

**VIET NAM – NETHERLANDS WATER PARTNERSHIP  
ON WATER FOR FOOD AND ECOSYSTEM (WFE)**

**MAIN CASE STUDY**

**TOWARDS BETTER USE  
AND MANAGEMENT OF  
WATER RESOURCES  
FOR AQUACULTURE  
AND AGRICULTURE  
PRODUCTION IN DAI  
HOA LOC AND BINH  
THOI COMMUNES, BINH  
DAI DISTRICT, BEN TRE  
PROVINCE”**



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**FINAL REPORT**

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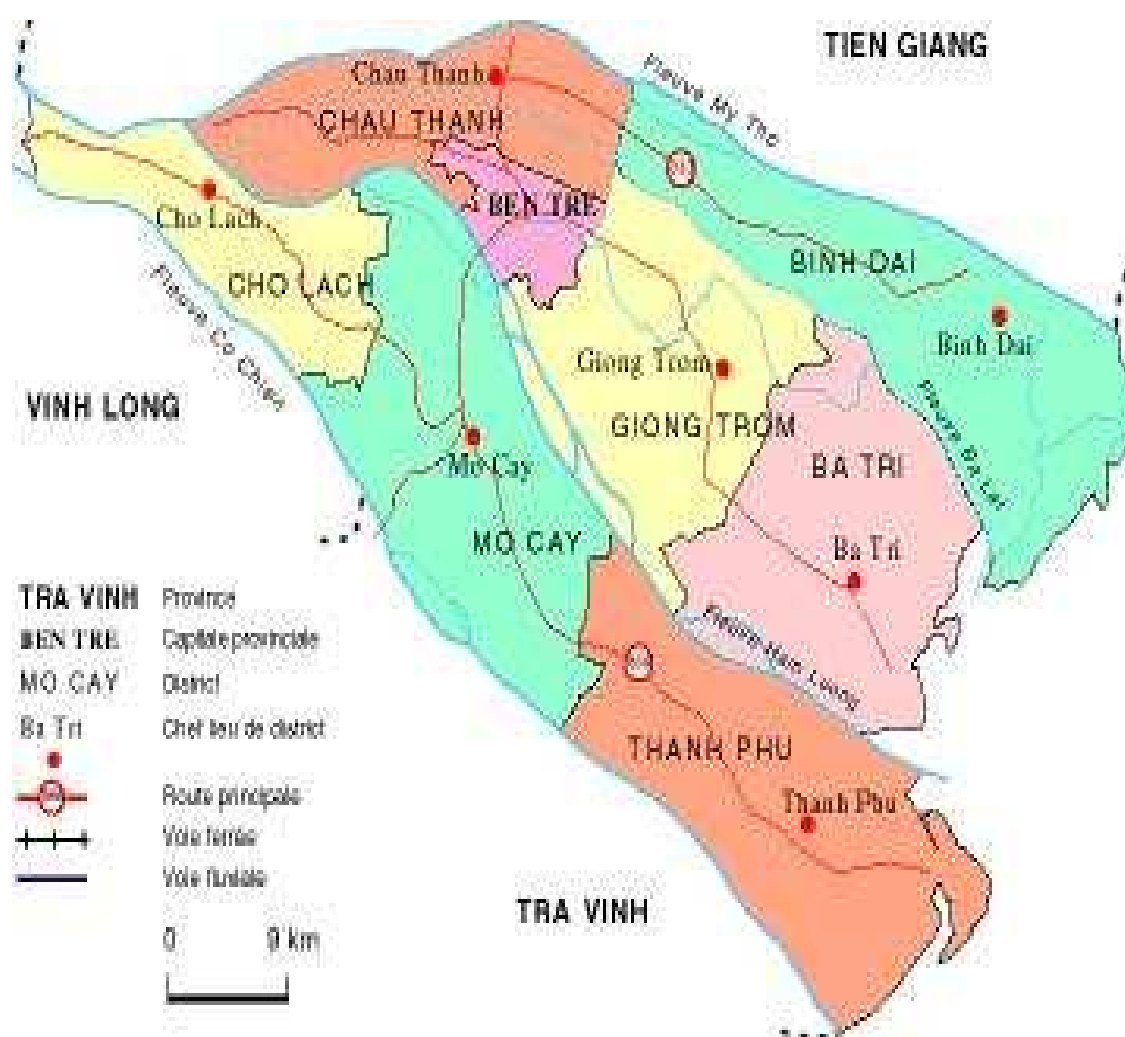
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**REPORT ON “TOWARDS BETTER USE AND MANAGEMENT OF  
WATER RESOURCES FOR AQUACULTURE AND AGRICULTURE  
PRODUCTION IN DAI HOA LOC AND BINH THOI COMMUNES,  
BINH DAI DISTRICT, BEN TRE PROVINCE”**



## **I. NATURAL CONDITIONS FEATURES OF BEN TRE**

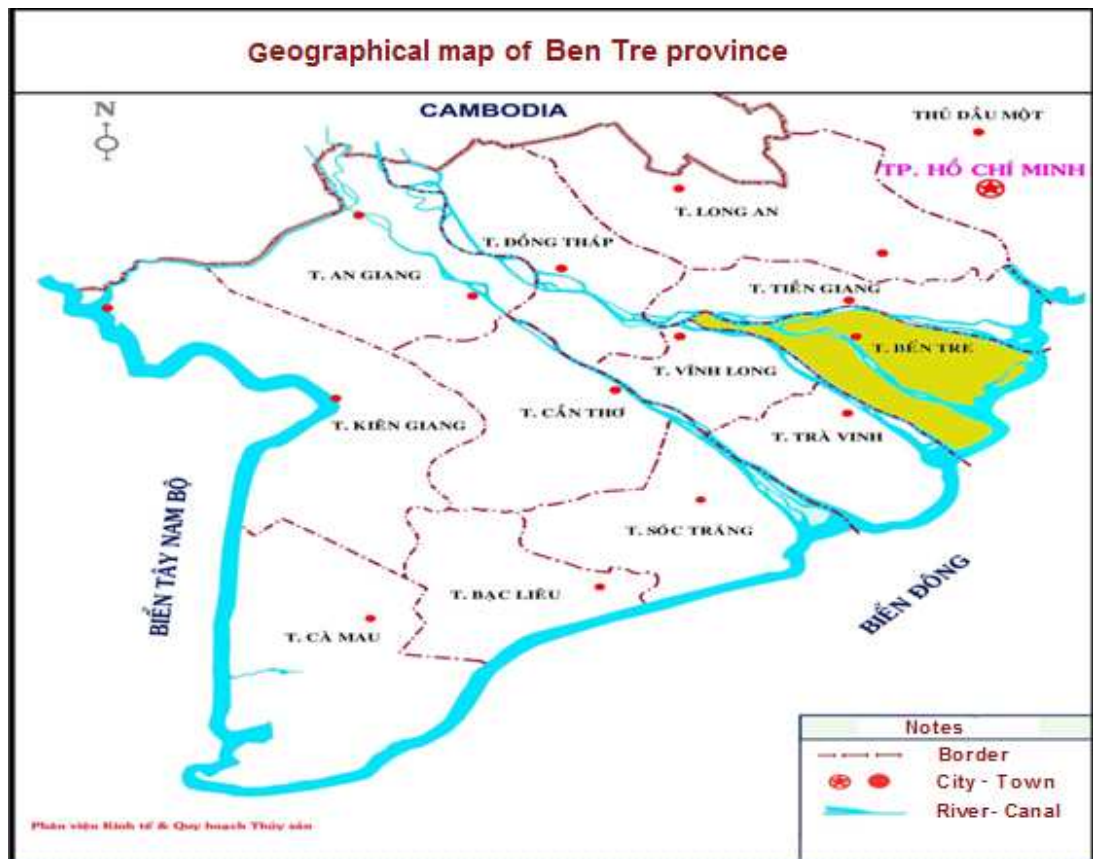
### **1. Geographical location and natural conditions**

#### **1.1. Geographical location**

Ben Tre is one of 13 provinces that make up Cuu Long River Delta. It is founded by three large islets mainly An Hoa, Bao and Minh which have been raised and deposited by four Cuu Long River's tributaries (Cua Dai, Ba Lai, Ham Luong and Co Chien).

Geographical coordinates of Ben Tre province are  $9^{\circ}48'$  -  $10^{\circ}20'$  North and  $105^{\circ}57'$  -  $106^{\circ}48'$  East

- + It borders Tien Giang province in the North.
- + It borders East Sea in the East.
- + It's bounded by Vinh Long and Tra Vinh provinces in the West
- + It's bounded by Tra Vinh province in the South.



## 1.2. Natural conditions

Ben Tre has three big estuaries directly flowing to sea mainly Dai, Ham Luong and Co Chien so it's effected of the exchanges of sea and river causing forming of three ecological areas (marine, fresh and brakish waters) with regional line to be changed according to seasons and hydrologic processes.

Region I (Fresh water ) : located on source comprising 37% of province's area including districts mainly Cho Lach, Chau Thanh, one part of Ben Tre town and the area situated in the Northern side of Mo Cay district. Due to hydrologic feature of this region is fresh water region it's fravourable for local speacility of fruit farming, 2-3 rice crops in rotation and specially fresh water aqualcuture.

Region II (Brackish water) : situated in the middle of province comprising 26% of province's area including districts such as Ba Tri, Giong Trom, Thach Phu, the Southern Ben Tre town and Southern Mo Cay district.

Brackish water region : borders on East Sea, occupies 37% of province's area.

### **1.2.1. Pedologic terrain features.**

Ben Tre has a flat terrain, lower toward sea. According to the result of Programme 60-02 of soil map of Ben Tre, there are groups of soil as following :

The group of soils in sand dunes : They are sand stretches distributing along the sea coast. This group of soil has light mechanic components, sandy rate 60 -80%, clay rate from 21-25%.

Group of yellow brown alluvial : It's non muddy area which is newly deposited alluvial in riverside islands. This soils continue to be deposited and submerged in the flood season. The layers of soil are still unstable, poor acid, rich organic substances which are good soil for growing plants.

Group of alluvial soil with yellow and red rusty spots : This is a soil region formed by sediment from sea and rivers. The structure of this soil contains alot of iron. It is deposited by sinking in salt-marsh and sand-bank. Its surface is strongly swept away by water so it has low salt content, medium protein. This soil is more favourable for crop plants than aquaculture.

Group of now and then salinity polluted alluvial soil : It's the same original with Group of alluvial soil with yellow and red rusty spots, but in the dry season, it's salinity polluted by sea water so it's high content of organic and protein and poor phosphate. Almost shrimp culture develops in this area of soil. Besides, in three districts namely Binh Dai, Ba Tri and Thanh Phu, the bottom floor of alluvial grounds at estuaries are identical (saline clay). They have



muddy layers from 0,05 to 0,2 on their surface and medium sinking level that are favourable for aquaculture.

### **1.2.2. Hydrologic Features**

Ben Tre is in monsoonal region and near equator, has monsoonal climate and as a coastal province so it's also effected by oceanic climate.

Hydrologic features of Ben Tre is estuarine and coastal so it's effected by 2 hydrologic processes which are estuary and seaport related directly to aquaculture. In Ben Tre there are 4 big rivers and hundred of interlacing canals. Ben Tre comprises 36% total water of Cuu Long River flowing into sea. This makes a big brakish water area : low salinity (0,5 - 5<sup>0</sup>/<sub>00</sub>) and medium salinity (5 - 18<sup>0</sup>/<sub>00</sub>.). This salinity depends on tide, wind speed, wind direction, rainy and dry seasons. In dry season, the area of salinity polluted regions increases and expands to inland.

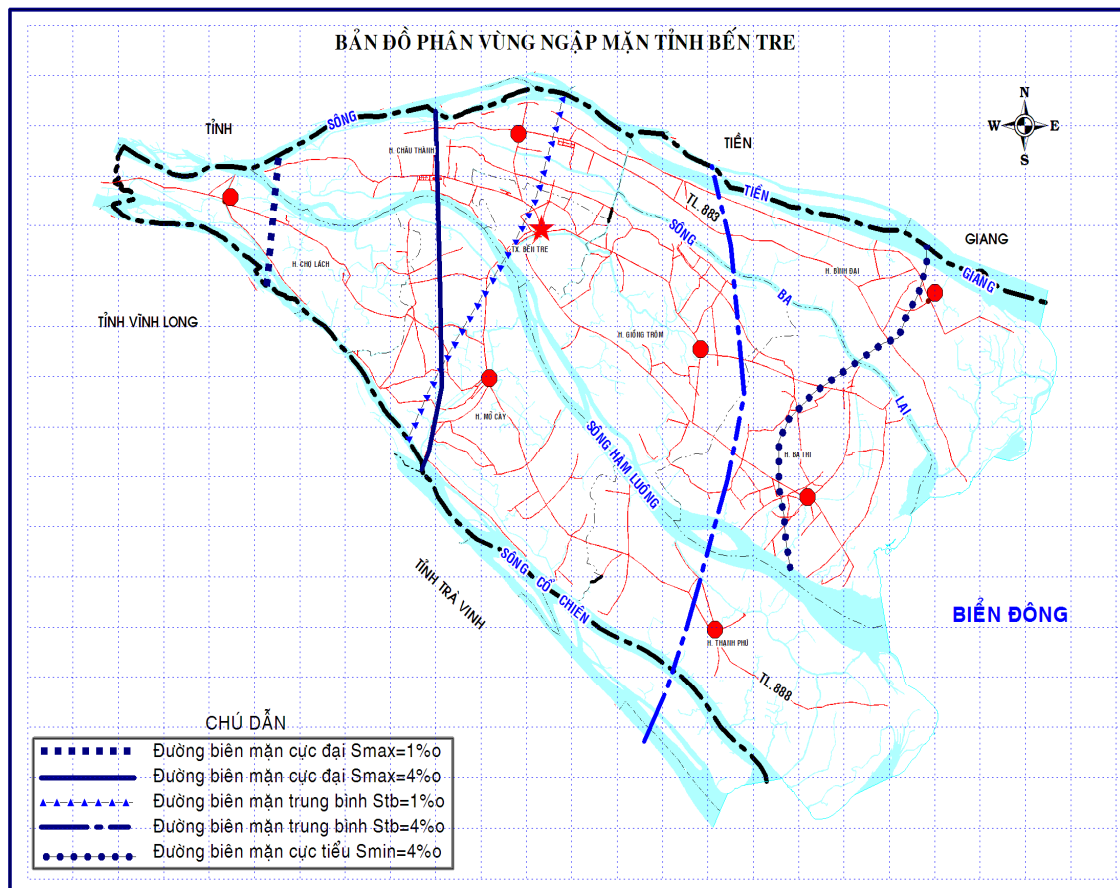
The tidal feature of Ben Tre is half-daily changeable and unregular. There 02 top level and bottom level of tide daily and 02 periods of high level water and 02 periods of low level water monthly. Tide reaches the highest level with 4m on december and lowest level on march, april, september and october. The big tide amplitude is convenient for water supply and drain in aquaculture area.

## **2. Area and population**

Ben Tre has area of 2.322 km<sup>2</sup>, population of 1.345.637 people (Department of Statistics, 2005). Average population density is about 569 persons/ km<sup>2</sup> . Ben Tre province has 07 districts namely Chau Thanh, Mo Cay, Cho Lach, Giong Trom, Binh Dai, Ba Tri, Thanh Phu and Ben Tre town.

Ben Tre has 65 km beach length which is favourable for marine economic development. It also has four big rivers flowing through such as Co Chien, Ham Luong, Ba Lai and Cua Dai with the total length of 298 km (in which Co Chieu : 81 km, Ba Lai : 55 km, Ham Luong : 72 km and Cua Dai : 90km). Besides, its

small and medium system of canals are plentiful making big potential for developing fisheries industry in province.



Picture 2 : salinity polluted region map of Ben Tre

### 3. Aquaculture activities in Ben Tre.

#### 3.1. Aquaculture area

Aquaculture area in Ben Tre province increased constantly in period of 2000-2005 (from 33.928,0 ha to 42.748,3 ha), the average growth rate gained 4,2%/year and then it decreased in 2006 (40.829 ha). Area for Tiger shrimp and clam farming mainly decreased (marine and brakish water). For intensive and half-intensive farming of tiger shimp, seed rearing gained 77,5% compare to

2006 plan. This was caused by productivity of farming reason in 2005, the cuturists had faced with difficulties in invest capital while banks limited to provide loans for intensive and half-intensive farming of tiger shimps in 2006, some aqualculture regions lacked of capital so they hadn't reared seeds for all culture area invested and culture area newly invested increased negligible.

The area under marine and brackishwater aquaculture increased quite stably in the period between 2000-2005, from 32,009 ha. to 37,366.6 ha. with the average growth rate of 3% per year.

The area for freshwater aquaculture tended to increase more quickly than marine and brackishwater aquaculture with the annual average growth rate of 19% in the period of 2000 – 2006.

Cage aquaculture appeared in 2004 and tended to increase in 2005 and 2006.

Table 1: Aquacultural area of Ben Tre province in the period 2000-2006

No.	Items	Unit	2000	2001	2002	2003	2004	2005	2006
	<b>Total aquacultural area</b>	<b>ha</b>	<b>33,928. 0</b>	<b>33,504.0</b>	<b>34,392. 0</b>	<b>36,000. 0</b>	<b>41,114. 2</b>	<b>42,748. 3</b>	<b>40,82 9.1</b>
<b>1</b>	<b><i>Area for marine and blackishwater aquaculture</i></b>	<b>-</b>	<b>32,009. 0</b>	<b>31,303.0</b>	<b>32,890. 0</b>	<b>32,154. 0</b>	<b>36,954. 9</b>	<b>37,366. 6</b>	<b>35,39 7.9</b>

1.1	Area for intensive and semi-intensive giant tiger prawn farming	-	244.0	700.0	1,500.0	2,322.0	5,328.0	6,466.3	5,189.0
1.2	Area for extensive and intercropping farming	-	28,119.0	26,573.0	27,902.0	25,469.0	27,040.0	26,252.3	25,959.9
1.3	Area for oyster and clam farming	-	3,366.0	3,680.0	3,208.0	4,260.0	4,586.9	4,608.0	4,249.0
1.4	Area for crap farming	-	280.0	350.0	280.0	103.0	-	40.0	
<b>2</b>	<b><i>Area for freshwater culture</i></b>	<b>-</b>	<b><i>1,919.0</i></b>	<b><i>2,20.,0</i></b>	<b><i>1,502.0</i></b>	<b><i>3,846.0</i></b>	<b><i>3,894.1</i></b>	<b><i>5,240.6</i></b>	<b><i>5,278.1</i></b>
2.1	Area for shrimp farming	-	698.0	698.0	829.0	1,807.0	1,359.7	2,001.6	1,987.0
2.2	Area for fish farming	-	1,221.0	1,503.0	673.0	2,039.0	2,534.5	3,239.0	3,291.1
*	<i>In which: catfish farming</i>	-	-	-	-	-	54.3	57.9	96.5
<b>3</b>	<b><i>Area for other species farming</i></b>	<b>-</b>	<b><i>-</i></b>	<b><i>-</i></b>	<b><i>-</i></b>	<b><i>-</i></b>	<b><i>264.5</i></b>	<b><i>141.1</i></b>	<b><i>153.7</i></b>
*	Volume of cage farming	m <sup>3</sup>	-	-	-	-	2,586.0	4,021.0	5,032.0
<b>No.</b>	<b>Items</b>	<b>Unit</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>

	<b>Total aquacultural area</b>	<b>ha</b>	<b>33,928. 0</b>	<b>33,504.0</b>	<b>34,392. 0</b>	<b>36,000. 0</b>	<b>41,114. 2</b>	<b>42,748. 3</b>	<b>40,82 9.1</b>
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1.4	Area for crap farming	-	280.0	350.0	280.0	103.0	-	40.0	
<b>2</b>	<b><i>Area for freshwater culture</i></b>	<b>-</b>	<b>1,919.0</b>	<b>2,20.,0</b>	<b>1,502.0</b>	<b>3,846.0</b>	<b>3,894.1</b>	<b>5,240.6</b>	<b>5,278. 1</b>
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	<i>In which:</i>								
*	<i>catfish farming</i>	-	-	-	-	-	54.3	57.9	96.5
3	<b><i>Area for other species farming</i></b>	-	-	-	-	-	<b>264.5</b>	<b>141.1</b>	<b>153.7</b>
	Volume of cage								5,032.
*	farming	m <sup>3</sup>	-	-	-	-	2,586.0	4,021.0	0

(Source: Report from Ben Tre Department of Aquaculture)

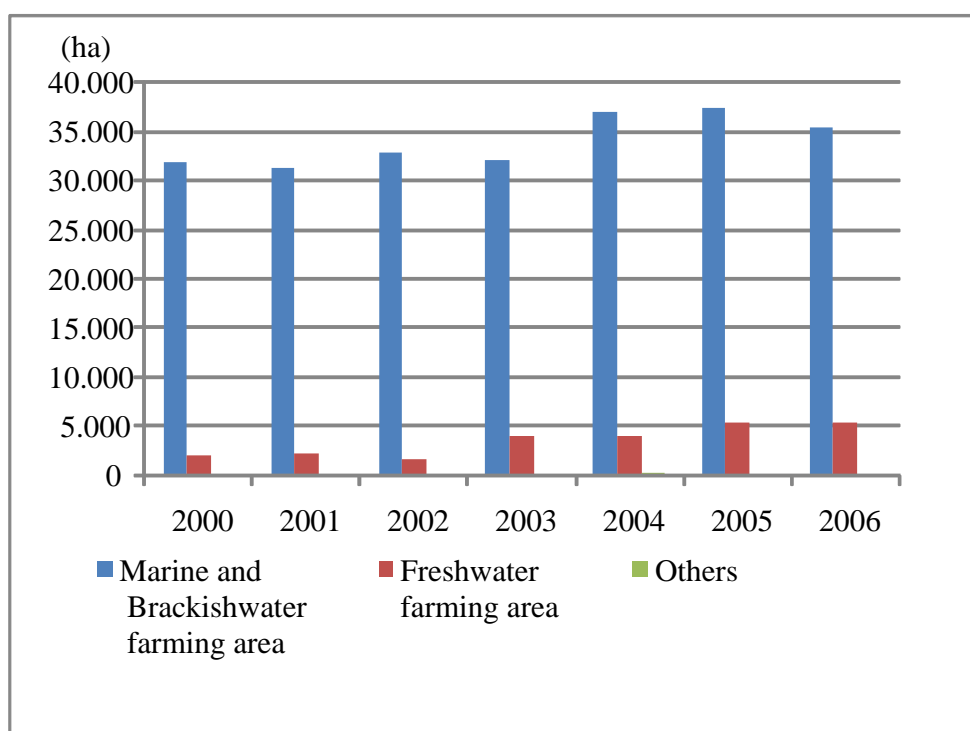


Figure 3: Area for aquaculture in different waters in period between 2000-2006

The area for giant tiger prawn farming always accounted for a highest percentage of the province's aquacultural area in the period between 2000-2006. In 2006, it accounted for 88% of marine and brackishwater aquaculture and 76% of the total aquacultural area of the province. The area for intensive and semi-intensive giant tiger prawn farming increased from 244 ha in 2000 to 5,189ha in 2006. The area for clam and oyster culture reached 4,249ha in 2006, accounting for 12% of the province's total marine and brackishwater aquacultural area.

Intensive catfish farming appeared in the province in 2004 and tended to develop stably and then expand across the area (the catfish farming area reached 54.3ha in 2004 and increased to 96.5ha in 2006).

Aquacultural activities were seen in every district in the province. In 2006, the total aquacultural area of the province was 40,829ha, of which 17,595.9ha, accounting for 43.1% of the province's total area, belonged to Thanh Phu district, followed by Binh Dai district with 14,932ha, accounting for 36.57% and the town accounting for the smallest percentage with only 129ha.

According to the statistics of 2006, area under aquaculture was divided into two relatively distinct regions: marine and blackishwater culture region mainly including 3 Eastern districts, namely Binh Dai, Ba Tri and Thanh Phu and freshwater culture region, mainly including Western districts namely Giong Trom, Mo Cay, Cho Lach, Chau Thanh and the provincial town.

Marine and blackishwater culture is practiced with a variety of species, including giant tiger prawn, clam, blood clam and some blackishwater fishes (utilizing natural varieties) farming. The area for crab farming decreased from 350ha in 2001 to no statistics of crab farming area in 2006 recorded. Various aquacultural forms and techniques are adopted. They are intensive and semi-

intensive giant tiger prawn, extensive shrimp, rice-cum-shrimp, mangrove-cum-shrimp, blood clam farming in batture (the biggest area in Binh Dai with 2,050 ha in 2006) and blood clam farming in the estuary of three coastal districts. In general, the farmed areas are quite well water supplied and drained.

Freshwater aquaculture systems include intensive and crop-rotating giant tiger prawn farming (in the area salinized for 6 months in dry season), riverine and earthen pond farming, and cage farming in rivers and ditches. Species farmed are diversified, including blue-pincer shrimps, catfish, and “white” fishes such as carp breams, mud carps, grass carps and Chinese carps.



**Table 2: Area under aquaculture of Ben Tre province in 2006 (ha)**

*(Source: Ben Tre Department of Aquaculture 200)*

No.	District	Total	Marine and brackishwater							Freshwater				Othe rs	Cage (m <sup>3</sup> )
			Intensi ve and semi- intensi ve crop 1	Intens ive shrim p farmi ng crop 2	Exten sive	Rice- cum- shrim p	Mang rove- cum- shrim p	Clam s	Oyste rs	Catfi sh	Mari ne fish	Blue- pince red shrim ps	Blue- pince red shrim p crop rotati on		
1	Ba Tri	4,624	834	36	1701	134	497	734	120		580	24			
2	Thanh Phu	17,595 .9	855	10	8,964. 5	5,157	798.4	804	55		462	500	1,800		
3	Binh Dai	14,932	3,500	891.3	5,313	922	2,473	2,050	486	16	150	20.7		1.3	
4	Giong Trom	420								11	359	50			
5	Mo Cay	1,995								5	950	1040			
6	Cho Lach	230.2								51	21.2	18		140	672

7	Chau Thanh	903.1								12.7	650.4	230		10	4,360
8	The town	129								0.8	21.2	104.6		2.4	
	<b>Total</b>	<b>40,829</b>	<b>5,189</b>	<b>937</b>	<b>15,979</b>	<b>6,213</b>	<b>3,768</b>	<b>3,588</b>	<b>661</b>	<b>97</b>	<b>3,194</b>	<b>1,987</b>	<b>1,800</b>	<b>154</b>	<b>5,032</b>

### 3.2. Aquaculture production

The area under aquaculture increased relatively stably in the period between 2000-2006; however, aquacultural production was unstable. The aquacultural production reached 81,730 tonnes in 2003, the highest level in the whole period. The fluctuation of clam yield was attributed to the decrease of the province's aquaculture production. The yield of other species increased quite stably in the period, except for 2006 when the production of giant tiger prawns decreased due to narrowed farmed area.

Although the area for shrimp farming always accounted for the highest percentage of the total farmed area, it was the clam yield that accounted for the highest percentage of total aquacultural production in the period between 2000-2004 thanks to higher productivity. In 2003, clam yield reached 53,949.5 tonnes (accounting for **Syntax Error**, % of the total production), down to 12,373 tonnes in 2006 (accounting for 18.4% of the total production) while the shrimp production increased from 10,101 tonnes in 2000 to 20,160 tonnes in 2006 (doubled) and in 2005 and 2006 the production giant tiger prawns was much higher than that of clams and oysters.

Although freshwater aquaculture production does not make up a high percentage of the province's total aquacultural production (the highest percentage of 44.2% was seen in 2006), its growth was quite stable in the period, with the annual average growth rate of 19.8%. Catfish contributed the highest percentage to the total 2006 freshwater aquacultural production, with 18,340 tonnes accounting for 61.7% of the total freshwater aquacultural production and 27.3% of the province's total aquacultural production.

Table 3: Aquaculture production of Ben Tren province in period between 2000-2006

N o.	Items	2000	2001	2002	2003	2004	2005	2006
<b>1</b>	<b><i>Marine and brackishwater production</i></b>	<b>33,696 .0</b>	<b>44,500 .0</b>	<b>57,815 .5</b>	<b>67,644 .0</b>	<b>57,709 .0</b>	<b>47,316.4</b>	<b>37,423 .0</b>
1. 1	Giant tiger prawns	10,101 .0	11,100 .0	15,905 .5	12,731 .0	20,561 .0	25,081.9	20,160 .0
1. 2	Marine fish						1,500.0	3,930. 0
1. 3	Clams and oysters	22,900 .0	32,300 .0	40,950 .0	53,949 .5	37,148 .0	20,284.5	12,373 .0
1. 4	Crab	695.0	700.0	960.0	963.5		450.0	960.0
<b>2</b>	<b><i>Freshwater production</i></b>	<b>10,049 .0</b>	<b>9,700. 0</b>	<b>9,389. 5</b>	<b>14,086 .0</b>	<b>12,876 .0</b>	<b>19,340.1</b>	<b>29,740 .0</b>
2. 1	Blue-pincered shrimps	349.0	2,000. 0	414.5	904.0	837.0	1,040.1	1,530. 0
2. 2	Freshwater fish	9,700. 0	7,700. 0	8,975. 0	13,182 .0	12,033 .0	18,296.9	28,210 .0
<b>3</b>	<b><i>Others</i></b>							<b>85.0</b>
	<b>Total</b>	<b>43,745 .0</b>	<b>54,200 .0</b>	<b>67,205 .0</b>	<b>81,730 .0</b>	<b>70,585 .0</b>	<b>66,656.4</b>	<b>67,248 .0</b>

(Source: Ben Tre Department of Aquaculture, 2007)

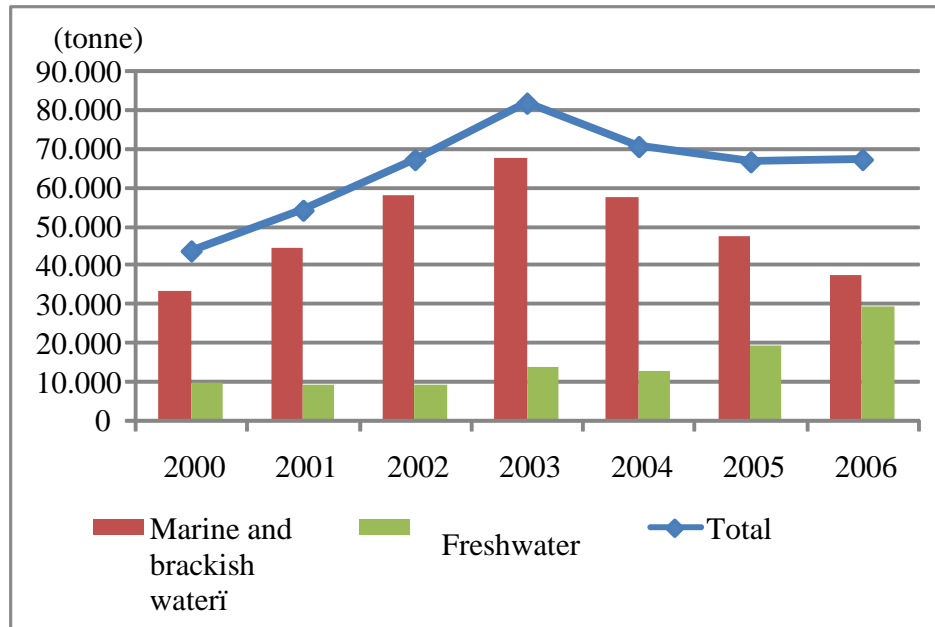


Figure 4: Aquacultural production in period between 2000-2006

## II. NATURAL AND SOCIO-ECONOMIC SITUATION OF DAI HOA LOC AND BINH THOI COMMUNES

### 1. Socio-economic and production situation

#### 1.1. Socio-economic situation

The project area is located in 2 coastal communes of Binh Dai district, a poor area in Ben Tre province. Due to the negative impacts of the war, the infrastructure and material facilities are still poor; welfare works are limited in number; agricultural production plays the major role while aquacultural and small-scale industrial production only started only a few years ago with unstable development.

#### 1.2. Population, laborforce and population distribution:

The total population of Binh Thoi and Dai Hoa Loc was 17,260 people, among which there are 6,188 males and 2,922 females in Binh Thoi and 4,014 males and 4,136 females in Dai Hoa Loc who are mainly Kinh people.

The residents of these two communes have medium intellectual level. 3 levels of education are introduced with the total number of 148 teachers:

- In Binh Thoi, there are 67 teachers and 1159 students in which there are 7 teachers and 200 students at nursery level, 29 teachers and 591 students at primary level and 31 teachers and 365 students at secondary level.

- In Dai Hoa Loc, there are 81 teachers and 879 students in which there are 6 teachers and 132 students at 3 nursery schools, 37 teachers and 289 students at 3 primary schools and 38 teachers and 458 students at one junior secondary school. According to 2007 statistics, the poor families accounted for 12.41%; the medium-income families 41.33%, quite high-income families 28.26% and rich families 18%.

- According to 2007 statistics, the per capita income of these two communes was from 6.7 to 8 million/year. The number of poor families was rather high, staying at 548 in which:

- + 281 families are in Binh Thoi.

- + and 267 in Dai Hoa Loc.

- + The residents' income is mainly from agriculture and aquaculture.

### **1.3. Infrastructure and welfare facilities:**

Infrastructure and welfare facilities in the project area are still poor.

**a) Domestic water supply:** The people in Dai Hoa Loc use water mainly from wells and also supply well water for the people in Thanh Phuoc and Thanh Tri of Binh Dai district. However, little underground water is used for domestic purposes by the people in Binh Thoi commune.

**b) Electricity supply:** Electricity is supplied for the people via national grid and transformer stations. The average number of families of the two communes using grid electricity is still low, only about 60% to 65% of the total population. Electricity supply can not meet the demand for domestic use, industrial production and aquaculture. To make it worse, electricity is often cut off, causing a lot of difficulties for production.

**c) Transportation:**

- Road transportation: running through Binh Thoi and Dai Hoa Loc communes are the provincial road 833 which is paved with tar and trans-hamlet and trans-communal roads which are paved with red stones. In general, road transportation is convenient.

- System of rivers, channels and ditches:

The waterway is convenient for the transportation of construction material and agricultural products inside and outside the communes.

The tangled system of rivers, channels and ditches is usually connected to two main rivers namely Tien and Ba Lai. Except for the irrigation system appropriated for shrimp farming, the irrigation system for agriculture can only serve agricultural production and not satisfy technically the requirements for farming shrimps in dry season rotated with rice cultivation in rainy season.

**d) Information – Culture – Social affairs and Post-office situation:**

Information is transmitted to every hamlet via receiving and transmitting station located in the communal centre. There is a cultural house, a center for population and family planning and a post office in these communes. Although there exist many limitations, this information public system is very useful in keeping the people informed about the situation district-wide, province-wide and nation-wide. However, sport and cultural activities are limited due to poor

infrastructure and fund although the culture-information department has made a lot of great efforts to improve the situation.

**e) Health care:**

Although there is a shortage of modern equipment and doctors and nurses, there has been much progress in health care in the area.

There are health care stations in every commune and even a General Hospital in Binh Dai town. Even though much attention is paid to disease prevention and sanitation, some diseases such as (dermatological diseases and conjunctivitis...) develop due to lack of clean domestic water; therefore, clean water supply to the community needs to be paid more attention in the future.

**2. Natural conditions of the project area**

**2.1. Geographical location**

**a) Dai Hoa Loc commune**

Is located along the left bank of Ba Lai river, near An Hoa isle of Ben Tre province and 12 km from the sea.

It borders Binh Thoi commune, Binh Dai town and Thua Duc commune to the North; Bai Lai river to the South, opposite to Tan Xuan and Bao Thach communes of Ba Tri district, Ben Tre province and Thoi Thuan commune of Binh Dai district, Ben Tre province to the East.

Terrain: medium-high terrain with the land along Bai Lai river being higher than the inner land. The land along Bai Lai river is 1.1 m higher than the river level, higher than the land along Bai Lai river belonging to Thach Phuoc commune at the height of 0.8m.

**b) Binh Thoi commune**

The project area is located in 2 communes namely Binh Thoi and Dai Hoa Loc, Binh Dai district, Ben Tre province.

- Binh Thoi commune borders



- + Dinh Trung commune to the North
- + Tien river (which runs to Cua Dai) to the East
- + Binh Thang commune and Binh Dai town to the South
- + Phu Long and Thanh Tri communes to the West

Terrain: relatively flat, with elevation from the North to the South. This commune is the lowland of Binh Dai district with the common terrain height of 0.50 – 0.75m and the lowest point of < 0.50m.

The terrain height of Binh Thoi commune is from 0.5-1.6m, sloping from the East to the West. The common height is from 0.6- 0.7 m.

## **2.2. Geology:**

The general feature of the coastal area of Ben Tre province is young sediment region. Outside the sandy sand regions are saltwater wetlands. The soil in this area is premature or newly mature, newly-deposited alluvial, salinized and usually dark brown, dark grey or yellowish-grey soil with weak basis. Therefore, special attention is needed during construction.

The soil in the rest of the land is completely salinized alluvial soil. In general, the soil is not contaminated with much acid with from-neutral-to-alkaline reaction. Due to being flooded with saltwater for a long time during a year, the chemicophysical properties of the soil are changed, making it very much different from alluvial soil. The soil is usually heavy and water drained slowly, causing slow organic matter decomposition.

## **2.3. Soil composition:**

Analysis of Binh Dai district's soil shows that the content of sandy soil is quite high, ranging from 8.83% – 28.23%, in which 20%-30% was found in 10% of the specimens. The variation of sand content is small at different heights.

The soil in Binh Dai district is composed of:

- 20-40% of clay.
- 20-30% of sand.
- a small percentage of sandy soil: which has bad organic substance accumulability, high mineralizability and relatively low fertility, so only food trees and some industrial trees are grown here. Besides, this type of soil can retain freshwater; therefore, residential areas are usually located on it.
- a high percentage of salinized alluvial soil which is being strongly classified. The soil basis is quite flat.

## **2.4. Wind**

Northern East - North and North - East monsoon winds blow almost in parallel with the seashore from October to March. The wind speed starts at 1-5m/s and increases gradually from 6 to 10m/s in February and then decreases gradually before a new season comes.

West and South-West winds blow from May to August at the speed of 6-15m/s which decreases gradually from August.

## **2.5. Sunlight:**

The total number of hours of sunlight is 2,630 h/year. The total radiation ranges from 18 to 18-22kcal/cm<sup>2</sup>/h.

The sun shines from 8 to 9 hours/day in dry season and from 5 to 7 hours/day in rainy season on average.

## **2.6. Moisture and evaporation**

- The moisture is relatively high. In general, it is about 79-84% in dry season and 85%-91% in rainy season.

- Evaporation quantity is high. It is 6mm/day in February and 2.5 to 3.5mm/day in rainy season. It is lowest in April, at 2-3mm/day.

## **2.7. Hydrography:**

### **a) Hydrographical regime:**

Due to being located near Cua Dai and Bai Lai rivers, not very far from the sea, the hydrography of the project area is mainly dependent on China sea tide. Generally speaking, the hydrography of the project area is stable.

The rivers and ditches in the project area are short and not big. Cua Dai and Ba Lai river do not have big water flow and located near the sea, so the project area is under the direct impact of semi-day tide pattern.

The hydrographical patterns here are similar to those in the coastal areas between Cua Dai and Co Chien rivers. Bai Lai river is the smallest one among the major rivers of Ben Tre with the length of 70km, the riverhead width of 25-50m and the lower section (near the estuary) width of about 200m. The flow reaches  $59\text{m}^3/\text{s}$  in dry season,  $240\text{m}^3/\text{s}$  in floody season; equal to 3.65-3.7% of Tien river flow and 7.12-7.14% of Ham Luong river flow.

#### **b) Tide:**

The tide in the project area is under the influence of China sea tide and intermittent semi-day tide pattern; the duration of a tidal day lasts about 24 hours and 50 minutes (with 2 rising tides and 2 falling tides). The tidal peak difference is about 0.2-0.4m and the tidal foot difference is bigger, 1-2.5m.

A tidal cycle lasts from 13 to 14 days (there are 2 tidal cycles every month: 2 flood tides and 2 ebb tides). In a tidal cycle, the sea level rise is high for 3 to 5 days; this phenomenon is called flood tide and tidal difference gets smaller in the next 5-6 days, followed by very weak flood tide and receding tide which is called low-water period. According to Lunar calendar, the tide comes in and goes out at high level at 2 points of time: after the day when the moon is “round” and on the day there is no moon (the 1<sup>st</sup> and 15<sup>th</sup> of Lunar months) or 1-3 days later.

The tidal peak recorded in the stations near the sea mouth is usually in November. The tidal amplitude in coastal regions is under little impact of floods.

The tidal lowest point is usually recorded in December in coastal stations.

The median lowest tidal point is recorded in June and the highest point in December. On the tidal day with the two approximately equal tidal bottoms, the durations of the flood tide and ebb tide are equal, about 6 hours on average and on the tidal day with two different tidal bottoms, the duration from low bottom to the peak or vice versa is about 7 to 8 hours and from the high bottom to the peak or vice versa is about 3 to 4 hours. The annual tidal amplitude is from 2.01 to 2.42m. In a year, the lowest tidal point is recorded from June to July with the lowest water level of 0.2m and the highest point in December or January.

## 2.8. Rainfall variation in the project area

In aquaculture as well as in agriculture, water plays the vital role in the production, so it is essential to investigate the water resource in the project area. The monthly rainfall of the project area is the total of the daily rainfall. Following are the results:

***Table 1: Average monthly rainfall in Dai Hoa Loc and Binh Thoi***

	Month			
	Jul.	Aug.	Sep.	Oct.
Rainfall (mm)	232.5	198.8	257.3	286.6

***Table 2: Average yearly rainfall in the project area***

Month	Year (mm)		
	2005	2006	2007
Jan.	-	-	20.5
Feb.	-	0.1	0.6

Mar.	0.4	25.1	0.1
Apr.	3.9	52.8	26.8
May	85.1	262.1	345.6
June	94.8	280.8	276.8
Jul.	299.2	222.0	254.9
Aug.	216.0	180.8	199.8
Sept.	209.4	360.2	260.6
Oct.	366.2	262.8	232.2
Nov.	264.5	37.7	26.8
Dec.	156.0	1.6	1.4
<b>Total</b>	<b>1,695.5</b>	<b>1,686.0</b>	<b>1,646.1</b>

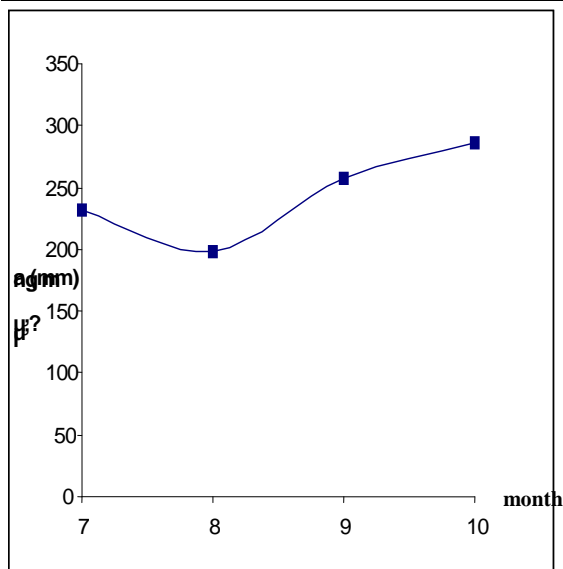


Figure 1: Rainfall from Jul. to Oct./2008 in the project area

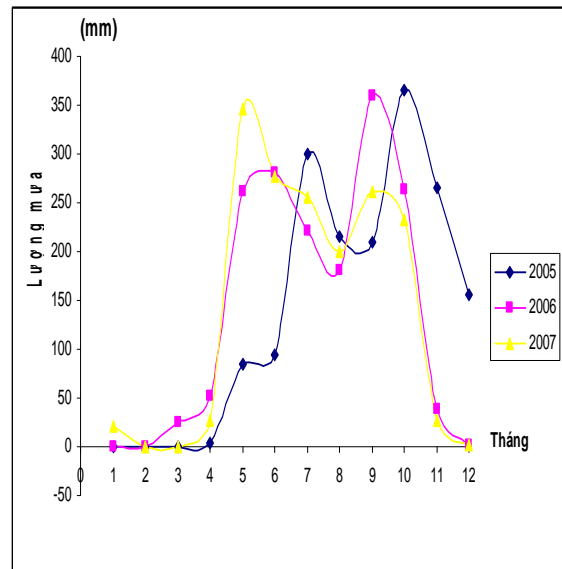


Figure 2 : Rainfall variation between 2005, 2006, 2007 in the project area

The results in figure 1 and 2 show that the project area has two distinct seasons due to the influence of North-East monsoon wind (blowing from Dec. to April of the next year), South-West monsoon wind (blowing from May to Nov.) and the transitional period with changed wind directions in Nov. and April. It is dry season when North-East monsoon wind blows and rainy season when South-West monsoon wind blows.

As it can be seen from the figure 1, the rainfall in the study period from July to October is quite high and it follows the existing law in comparison with the rainfalls over the latest 3 years namely 2005, 2006 and 2007. During the periods between Jan. and Mar. and between Nov. and Dec., the rainfall is usually very low; in contrast, in Sept. and Oct., it is very high; the highest rainfall is 286.6mm. The annual average rainfall ranges from 1,400-1,600mm.

Therefore, appropriate arrangement of crops can be done based on the monthly rainfalls to avoid the shortage of freshwater for production.

## 2.9. Temperature variation

The temperature in the project area is quite high; the average temperature is about 26.5-27.5<sup>0</sup>C; the highest temperature of 28,4 -29,3<sup>0</sup>C is recorded in April and May and the lowest temperature in Dec. and Jan. However, the lowest temperature does not have much negative impacts on aquaculture and agriculture in the area.

***Table 3: Average temperature from July to October/ 2008 in the project area***

	Time (month)			
	7	8	9	10
Temperature	27.0	27.1	26.3	25.8

**Table 4: Monthly average temperature in 2005, 2006, 2007 in the project area**

Month	Year (mm)		
	2005	2006	2007
1	24.7	26	24.9
2	26.1	26	25.7
3	27	27.8	26.8
4	28.8	29.3	28
5	29	28.4	28.3
6	28.1	27.3	27.1
7	26.6	27.6	26.9
8	27.4	27	27
9	27.1	27.6	26.9
10	27.2	27.1	27.4
11	26.8	25.9	27.2
12	25.4	25.9	25.5
	<b>27.02</b>	<b>27.16</b>	<b>26.81</b>

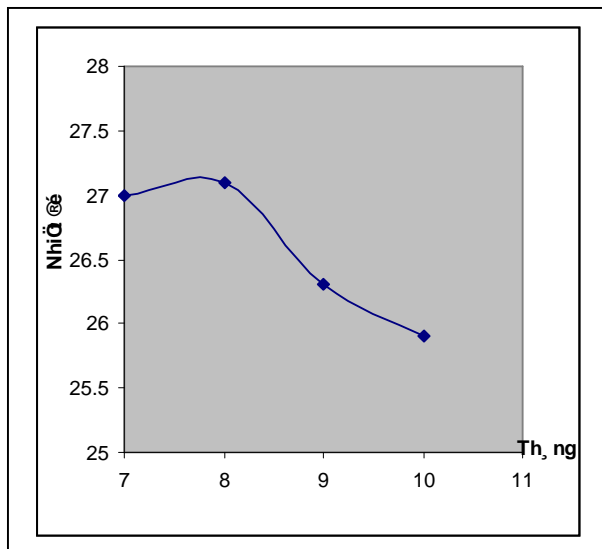


Figure 3: Temperature from Jul. to Oct./2008 in the project area

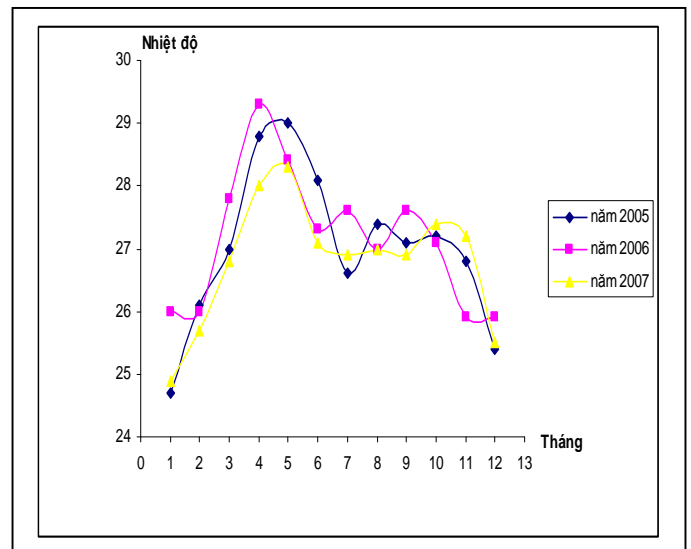


Figure: Temperature variation between 2005, 2006, 2007 in the project area

The table 3, 4 and figures 3 and 4 show that the temperature in the project period between July and October fluctuates from 25.8-27.1°C and this fluctuation is unremarkable in comparison with the temperature fluctuation over the latest 3 years namely 2005, 2006 and 2007.

High and quite stable temperature in a year with yearly average temperature of 26-27°C and without any monthly average temperature of under 20°C is due to the fact that Dai Hoa Loc and Binh Thoi are located in subequatorial monsoon tropical zone, but not influenced by pole monsoon; and near the China sea, but little influenced by storms thanks to being outside the low latitudes. Moreover, thanks to the inland wind, the temperature amplitude between the daytime and nighttime in different places is quite stable.

#### **2.10. Salinity in Bai Lai and Tien estuaries**

Ba Lai and Tien rivers are those that supply water for the whole project area and under the influence of the tidal patterns of the China Sea. Due to the fluctuation of the tides of the China sea and the temperature in the project area, the river water is seriously salinized. Saltwater intrudes most of the project land in dry season between Jan. and Mar., causing serious shortage of freshwater.

We investigated the water resource, starting from Bai Lai and Tien estuaries, aiming at prevent the adverse impacts on aquaculture and agriculture. The findings are presented as follows:

***Table 5: Average salt concentration in Ba Lai dam***

Salt percentage (‰)	Time			
	Jul.	Aug.	Sept.	Oct.
	5.05	4.98	3.83	3.76

***Table 6: Average salt concentration in Tien river***



Salt percentage (‰)	Time			
	Jul.	Aug.	Sept.	Oct.
	9.82	7.32	6.96	6.54

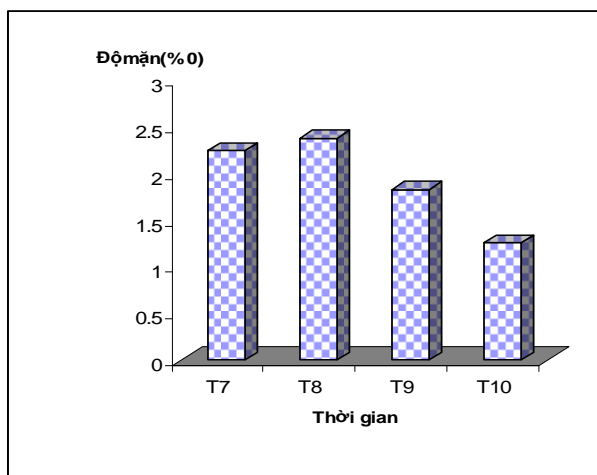


Fig. 5: Salt concentrations in Bai Lai dam between Jul. and Oct.

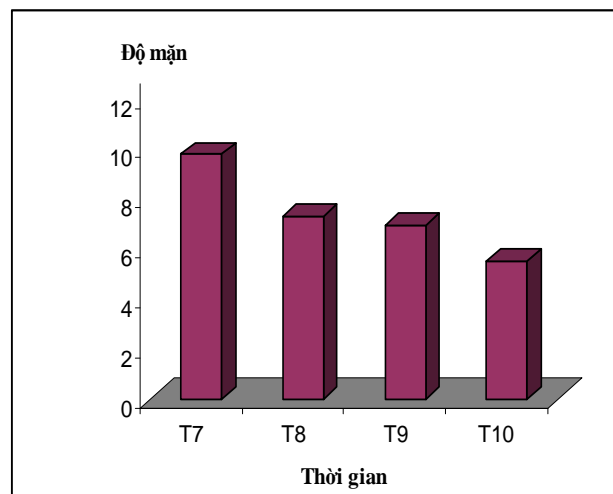


Fig. 6: Salt concentrations in Tien river between Jul. and Oct.

The tables 5 and 6 and figures 5 and 6 indicate that the salt concentration in these months is quite low, especially in Ba Lai dam. As a result, agricultural and aquacultural production is very convenient during this period.

### 2.11. Aquatic organisms in the project area

\* **Floating plants:** (Phytoplanton): The phyla of Silica algae (accounting for 78% of the total quantity of the species) and turquoise algae with typical classes such as Biddulphia, Niteschia, Chaetoceros, Cetrarium, Coscinodiscus, Rhizosolenia, skeletonema...increase quickly in number and density in the sea areas with high salt concentration and low opaqueness, to ....cells/m<sup>3</sup> of water and down gradually to 100,000 – 300,000 cells/ m<sup>3</sup> of inland water.

\* **Floating animals:** (Zooplankton): There are 36 species of floating animals belonging to Potaria including small-body group (12 species), big-body

group including Cladocera (11 species), and Copepoda (10 species). The density of these animals varies in different seasons: the density in dry season is 10 times higher than that in rainy season and on increase trend from the river to the sea; the maximum figure is recorded in the estuary.

There is a difference in species quantity and number in different waters between dry season and rainy season.

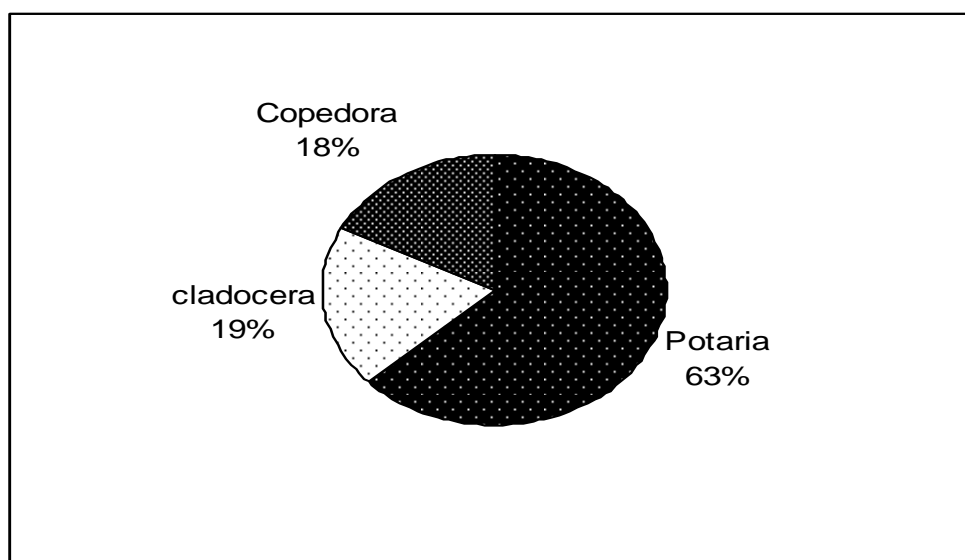
**\* Bottom-dwelling organisms:**

- include soft-bodied animals, annelids, mainly crustaceans and two-shelled organisms, representatives of the marine and brackishwater environment. Many representatives of bottom organisms such as silver prawns, giant tiger prawns, various types of crabs, clams, oysters, snails...are important subjects to be exploited and raised in brackish waters .

**Table 7. Alga types in Ba Lai dam and Tien river**

No.	Types	Ba lai	Tien river
1	<b>Phytoplanton</b>		
	Silic	+++	+++
	<i>Biddulphia</i>	+	+
	<i>Niteschia</i>	+	+
	<i>Cetarium</i>	+	+
	<i>Coscinodiscus</i>	+	+
	<i>Chaetoceros</i> ,	+	+
	<i>Rhizosoleni</i>	+	+
	<i>skeletonema</i>	+	+
2	<b>Zooplankton</b>		
	<i>Potaria</i>	+	+
	<i>Cladocera</i>	+	+

	<i>Copedora</i>		
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**Fig. 9: Types of floating animals in the project area**

The density of the animals varies in different seasons; the density in dry season is 10 times higher than that in rainy season and on increase trend from the river to the sea; the maximum figure is usually recorded in the estuary. Potaria accounts for the highest percentage (63%).

### **III. INFRASTRUCTURE FOR AGRICULTURE AND AQUACULTURE IN THE PROJECT AREA**

#### **1. Electricity**

Electricity is supplied for the people via national grid and transformer stations. The average number of families of the two communes using grid electricity is about 60% to 65% of the total population. Electricity supply can not meet the demand for domestic use, industrial production and aquaculture. To make it worse, electricity is often cut off, causing a lot of difficulties for production.

## **2. Transportation:**

-The provincial road 833 runs through Binh Thoi commune. However, only 5 km is paved with tar and the rest of 6 km is still paved with red stones.

- The trans-communal road 16 runs through Dai Hoa Loc commune. Transportation is mainly done on pond and ditch banks, causing difficulty for traveling.

- The system of rivers, channels and ditches: it is a tangled system and is usually connected to two main rivers namely Tien and Ba Lai.

- The dyke system is 3,590m long and 6m wide, used for preventing flood tide, but is deteriorating now.

In the project area, natural rivers, channels and ditches are usually short and flow to Bai Lai river. Most of them are narrow and shallow and separated from the freshened region by road 16, so the water comes in the project area mostly from Ba Lai river, posing a risk of flooding in the project area.

As planned, the drainage system along the road 16, aimed at draining freshwater and supplying salt water for 2 communes, is useful for cleaning and replacing water and adjust the freshness in the water of the project area.

The existing systems of rivers, channels and ditches in Binh Thoi and Dai Hoa Loc communes are supplied with water from two main directions.

## **3. The system of rivers and ditches of the two communes**

In recent years, water for production has been supplied for the two communes mainly from Cua Dai and Tien rivers via Dinh Trung watergates and ditches.

The people will be able to be active in supply water for production in a few years when Ba Lai freshened system which supplies freshwater from Ba Lai river is completed.

Dai Hoa Loc and Binh Thoi are situated near the sea and surrounded by big rivers, so they are strongly influenced by tide with the amplitude of 3 to 4 m, resulting in very good water drainage.

There are about 80 big and small watergates in these two communes, most of which have been exploited effectively. These watergates are also used to prevent salt intrusion or supply water in dry months with freshwater available. In the months of dry season, most of the land is salt intruded, causing serious shortage of freshwater and frequent droughts. The situation is worst in the period between February and May every year.

**a. *Dai Hoa Loc commune***

***Table 10: Names and lengths of some big channels in Dai Hoa Loc***

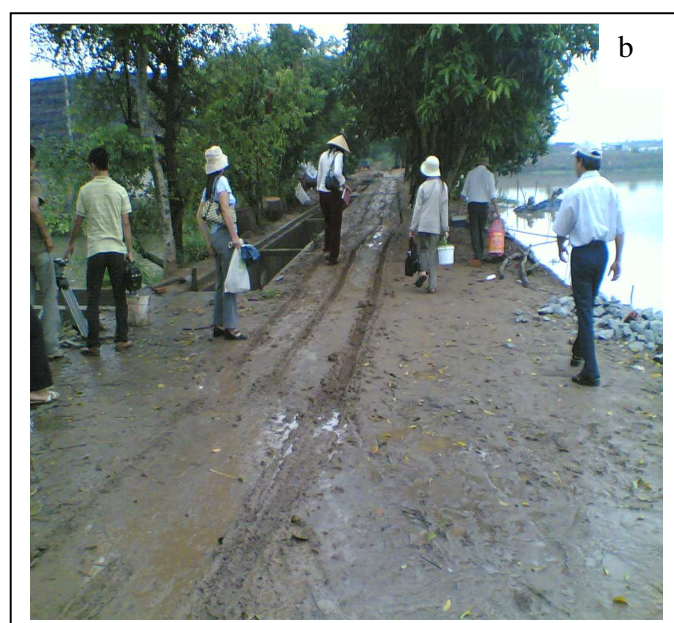
No.	Name	Length (m)
1	Dia Gua Dai	1325
2	Giong Cuoi	1685
3	Mat Mieu Dai	726
4	Giong Giang	1318
5	Ba Dong	840
6	Ban Da	665
7	Dia Cay Muoi (newly-dug channel)	2812

**b. *Binh Thoi commune***

***Table 11: Names and lengths of some big channels in Binh Thoi***

No.	Name	Length (m)
1	Cau Tau	860
2	19/5	2000
3	Hai Chi	1800

4	Sau Nhan	1400
5	Hai Phat	500
6	Sau Ha	1100
7	Nam Toi	650
8	Tap Doan 3	800
9	Tap Doan 4	700



***Fig. 8: Pictures of some channels  
in the project area***

a): Dia Gua Dai in Dai Hoa Loc

b): Hai Phat in

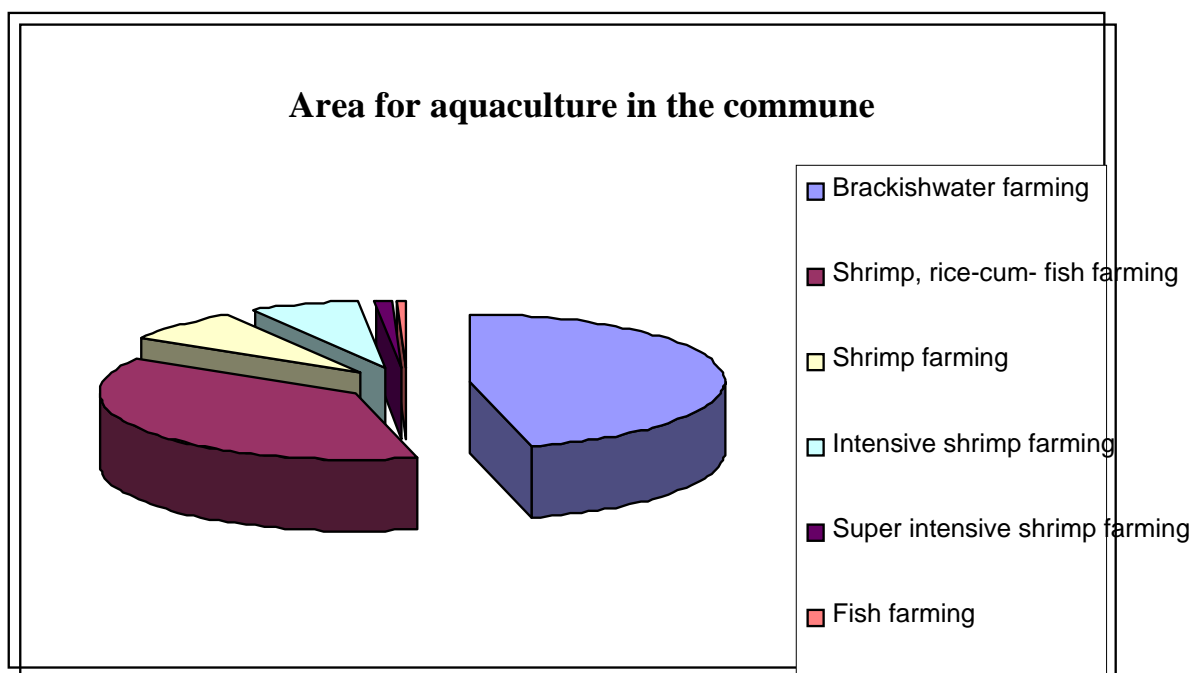
Bxnh Thúi

#### IV. AQUACULTURE SITUATION IN THE TWO PROJECT COMMUNES

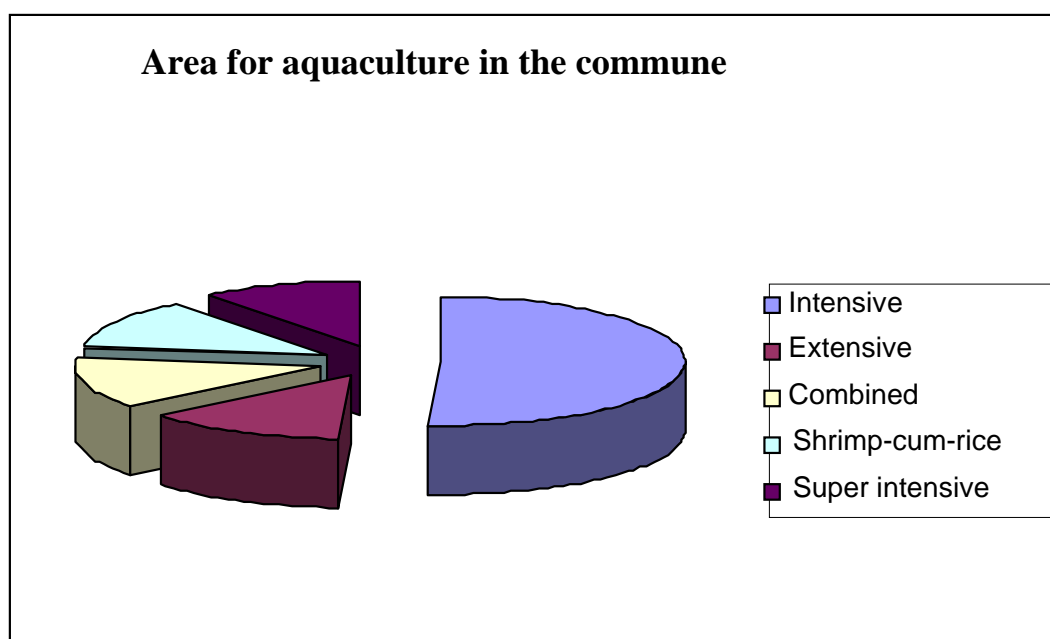
##### 1. Aquaculture in Binh Thoi and Dai Hoa Loc communes:

The total area under aquaculture in Binh Thoi is 650 ha with the production of 1.299 tonnes and in Dai Hoa Loc 1243 ha with the production of 1306 tonnes. Two main culture forms are prawn and rice-cum-shrimp farming.

##### - Dai Hoa Loc



- Binh Thoi commune



Average cost for the area of 3,500 m<sup>2</sup> for shrimp farming

Items	Index	Cost (đ)
Labor, upgradation		10,000,000
Time	90-100 days	
Seeds	(density of 120 shrimps/m <sup>2</sup> ) 420,000 con X 35 đ/con =	14,700,000
Food	3,850 kg X 13.000 đ/kg	50,050,000
Medicine, chemicals, bioorganism yeast		10,000,000
Electricity		10,000,000
Total cost		94,750,000
Average production	3,500 kg (40,000 đ – 45,000 đ/kg)	
Turnover		140,000,000 - 157,500,000



Net profit		45,250,000 - 62,750,000 đ/crop.
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As we can see in the table above, the sales and the net profit obtained from shrimp farming are very high; therefore, shrimp farming has been developing very quickly in these two communes. In comparison to shrimp farming, rice cultivation is not profitable, earning the farmers only about 6.9-7 million/year/ha (with the production of about 3 tonnes/ha)

- Epidemics: Common diseases found in the farmed area are white spot disease, MBV, protozoa, environment-related diseases. Due to these diseases, the sales decrease; crop duration is lengthened and the cost increases, lowering profit.

- Due to the rapid expansion of shrimp farming, the existing irrigation system, which was designed mainly for agriculture, can not meet the current demand. Consequently, it is used both for agriculture and aquaculture in many places, making disease spreading from one farmed area to another inevitable. In fact, this negative phenomenon has occurred.

- The district and communal governments have cooperated with the Department of aquaculture, Center for fishery encouragement, and Aqua-veterinary medicine - food companies in organizing training classes on solutions to treatment of diseases among cultured shrimps, techniques for giant tiger prawn farming in rainy season, how to manage the cultured ponds, how to select seeds and food and how to use chemicals for the farming households in the communes and districts.

- Study tours inside and outside the province and a workshop entitled “Sustainable aquaculture development in Ben Tre in order to meet the requirements for WTO entry” have been organized for the farmers.

- The seeds for the farming units in the two communes are mostly supplied by the aquacultural trading and farming units in the province which buy seeds from the central provinces.

- Aqua veterinary medicine and food units and other logistic units are distributed across the communes, creating a network supporting the aquacultural development in the communes.

- The farming environment in 2007 was very severe with long and continuous hot or rainy events, high temperature and high salt concentration in the waters of the coastal communes. Moreover, the quality of the seeds was low. These reasons altogether are attributed to the slow development of shrimps and prolonged crop duration. Right after harvesting the first crop in 2006 and the main one in 2007 and prior to the issuance of the directive on crop pause by the provincial People’s Committee, many households were rushed to prepare their farmed ponds for the next crop, which caused careless preparation and negative impacts on the surrounding environment due to mud. For these reasons, white-spot disease developed scatteredly among cultured shrimps in the project area, causing loss-making for the farmers.

## **2 - Advantages for aquaculture in the communes**

- The results achieved over the past time are partly thanks to concern and direction of the district Communist Party, People’s Committee and relevant organizations in planning and investment in infrastructure and techniques, ensuring the aquacultural development of the district on the right track and a continuing expansion trend and active participation of the people.

- The leadership is synchronized from the communal level to the district level. The aquaculture activities of the previous years were reviewed to draw out lessons and those of 2007 were planned carefully beforehand. Right at the beginning of the crop, the district government strengthens the Steering Committee for Aquaculture; and assigns every member to manage the farming activities in every commune and to cooperate with each other to implement the communal and district plans. As a result, the performance of the Board for Farmed area Management gradually has got better and the people's awareness of environmental protection has increased.

- Special attention has been paid to disease and environment control and the farmers have been kept informed about the disease and environment situation. Therefore, the farmers are more concerned about the impacts of the environment in order to minimize risks to aquaculture.

### **3/- Limitations and weaknesses:**

- The system of the cultured ponds does not meet the technical requirements. For example, there have not been ponds for discharged water treatment and for containing mud. As a result, untreated waste and pathogens are discharged to the environment stealthily.

- Although Boards for Farmed area Management are established in the communes, they do not work effectively because they prioritize having good relationship with their relatives or acquaintances or worry about being hated by other people in the communes, who may harm their own farmed ponds.

- Seeds are worse and worse. The seed investigation and management activities face many difficulties; therefore, they are not effective. Moreover, on-site seed production tends to decrease in compared to the same period of the previous years because the farmers think that the seeds bought from the central regions have better quality.

**\*Causes:**

**-Objective:**

- +Climate and weather get more and more complicated.
- +The environment is getting worse and worse as a rule.
- +The source of natural varieties is also getting worse and worse in quantity and quality.

**- Subjective:**

+Some farmers do not follow strictly the crop schedule; shrimp seeds are not strictly checked and the farmed ponds are not handled appropriately technically, causing the existence of pathogens in the farmed environment. For these reasons, aquaculture suffers from serious damage.

+ The irrigation systems in some farmed areas do not meet the requirements of large-scale intensive farming.

## **V. A STUDY OF WATER QUALITY IN THE PROJECT AREA**

We investigated and evaluated the water resource and domestic water use in the project area in order to develop strategies for sustainable development of aquaculture in the project area in the future. The water samples were collected from aquacultured places and the water supply systems in the project area. The findings are presented below:



Figure 9: One place where  
water sample was  
collected from area

Figure 10: Ba Lai dam  
where water sample was  
collected

*a) Dai Hoa Loc commune*

**Table 12: The analysis of water samples in Dai Hoa Loc commune in 7/2008**

No.	Parameter	Farmed ponds			Suggestions
		Ap 1	Ap 2	Ap 3	
1	Clarity (cm)	30	30	35	Prevent too high or too low
2	pH	7.5	7.7	8	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	20	22	25	Daily fluctuations should be < 0,50
4	Solvent oxygen (mg/l)	5	5.5	6	Not < 0,40
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	90	95	97	
6	Water temperature (°C)	26	25	26.5	
7	H <sub>2</sub> S (mg/l)	0.007	0.009	0.08	More poisonous when pH concentration is low
	NH <sub>3</sub> (mg/l)	0.005	0.006	0.008	More poisonous when pH concentration and T°C are high

**Table 13: The analysis of water samples in Dai Hoa Loc commune in 8/2008**

No.	Parameter	Farmed ponds			Suggestions
		Ap 1	Ap 2	Ap 3	
1	Clarity (cm)	35	37	40	Prevent too high or too low
2	pH	7.5	7.7	8.3	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	18	20	20	Daily fluctuations should be < 0,50
4	Solvent oxygen (mg/l)	5	5.5	6	Not < 0,40
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	100	120	110	
6	Water temperature (°C)	25	25.5	26	
7	H <sub>2</sub> S (mg/l)	0.01	0.02	0.01	More poisonous when pH concentration is low
8	NH <sub>3</sub> (mg/l)	0.006	0.007	0.008	More poisonous when pH concentration and T°C are high

**Table 14: The analysis of water samples in Dai Hoa Loc commune in 9/2008**

No.	Parameter	Farmed ponds			Suggestions
		Ap 1	Ap 2	Ap 3	
1	Clarity (cm)	30	35	40	Prevent too high or too low
2	pH	7.6	7.7	8	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	18	19	23	Daily fluctuations should

					be< 0,50
4	Solvent oxygen (mg/l)	5	5.5	5.3	Not < 0,40

No.	Names	Symbols/ Formula			Unit
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	24	25	25	
6	Water temperature (°C)	130	125	110	
7	H <sub>2</sub> S (mg/l)	0.02	0.02	0.03	More poisonous when pH concentration is low
8	NH <sub>3</sub> (mg/l)	0.007	0.009	0.008	More poisonous when pH concentration and T°C are high

**Table 15: Analysis of discharged water**

1	Hanging solid	SS	mg/l	50
2	Chlorine	Cl	mg/l	0.1
3	Colifom	-	MPN/l	2000
4	Animal and plant oil	-	mg/	0.3
5	Odor	Odor	Vision	Light
6	Chemical oxygen demand	COD	mg/	20
7	Biological oxygen demand	BOD5	mg/	10
8	pH	pH	-	6
9	Organic phosphorous	P - organic	mg/	0.1
10	Total phosphorous	P - total	mg/	1.5
11	Iron	Fe	mg/	0.5

***b)In Binh Thoi commune***

**Table 16: The analysis of water samples in Binh Thoi commune in 7/2008**

No.	Parameter	Farmed ponds			Suggestions
		Ap 1	Ap 3	Ap 4	
1	Clarity (cm)	26	28	30	Prevent too high or too low
2	pH	7	7.5	8	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	18	22	22	Daily fluctuations should be < 0,50
4	Solvent oxygen (mg/l)	5	5.5	5	Not < 0,40
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	120	125	115	
6	Water temperature (°C)	26	25.5	26	
7	H <sub>2</sub> S (mg/l)	0.01	0.012	0.015	More poisonous when pH concentration is low
8	NH <sub>3</sub> (mg/l)	0.005	0.003	0.004	More poisonous when pH concentration and T°C are high

**Table 17: The analysis of water samples in Binh Thoi commune in 8/2008**

No.	Parameter	Farmed ponds			Suggestions



		Ap 1	Ap 3	Ap 4	
1	Clarity (cm)	29.5	31.3	32	Prevent too high or too low
2	pH	7.2	7.6	8.1	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	20	23	25	Daily fluctuations should be< 0,50
4	Solvent oxygen (mg/l)	6	5.5	5	Not < 0,40
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	110	125	120	
6	Water temperature (°C)	27	25.5	28	
7	H <sub>2</sub> S (mg/l)	0.012	0.02	0.03	More poisonous when pH concentration is low
8	NH <sub>3</sub> (mg/l)	0.006	0.008	0.007	More poisonous when pH concentration and T°C are high

**Table 18: The analysis of water samples in Binh Thoi commune 9/2008**

No.	Parameter	Farmed ponds			Suggestions
		Ap 1	Ap 3	Ap 4	
1	Clarity (cm)	30	33	35	Prevent too high or too low
2	pH	7	8	8.5	Daily fluctuations should be < 0,5
3	Salt concentration (0/00)	28	23	20	Daily fluctuations should be< 0,50

No.	Names	Symbols/ Symbols/Formu la			Unit	
4	Solvent oxygen (mg/l)	5	5.5	6	Not < 0,40	
5	Alkali concentration CaCO <sub>3</sub> (mg/l)	130	135	140		
6	Water temperature (°C)	27.5	25.5	27		
7	H <sub>2</sub> S (mg/l)	0.013	0.01	0.02	More poisonous when pH concentration is low	
8	NH <sub>3</sub> (mg/l)	0.007	0.009	0.008	More poisonous when pH concentration and T°C are high	

No.	Names	Symbols/ Symbols/Formu la			Unit	
1	Hanging solid	SS			mg/l	60
2	Chlorine	Cl			mg/l	0.2
3	Colifom	-			MPN/l	3000

4	Animal and plant oil	-	mg/	0.5
5	Odor	Odor	Vision	Light
6	Chemical oxygen demand	COD	mg/	30
7	Biological oxygen demand	BOD5	mg/	20
8	pH	pH	-	7
9	Organic phosphorous	P - organic	mg/	0.2
10	Total phosphorous	P - total	mg/	2.0
11	Iron	Fe	mg/	0.8

***Table 19: Analysis of discharged water in Binh Thoi commune***

Based on the Vietnamese standards for aquaculture, the quality of the water in water supply systems and the farmed ponds in these two communes is considered good and suitable for aquacultural development. However, the parameters of discharged water are near the limit.

There is no remarkable difference in the quality of the water in the water supply systems and farmed ponds. However, water quality can vary in different survey periods.

According to the survey, pH value in all the surveyed places exceeds 6.5. However, there appear iron and aluminium alum in some low lands and inner ponds for shrimp farming in dry season. In some places, alum appears in some small ditches because the acid substances are discharged to them when the farmed ponds are upgraded and the water in these ditches is not well circulated. .

During the pond preparation process, FeS<sub>2</sub> when oxidized is converted into Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub>, decreasing pH in the land and causing the appearance of Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> and Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, which have big impacts on aquaculture, especially in rainy season.

## **VI. CURRENT POLICIES FOR AGRICULTURE AND AQUACULTURE IN THE PROJECT AREA**

### **a) Advantages**

- Thanks to the concern of the Department of Aquaculture, some ditches and channels in which alluvium accumulated have been dredged, speeding up the flow so that they can better serve agriculture and aquaculture activities in the project communes and the communes nearby.
  - 3.9 billion VND was invested in digging new ditches and dredging the existing ditches and channels in 2007 by the Department of Aquaculture.
    - Some policies have been adopted to boost the development of aquaculture and agriculture.
      - + Tax policies
      - + Incentive policies for the farmers confronting risks in aquaculture.
    - The steering machine for agricultural encouragement has been systemized.
- The technical office of the Department of Aquaculture and the provincial center for fishery encouragement (for aquaculture) steers the district technical office, communal Committee and hamlet staff in production and implementation of the State and provincial guidelines and policies.

### **b) Limitations**

- The policies for land use have not been concretized and consistent with land use for aquaculture and agriculture.
- The land area possessed by the people is scattered, partly affecting the construction of a complete irrigation system because some households when losing land, but not benefiting from the projects do not want to move or agree with compensation price prescribed by the State regulations.
- Although it is stated in the State policy that the use of some of the water surface can be shifted from agricultural purpose to aquacultural one, this activity has not been carried out synchronically; the area for rice-cum-shrimp scatters in

the household lands, causing the difficulties for arranging farmed lands into successive sub-regions.

- The punishment for mistakes made in agriculture and aquaculture activities has not received adequate attention. For example, some drugs and chemicals are used and the contaminated water which is not treated appropriately according to the regulations is usually discharged directly to the environment, causing bad impacts on these two sectors and other relevant sectors.

## **VII. THE RELATIONSHIP BETWEEN AGRICULTURE AND AQUACULTURE AND OTHER SECTORS.**

### **1. Aquaculture and agriculture**

- Due to climate and tide, only one rice crop is grown from June to September. During this period, the rainfall is high and Ba Lai and Cua Dai rivers are two freshwater supply sources.

- The agricultural and aquacultural activities in the project area are characterized by the following features:

#### ***for shrimp farming***

- + *Main crop*: from Feb.-Jun., it can be done with high density (the following schedule can be used):

- + *Sub crop* : it can start from 15/6 to 15/10: 120 days

- In general, the water resources for agriculture and aquaculture do not much affect each other. However, some inter-impacts are still seen:

- When pesticide for agriculture is discharged to the environment and is not completely decayed, it has bad impacts on aquaculture in the region.

- In contrast, when some chemicals for aquaculture are discharged to the environment and not completely decayed, they have bad impacts on agriculture in the region.

- The survey in the locality shows that in general, the farmers in the project communes release shrimp seeds in the prohibited times. More specific information is presented in the following table:

<i>No.</i>	<i>Commune name</i>	<i>No. of households releasing seeds</i>	<i>Area(ha)</i>	<i>Number of seeds</i>	<i>Note</i>
02	Binh Thoi	37	132.9	5,930,000	ditto
03	Dai Hoa Loc	14	48.3	1,578,000	ditto
<b>Total</b>	<b>2 communes</b>	<b>51</b>			

Although all of the farming families learn that they are not allowed to release seeds in the wrong time, they still do it because the price of shrimps is quite high now. Most of the seeds released are not checked. The seeds are supplied by the seed trading and producing units in the communes or taken from the central provinces by the farmers themselves.

- In most places in the project area, other production sectors have not appeared, so detailed inter-impacts between them and agriculture and aquaculture have not been identified.

- Most of the water after being used for agriculture and aquaculture is discharged to the environment without being treated, damaging the aquatic resource in the nature.

- The ditches and channels are more and more polluted, having serious impacts on the likelihood of the residents living along them.

## **2. Impacts of other sectors in the project area on the water resource used for aquaculture and agriculture**

- The small-scale industrial sectors in the project area somewhat have impacts on the water quality used for agriculture and aquaculture.

- Some aqua-product production and processing factories and factories in other sectors are being built in the project area, so there should be regulations and norms on water discharged from factories to the environment so that their impacts on agriculture and agriculture can be prevented.



*Some factories located in the project area which may pollute the water resource*

### **3. Some methods to manage the water resource to ensure high water quality for agriculture and aquaculture.**

- Plan the areas for aquaculture carefully to make sure that they satisfy all the requirements as prescribed.

- Apply specific standards on water resource used for agriculture and aquaculture before water is discharged to the environment.

- Introduce the list of prohibited chemicals and products in agriculture and aquaculture. Disseminate the information to the people so that they can obey strictly the State regulations.
- Punish the people who violate regulations on using or discharging water in aquaculture.
- Raise people's awareness of the consequences of water pollution, one of which is causing epidemics to develop in aquaculture and crop failure in agriculture.
- Clean the polluted water in ditches, channels and rivers immediately to ensure sustainable and long-term development.
- Organize training classes on models of aquaculture in which water does not need to be replaced frequently in order to save water.

## **VII. RECOMMENDATIONS AND SUGGESTIONS FOR THE PROJECT AREA**

### **1. Planning:**

Based on the geology, irrigation system, salinity, the area for aquaculture should be replanned; the area used ineffectively for agriculture should be planned to be used for shrimp farming in the forms of shrimp and rice farming rotation or species combination farming (fish-cum-shrimp, shrimp-cum-crab, forest-cum-shrimp, salt production-cum-shrimp...). The shrimp farming in the area should be steered according to the planning.

- The land for agriculture and aquaculture and other production sectors should be separated and defined clearly.

### **2. Farming technology:**

- One-crop semi-intensive shrimp farming should be done with medium density (12-15 seeds/m<sup>2</sup> in order to obtain the productivity of 1.5-2.0



tonnes/ha/crop). Shrimp farming in accordance with this standard is conformable with the infrastructure, especially irrigation infrastructure, technology level and investment and helps to minimize environmental pollution, diseases, risks and shrimp deaths and increase mature shrimp size. As a result, the efficiency of shrimp farming is improved.

- One improved extensive shrimp crop should be done without digging the fields deeply in order to prevent the loss of fertile soil. Channels and ditches should account for about 20-25% of the farmed area and the ditch and channel banks should be heightened so that the water level can be raised to 1.0 -1.2 m. The water level in the fields should be about 0.4-0.5 m. The density of the seeds released should be from 3- 5 seeds/m<sup>2</sup>. Industrial food can be used to feed the shrimps and the possible productivity can reach 0.6-0.8 tonnes/ha.

- Prohibited chemicals and anti-biotics should not be used in aqua-product production and trading to ensure food safety. IBM model should be used in agriculture to minimize the impacts of pesticides used for agriculture on shrimps.

- One-rice-crop farming plays an important role in maintaining and upgrading the farmed environment.

- Local guidelines on crop patterns should be followed strictly. As it is shown in reality, the best time for releasing shrimp seeds is from the end of Feb. to the beginning of May according to solar calendar. Many shrimps have died recently at the beginning of the crop in some places and this phenomenon sometimes spread widely across the project area, causing much damage to production. One of the reasons for this phenomenon is to release seeds at the wrong time. Moreover, shrimps should not be farmed in the third crop to minimize pathogens in the environment. It should always be remembered that only one shrimp crop is farmed in one area of land during a year and the land in

the rest of the year can be used for rice cultivation or farming other aquaspecies except crusaceans.

- Suggestions for shrimp farming in the two communes

No.	Species	Farming forms	Density (seed s/m <sup>2</sup> )	Seed size (seed s/kg)	Food		Farming duration (month h)	Production		Productivity (tonne s/ha)
					Ratio	Protein percentage		Alive percentage (%)	Size of harvested products (no./kg)	
1	Giant tiger prawns (Penaeus Monodon)	Intensive	25-30	P <sub>12</sub>	1.4-1.7	30-40	4	60 - 70	40-50	3-5
		Semi-intensive	10-20	P <sub>12</sub>	1.2-1.5	30-40	4	60 - 70	40-50	1.2 - 3
		Giant tiger prawn-cum-bream	Prawn: 15-20; Bream: 1-2	Prawn: P <sub>15</sub> Bream: 50g	Prawn: : 1.5-2	30-40	Prawn: 4 Bream: 2-3	Prawn: :70 - 75; Bream: 65	Prawn: 40-50; Bream: 300g	Prawn: 2-3; Bream: 0.2-0.4

### 3. Irrigation:

- Irrigation systems should be planned to be able to serve aquaculture in each sub-region. Irrigation systems for shrimp farming with separate water supply and drainage systems should be built with the participation of the local people in order to prevent disease widespreading across the farmed areas in the communes.

- The existing irrigational systems should be fully exploited and upgraded for shrimp farming. The existing saltwater preventing dams should be protected and new dams should be built for the inland areas planned for rice cultivation. A freshwater supply system should be built to ensure adequate freshwater supply for rice cultivation.

- The existing irrigational system should be repaired and a new system should be built to make them serve agriculture and aquaculture better. At the same time, the existing channels and ditches which have been filled up with alluvium and mud discharged from shrimp farmed ponds should be dredged.

- A standard system of water supply and reserving ponds should be built for aquaculture.

- Separate systems of water supply and drainage waterways should be built for aquaculture and agriculture.

- In Binh Thoi commune: the following 3 channels and ditches should be dredged:

- Ben Kinh channel, 1,000m long (13 households)
- Ba Trang, 1,200m long (23 households)
- De Bien, 1,700m long (5 households).

#### **4. Seeds:**

- Seeds brought from other provinces to the communes should be checked carefully to prevent low quality seeds which may harm the aquaculture in the communes.

- A concentrated aquaculture area should be built to attract investment from the State in necessary infrastructure construction (roads, water supply and discharged water treatment systems, seed quality checking equipment), and from different economic sectors in high quality shrimp production for on-site timely and sufficient supply of good shrimp seeds at reasonable price and gradually satisfaction of the farmers' demand for shrimp seed on-site.

- The local government should cooperate with nearby provinces to meet the farmers' demand for aquaseeds.

### **5. Policy:**

- Continue to implement the Decision No.224/1999 dated 8th December 1999 by the Prime Minister on the approval of the Program for Aquaculture Development during period between 1999-2010; Decision No. 103/2000/QĐ-TTg dated 25th August 2000 by the Prime Minister on some policies on aquaseed development; Resolution No. 09/2000/NQ-CP dated 15th June 2000 by the Prime Minister on some policies on economic restructure and agriproduct consumption; Decision No. 112/2004/ QĐ-TTg dated 23rd June 2003 by the Prime Minister on the approval of the Program for aquaseed development upto 2010.

- Basing on the practical situation, promulgate policies on land use and land use conversion which are appropriate with the communal features; support the infrastructure construction of the transitional regions and encourage individuals and organizations' participation in aquaculture development in general and rice and shrimp farming in particular.

- Create favourable conditions for farmers to borrow long-term, medium-term and short-term capital with various loan limits and return deadlines appropriate with different forms of aquaculture.

- Implement projects for the improvement of the provincial infrastructure for aquaculture and agriculture and for application of technology to the practice in order to reduce natural aquaprodukt exploitation and protect natural resources.
- Complete early the system of management institution and encourage investment in irrigation system to serve aquaculture effectively as planned.

## **6. Water resource management for agriculture and aquaculture:**

- Impose strong punishment on the discharge of untreated water from farmed ponds and lakes infected with diseases to the environment;
- Impose strong punishment on the households who do not follow the crop schedule, causing bad influence on the surrounding environment.
- Control the amount of seeds and chemical concentration left in farmed aquaproducts. Speed up the progress of constructing and well equipping the Centre for Environment Warning of the Department of Aquacultural farming and of communal stations.
- Cooperate with agriculture staff in directing rice cultivation in the transitional regions doing shrimp-cum-rice farming.
- Monitor the use of chemical fertilizers and pesticides in agriculture to prevent the risk of polluting the environment in aquaculture, agriculture and other sectors and to protect the water resource in general.

## **7. Management and Production**

- Reorganize production, duplicate the models of collective production in form of co-operatives and associations and mobilize the participation of the community (including professional societies, mass organizations, clubs...) in providing mutual support in techniques, seed and food service, water and environmental management, capital and product consumption.

- Attach product processing and consumption to the shrimp farmers on the basis of economic contracts.

With rational policies, synchronic solutions, rice and shrimp farming will bring big economic outcome, increasing income on a farmed area unit, contributing to poverty reduction and hunger elimination and enhancing the living standards of the people in the communes.

- Keep the community informed and aware of aquaresource protection, and make full use of all potentials for aquaproduct farming, processing and exploiting to increase farmers' income together with aquaresource and ecosystem protection.

- Train the workforce for aquaculture:

- + Workforce is the decisive factor for all forms of production and the application of modern technology in production, so the workforce has to be conformable with the features and levels of production to be effective. A team of high quality staff obtaining degrees and certificates from vocational schools, colleges and universities can satisfy the demand for aquacultural development in the project area.

- + Train the communal cadres and technicians in biology, seed production techniques and aquaculture.

