7.3 The Mangrove Ecosystem

7.3.1 Introduction

The aim of this Chapter is to describes the mangrove ecosystem of Bai Chay Bay in relation to the proposed Cai Lan Port Project. The account focuses on several key aspects of relevance to the mangrove ecosystem. It describes the estuarine biology which should be taken into consideration during both the construction and operational phases of the port development.

These key aspects include :

- Mangrove species in northern Vietnam and their status in relationship to mangroves elsewhere in Vietnam and, where relevant, to mangrove vegetation in the Indo-Pacific biogeographic region.

- The ecological and economic value of the mangrove ecosystem.

7.3.2 Survey Methods

7.3.2.1 Survey Approach

The findings of this chapter are based on field work in Bai Chay Bay conducted by the Environmental Specialists. First hand data and observations were gained on field surveys conducted over a total of five days in December 1993 and in January and June 1994 (Table 7-3-1). Both foreign and Vietnamese co-workers were involved in the field surveys.

The first hand data and observations, and the available published data and other printed literature (local reports, papers, documents, books, etc.) have been used to put the environmental issues regarding the mangrove ecosystem into perspective in this EIA.

Table 7-3-1 Field surveys of the mangroves of Bai Chay Bay.

Date	Location	Main Activity	Personnel Foreign (F) Vietnamese (V)
27-28 Dec, 1993	Cai Lan Port area	Site inspection of port coastal environment. Visual reconnaissance of Bai Chay Bay	Dr R. Bartlett (F) Dr G. Maxwell (F)
6-8 Jan, 1994	Bai Chay Bay i. Kend dong ii. Le Loi iii. Lang Bang	Mangrove and mud studies including vegetation transects and mud macrochemistry with LD80A	Dr G. Maxwell Mr Dang Viet Khoa (V)
9-10 June, 1994	i. Yen Lap Experimental Enterprise, Yen Hung Town, Quang Ninh Province	Interview with Mr Le Dinh Tram (Director Yen Lap EE) and discussion with Hoang Cong Dang (PhD student at EE)	Dr G. Maxwell Dr Nguyen Hoang Tri (V) (Mangrove Ecosystem Research Centre)
	ii. Le Loi Experimental Production Project	Field visit and inspection of Le Loi dyke, aquaculture and mangrove scheme	"
	iii. Bai Chay Bay and Yen Hung District	Aerial reconnaissance. Inspect and evaluate Dai Yen coastal mangrove as potential mitigation area. Meeting with Mr Le Dinh Tram	Dr G. Maxwell Dr N. H. Tri Mr H. C. Dang (V)

7.3.2.2 Field Methods

(1) Aerial Reconnaissance

Aerial reconnaissance from a helicopter and a light sea plane was undertaken during the December 1993 and June 1994 field excursions respectively. This enabled an overview to be taken of the macro-ecological and geographic setting of the Cai Lan Port area and Bai Chay Bay and its agricultural hinterland. Some patterns of water current and surface dynamics were also detectable by this method.

(2) Ground Surveys

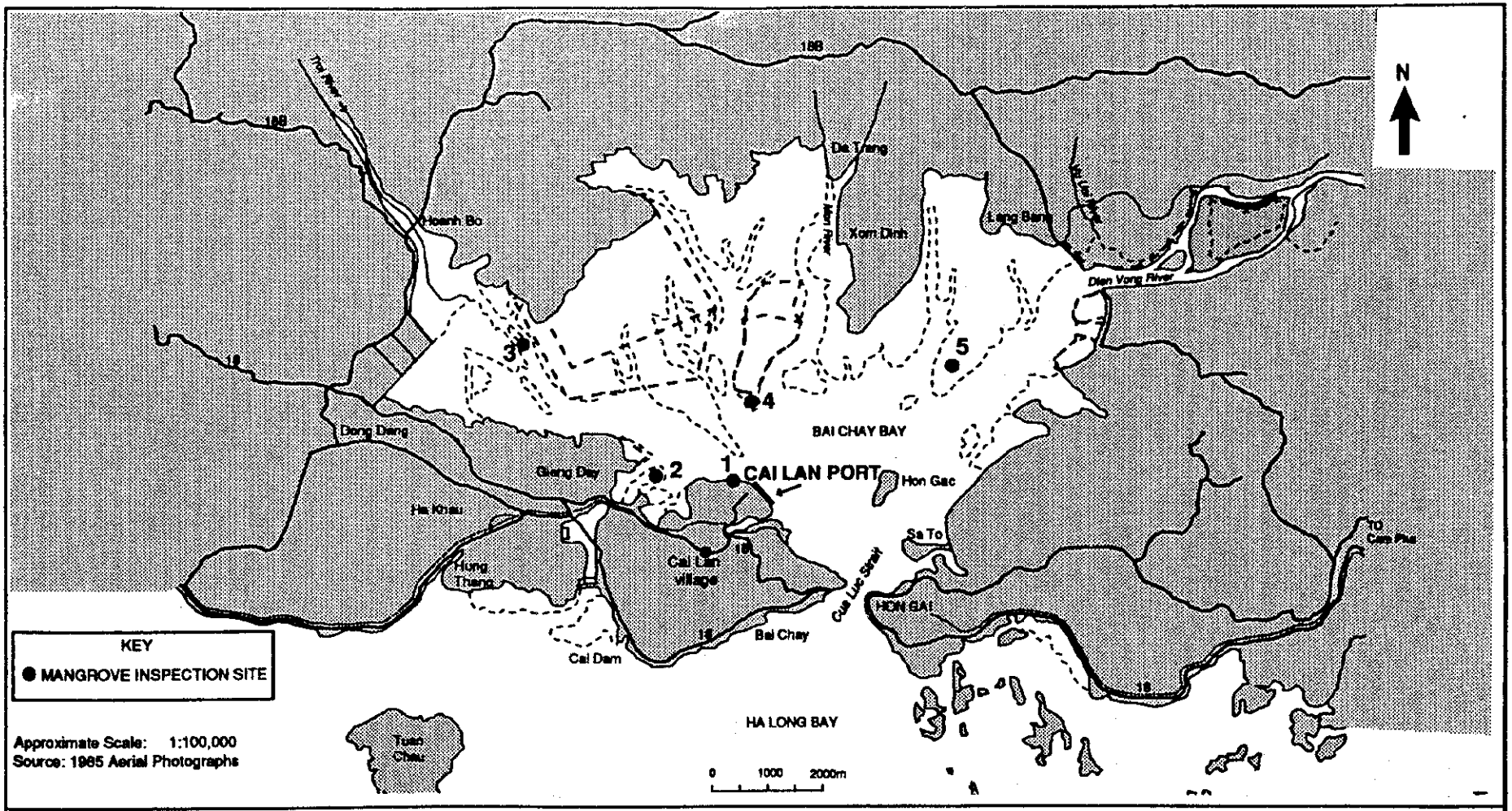
Both the paddy and farm lands behind the extensive (~ 2,000 ha) mangrove zones and the mangroves themselves were visited on foot. The locations of the sites are described in Table 7-3-1 and shown in Fig. 7-3-1. Approximately 10 km of paddy, paddy-mangrove fringe, aquaculture zones, sand flats and mud flats were covered on foot during the surveys.

The seaward mangrove area on the northern side of Bai Chay Bay was examined while the tress were partly submerged (water depth ~ 25 to 40cm). This enabled the condition of the seaward belt of pioneer species (*Avicennia marina* and *Kandelia candel*) to be inspected and later compared with that towards the landward zone of the mangrove vegetation. In addition, these excursions into the outer mangrove zones of *Rhizophora stylosa*, where the subtraction is soft and muddy, enabled assessments to be made of such matters as the relative importance of different mangrove species in the day to day economic activities of the local people.

(3) Interviews and Instrumentation

Interviews were conducted in both January and June 1994 with local people encountered on the field excursions. In January, some San Diu people were interviewed near Xom Trai (site 5 in Fig. 7-3-1). In June local mangrove firewood gatherers were interviewed, along with soldiers involved in dyke and flood gate construction on the Le Loi Experimental Production Project.

Instrumentation used during the extensive field work is described in Table 7-3-2. In addition to the instruments shown, basic ecological equipment such as binoculars, camera, diameter at breast height (dbh) tape, transect tapes and sediment bottles were also used.



FIELD SURVEY SITES IN BAI CHAY BAY

FIG. 7-3-1

FEASIBILITY STUDY FOR CAI LAN PORT CONSTRUCTION PROJECT

Plate 7-3-1: Instrumentation utilized in the BCBA field surveys, January 1994.

(A) The LD 80A electronic redox meter (blue box beside back pack) with Platinum-spike tip probe placed into fresh sample of mangrove substratum obtained with stainless steel D - section corer.

(B) Tree in lower inter tidal mangrove on North side Bai Chay Bay. Approx. height 2.1m. D - section corer beside *R. stylosa* aerial pro root system.

(C) and (D) forester tape beside dwarf and stunted *Avicenia marina* tree in upper tidal zone of extensive *Avicennia* mangrove sand flats near Le Loi village (site 4 on Fig 6.2). These stunted trees are a growth form induced by the combined prolonged effects of cattle foraging and firewood cutting.

Table 7-3-2 Instrumentation used during field surveys.

Date	Instrument	Function	Source
7.1.94	D-section corer (see Plate 7-3-1).	To take un-compacted soil or mud samples.	Environmental Specialist.
9-10.6.94	LD80A redox, pH and temperature probe system (see Plate 7-3-1).	To measure mud anoxic status in the field; macrochemistry of sulphate-sulphite and oxygen status.	Environmental Specialist. This was involved in technology transfer to Vietnamese counterparts. The instrument is computer-compatible and recommended in "The Mangrove Ecosystem - Research Methods", UNESCO 1984.
	Salinity refractometer (Atogo brand, calibrated in ppt)	To determine water salinity.	Dr N. H. Tri, Mangrove Ecosystem Research Centre.

7.3.3 The Eco-Geographic Setting of Bai Chay Bay

The physical environment of Bai Chay Bay is described in detail in Chapter 5 and is not revisited here. The aim of this section is to characterise the combined ecological and geographic features of Bai Chay Bay which are most important in the understanding of the mangrove ecosystem. Of paramount importance is the fact that this environment is an estuarine ecological system.

Five rivers (the Troi, My, Man, Thanh and Dien Vong Rivers) together with their tributaries and extensive catchment areas drain into Bai Chay Bay. A system of mud flat deltas has evolved. Tidal waters bring saline water into the fresh riverine water and a complex estuarine environment has been created. Wide variations in soil and water salinities occur due to the estuarine environment and to climate and rainfall conditions. The complexities of the aquatic environment are, to some extent, mirrored in the complex soil system. A mosaic of sand, loamy sand, silty clay sand and clay make up the substrata of the deltaic system. A recent study (Anh, 1992) showed that these various soil types had the following representation in Bai Chay Bay:

Sandy soil:	7-9% of Bai Chay Bay
Loamy sand:	50-60%
Silty clay sand:	30%
Clay:	6-8%

There is some evidence that the loam and silt components have increased in recent decades. This trend is thought to be associated with deforestation on the hillsides beyond the river deltas and the consequent erosion of soil and subsoil.

Another salient point is climatic. On occasions cool (~ 7°C) winter days occur and place ecophysiological stress on the growth of mangrove species. Some mangrove are more cold (chill) tolerant than others. *Kandelia candel* especially, and to some extent *Avicennia marina* are well adapted to withstand both cold and the wide variety of soil types which exist in this estuarine system.

The ecologically important mangrove species of this northern province of Vietnam are *Kandelia candel, Avicennia marina, Aegiceras corniculatum, Bruguiera gymnorrhiza* and *Rhizophora stylosa*. The first three species (*Kandelia, Avicennia* and *Aegiceras*) may be eco-dominant in Bai Chay Bay because they are suited to the physical challenges of the habitat. These include cold, variable substrata and variable salinities, and moreover, the human factors of firewood harvesting and buffalo grazing and foraging.

Thus the eco-geographic characteristics of Bai Chay Bay may not be entirely natural: human factors have a long history and are very important. This consideration is crucial in the management of the mangrove ecosystem, the rehabilitation of degraded mangrove stands and the assessment of environmental impacts associated with the development of Cai Lan Port and the attendant economic and industrial developments in the future.

7.3.4 The Abiotic Mangrove Environment

7.3.4.1 Introduction

This section briefly addresses the main physico-chemical features of the mangrove soils, estuarine water and the waters of Bai Chay Bay itself. Some of the salient features of the soil were mentioned above.

7.3.4.2 Chemical Analyses of Mangrove Soils

The chemistry of the mangrove soils is shown in Table 7-3-3. The data is based on two sources: Anh (1992) and field work conducted by the Environmental Experts.

Table 7-3-3 Chemical analysis of mangrove substrates typical of Bai Chay Bay.

Parameter	Value
Organic matter upper layer lower layer	1-30 % 4-5 %
Total-N	0.05-0.2 %
Total-P	1-4 mg P_2O_5 per 100 g soil
K	30-80 mg K_2O per 100 g soil
pH	4.5-5.5
Al^{3+}	5-10 mg per 100 g soil
Fe^{3+}	150-300 mg per 100 g soil
Soil water salinity	10-30 %
Cl^-	0.3-0.6 %
SO_4^{2-}	1-3 %
Mud redox status (LD80A instrument)	i) 0-3 cm depth= -106 mV ii) 10-15 cm depth= -200 mV iii) max recorded in soft estuarine ooze = -215 mV

The values for the various chemical species are within the range for mangrove substrata in the Asia-Pacific region. The soil water salinities are somewhat lower than expected, while those for pH are more acidic than expected. However, values for the more important macro-chemical parameter of mud redox status were indicative of low anoxia. They are not extreme values and indicate that in terms of the complex sulphate-sulphide oxidation-reduction reactions typical of mangrove mud, the muds and sands of Bai Chay Bay are favourable for mangrove growth.

7.3.4.3 Chemical Analyses of Mangrove Waterways and Bai Chay Bay Water

The results of a chemical analysis of mangrove water ways and Bai Chay Bay waters (Anh 1992) are shown in Table 7-3-4.

The results are within the ranges expected for estuarine, riverine and mangrove ecosystems. The pH values (7.2 to 7.5) are rather different from the equivalent values in mangrove soils. This is not surprising as a host of microbe-mediated chemical reactions occur within the mangrove substratum. At times, pH values can vary depending on the state of the tide, peaks in microbial activity, temperature and the anoxic status of a given mud sample. It is possible that the pH readings for mangrove mud were taken at a time of peak microbial action involving the release of complex organic acids associated with the tannin-laden derivatives of decomposing mangrove material. The pH patterns in mangrove mud especially and to a lesser extent in mangrove waterways require further study in a long term programme involving seasonal variations.

7.3.4.4 Underground Waters

The results of an analysis of underground waters associated with the paddy-mangrove transition zone are presented in Table 7-3-5. They contain no surprises. The ground water within the mangrove-paddy transition zone

is similar to what would be expected in waterlogged soils and old estuarine and alluvial sedimentary deposits.

Table 7-3-4 Chemical composition of mangrove waterways and Bai Chay Bay waters (from Anh 1992).

Parameter	Value (all units mg l^{-1} except pH and salinity)	
	Mangrove	Bai Chay Bay
pH	7.2-7.5	7.3-7.5
Al^{3+}	0.05-0.07	0.0
Fe^{3+}	0.03-2.0	0.02-0.05
P	3-10	3-15
Ca^{2+}	7-20	20-40
Mg^{2+}	14-60	120-160
SO_4^{2-}	121-164	288-300
Cl^-	0.25-2.59	5.1-7.55
Salinity *	9-18 parts per thousand	24-30.5

Note: * June refractometer readings after heavy rain, Environmental Specialist, 9.6.94.

Table 7-3-5 Chemical composition of underground waters associated with the paddy-mangrove transition zone.

Parameter	Value (mg l-1)
pH	6.9-7.1
Al^{3+}	4-10
Fe^{3+}	0.08-0.4
P	10-17
Ca^{2+}	18-68
Mg^{2+}	88-206
SO_4^{2-}	170-330
Cl^-	13-15

7.3.5 Mangrove Vegetation

7.3.5.1 Introduction

Mangrove vegetation is an outstanding feature of protected maritime locations throughout the tropical and subtropical regions of the world. Plants which make up mangroves come from a wide variety of taxonomic groups, many of which are not closely related. An important concept in the understanding of the ecology and biology of these "trees which grow in the sea" is that they represent, in biological terms, a life form and not one particular type or even family of flowering plants.

In the past decade, mangrove research has seen dramatic growth. It is now possible to state, with much confidence and scientific power, that the battle of viewpoints between the conflicting social forces of mangrove forest conservation and conversion is, at last, over. Very few mangrove scientists now doubt the ecological and economic importance of mangroves. They have been aptly described as perhaps the most productive ecosystem on earth.

It is against this background that we must assess the importance of the 2,000 ha of remaining mangrove that exists in Bai Chay Bay.

7.3.5.2 The Mangrove Zones of Vietnam

The mangrove vegetation of Vietnam has been divided into four major eco-geographic zones (Hong 1984, 1993). The use of the term eco-geographic to describe aspects of mangrove biogeography has been advocated recently by Maxwell (1994) and used in relation to ecotypes by Aksornkoae et al. (1992).

Hong and San (1993) subdivide the major zones into 12 subzones. All zones are essentially based on latitude. The major zones are:

Zone 1:	North east coast from Ngoc Cape to Do Son Cape (~ 22° to 21° N).
Zone 2:	Northern delta Do Son Cape to Lach Truong River (~ 21° to 20°N).
Zone 3:	Central coast from Lach Truong to Vung Tau Cape (~ 20° to 10° 30'N)

Zone 4: Southern delta from Vung Tau Cape to Ha Tien (~ 10^{o} 30' to 9^{o} 30'N).

Bai Chay Bay is thus in Zone 1.

7.3.5.3 The Present Status of Mangrove Forest in Vietnam

Largely due to the two Indochina wars, which together lasted almost 30 years, the quantity and composition of mangroves have changed markedly (Hong and San, 1993). The estimated present status of mangrove in Vietnam is shown in Table 7-3-6.

To place these 1983 estimates in perspective it is useful to mention that before the second Indochina war (1962-1971), mangrove forests in Vietnam covered some 400,000 ha (Maurand, 1943).

Table 7-3-6 Mangrove forest in Vietnam (ha) based on 1983 studies.

Zone	Estimated Total Area	Natural forest Trees	Natural forest Shrubs	Plantation
1. North east	39,400	3,000	36,400	-
2. Northern delta	7,000	2,800	-	4,200 (i)
3. Central	14,300	-	14,300	-
4. Southern delta	191,800	135,900	13,500	42,400

Note: Hong (1994) reports investigations under way to plant circa 2,000 ha of *Kandelia candel* mangroves in Thai Binh and Nam Ha Provinces. The plantation potential is considerable.

7.3.5.4 The Bai Chay Bay Mangroves in relation to Other Zone 1 Mangroves

Zone 1 has the most complex physical environment of all the mangrove zones. Salinity, for example, ranges from 21 parts per thousand (ppt) to 27 ppt, depending on seasonal rainfall. (By comparison, normal seawater has salinity of 35 ppt). Cool winter temperatures in this northern zone tend to limit the growth potential of mangrove trees.

Hong and San (1993) subdivide Zone 1 into 3 subzones, designated 1A, 1B and 1C. Zone 1A covers around 55 km of coastline from Mong Cai to Cua Ong. The relatively low human population in many parts of Zone 1A has enabled many species of mangrove here to reach their climatically controlled growth potential. Some trees have reached 8 m in height and 20-30 cm in diameter.

Zone 1B covers some 40 km of coastline from Cua Ong to Cua Luc. Bai Chay Bay is included in Zone 1B. The mangroves in Zone 1B are not as extensively developed as those in other zones. The area is close to coal mines. Exploitation of this resource has worked against the mangrove stands. In addition, trees have been used by local people for many functions, from firewood to cattle fodder. Typically, the mangroves do not reach their full growth potential in Zone 1B. Stunted trees and shrubs are common, although *Kandelia* and *Bruguiera gymnorrhiza* can reach 2-3 m tall in places.

Zone 1C covers over 5km of coastline from Cua Luc to Do Son Cape. Like the trees in Zone 1B, the mangroves of Zone 1C tend to be small-sized trees.

Generally speaking, the mangroves throughout Zone 1 are notably smaller than their counterparts in Zone 2. The main factors responsible for this condition include cool winters, higher salinities, human exploitation and a complex natural physical environment, especially of the soils (alluvium, sand and sandy mud).

7.3.5.5 Characteristics of the Mangroves of Zones 2, 3 and 4

(1) Zone 2 Mangroves

Like Zone 1, Zone 2 can be subdivided into Zones 2A and 2B. Zone 2A is, essentially, a transition area between Zone 1 and Zone 2.

In Zone 2A brackish water species typify the area. Some very large (6-8 m tall) *Sonneratia caseolaris* occur. Under these substantial trees a shrub layer of *Aegiceras* and *Acanthus* occurs. In recent years the expansion of shrimp ponds has resulted in the depletion of the dominant *Sonneratia* forest here. Zone 2B is centred on the Hong River system and, as with Zone 2A, brackish water mangrove species characterise the area. A huge input of water-borne sediment (114 million tons of suspended particles are carried every year, according to Pho 1983) enters the Hong River. Mangrove development potential is great but monsoons and storms inhibit the expansion of mangrove vegetation. *Kandelia candel* has been used successfully as a mangrove protector of dykes and soil, and appears to be a key species in mangrove rehabilitation.

(2) Zone 3 Mangroves

Due to monsoons and storms and the lack of suitable alluvium, mangrove areas in Zone 3 are few and far between. They are restricted to a limited number of protected sites and situations. Nevertheless, compared to Zones 1 and 2, the species diversity is relatively high, with many more species here than are found in the northern zones.

(3) Zone 4 Mangroves

Relatively free from floods and storms, blessed with some very large river systems and biogeographically close to the tropical mangroves of the Indo-Malaysian archipelago, conditions in Zone 4 are most favourable for the extensive development of mangroves (Hong and San 1993). Most of the 32 true mangrove species listed for Vietnam (Hong 1991) can be found in Zone 4.

The tree growth potential (height and girth) is very good indeed. *Avicennia marina* occurs in the far north (Quang Ninh Province) and in the far south, and illustrates the difference between northern and southern Vietnam mangrove conditions very well. During the survey in January 1994 many small (< 0.5 m) squat bonsai-like *Avicennia marina* shrubs were observed in the northern Bai

Chay Bay. By contrast, Hong and San (1993) report *Avicennia marina* trees with diameters of 35-50 cm in the Bo De estuary of Zone 4.

Both natural and man-assisted mangrove forest regeneration following defoliation and mangrove mortality due to herbicidal sprays during the second Indochina war, is an important feature of Zone 4.

7.3.5.6 Summary of the Mangrove Vegetation of Vietnam

The mangroves of Vietnam can usefully be divided into 4 major eco-geographic zones based on latitude, climate, hydrography and topography. Zone 4, which covers the coast of southern Vietnam, provides the most favourable conditions for mangrove development. This is mirrored in their size (potential for maximum growth), abundance and ecological pattern. Zone 1, on the other hand, in which Bai Chay Bay is located, suffers from the northwest monsoon and relatively low (10-15 ^{o}C) temperatures. Tree growth and species diversity are therefore limited.

7.3.5.7 Ecological and Economic Classification of Mangrove Vegetation in Bai Chay Bay

Based on the combined result of the field studies in January and June 1994, it is possible to broadly classify the Bai Chay Bay mangrove stands into several eco-economic categories. The classification given in Table 11-2-2 of Chapter 11and shown in Fig. 11-2-2 of Chapter 11 is based on professional estimations but should not be regarded as absolute. The scheme is tentative. Mangrove research is on-going and the full biological, economic, ecological and even medical value of mangrove materials is yet to be realised. In this context, the traditional medicinal uses of mangrove extracts such as leaf extracts of *Acanthus ilicifolius* in treating rheumatism (Chapman 1976; Hong 1993) are a reminder that when the full pharmaceutical, biochemical and medical aspects of mangrove products are known the dollars value of these plants may increase. It was recently found, for example, that extracts of *Avicennia marina* (an important mangrove species in Bai Chay Bay) may have anti-fertility properties and could be useful in the drug industry.

It is emphasised that the tentative eco-economic classification given above could change considerably in the future. Very recently even in Bai Chay Bay the importance of mangrove in sustainable integrated agro-forestry-aquacultural systems has been realised in a pragmatic way. Some experimental planting schemes are now under way.

7.3.6 Mangrove Dependent Biota

7.3.6.1 Introduction

This section describes the fauna of ecological and economic importance which is either directly or indirectly dependent on the primary producers of the mangrove ecosystem - the mangrove trees themselves. These plants furnish the fundamental food supplies in the form of leaf and other plant material. Such primary products are the basis of the food chain and the complex food webs of estuarine ecosystems. The system is interesting and complex. Subtle systems, such as coprophagy, are involved. This system involves the use and reuse of fragments of mangrove leaf matter by first order consumers such as detritivorous crabs including the fiddler crab (*Uca* spp.) and the opportunist members of the genus *Chiromanthes* which consume a wide range of mangrove products such as leaf fragments, propagules (droppers) and other reproductive material. Some mangrove-inhabiting crustaceae ingest leaf fragments, digest the microbial film that has developed on the leaf material and egest the remaining leaf tissue. This tissue is again colonised by microbes and may once more be ingested by the crustaceae. The crabs are, in turn, food for higher order consumers such as resident populations of estuarine finfish which dine in the shallow, tranquil (low velocity) water of the mangrove at high tide. In addition, many pelagic finfish also visit the mangrove estuary at high tide or feed on the resident finfish.

This section describes the main groups of animal biota which are dependent on the mangroves. These include:

- Shellfish.
- Crustaceae.
- Finfish.
- Other vertebrates (birds, mammals, reptiles and amphibians).
- Other mud-dwelling macro invertebrates such as polychaetes and sipunculid worms.

Each group will be addressed in turn.

7.3.6.2 Shellfish

The mangrove vegetation supports important populations of edible molluscs, including oysters, mussels and other bivalves as well as a variety of snails. Some of these shellfish are illustrated in Plates 7-3-2 and 7-3-3. Oysters (*Ostrea* sp.) are collected by hand. Some mud-

dwelling burrowing species such as *Cylina sinensis, Meretrix meretrix* and *Mactra quadrangularis* require digging usually with simple implements (Plate 7-3-2 C).

The mangrove ecosystem of northern Vietnam supports a rich and diverse mollusc fauna. Due (1991) reports that over a 23 years period of study, 169 different species of molluscs representing 51 families have been found in the mangrove-dependent ecosystem of Quang Ninh Province. This is a huge resource in term of biodiversity alone.

The molluscan fauna of Quang Ninh Province, including Bai Chay Bay, appears to equate with the highly valued mangrove mollusc resources of Malaysia as described by Wong et al (1984). The biological richness of the Quang Ninh shellfish resource is underscored by the biogeographically interesting fact that of the 254 known species of mollusc within the Asia-Pacific region, almost 70 % of them can be found in Quang Ninh Province. The most important in terms of abundance and distribution include *Nerita, Clithon, Litorina, Cerithium* (whose abundance can reach 200-300 m^{-2} as observed during the field surveys), *Natica maculosa, Modiolus, Ostrea* (Plate 7-3-3 A and C) *Mactra quadrangularis, Teredo* and *Bankia.*

Shellfish densities depend on mangrove productivity. Loss of mangrove biomass, due to excessive exploitation by local residents or destruction during the construction of aquaculture ponds, results in a decline in mollusc numbers and species diversity. This fact is illustrated in Table 7-3-7.

A well planned scientific approach to mangrove resource management is required to ensure sustainable use of these variable molluscan resources.

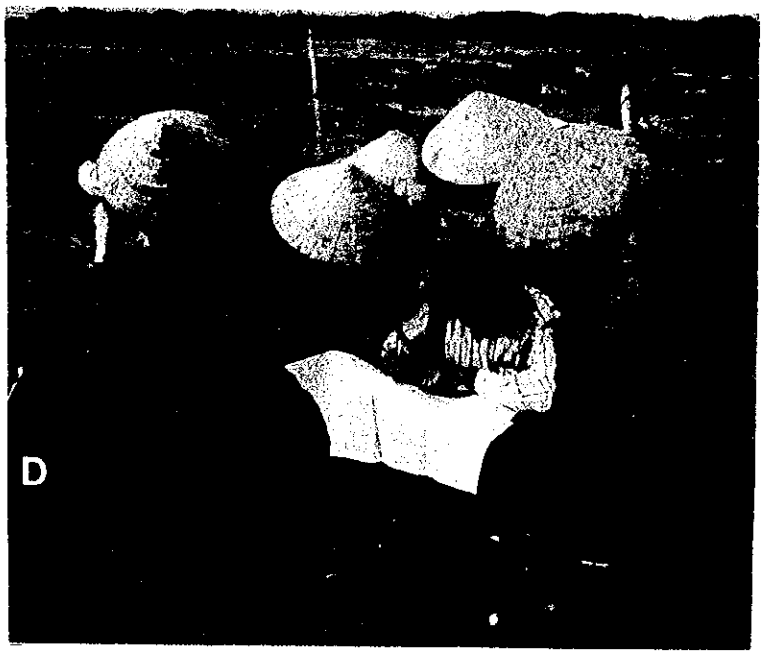


Plate 7-3-2: Fuel and food from the mangroves in zone D (Fig 6.2).

(A) A harvest of firewood from the mangrove *Avicennia marina* growing extensively on salt flats, northern Bai Chay Bay.

(B) Bundles of firewood collected from the mangrove *Aegiceras corniculatum* left to dry near a village landward of the mangrove belt.

(C) Recently harvested mangrove mud-dwelling mollusks (*Meretix* and *Mactra sp*) ; up to 2 kg per hour can be gathered in places.

(D) Discussions with local people.

Plate 7-3-3: Zone G shorescape near Cai Lan Port, December 1993.

(A) Local people obtaining oyster (*Ostrea* sp.) from rocks in lower littoral.
(B) Stunted mangrove (*Avicennia marina*).
(C) Zone G has very limited remaining shellfish resources.The zone has been classified as having low ecological-economic status.

The integrated, experimental dyke-aquaculture-mangrove system being set up near Le Loi in Bai Chay Bay may provide a model for the future.

Table 7-3-7 Variation in numbers of mollusca within mangrove forest compared to fish culture ponds.

Class	Species Number in Pond	Species Number on Mangrove Flat Outside Pond	Number of Species Common to Both Areas
Gastropoda	16	23	11
Bivalvia	10	22	11

Note: Data based on a 1982-1983 study near coastal Hai Phong (Duc 1993).

7.3.6.3 Crustaceae

Some 46 different species of sesarmids (crabs) inhabit the mangrove ecosystem of the Indo-Malaysian region. Many of these penetrate into the long coastline of Vietnam. There is some decline in diversity with increasing latitude.

Detailed studies of crabs with little known economic importance in Quang Ninh Province have not yet been carried out. However the surveys reported here have shown them to be ecologically important throughout the mangrove intertidal zone. Sand processors such as *Uca* sp. and opportunistic, broad-spectrum herbivores such *Chiromanthes* spp. were observed in good numbers at the sites visited. Some of the sesarmids belonging to the important mangrove crab genus *Chiromanthes* are well known propagule predators. Evidence of propagule damage was observed in the mid and lower littoral zones, where the mangrove *Kandelia candel* occurred.

The best known crab is the economically important "mangrove crab", *Scylla serrata*. This is the largest edible crab in the Indo-Pacific region and is very common in Vietnam's coastal zone (Hong and San, 1993). The meat of this crab is highly valued and very tasty with an excellent nutrient status. *Scylla serrata* are caught in crab traps and with long iron hooks and sold in local markets. A large number are exported. The ecology of this species should be fully studied in the context of Bai Chay Bay as the dollar value of farmed populations of this large "mangrove crab" would be considerable in export terms.

Other crustaceae are important too. Both traditional aquaculture and more advanced systems of aquaculture feature prawn culture. Like the molluscs mentioned above, the prawns are very important in both the daily and market activities of the local people of Bai Chay Bay. Plate 7-3-4 C illustrates a more traditional aquacultural system, typical of the northern shores of Bai Chay Bay

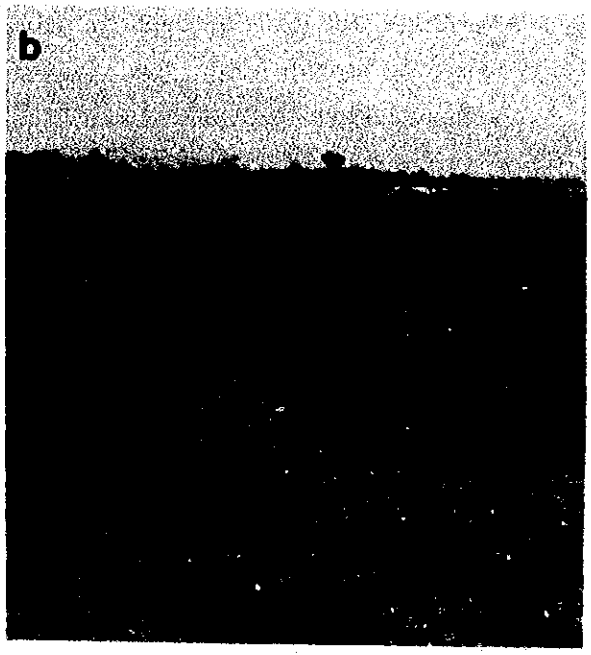
The most important shrimp and prawn species found in Bai Chay are *Penaeus merguiensis, Palaemon carinicanda, Metapenaeus ensis,* and *M. joyneri* (Anh, 1992).

7.3.6.4 Other Mud-dwelling Macro-invertebrates

As well as the shrimps and crabs described above there are other mangrove-dependant biota which are usually not seen. These live hidden inside the mud and are termed "infauna". The most important infauna include the polychaete and sipunculid worms. Observations were made of polychaetes during mud excavations with the D-section core sampling (refer Plate 7-3-1). The most common was a member of the genus *Perinereis,* probably *P. singaporensis.*

Counts of the edible sipunculid *Siphonosoma* (or similar species, *Phascolosoma lurco*) were made during the field survey. Densities of around 30-42 m^{-2} were harvested at site 5 (refer Fig. 7-3-1) by local people. These densities equate with those recorded in parts of east coast peninsular Malaysia, which ranged from 8.3 to 266 m^{-2} (Wong et al. 1984).

The full economic value of these macro-invertebrates remains to be determined. They are sold at markets near the Vietnamese-China border. Some of the customers are Chinese. Also, the importance of these and other macro-invertebrates as a protein source for the local inhabitants must be emphasised.



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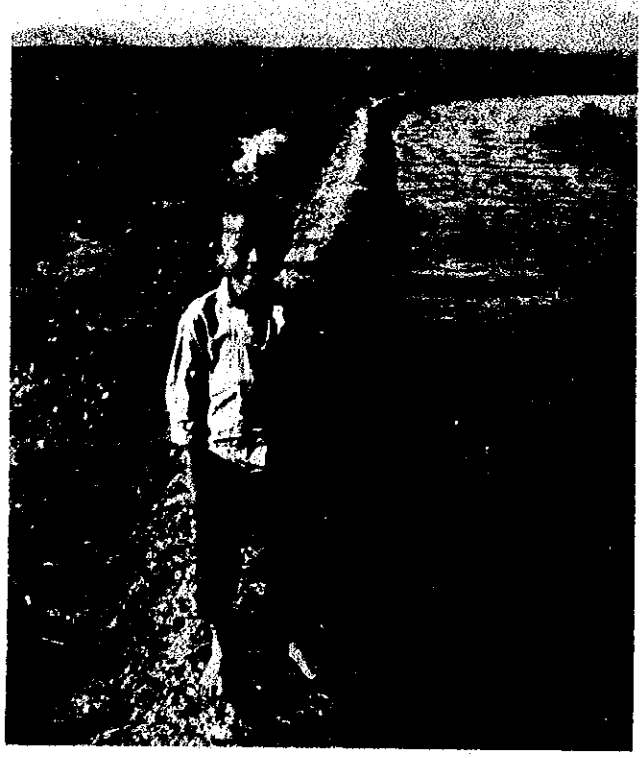

Plate 7-3-4: Food, fodder and the future.

(A) Sipunculid worm collected in upper littoral near *Aegiceras* mangrove trees near site 3 (Fig 6.2).
(B) Cattle grazing on the nutritious sweet and sour leaves of *Avicennia marina* : the minerals (salt) contained in these mangrove leaves are important for cattle health.
(C) Man-made dyke beside extensive mangrove belt.

7.3.6.5 Finfish

The widespread use of baited fish traps and various type of nets (casting and gill) in Bai Chay Bay demonstrates the variety, availability and importance of many species of finfish in the estuarine system here. Some features of the finfishing industry are illustrated in Plate 7-3-5.

Finfish associated with the mangrove ecosystem in Quang Ninh Province have been listed in the Red Data Book of Vietnam, Vol 1 (1992). This important volume included a section on the Cai Lan region. Finfish found in this region are many and varied and include well known species such as the eel (*Anguilla japonica*) and sharks such as *Rhincodon typicus*, which are also sustained indirectly by mangrove ecosystems. Likewise the scientifically unusual species such as *Branchiostoma belcheri (Amphioxus belcheri)* and *Hippocampus histrix* (seahorse) are also sustained by complex food webs driven by mangroves as primary producers. It is thought useful to mention species such as *Amphioxus* and *Hippocampus* as they are examples of marine vertebrates which are yet to be fully studied both zoologically and economically. The capture and fish culture of such species may well fill a niche market in the future.

7.3.6.6 Other Vertebrates

The avifauna (birds), mammals, reptiles and amphibian associated with the mangrove ecosystem have declined over the years. Excessive hunting and trapping of birds for the feather industry, mammals (e.g., for tiger products) and reptiles (for items such as skin and bile) have resulted in many species, which were once part of the broader mangrove and coastal ecosystems, becoming rare, endangered or extinct.

During the field surveys, sightings of vertebrates were limited to sea eagles and the kingfisher (*Halcyon coromando*). An unconfirmed sighting of the black-headed duck, *Aythya baeri*, was made at site 5 in January, 1994.

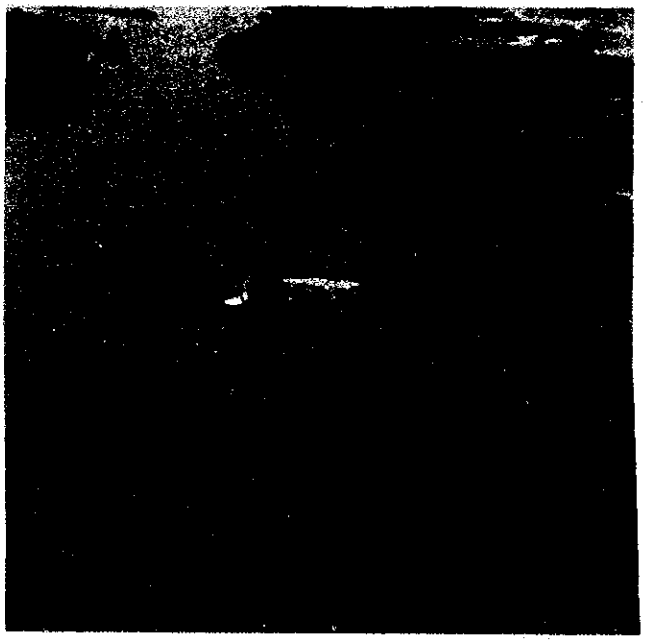

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Plate 7-3-5 : Finfishing in Bai Chay Bay.

(A) Net casting in mangrove water-way.
(B) Small edible finfish drying.
(C) Portable fish traps awaiting placement in mangrove for a high tide harvest of finfish.

The setting aside of limited-access bird reserves at remote areas within Bai Chay Bay (e.g., zone E in Fig. 7-3-2) may attract birds back to Bai Chay Bay. If such returnees include keystone species such as the black-faced spoonbill, *Platalea minor*, then the eco-tourism potential of Bai Chay Bay could be enhanced. This species has of late attracted considerable international attention, having just two known remaining breeding sites in the world. One of these is in northern Vietnam, the other in Southern Taiwan. The species is endangered and of much interest ornithologically around the world. To take action to help bird species such as the black-faced spoonbill which feeds in mangrove areas would help promote Bai Chay Bay as an eco-tourism destination. Such action would be in keeping with the multi-use master plan concept for natural resources in Vietnam.

If such action (establishment of bird reserves or bird preservation sites) took place alongside the development of a new port at Cai Lan, then this would be very positive situation, in which both industrial and eco-tourism developments could proceed hand in hand.

No snakes were seen in the area surrounding Bai Chay Bay. Amphibian (frogs) were observed in the paddy-mangrove transition zone but not within the mangrove habitat itself.

Wild terrestrial vertebrates such as lizards, snakes and bats are listed as part of the remaining vertebrate fauna associated with Bai Chay Bay (Anh, 1992).

7.3.6.7 Mangrove Food Chains and Trophic Dynamics

The complex nature of mangrove ecosystems is evident from the accounts given in sections 7.3.5 and 7.3.6 above. Some idea of the rather subtle networks which make up the food chains and food webs of mangrove ecosystems was given in section 7.3.6.1. The ecological importance of mangroves and their economic values go well beyond the obvious boundaries of these trees of the intertidal estuaries.

Even some pelagic finfish species depend on the mangrove-driven system for the resources needed to complete their life cycles. For example, many large fish species utilise the mangrove estuaries as nurseries as juveniles. In addition, they visit this environment at high tide on feeding excursions into the mangrove waterways.

Not all of the life forms which make up the complex food webs of mangrove systems have the same degree of tolerance to environmental changes. This fact is especially important in the context of oil and chemical spill management. This is a very important topic and is addressed more fully in section 7.3.6.8 below.

7.3.6.8 Mangrove Ecosystems and Environmental Vulnerability

Shallow habitats, unlike exposed high energy coastal areas, have a higher vulnerability index in relation to oil and chemical mishaps. The quiet (low energy) waterways of mangrove deltas are highly vulnerable to oil impact especially if the spills are taken into the estuarine waterways by tidal currents. In a Malaysian study of environmental vulnerability of coastal habitats in relation to oil spills, mangrove swamps had a high vulnerability index (V.I.) of 10. In contrast, open coasts with strong wave action had a V.I. of 1. Coral reefs in moderately deep water (720 feet) with a salinity of 34 ppt had a V.I. of 4-5. Mud flats, typically exposed at low tide and composed of a sandy-mud substratum are biologically rich and exposed to a variable salinity, often 20 to 30 ppt. Such habitats have a V.I. of 8-9 (Chua, 1984).

Oil spills are unlikely to occur at Cai Lan Port, which will not be shipping oil or fuel. Potential sources of oil would be limited to the ships' fuel tanks. However, it is important to emphasise that oil products in crude or fuel oil form contain a whole range of hydrocarbon compounds. Many of these can be toxic and/or lethal in the mangrove zone and in tidal estuaries. A discussion of contingency requirements regarding oil spills is given in Chapter 8. It must be noted that the existence of the B-12 oil port at the entrance to Bai Chay Bay is of considerable concern from an environmental standpoint. The large quantities of oil carried by these tankers pose a much greater risk to Bai Chay Bay than the quantities of fuel likely to be carried by ships calling at Cai Lan. The high vulnerability index of mangrove areas is an extremely important environmental consideration in the context of the Cai Lan Port Project and port and shipping operations in the adjoining bays and coastal areas.

7.3.6.9 Summary

Sections 7.3.4 to 7.3.6.8 have addressed some of the outstanding features of the mangrove ecosystem within Bai Chay Bay. Although the size and diversity of mangrove species found in this northern province of Vietnam does not match that of southern Vietnam where temperatures are consistently warmer, the biological importance of the remaining 2,000 ha of mangrove in Bai Chay Bay to a host of finfish, shellfish and crustaceae and to numerous communities of local people is immeasurable.

7.3.7 Economic Considerations

7.3.7.1 Introduction

The remaining sections of this chapter seek to show that although the absolute biological, ecological and economic values of Bai Chay Bay are difficult to define, it is possible to assign a tentative dollar value to some components and products of the mangrove ecosystem. This is rarely attempted but has been done before, for example, in the context of Bruneian finfish values (Maxwell 1991) and with the molluscs of Ha Nam Ninh Province (Duc 1993).

Mangroves have long provided economically important products. Some of these traditional uses still apply today. They include fuel exploitation (firewood), wood and charcoal production, bark extraction and tannin products, nipa palm (*Nypa fruticans*) products such as roofing materials, rice rapping, fishing floats, plant protein and alcohol manufacture, cattle fodder, fertiliser, art and craft manufacture. Specialist products include latex, fish poisons, cork and medicines such as *Acanthus ilicifolius* leaf extracts (used as a rheumatic reducing agent) and the pounded rhizome of the mangrove fern *Acrostichum aureum* (used as an antiseptic applied to wounds and boils (Hong and San 1993)).

Not all of these products are relevant to Bai Chay Bay, however, firewood exploitation is an on-going activity studied in some detail during the field surveys. The surveys form the basis of the first of two case studies presented below. The second is regarding mangrove-dwelling shellfish.

7.3.7.2 Case Study 1. The economic value of *Avicennia marina* firewood in a hamlet near Le Loi Bai Chay Bay.

(1) Basic Premises

The firewood.

Avicennia marina is a small, hardy, bonsai-like shrubby tree with yellow-white bark, olive to radiant green small leaves and small buoyant edible fruit. The sweet and sour leaves are popular and nutritious as cattle fodder. The mineral and polyphenolic content of the wood renders it mildly explosive when dry. It is an excellent and "hot" firewood, ideal for cooking.

Estimated gathering rate.

The estimated gathering rate from field observations, measurements and calculations (see Plate 6-2 A) was 50 kg per morning and afternoon session (Plate 6-2 A & B). Typically the people worked for two sessions per day. Some sessions involved walks of 3 - 6 km across sand and mud flats (Plate 6-4 B).

Charcoal equivalents.

Wood charcoal is a popular and affordable cooking fuel. Charcoal costs and quality vary. Poor quality charcoal sells for between 5,000 and 7,000 dong in the market. Local people use around 2 kg per day for cooking. Assuming 1 kg of poor quality charcoal was used in one cooking session and that two cookings took place per day we have:

(i)	cost of charcoal	= 6,000 dong /kg
(ii)	two cookings per day	= 2 kg per day
		= 14 kg per week
		= (14 x 4) 56 kg per month

The cost of cooking per month

	= 6,000 dong
x 56 kg	= 336,000 dong

At a conversion factor of dong to $US of 10,936, the value of firewood used by an average family per month is $US 30.72.

Firewood vs. charcoal.

Assuming the gathering rate described above and that fuel is fives times less efficient than charcoal, we have:

(i)	100 kg wood gathered per day	
(ii)	100 kg wood / 5	= 20 charcoal kg equivalents
		= 20 kg x 6,000 dong
		= 120,000 dong / 10,936
		= $US 10.90.

So 100 kg of *Avicennia marina* firewood is estimated to be worth $US 10.90.

Cooking with *Avicennia marina* firewood.

Having established that 5 kg of wood would equate with 1 kg of poor quality firewood we can calculate, as follows:

At 5 kg /cooking session and 2 cookings sessions per day:

= 10 kg used per day

=300 kg per month

This 30 kg wood is approximately equivalent to 56 kg of poor charcoal valued at $US 30.71 as above, or $US 368 per annum.

(2) Extrapolation of the Above

The local people do not gather mangrove firewood consistently. However, the exploitation is frequent with perhaps more activity in the winter months. Assuming a gathering season of around 5 months per year as a conservative estimate, we have:

300 kg wood per month x 5 months = 1500 kg per person .

Assuming that a village of 20 households with the average of 4 people per household (refer Chapter 3) consuming fuel at the rates described above we have:

10 kg x 20 households x 365 = 73,00 kg of wood burnt per village per annum.

At $US 10.90 per kg, this has a value of approximately $US 730.

There are 2,000 ha of mangroves in the Hoanh Binh district of Quang Ninh Province. Although the exact proportion of *Avicennia marina* is not known in relation to other species, it is reasonable to assume on the basis of the field surveys and literature such as Hong and San 1993 that the species occupies some 20-25% of the total mangrove area, or some 400 ha. If this 400 ha were to supply just two villages of 20 households (a conservative estimate) with their annual cookery needs this gives a dollar value of at least $US 1,460.

(3) Conclusions

This case study highlights the dollar value of one mangrove species simply in terms of its use as firewood. The known economic uses of mangrove are many and varied as already described. However, it is emphasised that the use of *Avicennia marina* or any other species as firewood may not be the most economically or scientifically sound use of the resource. Nevertheless, this study does show that mangroves are very important in the lives of people living around Bai Chay Bay. The case study described below, however, shows that the mangrove-dependent biota, including finfish, crustaceae and molluscs carry a far superior dollar value than firewood.

7.3.8.3 Case Study 2: The estimated economic values of the two molluscan resources in two areas of Ha Nam Ninh Province, Vietnam (after Duc 1993).

The shellfish (molluscs) for which economic values were estimated were *Meretrix meretrix* and *Mactra quadrangularis*. These occur on tidal mudflats of Kim Son and Xuan Thuy districts in Ha Nam Ninh Province.

The methods of estimation and the parameters used are shown in Table 7-3-8. The estimated dollar values are shown in Table 7-3-9.

Table 7-3-8 Harvest of the two molluscs *Meretrix* and *Mactra* in the Xuan Thay and Kim Son areas of Ha Nam, Nam Ninh Province (after Duc 1993).

Species (district)	Number of People Involved in Harvest	Tons Harvested
Meretrix		
(a. Xuan Thay	100	60
b. Kim Son)	50	30
Mactra		
(a. Xuan Thay	200	1,200
b. Kim Son)	100	360

Note: Harvest was caluculated at the rate of 10 harvest days per month over 6 months.

7.3.8.3 Deductions from the Data

The economic worth of mangrove-generated products is clearly considerable. Economic analyses involve many factors, projections and calculations and are complex to perform. Many more case studies invite attention, however, they are beyond the scope of this assessment. The two case studies given here nevertheless underline the combined ecological and economic value of the mangrove ecosystems in Bai Chay Bay and environs. The economic importance and need for sustainable management practices in these coastal environments is paramount. The fact that 10,000 people are directly involved in finfishing alone in Quang Ninh Province (refer section 3.2.2) emphasises this point.

Table 7-3-9 Estimated economic value of the *Meretrix* and *Mactra* resources in Xuan Thay and Kim Son areas of Ha Nam Ninh Province (after Duc 1993).

Points of Comparison	Meretrix		Mactra	
	Xuan Thay	Kim Son	Xuan Thay	Kim Son
Area involved (ha)	1,000	800	1,400	1,200
Shellfish density (no./m2)	0.1	0.1	40	3
Biomass (g)	140	140	20	20
Meat/mollusc ration	1:10	1:10	1:4	1:4
Total yield of area (ton)	140	112	12,200	720
Yield taken (ton)	70	56	5,600	360
Market price (dong /kg)	400	400	60	50
Economic value (million dong)	28	22.4	336	21.6
Export value ($US)				
a. meat	18,900	15,120	7,500,000	243,000
b. shell	14,175	11,340	1,890,000	60,750
c. total	33,075	26,460	9,450,000	303,750

PART II

PLANNING

CHAPTER 8 SOCIO-ECONOMIC FRAMEWORK UP TO THE YEARS 2000 AND 2010

8.1 Hinterland of Cai Lan Port

8.1.1 Conceptual Framework of Hinterland

In order to forecast the future cargo volume for Cai Lan port, the hinterland should be defined. The hinterland of each port depends on various factors such as the proximity to consumption/production center from the port, customary business practices, etc. In this section, the hinterlands of each port, especially Hai Phong Port, are considered within the following framework.

First of all, expected roles and function of each port are outlined as follows.

(1) Hai Phong Port functions as the major international port in northern Vietnam. Thus, cargo flow at Hai Phong port has a close relationship to the northern provinces. Hai Phong Port is managed by VINAMARINE.

(2) Quang Ninh Port handles mainly coal and general cargo. Most cargoes are being handled for domestic transport; general cargo has quite a low percentage in the total cargo volume. Quang Ninh Port is managed by VINAMARINE.

(3) Cam Pha Port and Hong Gai Port are handling coal for export and are managed by Cam Pha Coal Company Port and Trading Enterprise and Hong Gai Coal Co. under the Ministry of Energy.

(4) B-12 Port handles petroleum for import and is managed by PETROLIMEX (Vietnam National Petroleum Export-Import Co.) under the Ministry of Trade.

(5) Cai Lan Port is under construction as an international deep-sea port. Once this is developed cargo will be divided between Hai Phong and Cai Lan. The port will be managed by VINAMARINE.

Based on an analysis of functions and roles, the hinterland of each port is defined as follows.

(1) The hinterland of Hai Phong Port is indicated by the cargo flow at Hai Phong City as shown in Figure 8-1-1 and Table 8-1-2.

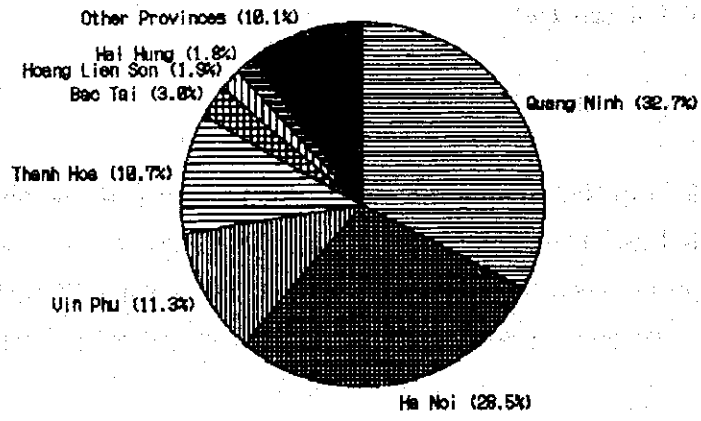


Figure 8-1-1 Inter-Provincial Cargo Flow from/to Hai Phong City (1990)

Table 8-1-1 Inter-Provincial Cargo Flow from/to Hai Phong City (1990)

Unit:1,000t

No.	Province	In	Out	Total	
1	Quang Ninh	974	332	1,306	32.73%
2	Ha Noi	138	998	1,136	28.50%
3	Vin Phu	179	271	450	11.28%
4	* Thanh Hoa	195	231	426	10.68%
5	Bac Tai	40	81	121	3.03%
6	Hoang Lien Son	21	56	77	1.93%
7	Hai Hung	12	59	71	1.78%
8	Ha Nam Ninh	15	55	70	1.75%
9	* Ho Chi Minh City	13	34	47	1.18%
10	* Binh Dinh		41	41	1.03%
11	Ha Bac	6	35	41	1.03%
12	* Khanh Hoa		39	39	0.98%
13	* Quang Nam-Da Nang	19	19	38	0.95%
14	* Nghe Tinh	4	25	29	0.73%
15	Ha Tuyen	2	24	26	0.65%
16	Thai Binh	3	22	25	0.63%
17	Ha Son Binh	9	13	22	0.55%
18	Lang Son	12	3	15	0.38%
19	* Thua Thien-Hue	2	1	3	0.08%
20	Son La	2		2	0.05%
21	* Quang Tri	1	1	2	0.05%
22	* Quang Binh		1	1	0.03%
23	* Phu Yen	1		1	0.03%
24	* Quang Ngai	1		1	0.03%
Total		1,649	2,341	3,990	100.00%

Source: 'National Transportation Sector Review' Vol II UNDP

The hinterland of Hai Pong Port includes 20 provinces of northern part of Vietnam and, with Thanh Hoa province added, totals 21 provinces.

(2) Quang Ninh Port mainly handles coal for export from the coal resources of Cam Pha town and Hong Gai town, thus its hinterland is Quang Ninh province.

(3) Cam Pha Port and Hong Gai Port handle coal for export from the coal resources of Cam Pha town and Hong Gai town, thus, their hinterland is Quang Ninh province.

(4) B-12 Port handles petroleum which is transported by pipes in four directions: Hanoi City, Hai Phong City, Hai Duong City, and Thai Binh town. Besides these destinations petroleum is transported to all provinces of the northern part of Vietnam.

(5) Based on the functions and roles of Cai Lan Port, hinterland of Cai Lan port is considered to be the same 21 provinces as Hai Phong Port. However, in view of its geographical position and transport network, Thanh Hoa province can be said to be connected to Hai Phong Port strongly, but is excluded from the hinterland of Cai Lan Port. Thus, the hinterland of Cai Lan Port consists of 13 provinces in the Northern Mountain and Midland and 7 provinces in the Red Rive Delta.

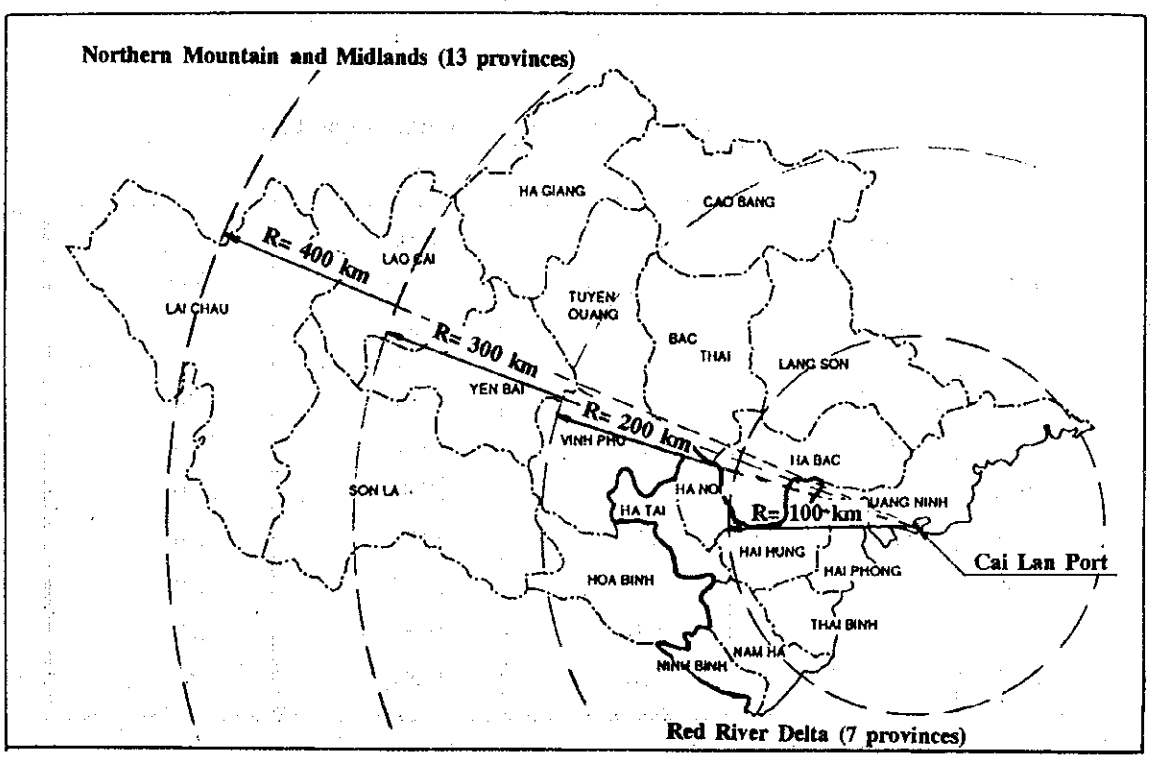


Figure 8-1-2 Hinterland of Cai Lan Port

8.2 Population

8.2.1 General

At the end of 1993, Vietnam's population had reached 70 million. If the present population growth rate (which is over 2 %) continues, Vietnam's population will double in 30 years.

The National Committee for Population and Family Planning (NCPFP) is a directory subordinate organ of the Government which has the function of state management on population and family planning. It coordinates with several ministries, other subordinate organs of the Government and popular organizations to carry out population and family planning programs nationwide.

At the 4th Session of the 7th Term of the Party's Central Committee in January 1993, a resolution on population and family planning policies was adopted. This set up a long term plan to the year 2015 with the aim of solving the issue of population size and age structure, and in fact, achieving a drastic fertility rate reduction. Table 8-2-1 shows goal-oriented demographic indicators of Vietnam's population. Figure 8-2-1 shows the population forecast for Vietnam by year.

Table 8-2-1 Goal-Oriented Demographic Indicators

Year	Population Size (Thousand)	Pop. Growth Rate	Birth Rate (thousand)	TFR
1993	71,979.5	2.14	28.91	3.70
1994	73,508.9	2.10	28.37	3.65
1995	75,028.7	2.06	27.84	3.60
2000	82,644.9	1.72	23.92	2.88
2005	89,146.2	1.40	20.34	2.39
2010	95,037.0	1.24	18.60	2.20
2015	100,859.5	1.16	17.89	2.10

Source : NCPFP

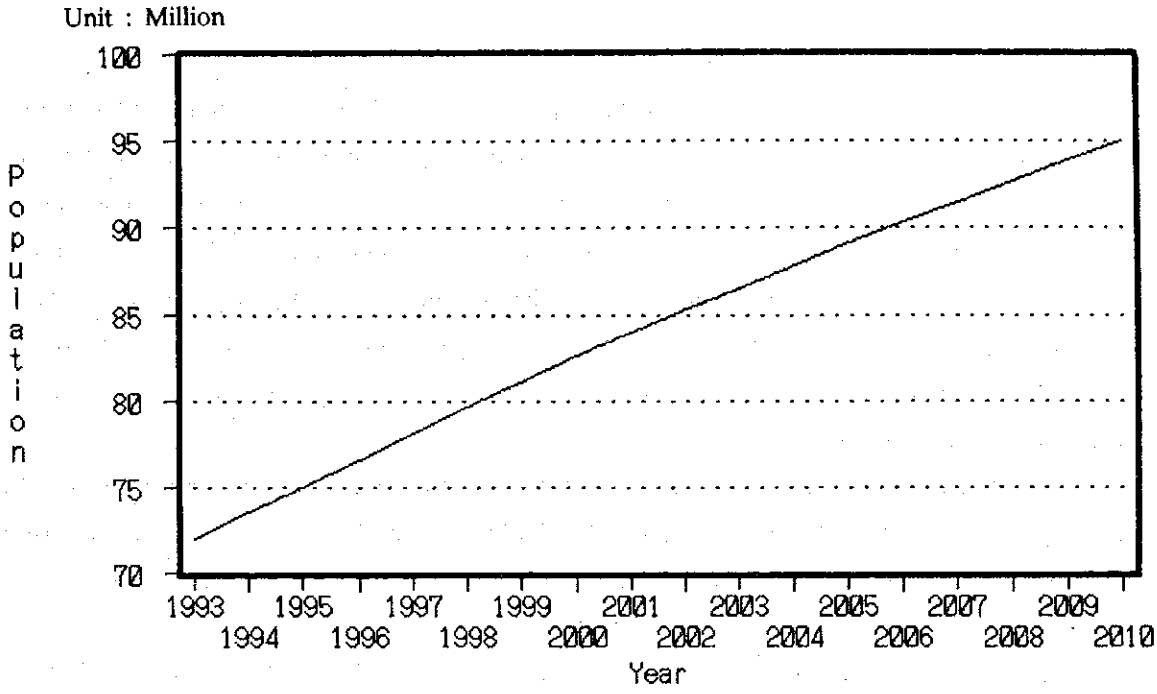


Figure 8-2-1 Population Forecast of Vietnam

8.2.2 Population forecast of each area in Vietnam

Using growth rates provided by NCPFP, the population of the hinterland is estimated in Table 8-2-2.

Table 8-2-2 Population Forecast of Each Area in Vietnam

Year	Quang Ninh Province		North mountain Midland		Red river delta		The northern of Viet Nam		Viet Nam	
	Population	Growth Rate	Population	Growth Rate	Population	Growth Rate	Population	Growth Rate	Population	Growth Rate
1986	732,000		9,691,400		12,919,200		22,610,600		61,110,000	
1989	814,100		10,731,100		12,716,200		23,447,300		62,452,000	
1990	830,900	2.1%	11,261,300	4.9%	13,024,900	2.4%	24,286,200	3.6%	66,033,000	2.5%
1991	857,500	3.2%	11,565,800	2.7%	13,266,600	1.9%	24,832,400	2.2%	67,606,000	2.4%
1992	878,800	2.5%	11,845,000	2.4%	13,546,900	2.1%	25,391,900	2.3%	69,306,000	2.5%
1993	889,600	1.2%	12,109,300	2.2%	13,808,800	1.9%	25,918,100	2.1%	70,982,500	2.5%
2000	1,036,013		14,102,283		16,081,491		30,183,774		82,665,000	1.7%
2010	1,191,067		16,212,891		18,488,316		34,701,208		95,0.7,000	1.1%

Source : General Statistical Office, NCPFP

Note : No migration to other provinces is taken into account

8.3 Basic Economic Indices

Basic economic indices like GDP, GRP, GPI or GPA are of most importance to the Study, from which demand forecast can be conducted and then the quantity and scale of facilities to be planned can be determined. Therefore, intensive study is required to determine the economic indices in target years. It is, however, true that the economic indices in the target years imply a sort of political target as well as values to be estimated through study. From this implication, it is advisable that economic indices should be advisably to be coincident with all national plans. It is preferable that the indices in this Study coincide with those of the Master Plan Study of which this study is though to be a sectorial detail.

Therefore in this Study examination of the economic indices in the future starts with referring to those of the Master Plan Study. The indices in the Master Plan Study are reviewed and compared with the latest available statistics; unless a major discrepancy is apparent, indicies of the Master Plan Study will be applied in this study.

After reviewing the future socioeconomic framework described in the Master Plan Study, no revision was deemed necessary for this Study except one item, the growth rate of regional GPI up to the year 2000. The value in the Master Plan Study is defined to be 9% which is below the targeted figure for the whole country basis announced at the 7th National Congress 1991 as seen in Table 8-3-1.

Table 8-3-1 Target Growth Rates of Major Socio-economic Indicators

Target Growth Rates (%)	1991-1995	1996-2000	1991-2000
Average GDP Growth Rate			
Option -1	5-5.5	8.0	6.9
Option -2	6-6.5	8.5	7.5
Average Growth Rate of Agricultual Output			
Option -1	3.7-4.0	4.0-4.5	4.0
Option -2	4.0-4.5	4.0-4.5	4.2
Average Growth Rate of Industrial Output			
Option -1	8.0-9.0	10.0-10.5	9.5
Option -2	10.0-11.0	14.0-15.0	12.5

Source: 7th National Congress 1991

However according to the latest statistics, the growth rate of GPI in the Northern part of Viet Nam in 1993 has already exceeded that of the whole country as shown in Table 8-3-2 and Table 8-3-3.

Table 8-3-2 Gross Products of Industry

Unit:Billion Dongs in Constant Price of 1989

	1989	1990	1991	1992	1993
Mountain and Midland	1,071,852	1,037,606	998,371	1,149,906	1,252,000
Red River Delta	2,485,323	2,691,744	2,108,161	2,376,586	2,734,000
Northern Part of Viet Nam	3,557,175	3,729,350	3,106,532	3,526,492	3,986,000
Coast of Northland	664,939	682,261	705,941	811,334	898,000
Central Coast of Southland	1,118,813	1,102,087	1,047,460	1,145,954	1,236,000
Central Highland	137,287	145,806	155,619	220,610	265,000
North East of Southland	5,795,866	6,143,936	6,987,793	8,711,722	9,756,000
Mekong River Delta	2,309,122	2,207,633	2,369,627	2,542,543	2,871,000
REV. could not be Classi.	-	-	1,098,120	1,158,240	1,288,000
TOTAL	17,140,377	17,740,423	18,577,624	21,643,387	24,286,000

*Based on 'VIETNAM INDUSTRIAL DATA 1989-1993' STATISTICAL PUBLISHING HOUSE

Table 8-3-3 Yearly Growth Rate of GPI by Region

	1990	1991	1992	1993	'89-'93
Mountain and Midland	-3.2%	-3.8%	15.2%	8.9%	4.0%
Red River Delta	8.3%	-21.7%	12.7%	15.0%	2.4%
Northern Part of Viet Nam	4.8%	-16.7%	13.5%	13.0%	-100.0%
Coast of Northland	2.6%	3.5%	14.9%	10.7%	7.8%
Central Coast of Southland	-1.5%	-5.0%	9.4%	7.9%	2.5%
Central Highland	6.2%	6.7%	41.8%	20.1%	17.9%
North East of Southland	6.0%	13.7%	24.7%	12.0%	13.9%
Mekong River Delta	-4.4%	7.3%	7.3%	12.9%	5.6%
REV. could not be Classi.					
TOTAL	3.5%	4.7%	16.5%	12.2%	9.1%

*Based on 'VIETNAM INDUSTRIAL DATA 1989-1993' STATISTICAL PUBLISHING HOUSE

Since the regional growth of GPI is the most significant index in this Study, this value was revised to 12%, which is around the value set in the frame announced at the 7th National Congress 1991. But GRP, which is the most basic index, is left intact. As a consequence the growth rate of the primary sector up to the year 2000 and the GPI growth rate after the year 2000 decrease as shown in Table 8-3-4.

The growth rate in the primary sector has fluctuated ; growth rate was quite low until the goverment introduced several incentives for the farmers to promote productivity under the economic reform policy. Following the introduction of those incentives, the growth rate increased rapidly. More recently, the growth rate has continued to climb, though more gradually, with the progress of mechanization.

Table 8-3-4 GDP by Sector (Northern Part of Viet Nam)

(Unit: Constant Price 1993 US$)

Year	GDP BY SECTOR						GRP (Mil $)
	Primary		Secondary		Tertiary		
	Mill.$	Growth Rate	Mill.$	Growth Rate	Mill.$	Growth Rate	Mill.$
1993	1,801		796		1,592		4,190
	43%	6%	19%	9%	38%	10%	
2000	2,414		1,466		3,023		7,197
	38%	5%	20%	19%	42%	14%	
2005	3,457		3,498		5,924		12,879
	27%	4%	27%	16%	46%	15%	
2010	4,206		7,461		11,667		23,334
	18%		32%		50%		

Source : The Master Plan Study on the Transport Development in the Northern Part of Viet Nam (JICA)

In conclusion the following economic indices listed in Table 8-3-5 are applied in this Study. These slightly modified figures are almost the same values as socio-economic indicators in Institute of Long-term Strategy under State Planning Committee in 1994.

Table 8-3-5 Estimated GDP by Sector(Northern Part of Viet Nam)

Year	GDP BY SECTOR						GRP	
	Primary		Secondary		Tertiary			
	Mill.$	Growth Rate	Mill.$	Growth Rate	Mill.$	Growth Rate	Mill.$	Growth Rate
1993	1,801		796		1,592		4,190	
		4%		12%		10%		8%
2000	2,414		1,760		3,023		7,197	
2001								
		5%		17%		14%		12%
2005	3,097		3,858		5,924		12,879	
2006								
		4%		15%		15%		13%
2010	3,800		7,867		11,667		23,334	

For reference, the significant values necessary in the process of determination of the economic indices applied in this Study are quoted from the Master Plan Study and listed below.

Table 8-3-6 GDP Forecast (Whole Country)

Year	GDP/Capita	Population	Population Growth Rate	GDP (Mil.$)	Growth Rate (GDP)	Remarks
1993	240	69.6	2.20%	16,704		
2000	333	80.5	2.09%	26,822	7.0%	
2005	491	88	1.80%	43,198	10.0%	
2010	732	95	1.55%	69,570	10.0%	
			Average Growth Rate (1993-2010)		8.8%	

Source : The Master Plan Study on the Transport Development in the Northern Part of Viet Nam (JICA)

Table 8-3-7 GRP Forecast of the Study Area

(Unit: Constant 1993 US$)

Year	GDP/Capita	Population	Population Growth Rate	GDP (Mil.$)	Growth Rate (GDP)	Target % of GDP per Capita to national Ave.
1993	162	25.9	2.20%	4,190		67%
2000	240	30	2.09%	7,197	8.0%	72%
2005	393	32.8	1.80%	12,879	12.3%	80%
2010	659	35.4	1.55%	23,334	12.6%	90%
			Average Growth Rate (1993-2010)		10.6%	

Source : The Master Plan Study on the Transport Development in the Northern Part of Viet Nam (JICA)

CHAPTER 9 REGIONAL DEVELOPMENT DIRECTION OF BAI CHAY BAY AREA

9.1 General

Quang Ninh province is located in the north east coastal zone of Vietnam adjacent to south China. In the strategy for general socio-economic development of Vietnam, Quang Ninh is identified as an important province
within the development triangle, Hanoi-Hai Phong-Quang Ninh.

Quang Ninh Province is endowed with many natural and industrial resources. Many agricultural and aquacultural products are consumed in Vietnam and other foreign countries. Ha Long Bay is famous for its unique scenery that attracts many domestic & foreign tourists. People also enjoy marine sports and fresh sea foods. Quang Ninh is also known as an industrial state. Coal mines, limestone mines, sand, clay and rock fields stretch along the mountain area.

Ha Long City, newly created in December, 1993, is recognizedd as the center of the developing province, therefore, a master plan is necessary. Since Cai Lan port is located and is considered as a sea transportation terminal, future regional development direction of Ha Long City should be taken into consideration.

9.2 Regional Development Direction

9.2.1 Ha Long City Master Plan

Vietnamese urban & rural planning system consists of a regional plan and an urban plan. Each People's Committee (Province) is responsible for making a master plan. Among the north Vietnamese Economic Triangle, master plans have already been drafted for Ha Noi, Hai Phong and Quang Ninh, Ha Noi and Hai Phong, only that for Ha Long city remains to be drafted.

As Ha Long city was just formed in 1993, Quang Ninh People's Committee (the Province) requested the National Institute for Urban & Rural Planning , Ministry of Construction to make a master plan of Ha Long city. The institute is conducting the master plan over a period of 2 years. The results of the 1st year that include development direction of urbanization and industry, were discussed with the related ministries and organizations, and submitted to the province. The Province submitted it to the prime minister in March, 1994. The whole master

plan will be completed by 1995.

Generally, we have followed the master plan, because the results of the 1st stage of the master plan were already approved by the Province.

However we have modified some parts of the master plan. Around Cai Lan Port, the master plan roughly allocates port and port related land use. We specifically propose three alternative land use plans, because we have to arrange many port related industries that are willing to be located near the port. We change the location of cement factories and add the fertilizer factory based on recent information from related organizations. And we eliminate the industrial road that passes through the Bai Chay Bay Area to prevent environmental impact to Bai Chay Bay. The detailed description is as follows.

1. Land Use Around Cai Lan Port:

(The Ha Long City Master Plan = M/P, see Figure 9-2-1)
Cai Lan Port (expansion)

Scale: 150 - 300 ha

Location: North east area of Bai Chay Peninsula

Capacity: 20 - 30 million tons (year 2010)

Cai Lan Export Processing Zone - CLEPZ (newly developed)

Scale: 100 ha

Location: Between Cai Lan Port and the brick factory

Ha Long Shipyard (expansion)

Scale: 40 - 60 ha

Location: Adjacent to the Gieng Day Brick Field

Capacity: 10000 DWT, 1-5 vessels/year

(Our Suggestion)

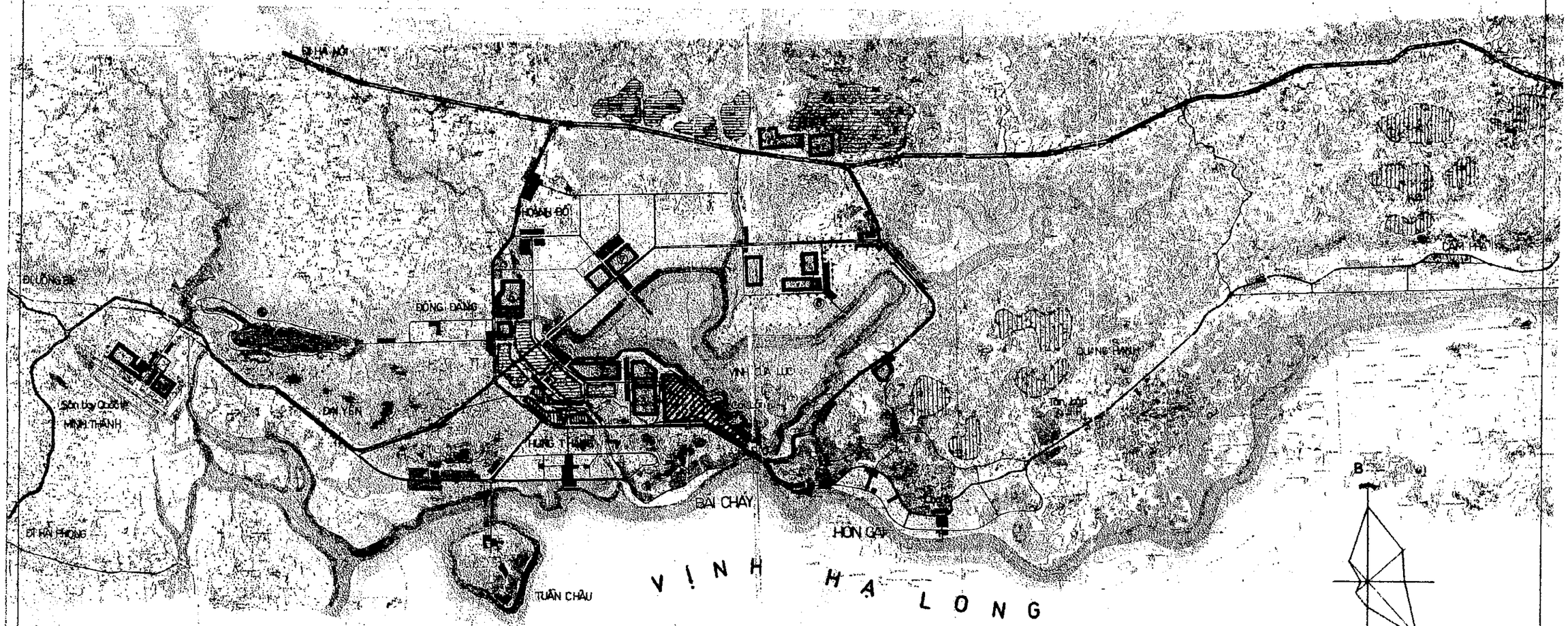
Cai Lan Port: In the 1st stage (by the year 2000) Cai Lan Port will expand from the existing berth to the Cua Luc Strait. And by the year 2010, the port will expand to the west along the Bai Chay coast. The scale of the port is around 300 ha.

CLEPZ: Since Cai Lan Port will accommodate large vessels including container ship, more port-oriented industries are eager to select CLEPZ. So the necessary scale for these industries must be no less than 120 ha.

Figure 9-2-1 Ha Long City Master Plan

HA LONG CITY

MAP FOR ORIENTATION OF SPACIAL DEVELOPMENT STAGE 1994 - 2010



LEGEND

- PRESENT RESIDENTIAL LAND
- EXPECTED RESIDENTIAL LAND
- CENTRAL LAND
- TOURIST LAND
- PRESENT INDUSTRIAL LAND
- EXPECTED INDUSTRIAL LAND
- HABOUR LAND, BERTH, WAREHOUSE
- COAL MINE
- LIME MOUNTAIN MINE
- CLAY FIELD
- TREE FOR ENVIRONMENTAL PROTECTI
- PLANTING AND RECLAMATION LAN
- HIGH WAY
- ROAD FOR INDUSTRY
- CITY ROAD, TOURIST ROAD
- WATER SURFACE

NOTE

1. CAILAN PORT 300 HA
2. HALONG SHIP MANUFACTURING FACTORY 60 HA
3. EPZ 100 HA
4. GIENG DAY BRICK PLANT
5. CEMENT PLANT
6. CENTRALIZED INDUSTRIAL ZONE 100 HA
7. HIGH TECHNICAL INDUSTRIAL ZONE 300 HA
8. HABOUR ZONE FOR CEMENT EXPORT
9. HA LONG STATION
10. CUA LUC HANGING BRIDGE

THE DOCUMENT IS BEING USED IN THE STUDY PROCESS

THÀNH PHỐ HẠ LONG TỈNH QUẢNG NINH		BỘ XÂY DỰNG VIỆN QUI HOẠCH ĐÔ THỊ-NÔNG THÔN	
SƠ ĐỒ ĐỊNH HƯỚNG PTRIỂN KHÔNG GIAN GIAI ĐOẠN (1994-2010)		Thể hiện	Lê Tuấn Kiệt	
		Thiết kế	Ngô trung Hải	
MẶT BẰNG TỔNG THỂ		Chủ nhiệm	Ngô trung Hải	
		Trưởng phòng	Ngô trung Hải	
TỈ lệ SCALE 1/50.000	Ngày hoàn thành Finish Date 25-2-1994	Số bản vẽ 01	QL kỹ thuật	Phạm văn Nghị	
			Phiên trưởng	Ngô đình Trí	

Shipyard: The scale of the expanded shipyard is 32 ha. The expansion space for the shipyard is restricted, because the shipyard is surrounded by 2 brick factories and CLEPZ. The capacity of the shipyard should be increased to 50000 DWT, the maximum ship-size calling Cai Lan Port.

Other Land Use: A steel billet factory and a wheat mill factory that are closely related to the port, have been preparing feasibility studies in that area. Environmental impact by the steel billet factory is slight. Water, volume is 160m^3 per day, is used mainly for cooling, and dust is also cut by dust cleaning machine. Environmental impact by the wheat mill factory is also slight. Water is used for cooling and the volume is 40m^3 per day. In conclusion these factories are suitable to be located in the Bai Chay Bay Area.

2. Cement Industry:

(M/P)

By the year 2010, 5-7 cement factories will be located in the north of the Route 18B near the limestone mines. The total capacity is 7-10 million tons/year. Port facilities for these factories will be constructed along the north east coast of Bai Chay Bay.

(Our Suggestion)

Based on the recent survey of the Vietnam Cement Corporation, three cement factories are planned to be located around the Bai Chay Bay Area. Among these, two Joint Venture Companies have almost finished feasibility studies on cement factories. We have assumed that one cement factory will start production by the year 2000 and the other by 2010. Port facilities for cement export are also allocated based on the feasibility study made by TEDI.

3. Road System :

(M/P)

Route 18A (southern route) and 18B (northern route) will be graded up to express way. Cement factories, Cai Lan Port, port related industries and Hon Gai Town are connected by the ring road - new industrial roads.

(Our Suggestion)

Rather than constructing new roads, we have decided to upgrade the existing roads as much as possible. We plan an industrial road only for the port related industries around Cai Lan port. The heavy traffic on the new ring road will possibly impact air and noise levels

around Bai Chay Bay Area. It will also impact the mangrove forest in the northern Bai Chay Bay.

9.2.2 Future Characteristics of the Region

(1) Future Roles

According to the Ha Long City Master Plan, the city including Bai Chay bay area in its core will soon play an important role in Quang Ninh and within the development triangle. The city will have the following characteristics.

1. Be the provincial city - the political, economic, cultural center of Quang Ninh province.
2. Be a domestic and international tourist center.
3. Be the transport terminal for the area, especially with the deep sea port of Cai Lan.
4. Be the main commercial and service center of the area.

(2) Estimated scale and population of the city

Based on the master plan Ha Long city will expand three times by the year 2010. In the 1st stage (1994-2000) Hon Gai town, base of Ha Long city will annex two communes, Viet Hung and Dai Yen. In the 2nd stage, the city will include the whole Bai Chay bay area. And in the 3rd stage, the city will annex Cam Pha town (see Figure 9-2-2).

The forecast future population in the master plan considers natural increase, mechanical increase (labor demands for new industries) and increase due to expansion of the city.

Table 9-2-1 Estimated population and area

Planned figures	Stages		
	- 2000	2000 - 2010	2010 -
1 Total land	221.2 km^2	354.5	842
of which			
a. Urban	98.5 km^2	175.0	578.45
b. Suburban	22.7 km^2	197.5	263.55
2. Population	230,000 pers.	460,000	650,000
of which			
a. Urban	210,000 pers.	390,000	565,000
b. Suburban	20,000 pers.	70,000	85,000

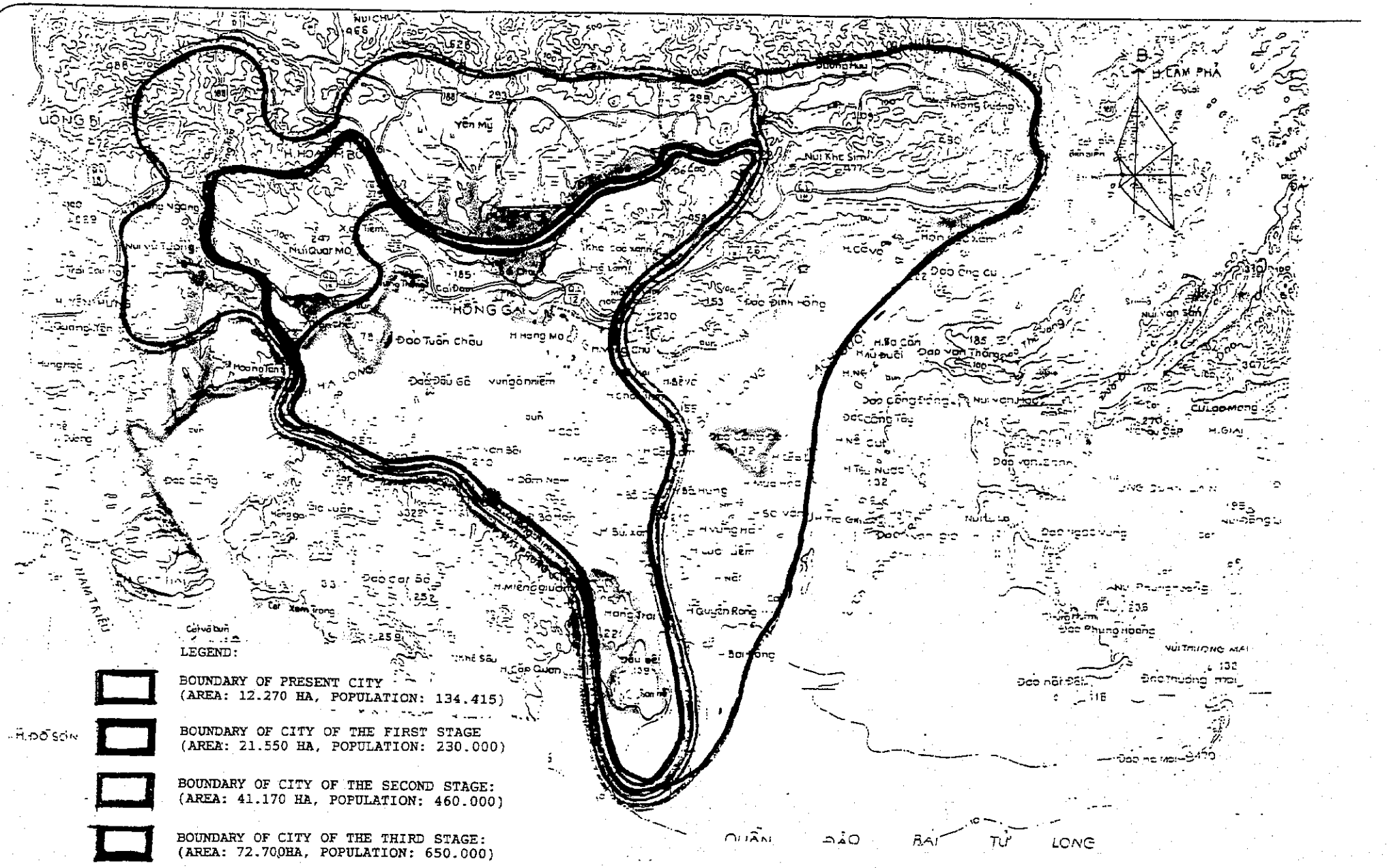


Figure 9-2-2 Ha Long City Boundary By Stage

9.2.3 Regional Development Direction

(1) Location of Bai Chay Bay Area in Quang Ninh Province

As a result of our survey on Quang Ninh Province, industrial zones will extend from Dong Trieu to Cam Pha by the year 2010. Cement and sand factories are located in Dong Trieu, coal and stone factories in Uong Bi, cement and brick factories in Bai Chay, coal in Hon Gai and coal, stone, electric power plant and electric-oriented industries (ex. aluminum smelting factory) in Cam Pha. Tourism area will expand from Bai Chay beach to Ha Long Bay, Tuan Chau island and Yen Lap lake. Fisheries extend from Yen Hung district to Co To island. Ha Long Bay is well-known for its good fishery industry.

Bai Chay Bay is located at the center of future industrial zones,
but simultaneously is located close to the tourism area. Transportation modes - road, railway and maritime transportation, also concentrate around Bai Chay Bay. To prevent harmful environmental effects to the tourism area, industries around Bai Chay Bay area should be non-polluting as much as possible.

Factories or facilities, whether existing or planned, that could potentially pollute water or air, have to be moved from the Bai Chay Bay area. These industries can be concentrated at a place far from the tourism area, for example Cam Pha town (see Figure 9-2-3).

(2) Land Use Direction Around Bai Chay Bay

The Ha Long City Master Plan, which is defined as the starting point for the general layout and initiations for establishment of industrial zones, important transportation terminals, main projects and also projects of priority, identifies the direction of space development. We determined regional development direction based on that of the master plan but modified in some part as follows (see Figure 9-2-4).

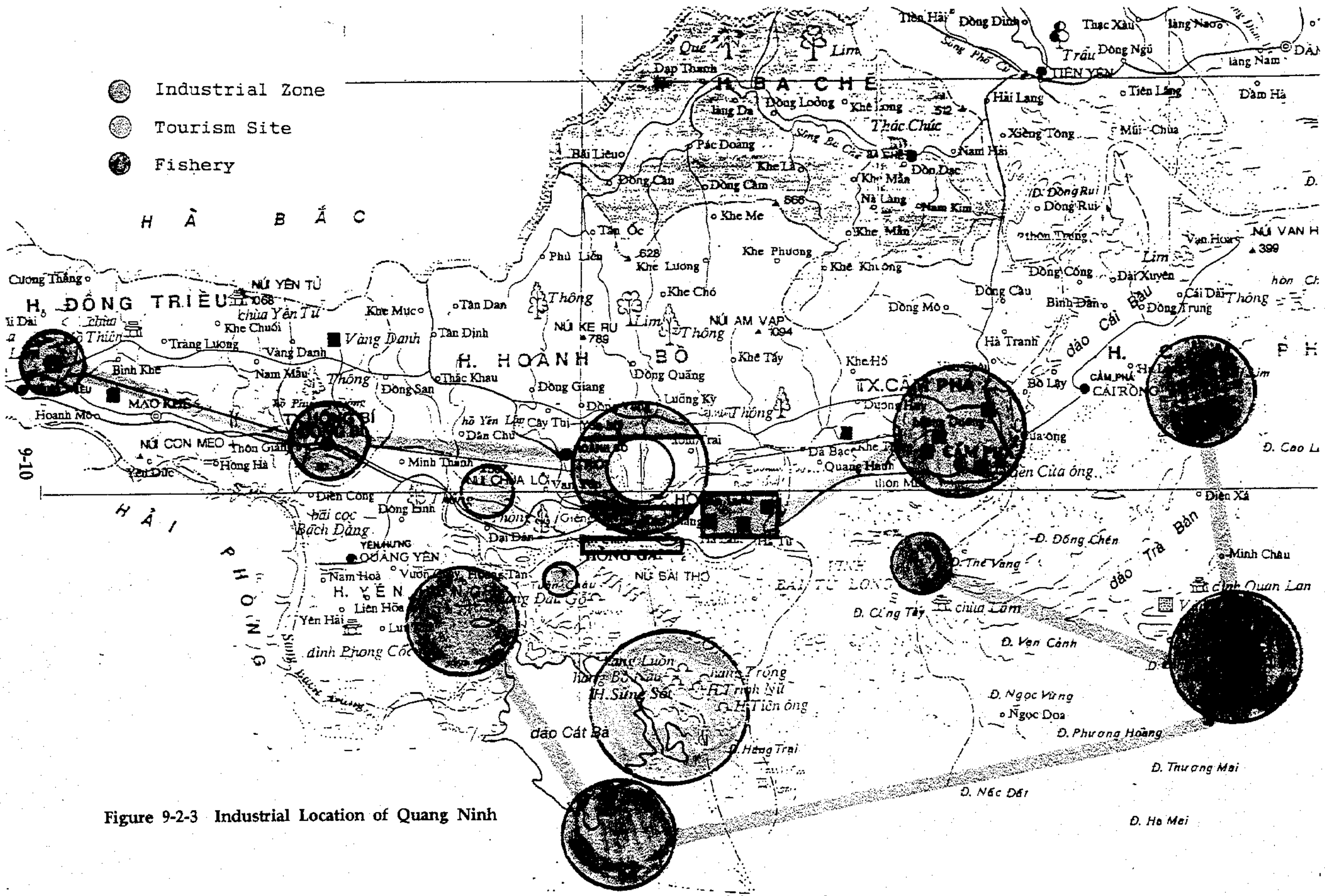


Figure 9-2-3 Industrial Location of Quang Ninh

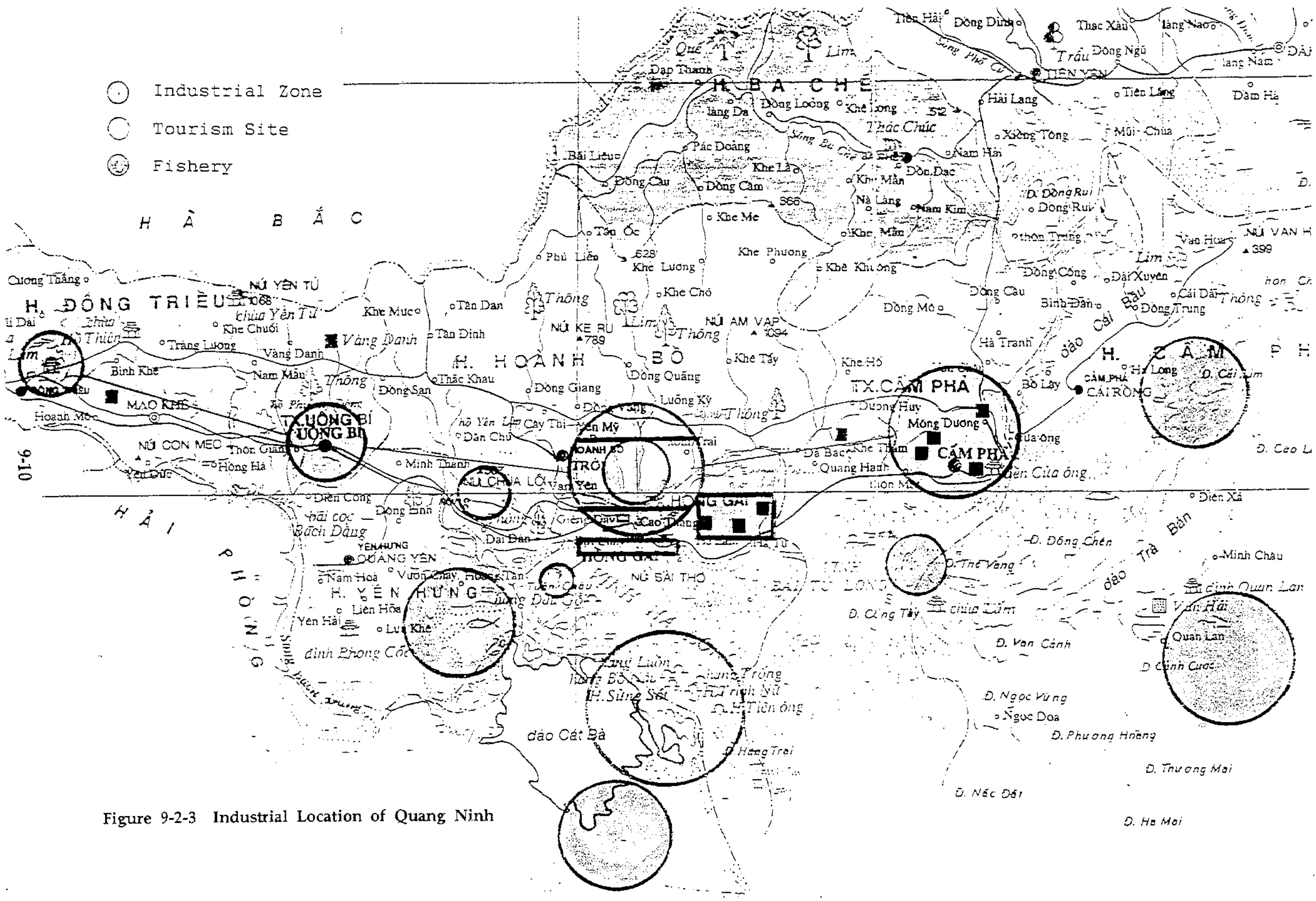


Figure 9-2-3 Industrial Location of Quang Ninh

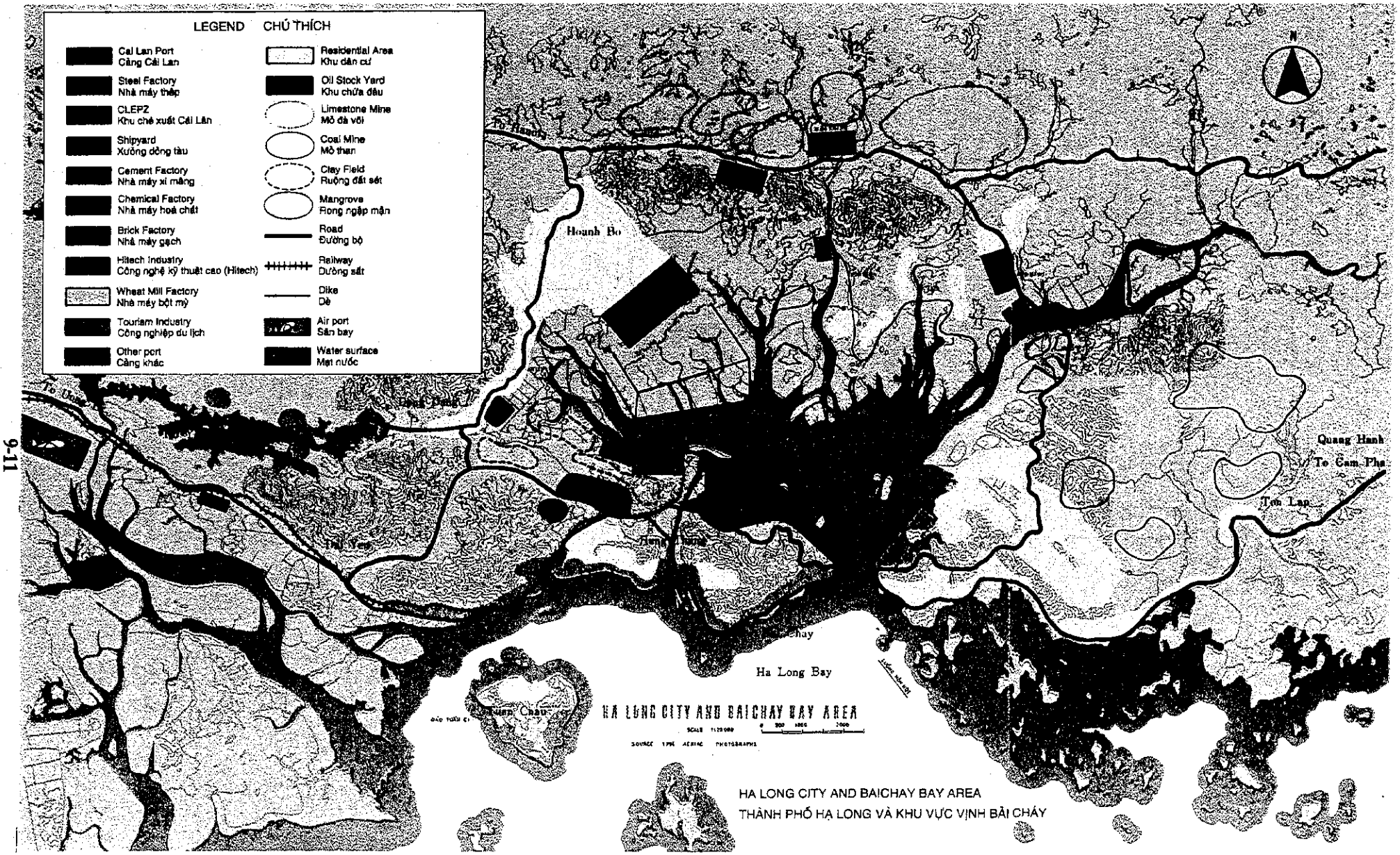
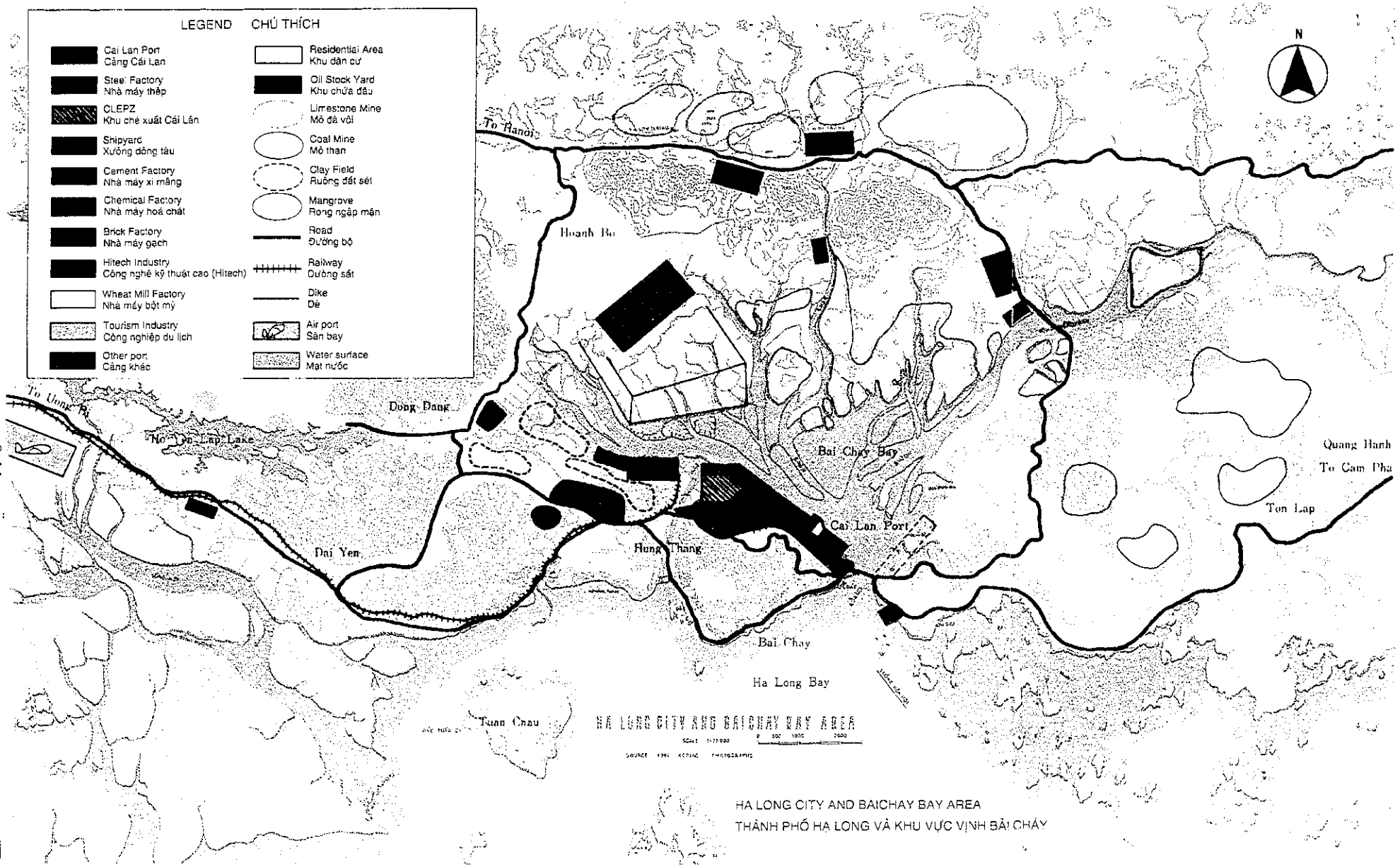


Figure 9-2-4 Regional Development Direction

(- 2010)



HA LONG CITY AND BAICHAY BAY AREA
THÀNH PHỐ HẠ LONG VÀ KHU VỰC VỊNH BÁI CHÁY

Figure 9-2-4 Regional Development Direction
(- 2010)

1. Within Bai Chay Bay Area

(M/P)

Generally only non-polluting industries should be located along Bai Chay Bay Area, for example high-tech industry. Cement industry and brick industry must inevitably be located in the area because these industries have to be close to mines. Existing environmentally polluting facilities, B-12 oil berth, Hon Gai coal handling port and coal screening factory will be removed by the year 2010. Industries in the Cai Lan Export Processing Zone should also be non-polluting.

(Our Suggestion)

Since Bai Chay Bay is a closed water area and is adjacent to the famous tourism area, Ha Long Bay, non-polluting industries are the most suitable for the Bai Chay Bay area. However we have decided to allocate two factories (one steel billet factory and one wheat mill factory) in the area. These industries are closely related to the port and environmental impact is relatively small. Moreover, products (steel billet & flour powder) and wastes (slag-material of blast furnace slag cement) from the factories are indispensable for the future development of Ha Long City.

The location of the wheat mill factory is not yet specified. Two alternative locations are presented.

Alternative 1: In the CLEPZ

Advantage: Privileges from EPZ system (tax exemption, infrastructure)

Disadvantage: Completion year of CLEPZ is uncertain. The production starting year will be late.

Alternative 2 : In the Cai Lan port

Advantage: The Vietnam Central Food Corporation (VINAFOOD1) already has land behind the existing berth.

Disadvantage: The wheat mill factory will interfere with other port activities.

As for the existing polluting facilities, B-12 oil berth, Hon Gai & Sa To coal port that are located within Bai Chay Bay and coal screening factories of Hon Gai, we agree that they should be removed. These facilities should be concentrated in Cam Pha.

There is a large agricultural zone (300 ha) in Bai Chay Bay, consisting of a shrimp-breeding swamp, rice field and mangrove plants. Since this area will be kept for some time, future industries should avoid water contamination.

Around Bai Chay Bay, many fisheries and aquacultural areas are located and many food-processing industries will be located either within CLEPZ or near Cai Lan Port in the future. Thus Bai Chay Bay will become the center of the agriculture industry.

2. Area Outside Bai Chay Bay

(M/P)

Other industries, especially water/air polluting industries will be constructed outside the Bai Chay Bay area. Minh Thanh Airport will be located along Route 18A, west of Bai Chay. Thermal power plant and coal screening factory will be located in Cam Pha Town.

(Our Suggestion)

Besides the above, we propose that one fertilizer factory is located near Minh Thanh Airport.

3. Bai Chay Beach & Ha Long Bay

(M/P)

Tourism area will expand along Bai Chay beach. Tuan Chau Island and Yen Lap Lake will be exploited by the year 2010.

(Our Suggestion)

After removal of Sa To and Hon Gai coal handling port facilities, the character of these ports will change. Hon Gai port will become a tourist port, and include a berth for passenger ship and marina for marine sports. Sa To port is reserved for the near future expansion of Cai Lan Port.

(3) Transportation

As for the transportation system, the general development direction of Bai Chay bay area is described in the Master Plan on the Transport Development in the Northern Part (Transport Master Plan). We have followed the general direction of this Plan.

1.Road :

Based on the Transport Master Plan, the estimated daily traffic volume of Route 18 is 10.4 thousand (year 2000), and 29.1 thousand (year 2010).

Part of Route 18 (Hon Gai -Chi Linh) will be up-graded to a four-lane road by the year 2000. The remainder of Route 18 (Chi Linh - Route 1) will be upgraded to four-lane road after 2000. Another alternative route to Ha Noi by way of Hai Phong, Route 18 - Route 10 - Ha Noi Outer

Ring (highway), will also be available by the year 2010.

In the Bai Chay Bay area, Route 18A will be upgraded by 2000, Route 18B and connection road between 18A and 18B will be up-graded by 2010. On the Cua Luc strait the new hanging bridge (Bai Chay Bridge) will be constructed. Bai Chay Bay will be connected by the ring road by the year 2000.

2. Railway :

Based on the Transport Master Plan, the cargo demand on Ha Noi - Cai Lan line is 351 thousand tons by 2000, and 902 thousand tons by 2010. Since the railway track between Ha Noi and Cai Lan has a standard gauge, it is suitable for double-decker loading of container. Improvement of facilities and tracks will be completed by 2005. Railway to the Ha Long station is extended to the port. Generally the railway extends parallel to the industrial road and also serve port related industries.

3. Airport:

To promote future tourism industry and economic activities, airport will be located at Minh Thanh by the year 2010. The airport is located inland to avoid environmental effects (noise and water discharges) on Ha Long bay and Ha Long city. The runway is 2500 m.

(4) Regional Development by Stage

Based on the master plan, Ha Long City will extend its boundary three times by the year 2010. By the year 2000 the city will annex Viet Hung and Dai Yen. By the year 2010 it will annex northern Bai Chay bay area. At last it will annex most of Cam Pha town. After annexation of the commune, urban development will start in that area. Direction of city extension coincides with that of urban development.

Based on the master plan and our survey we propose the stage plan. Cai Lan Port will be constructed in each stage. During the 1st stage, berths and related port facilities for the cement factoriy, the steel billet factory, the wheat mill factory, fertilizer factory have priority. Access roads and railway will be completed in this stage. Berths for other industries and general cargo for daily consumption will be constructed during the 2nd stage. In the last stage, Cai Lan Port will expand out of Bai Chay Peninsula.

1. *Stage 1* (by 2000)

- Development of the industrial zone of Gieng Day (brick & tile)
- Construction of Cai Lan port (1st stage)

7 berths, cargo handling equipment, access road, stock-yard
dredging, supply facilities (water, electricity),

- Expansion of Ha Long Shipyard
- Following projects are completed within this stage :

One cement factory (Lang Bang),including private port
Wheat mill factory
Steel billet factory
Fertilizer factory
Grade up of route 18 (4 lanes, Hong Gai-Chi Linh)
Railway extension
Cam Pha port expansion (available for 50,000 DWT ship)
Tourism development (4-5 major hotels in Bai Chay)
Residential Area Development

2. *Stage 2* (2000 - 2010)

- Development of the CLEPZ, industrial zone of Dong Dang and High-tech Industrial Zone.
- Construction of Cai Lan port (2nd stage)
- Following projects are completed within this stage :

2 cement factories (Ha Long, Hoanh Bo)
Grade up of route 18 (4 lanes, Chi Linh-Route 1, Hon Gai- Lang Son, connection road between 18A and 18B, industrial road, Bai Chay bridge)
Railway (Direct railway to Ha Noi)
Removal of B-12 to Cam Pha or outer Ha Long Bay
Hon Gai port redevelopment (over 20000 GT passenger ship available, marina)
Water supply and sewage system finish
New electric power plant (Cam Pha)
Tourism development (Tuan Chau island, Yen Lap lake)

- Development of Troi-Le Loi residential area

3. *Stage 3* (after 2010)

- Development of Cai Lan Port (3rd stage)

port will expand from Cai Lan area to Giapkhau area

- Development of new residential area
- Development of tourism area (expand to eastern Hon Gai)
- Minh Thanh airport