf, Southern Central Sea	Shallow-water coral reefs in lagoons and bays	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E. coioides	Orange-spotted grouper	Ton Kin gulf, Southern Central Sea	Marine and brackishwater	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E. sexfasciatus	Sixbar grouper	Ton Kin gulf, Southern Central Sea	Silty sand or muddy bottoms	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E.bleekeri	Duskytail grouper, Yellow spotted grouper	Ton Kin gulf, Southern Central Sea	Shallow rocky banks.	wild	Cage, pond	Quang Ninh, Phu Yen, Khanh Hoa
E. fuscoguttatus	Brown marble grouper, Flowery cod	Ton Kin gulf	Marine, shallow coral reefs and rocky bottoms, clear water. Juvenile found in sea-grass	wild	Cage	Quang Ninh
E. tauvina	Greasy grouper, Green grouper	Ton Kin gulf	Marine, clear oceanic water and coral reefs, hard bottom; juveniles in reef flats and tidal pools	wild	Cage	Quang Ninh
Cephalopholis miniata	Coral hind	Southern Central Sea	Well-developed exposed coral reefs, clear water	wild	Cage	Khanh Hoa
Seriola dumerili	Amberjack, Dumeril's amberjack	Southern Central Sea Lat. 14°34N to 17°32N; Long. 109°30E to 108°22E	Intersecting water with floating seaweed	wild	Cage	Da Nang
S. nigrofasciata	Black-banded kingfish, Black-banded travelly	Southern Central Sea Lat. 14°34N to 17°32N; Long. 109°30E to 108°22E	Intersecting water with floating seaweeds	wild	Cage	Da Nang
Rachycentron canadum	Black kingfish			Hatchery	Cage	Quang Ninh
Lates calcarifer	Seabass, Baramundi	Ton Kin gulf, Central Sea, South Sea		Wild, Hatchery	Cage	Khanh Hoa
Hipppocampus kuda	Black sea-horse	Southern Central Sea		Wild, Hatchery	Cage	Khanh Hoa
H. trimaculatus	Three-dotted sea-horse	Southern Central Sea		Wild, Hatchery	Cage	Khanh Hoa
H.histrix	Thorn sea-horse	Southern Central Sea		Wild, Hatchery	Cage	Khanh Hoa
H. spinosissimus	Short-mouth sea-horse	Southern Central Sea		wild	Cage	Phu Yen, Khanh Hoa
Panulirus ornatus	Yellow ring spiny lobster	Southern Central Sea	Rocks	wild	Cage	Phu Yen, Khanh Hoa
P. hormarus	Spiny lobster	Southern Central Sea	Rocks, coral reefs	wild	Cage	Phu Yen, Khanh Hoa
P. stimpsoni	Hair spiny lobster	Northern Central Sea	Rocks, coral reefs	wild	Cage	Phu Yen, Khanh Hoa

Table 1. Summary of the commonly cultured species in Vietnam (cont.)

Scientific name & synonyms	Common names	Distribution	Habitat	Seed supply	Culture form	Culture Area
Ctenopharyngodon idellus	Grass carp			Hatchery	Cage, pond	The whole Country
Oxyeleotris marmoratus	sand goby			Hatchery	Cage, pond	In the South
Ophiocephalus spp	snakehead			Wild	Cage, pond	South
Channa micropeltis	Spot snakehead			Hatchery	Pond, canal, rice-field	Mekong delta
Channa striata	Snakehead			Hatchery	Pond, canal, rice-field	Mekong delta
Leptobarbus hoeveni	Hoeven's carp			Wild, Hatchery	Pond, canal, rice-field	Mekong delta
Cyprinus carpio	common carp			Hatchery	Cage, pond	The whole Country
Pangasius bocourti	Catfish			Hatchery	Cage	Mekong delta
P. hypophthalmus	(River) Catfish			Hatchery	Cage, pond	Mekong delta
P. micronemus	Catfish			Hatchery	Cage	Mekong delta
Clarias macrocephalus	(Walking) Catfish			Hatchery	Cage, pond	South
C. gariepinus	Catfish			Hatchery	Cage, pond	South
Trichogaster pectoralis	Snakeskin gouramy			Hatchery	Pond, rice-field	Mekong delta
Barbodes gonionotus	Silver barb			Hatchery	Pond, canal, rice-field	Mekong delta
Barbodes altus	Tin foil barb			Hatchery	Pond, canal, rice-field	Mekong delta
Anabas testudineus	Climbing perch			Hatchery	Pond, canal, rice-field	Mekong delta
Notopterus notopterus	Grey feather back			Wild, hatchery	Pond, canal, rice-field	Mekong delta
Notopterus chitala	Feather back			Hatchery	Pond, canal, rice-field	Mekong delta
Hypophthalmichthys molitrix	Silver carp			Hatchery	Cage, pond	The whole Country
Aristichthys nobilis	Bighead carp			Hatchery	Cage, pond	The whole Country
Labeo rohita	Rohu, Indian carp			Hatchery	Cage, pond	South
Cirrhinus mrigala	Mrigal			Hatchery	Cage, pond	South
Tilapia mossambica	Tilapia			Hatchery	Cage, pond	South
Tilapia nilotica	Tilapia			Hatchery	Cage, pond	South

(Source: Son,1996 [a,b]; Hambrey, 1997; Trai, 1997; Phuong, 1998 Phuong, 1998; Tuan, 1998; Khanh et al., 2000; Van and Luu, 2001; Viet, T.T., et al., 2001)

Seed supply is one of the major constraints to the development of the aquaculture in Vietnam.

2.3 Production systems

The two main aquaculture systems in Vietnam were pond and cage culture. Ponds were used commonly to raise shrimp along the coastal area and freshwater fish species in the inland area. Ponds normally had a rectangular shape and various

sizes from 100 square meters to few hectares. Cages were designed in various ways depending on cultured species and characteristics of culture areas (Table 2).

Table 2. Summary of commonly used cages in Vietnam

Candidates cultured	Cage				Culture Area
	Type	Shape & size	Frame	Bag	
Freshwater Fish as food: Grass carp, sand goby, snakehead common carp, catfishes, etc.	Floating	Bottom: rectangular; Various size: 2*4*1.5, 3*4*2m, etc.	Wood and buoys	Net	Sites with various depths in reservoirs in mountainous areas and in Mekong river
Marine Fish as food: Grouper, Yellowtail, Black kingfish, Seabass, Snapper, Seabream, etc.	Floating	Bottom: rectangular; Various size: 2*1.5*2, 2*2*2, 4*2*2, 10*5*2, 3*3*3m, etc.	Salt-resistant wood and buoys	Net	Sites with depth of 20-50m in bays (Quang Ninh, Da Nang, Phu Yen, Khanh Hoa)
Ornamental fish: Butterfly fish, anemone fish, etc.	Floating	Bottom: rectangular; Various size: 2*1.5*2, 2*2*2, 4*2*2	Salt-resistant wood and buoys	Net	Sites with depth of 20-50m in bays (Khanh Hoa)
Fish as medicine: Sea-horse	Fixed	Bottom: rectangular; Size: 3*6*1m	Salt-resistant wood	Net with mesh size 1mm	Estuaries, lagoon (Khanh Hoa)
Crustacean: Lobster	Fixed	Bottom: rectangular, square Various size: 2*1.5*2, 2*2*2, 4*2*2, 10*5*2, 3*3*3m, etc	Salt-resistant wood	Net	Shallow sites in bays (Phu Yen, Khanh Hoa)
	Submerged	Bottom: rectangular, square; Bottom area 20-50m, height 1-1.5m	Iron	Net	Shallow sites in bays (Phu Yen, Khanh Hoa, and Ninh Thuan).
Shrimp	Fixed	Cylinder shape; bottom diameter 2.5-2.8m, height 1.5m	Bamboo	Bamboo	Lagoon (Thua Thien-Hue)

(Source: An, 1994; Son, 1996 a,b; FEC of Thua Thien-Hue province, 1998; Luong, 1998; Phuong, 1998; Van and Luu, 2001*)*

In general, the aquaculture industry in Vietnam developed spontaneously (fig. 7). That caused pollution, and disease problems. Many shrimp farms and recently, lobster farms have failed.

Figure 7. Lobster farms spontaneously bloomed out in Khanh Hoa

2.4 Feed supply

Feed and feeding applied in culture of commercially important species in Vietnam are summarized (RIMP, unpubl; Ky, 1994; FEC, Ninh Thuan province, 1996; Trai, 1997; Deng, 1998; Phuong, 1998; Hoa, 1999; Thuy, 2000) in table 3 below.

More than 42 kinds of formulated feed such as CP.Group, Betagro Kiladum, Classic, Grobest... (Thailand), Woosung (Korea), Seahorse (Taiwan), KP 90, Thanh Toan, Nam O (Da Nang, Vietnam), etc self-made feeds and trash fish were applied in shrimp farming in Vietnam. Many formulated feeds were applied without confirmation/testing of their quality.

Lobsters are fed exclusively with fresh whole or chopped fish and shellfish (fig. 8). The most commonly used species/groups for feeding lobster are Lizardfish (*Saurida* spp); red big-eye (*Priacanthus* spp); Pony fish (*Leiognathus* spp); pomfret; snails, oyster and cockles; small swimming crab, other crabs and shrimps. Finfish comprizes about 70% of the diet, with 30% shellfish. The preferred fish (comprizing 38% of fishes in diet) was lizardfish (Tuan et al., 2000).

Table 3. Feed and feeding in aquaculture in Vietnam

Cultured species	Feed and feeding
Tiger shrimp	Most intensive and semi-intensive farms used pelleted feeds. The self-made feeds and trash fish were commonly used in the third month just before harvest to reduce the production cost in those systems or in extensive farms. Feeding and FCRs changed depending on the kind of feed used.
Groupers	Trash fish; FCR=4-17; feeding 3-5% body weight;
Asian Asian sea bass	Trash fish
Black kingfish	Trash fish
Yellowtail	Trash fish and crustacean.
Sea-horses	- Fry: zooplankton, mainly on *Copepods*; feeding 10-15% body weight, twice/day: 8am and 4pm. - juvenile (>30mm body length): small crustacean such as *Mysidacea, Palaemonidae, Amphipods*, *Lucifer*, etc.; feeding 5-8% body weight; twice/day: 8am and 4pm. - Sea horses only feed on live food.
Lobsters	Preferred feeds were shellfishes such as mollusks, crustacean. Among trash fishes, lobsters prefer Red Big-eye, Pony fish, Lizardfish. FCR= 28-29. Feeding: small-sized lobster: 3-4 times/day. Feed amount was increased in the evening. Trash fish was chopped into small pieces, and mollusks'shells were excluded; Large-sized lobster (>400g/pc): 2 times/day. Feeding intensity of lobster increased strongly just before melting. In last few months of a culture cycle, shellfish amount (mollusks, crustacean) was increased while trash fish decreased
Pangasius fishes	Self-made feeds or moisture feeds made of trash fish and rice bran was used. FCR=1.35-6. Feeding frequency = 1-5 times/day.

Figure 8. Preparing trash fish for lobster

Previous studies (Trai 1997) have shown that only whole fresh trash fish are used, and that food conversion ratio in cage culture, averaging 5.9 (fresh weight) is significantly higher than that for pond culture of grouper where average FCR was found to be 4.3. Feed costs comprise around 18% of the farm gate price of grouper.

Using low quality formulated feeds and trash fish may cause polluted waters.

2.5 Seed supply

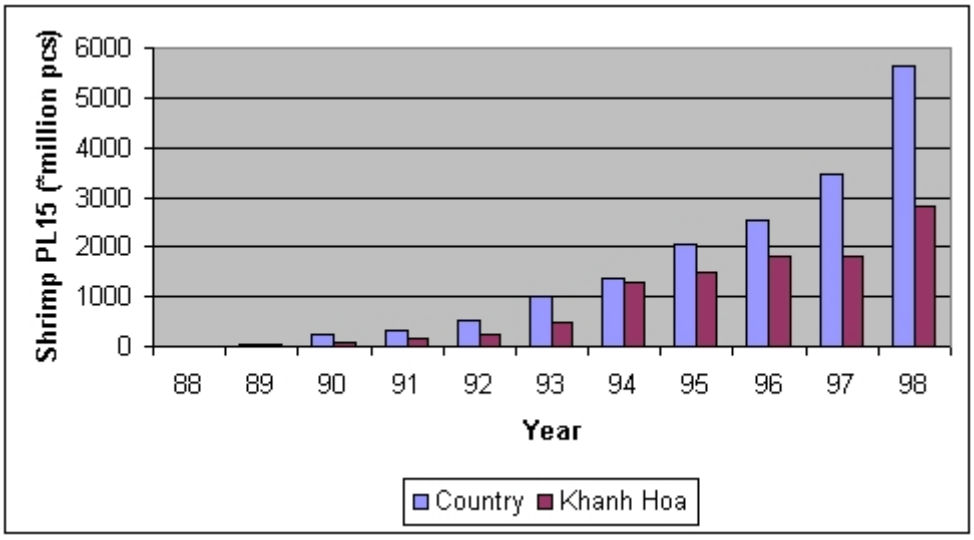

Figure 9. Shrimp seed production by year

The shrimp seed production has increased significantly since the year of 1988. Khanh Hoa was the first and biggest producer of shrimp PLs (Fig. 9). Recently, many provinces countrywide have produced the seed to meet their own demand. However, there is still a shortage of the seed in the country. Some enterprises imported shrimp brood-stock from the Philippines, Singapore, and Malaysia. There have been disease outbreaks due to the imported brood-stock in the country.

Total grouper seed came from the wild and recently from hatchery. One hatchery in Khanh Hoa province produced approximately 1,000,000-2,000,000 juveniles a year enough to meet the local demand and sell elsewhere. In addition, some companies imported grouper seed from Taiwan and sell locally without testing the quality. There was a disease problem in Khanh Hoa last year (fig. 10).

The potential supply of lobster seed is also being assessed roughly from first principles, using area of suitable habitat and natural productivity as indicators of potential seed production. Total lobster seed production (mainly *Panulirus ornatus*) of the country was around 1,000,000-2,000,000 pieces per year in recent years. The price was between VND 20,000 and 120,000 (ca US$1.4-8.6). It tended to increase by size and by year.

Figure 10. Disease Outbreak in grouper cultured in Khanh Hoa

Although the central government had a decree on seed management (MoFI, 1996[a]), the implementation seemed not good in practice.

2.6 Ownership

Ownership of aquaculture farms changed over time and by region. Before 1975 all famrs in the North belonged to the state-owned or co-operative-owned enterprises while in the South those were private-owned ones. Between 1975 and 1986 Most aquaculture farms were co-operatives. Since 1986, especially after "the open door policy" was initiated, aquaculture farms have belonged mainly to the private sector since 1990. Although most of them were active and creative, they were still too small to compete with foreign companies, and too spontaneous to plan. Currently, there have been five major types of enterprises as follows:

- Private;
- Improved co-operative;
- State-owned;
- Joint-venture between Vietnam partner(s) and overseas partner(s); and
- 100% foreigner-owned

Planning and environmental management were implemented well in large-scale enterprises.

3 Environmental issues

Table 4. Summary of Environmental status associated with aquaculture

Env. issue Type of aquaculture activity	Water quality (nutrient loading)	Water management	Disease	Habitat damage	Soil quality	Feed	Owner-ship / access rights	Soil salination
Aquaculture in the North (Dr Dung?): 1. Shrimp culture 2.								
Aquaculture in the Middle: 1. Cage culture of lobster, sweet snail, seabass in Xuan Tu water. 2. Shrimp culture and lobster nursing in Nha Phu lagoon 3. Farming of shrimp, grouper, and lobster in Cam Ranh bay.	*** *** **	* * *	** *** ***	** *** **	** ** ***	*** ** ***	*** *** **	* *** ***
Aquaculture in the South (Mr Tu?): 1. Shrimp culture 2.								

**** is high; ** is medium, * is low*

In the Middle from Da Nang province to Binh Thuan province, Khanh Hoa was the biggest producer of aquaculture products, especially sea products. There are approximately 12,000 lobster cages producing ca 1,000mt a year currently. There have been disease problems for two years. This may result from exceeding of the environmental capacity, especially in the Xuan Tu water where there were about 2,000 lobster cages and 100 snail cages and few seabass cages. The same problems also occurred in the Nha Phu lagoon and in the Cam Ranh bay.

4 Environmental policy and implementation at national or regional level

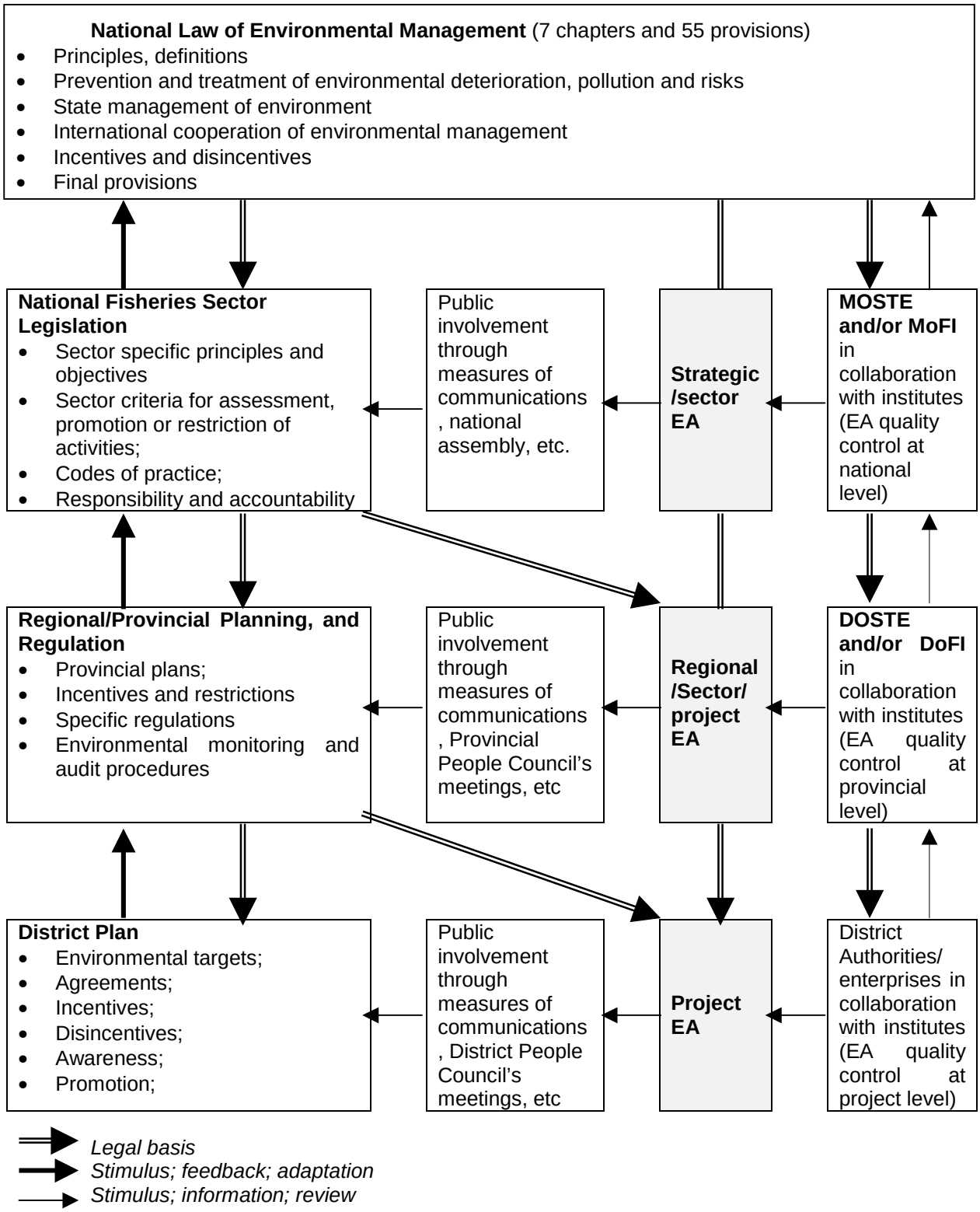

Figure 11. The legal and institutional Framework for Environmental Assessment (EA) of Aquaculture in Vietnam

The environmental policy and implementation at national or regional level are summarized in the figure 11 (Modified from Hambrey's model, 1998). Vietnam Assembly issued the Law of Environmental Management in 1994. The Law 's objectives were to protect the salubrious environment for people's health and living, to ensure the sustainable development in harmony with the whole environment. At lower levels including regional/provincial/sector and district levels, there were plans, regulations, and criteria for the environmental management (table 5). In general, each province or each sector had its own regulations based on the Law and its specific circumstances.

Table 5. National environmental quality standards of coastal water

Factor	Unit	For swimming	For Aquaculture	Other places
Temperature	^{o}C	30	-	-
Smell		no	no	no
pH		6.5 – 8.5	6.5 – 8.5	6.5 – 8.5
DO	mg/L	≥ 4	≥ 5	≥ 4
BOD (5 day period)	mg/L	< 20	< 10	< 20
Suspended solids	mg/L	25	50	200
Asenic	mg/L	0.05	0.01	0.05
NH_3 (based on N)	mg/L	0.1	0.5	0.5
Cd	mg/L	0.005	0.005	0.01
Pb	mg/L	0.1	0.05	0.1
Cr (VI)	mg/L	0.05	0.05	0.05
Cr (III)	mg/L	0.1	0.1	0.2
Cloride	mg/L	-	0.01	-
Copper	mg/L	0.02	0.01	0.02
Floride	mg/L	1.5	1.5	1.5
Zinc	mg/L	0.1	0.01	0.1
Mn	mg/L	0.1	0.1	0.1
Ferric	mg/L	0.1	0.1	0.3
Hg	mg/L	0.005	0.005	0.01
Sulfide	mg/L	0.01	0.005	0.01
Cyanide	mg/L	0.01	0.01	0.02
Total phenol	mg/L	0.001	0.001	0.002
Oil foam/skin	mg/L	no	no	0.3
Oil suspension	mg/L	2	1	5
Chemicals used as pesticides	mg/L	0.05	0.01	0.05
Coliform	MPN/100mL	1000	1000	1000

The implementation of the Law and regulations has not been good yet, especially at local levels because there was a shortage in human resource as well as facilities for environmental assessment, mitigation and management of impacts, etc.

5 Current research and implementation and opportunities for collaboration

There have been 121 fisheries sector projects in Vietnam since 1982. About one-tenth of the projects are occurring of relevance to the TROPECA project (Table 6). Danida-SUMA and Hon Mun MPA projects are among potential collaborators.

Table 6. List of fisheries sector projects that may be relevant to TROPECA

Donor	Project Title	Project date	Commitment (US$'000)	Grant/ Loan	Executing Agency (EA)	Implementing Agency (IA)	Co-implementing	Project Objectives	Location
ADB (RETA 5552)	Coastal and marine environmental management	.	.	.	.	MOSTE	.	Regional technical assistance involving Cambodia, Viet Nam and China. In Viet Nam the RETA is preparing investment projects . The Minh Hai component involves the preparation of an integrated environmental management plan, including mangrove reforestation and aquaculture.	Ha Long Bay, Minh Hai, Ho Chi Minh city
DANIDA	Fisheries Sector Programme Support (Fisheries SPS) (104.Vie.41)	TBA	41	Grant	MOFI	Provincial Fisheries Dept.	.	Environmentally and socially sustainable growth in the fisheries sector in line with the international standards	Nghe An; Ha Tinh; Bac Kan; Khanh Hoa; Quang Ninh
DANIDA	Coastal Aquaculture	TBA	1,000	Grant	.	.	.	Environmentally sustainable coastal aquaculture development in the North-Central Coastal region of Vietnam	Thanh Hoa; Nghe An; Thua Thien-Hue
DANIDA/WB	Viet Nam coastal wetlands protection and management development.	2000-ongoing	65,600	31,100 loan and 11,300 grant	DANIDA	MOSTE	.	Restore mangrove forests along the 470 km Mekong coast, giving a boost to aquaculture and improve the quality of live.	Tra Vinh, Soc Trang, Bac Lieu, Ca Mau

DANIDA	Support for brackish water and Marine Aquaculture (SUMA) (a component of the Fisheries SPS)	2000-2005	6,460	grant	DANIDA	MOFI	.	To strengthen the administration and management practices as required to supply marine aquactic products through environmentally and socially sustainable aquaculture development. Topics: Legislation, Aquaculture planning, Technology development, pilot community projects, Credit, HRD capacity building, Information collection and dissemination	On national level and 5 provinces , Quang Ninh, Ha Tinh, Nghe An, Khanh Hoa and Ca Mau
IUCN/GEF/ DANIDA	Hon Mun Marine Protected area Pilot Project	2001-2005	2,123	Grant	IUCN	MOFI	.	To conserve a representative example of internationally significant and threatened marine bio-diversity. To enable local island communities to improve their livelihoods and in partnership with other stakeholders to effectively protect and manage the marine bio-diversity at Hon Mun as a model for collaborative MPA management in Vietnam.	Khanh Hoa
MRC	Assessment Mekong Fisheries: Migration and Spawning and impact of Water Management	1997-2003	5,213	grant	MRC	MOFI, (RIA2)	.	covers 4 countries	Mekong Delta in Viet Nam
MRC	Management of the Reservoir Fisheries in the Mekong Basin, Phase II	2000 - 2004	4,455	grant	MRC	MOFI (RIA3)	.	Sustaninable co-management models for optimal fish production in reservoirs develop, implemented and disseminated in the Lower Mekong Basin (4 countries)	Central hihgland of Viet Nam (Daklak)
Netherlands	Vietnam-Netherlands Integrated Coastal Zone Management Project	2000-2003	2,000	grant	SNV	MOSTE	Doste	Assist in the establishment of the required institutional structures at national and provincial level for ICZM, expand institutional and professional capacity to apply ICZM, develop long term strategy and action plans; and initiate short term application of ICZM in three provinces	Thua Thien Hue, Nam Dinh, Baria-Vung

								through practical problem solving approaches.	Tau
PEMSEA	National Demonstration Site for Integrated Coastal Management at Danang	2000-2004	.	grant	PEMSEA	DOSTE, Danang	PPC Danang	Workshop on Integrated Coastal Management. PEMSEA's project design is based on two management frameworks, namely:integrated coastal management and risk assessment/risk management. Demonstration sites will be set up throughout the region to implement these two mechanisms	coastal lands and waters of Danang Municipality including Son Tra Peninsula, Danang Bay, Son Tra coastal waters and their adjacent lands
SEAFDEC	Pilot project for semi-intensive culture of shrimp (to include conservation of mangrove friendly aquaculture) (SD/AQ99-CM03)	1999-2002	.	.	Seafdec	RIMP	MOFI	Project operated by RIMP staff to make a model for semi-intensive culture of shrimp to increase production and thus profitability, and at the sam time teach the fishfarmers how to conserve the resources, e.g mangroves	SEAFDEC
UNDP	Environmental Management in Coastal Aquaculture	2000	375	Grant	MOFI	Ria No.1	.	Environmentally sustainable coastal aquaculture development in the North-Central Coastal region of Vietnam	Thanh Hoa; Nghe An; Thua Thien-Hue

(Source : FAO Hanoi, Vietnam, http:www.fistenet.gov.vn)

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