

THE MAIN ENVIRONMENTAL ISSUES NEEDED TO BE GREATLY CONCERNED IN SETTING UP A MASTER PLAN OF SOCIO-ECONOMIC DEVELOPMENT FOR THE RED RIVER DELTA REGION

Prepared by Le Trinh, SEA Consultant

Based on the data/information collected from various national research institutes and the Provincial People Committees (PCs), the main environmental conditions at the Red River Delta plus Quangninh province (hereafter: the project area or the Red River Delta) are summarized as follows.

1. MAIN CHARACTERISTICS OF THE PHYSICAL ENVIRONMENT

1.1. Geographic Location

The project area covers 12 provinces and cities, namely: Phutho, Vinhphuc, Hanoi, Bacninh, Hanam, Ninhbinh, Namdinh, Hungyen, Haiduong, Thaibinh, Haiphong and Quangninh, of which 10 provinces, excepted for Quangning and Phutho provinces, are located in the Red River Delta.

In general, the project area borders with:

- China in the Northeast with the border line of 132.8 km (in districts of Binhlieu, Haiha and Mongcai town of Quangninh province);
- Provinces of Yenbai, Thainguyen, Bacgiang and Langson in the North-Northwest;
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Figure Error! No text of specified style in document.. Coverage of the Red River Delta Region

- Provinces of Hoabinh and Thanhhoa in the West – Southwest;

- The East Sea in the East and Southeast with the coast line of 425 km (from Haihoa commune, Mongcai town in Quangninh province to the Tong estuary at Kimhai commune, Kimson district in Ninhbinh province).

In the project area there are 2 mountainous provinces, (Quangninh, Phutho in the Northwest and Northeast regions of Vietnam). There are 5 coastal provinces (Quangninh, Haiphong, Thaibinh, Namdinh and Ninhbinh). The location of the Project area is shown in *Figure 1*

1.2. Topography

Topography is a critical factor influencing on climate, hydrology and economic development. An outline of topography of the project area is given below.

In general, the terrain can be divided into 4 zones (*Figure 2*).

- The mountainous midland of Quangninh, Phutho, Vinhphuc provinces and the North of Hanoi City.
- The plain formed by the Red and Thaibinh rivers system
- The coast extending from Mongcai (Quangninh) to Kimson (Ninhbinh);
- Islands mostly in Quangninh and Haiphong.

Characteristics of each zone are as follows

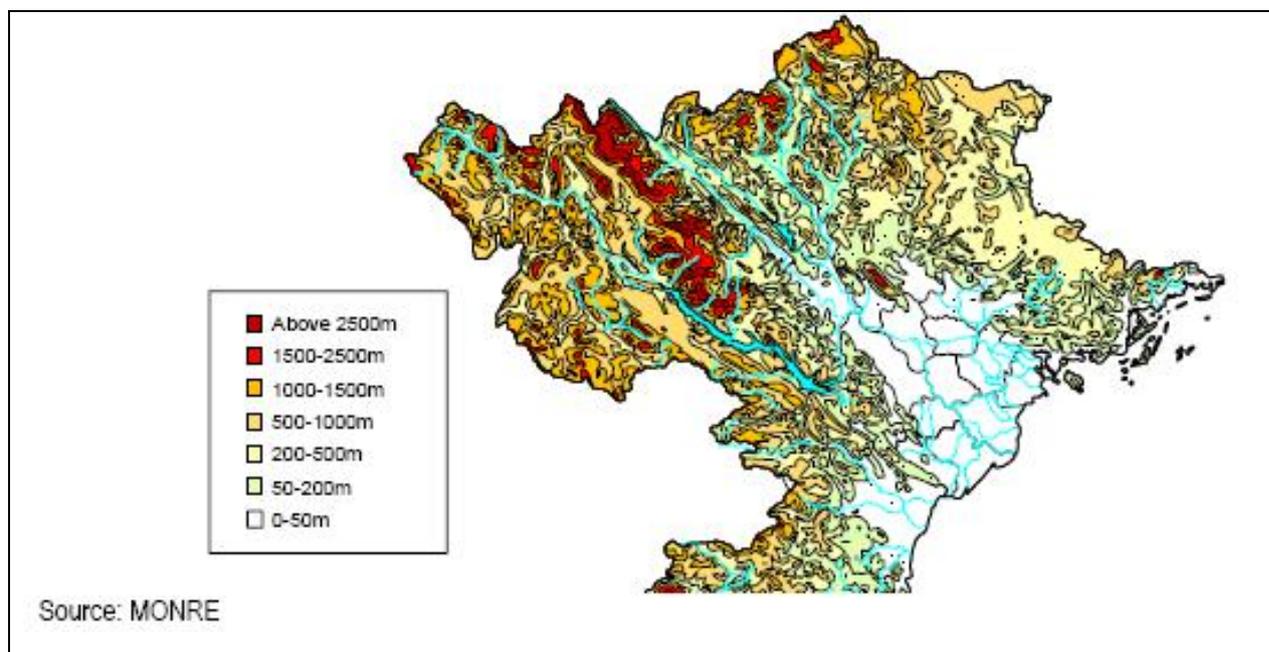


Figure 2. Topography of the Northern Vietnam

(detailed map will be made by DSI)

1.2.1. Mountainous and Midland Area

- Quangninh province

Low hills and mountains cover more than 90% of the land surface of the whole Quangninh province. Dongtrieu mountains, consisting of Nammau and Binhlieu ranges have some peaks of 500- over 1,500 m (above the sea level -ASL)). Mounts higher than 1.000 m include Caoxiem (1,330m), Chaulinh (1,507m). The common altitude in the Southwest is 200-500m with some mounts higher than 1,000 m such as Yentu (1,063 m), Amvap (1,094 m). The range of low hills of Southern Dongtrieu – Mongduong, the largest coal reservoir in Vietnam, is located at altitudes of between 200-400m. From Campha town to Mongcai town there are many mounts higher than 1,000 m. The terrain there is strongly cut with abrupt slopes, narrow valleys and limited visibility.

- **Phutho province**

This province is located in the buffer zone between the Hoanglienson range at the West and the midland area in the center of the province. Total area of mountains and hills occupies over 64% of the provincial area. The province may be divided into 3 district zones: the Southwest Mountainous Zone with an elevation of 200 – 500m (ASL), the Midland Zone with an elevation of 50 – 200m and the Plain Zone with an elevation of under 50m. Each zone occupies about 30 -40% of the provincial area.

- **Vinhphuc province**

Over 50% of the provincial area is located in the plain of the Red River Delta. At the North and Northeast of the province there are Tamdao mountain with the highest peak of 1,591m. Tamdao mountain included the surrounding area is a National Park of Vietnam.

- **Hanoi City**

Hanoi City has a mountainous zone at the Northwest and West, occupying about 30% of the city area. In this zone the highest peaks is Bavi (1,282m) at the Southwest there are a number of limestone mountains. At the East and Southeast of the city there is a wide plain of the Red River Delta. This plain zone occupies over 70% of the city area.

1.2.2. Plain Area

- **Red River Delta**

The topography of the whole zone is relatively flat, slightly sloping to the sea in the NW-SE direction. The general altitude is low, about 2-3 m from Hungyen to the South and 1-2 m in Thaibinh and Ninhbinh. The frequently flooded regions in Hanam, Namdinh and Ninhbinh have altitudes 0.6 to 1m only. The inland is dissected by dikes along the Red river and its branches into independent segments with coastwise stretches of sandy dunes. In the West of Ninhbinh and Hanam provinces there are many low mountains of 50-500 m in height, and particularly, many limestone mountains scattering from Nhoquan (Ninhbinh) to Kimbang (Hanam).

- **Thaibinh River Delta**

An overall characteristic of this zone is its limited alluvium with many hills of 100 m in both sides of the Kinhthay and the Dabac rivers. In the vicinity of the sea there are Voi mountain (137 m), Doson mountain (125m), Phulien mountain (115m) and numerous hills of 50-60m in Kinhmon district. Many mounds and knolls are scattering along the Thaibinh river, from Phalai to Kienan. The altitude of the coastal area, particularly the regions in the Southeast, is at most 0.5m.

- **Coastal plain of Quangninh Province**

Consolidated by old and recent alluvium, the coastal plain from Yenhung district to Mongcai town is small and dissected by mountains and hills. The stretches of plains are located along National Roads 18 and 4, from Tienyen to Haininh with the largest width no more than 10 km. Particularly, warped by alluvia of the Thaibinh river, the plain in Yenhung district is wider. Continuation of the plains toward to sea are wetlands.

1.2.3. Coastal area from Mongcai to Kimson

From Mongcai to Yenlao is a section of numerous tidal mud flats with the largest one covering up the whole area of 120 km² of Cualuc. The total area of tidal wetlands in Quangninh is 282.270 ha, of which vegetation covers 27,131 ha. Mangrove forests develop in many layers along coastlines and islands in the gulf, mostly in the coastal area of Campha town, Cualuc gulf and Yenhung district. Particularly, in the section of Traco, which is not protected by any islands, wind and wave are strong; the coast is constituted of long and wide sand beaches.

In the section from Cuaong to Yenhung, hills and mountains are close to the sea and the coast is eroded. From Yenlao to Lachtuong is a section of low and muddy coast. In the South of Doson and in the coast of Thaibinh, as a result of sedimentation by alluvia from the Red river, there are many shielding island with many emerging sandy dunes that change flow directions. Tidal mud flats from dikes inwards are narrowed and there are less mangrove forests. From the Balat estuary (the Red river) to the estuary of the Thaibinh river, there are two attentive kinds of coast as follows:

- **Eroded coast**

The coast from Thuyxuan to the North of the Diemdien estuary and the section from Donglong to Cualan are eroded by waves and flows that go over sand dunes to approach the coasts. At the same time, the rivers of Diemho and Cualan are used for discharging water and therefore also short of supplementary materials. Erosion also occurs in the East side of Vanh islet (Balat estuary), Den islet (Traly estuary). The eroded materials are pushed Northwardly (following the flow of summer coastal alluvia), making sane dunes in parallel with the coastline extension and elevate.

- **Alluvial coast**

This is seen in the sections from Diemdien to the Traly estuary, the North of the Balat estuary and the South of the Thaibinh estuary. The strong alluviation is resulted from the combination of rivers, the sea and halophytic vegetation with the shield of estuarine bars and islets such as Den, Vanh and Thu.

1.2.4. Islands

Islands have an important role in the development of tourism, fishery, marine transport and natural reservation.

There are thousands islands and islets in the inshore and offshore of Quangninh and Haiphong. They form a bow in parallel with Dongtrieu range. A major part of islands and archipelagos scatter in Halong Bay (amid Hongai and Catba Island) and Baitulong Bay (amid Hatu and Caibau Island). There are many inshore big islands such as Caibau, Caichien and Vinhthuc. At the distance of 20 to 40 km from the coastline are islands such as Ngocvung and Traban, etc. The front line is Coto archipelago, which includes big islands such as Coto, Tran, Thanhlan, Thuongmai, Hamai, etc. The

common altitude of mounts on islands is 100m. The highest mounts include Nangtien on Traban Island (445m), Vanhoa on Caibau Island (399m). That is an area of old wet limestone, a typical caster zone with abrupt rock mountains with numerous caverns, etc. A minor part of islands is earth island (including Tuanchau, Reu, Ngocvung) with structures of schist, silica sandstone, and red-yellow ferralite soil like earth in low hills. Halong Bay has been declared by UNESCO as a *World Heritage*.

About 20 km from the coast of Haiphong there is Catba island (about 150 km²) with many beaches, caverns and natural forest of over 13,000 ha, and numerous islets in the surrounding offshore.

Recently, a major part of Catba island and the surrounding water is recognized by UNESCO as a *World Biosphere Reserve*.

At the distance of 12 m from Catba island in the Southeast is Longchau archipelago, about 70 km from which is Bachlongvy Island, located in the middle of the Tonkin Bay.

1.3. Soils

10 main groups of soils include sandy soil, saline soil, acid sulphate soil, alluvial soil etc. Each group includes many classes (22 in total). The distribution of soil groups is shown in the soil map given in *Figure 3*. Pedologic properties directly cause not only influence on cultivation, construction of roads and houses but also environmental impacts, particularly impacts on the ecosystems, quality of water used for living, aquaculture and cultivation.

1.3.1. Ferralitic soil

- Red-yellow ferralitic soil of low hills is distributed in mountainous areas lower than 700m, in valleys of the Red river, the Da river, plains with monad rocks, in the South of Quangninh and provinces of Vinhphuc and Phutho. This soil can hold water; it is acidic and not lateralized.
- Ferralitic soil in grasslands of Hoangbo district, the West of districts of Tienyen, Haiha, Binhlieu. This kind of soil was formed after the vegetation covers there were destroyed.
- Red-yellow ferralitic soil with humus on mountains is distributed in mountainous areas higher than 700m at some places in Quangninh, Vinhphuc, and Hanoi City. The soil has thick rotten-leave and humus covers.

1.3.2. Alluvial soil

- Inside dike alluvial soil is originated from alluvia of the Red River and the Thaibinh River. At present, with the presence of anti-flood dikes, it is no longer alluviation.
- Outside dike alluvial soil is distributed alongside the Red River, the Thaibinh River and its branches. It is more or less flooded and warped annually.

Coastal alluvial soil is mainly distributed in the coastal plans of Quangninh, Haiphong, Thaibinh, Namdinh and Ninhbinh provinces.

Figure 3: Soil Map of the Red River Delta
(to be added by DSI)

1.3.3. Saline soil

- Saline soil is mostly distributed in areas adjacent to coastlines, islands, and dikes. It suffers tidal influences. Inside dike saline soil is usually more saline and dry when not inundated by tidal water. Outside dike saline soil is found in alluvial warps.

1.3.4. Acid sulfate soil

- Saline acidic soil is distributed in low areas, which suffer influences of both sea water and river water. This kind of soil strongly develops in the estuaries of the Thaibinh river in Haiphong, Thaibinh and some regions in Hanam and Ninhbinh.

1.3.5. Others

- Other kinds of soil include sandy soil in coastal line, on islets such as Vanh, Thu and Den, alongside islands and archipelagos.
- Soil on limestone mountains is usually mixed with stone, mostly found in narrow lands on mountain feet and sides in Ninhbinh, Hanam and parts of Hanoi, Phutho, Quangninh, Haiphong, Haiduong provinces;
- Muddy soil is formed in low lands, which is inundated all year round and more acidic. This is found in depressed zones in Namdinh, Hanam and Ninhbinh.

1.4. Climate

Climate through factors such as rain, wind, humidity, and storm, etc. is causes of direct influence on human health, wild life, construction and operation of infra-structural facilities.

Climatic characteristics of the Red River Delta area are summarized below.

1.4.1.. Temperature

Districts in Northeast of Quangninh province (namely Mongcai town, Haiha, Damha, Tienyen) and islands have the annual atmospheric temperature at 20-22⁰C. From March the average temperature falls below 20⁰C and January is the coldest month (15.3⁰C on average). July is the hottest month (28.4⁰C on average). The absolutely highest temperature is 39.1⁰C in Mongcai (July 1935), 36.2⁰C in Coto island (July 1976), 33.9⁰C in Bachlongvy island (July 1968). Some regions in districts of Binhlieu, Haiha, and Tienyen have the annual average of temperature at 16 – 20⁰C. Those are the coldest regions in the project site. The absolutely lowest temperature at Tienyen is 0.9⁰C (January 1967), at Coto island 4.4⁰C (January 1977), and Bachlongvy island 7.0⁰C (March 1975).

Some small regions in Tamdao district (Vinhphuc province) also have the annual temperature of 18 to 22 ⁰C. Besides, most of provinces and cities have the annual average of 22-24⁰C. January is the coldest month with the average temperature of between 15.7-16.8⁰C, July is the hottest month with the average temperature of 28.8-29.4⁰C. The differences in temperature of the hottest and the coldest months are 13.2⁰C (Haiduong), 12.7⁰C (Hungyen), 13.1⁰C (Thaibinh). The absolutely highest temperature was measured at 41.5⁰C (Phulien, May 1914), and the lowest 1.9⁰C (Tamdao, January 1961). The variation of temperature in a day in the whole region is approximately 6-7⁰C (5⁰C in coastal areas).

1.4.2. Sunlight

The average of sunny hours in the project area is 1.600 to 1.800 hours per year with limited differences between areas. The highest value is recorded in Coto (1,814.9 hours/year), then Haiduong (1,691.5 hours/year), Hungyen (1,668.7 hours/year), Namdinh (1,665.1 hours/year), Thaibinh (1,654.9 hours/year), Ninhbinh (1,640.9 hours/year), Mongcai (1,633.0 hours/year), Phulien (1,631.2 hours/year). July and August have the longest sunny hours, for instance 229.8 hours (Coto Island) and 230.4 hours (Vanly). The fewest sunny hours are found in February and March with the lowest average of 39.2 hours (Namdinh) and 35.3 hours (Thaibinh).

1.4.3. Radiation

The annual average of radiation measured is 106.5 Kcal/cm² at Mongcai, 113.8 Kcal/cm² at Phulien. May is the month when the total radiation in Mongcai is highest (12.2 Kcal/cm²), and the same for Phulien is July (14.6 Kcal/cm²).

1.4.4. Cloud

The provinces in the Red River Delta have the average cloud of 7.4 to 7.8 (unit: one tenth of sky cover), and the coastal area in Quangninh 7.2-7.7. The cloudiest months include February and March and the least ones are September through December.

1.4.5. Rainfall

The highest rainfall per year is found in the coastal areas of Quangninh (2000 – 2400 mm) with 130-160 rainy days. The average of rainy days is 90-120 per year and the highest rainfall in a day was recorded at 422.5 mm (Tienyen, 03 September 1973).

Most districts in Haiduong, Hungyen and Dongtrieu district in Quangninh suffer the lowest rainfall (1200 - 1600mm per year).

In other places in the project site, rainfall is evenly distributed, averaging at 1.600-2,000 mm over 110-160 rainy days per year. The highest rainfall in a day was recorded at 490.5 mm (Phulien, 22 September 1927). The less rainy period is the beginning of winter.

The absolutely highest rainfall in continuously rainy periods may be up to 110 – 146 mm within 60 minutes of 136 – 221 mm in 120 minutes.

1.4.6. Humidity

In the whole project area, the relative humidity in a year is 82 to 86% on average. The beginning of Winter is the start of the dry period with humidity falling to 76-77% (November and December) in coastal areas and rarely to 80% in plains. The highest humidity is found in March, 90-92% on average.

The content of salt in the air in coastal stretches is high. It increases in the dry season (Winter and Spring) and decreases in the rainy season. In Thaibinh – Ninhbinh, the salt content in the air in the areas 5 km from the coastline is 1.5 to 2.5 mg/m³.

1.4.7. Evaporation

The annual average of evaporation is lowest in Phulien (698 mm), Phutho (762 mm), compared with 800-1.000 mm of other inland regions. The coastal areas have higher

evaporation than the inland for instance, Doson – Haiphong: 1,138 mm; Kimson – Ninhbinh: 1,250 mm.

1.4.8. Wind

The dominant wind in coastal areas of Quangninh is NE in winter, SE or SW in summer at 1.9-3.1 m/s on average.

The regions located on relatively flat terrain of the Northern Delta see high wind speeds (1.8 –3.8 m/s). Dominant wind directions are NW or N in Winter and SE or S in Summer. The region of Vinhphuc, Phutho has the lowest wind speed (1.0 m/s).

1.4.9. Special weather phenomena

Special weather phenomena (storm, hoarfrost, fog, tempest, etc.) cause direct influences upon human health, equipment, construction and operation of transport facilities.

- **Storm**

The coastal area from Quangninh to Ninhbinh is the place suffering most influences of storms and particularly, Quangninh sees one of the highest frequencies of storm in Vietnam. On average, 3 to 5 storms go into the sea of the North Vietnam's Plain. Storms are usually associated with heavy rains, threatening transport facilities and operation. Usually, storms appear from June through October and it is counted that 40% of storms land in July and August. Recently changes in storm became abnormal with storms even in September and October. For instance, the 5th storm in 2007 landing Ninhbinh in late September caused bad floods and heavy loss of assets over a wide area.

- **Hoarfrost**

With winter colder than that of others, some regions in Quangninh, Phutho and Vinhphuc may see hoarfrost. On average, hoarfrost appears in Mongcai in 0.5 days and in Hoabinh in 0.9 days per year.

- **Fog**

Fog usually appears in coastal areas, particularly islands and high mounts. The highest number of foggy days is found at Phulien at 38.3 days, Coto island: 9.8 days, compared with 20 to 30 days in other regions. The month with much fog is March. In provinces of the Red River Delta, fog rarely appears (10-20 days per year), and usually in winter, if any.

- **Drizzle**

Drizzle is a common phenomenon in Winter, particularly in March. The average days of drizzle in the whole region are 6.0 to 43.1. with the highest (43.1 days) at Hungyen. In general, drizzle less appears on islands (Coto: 11.3 days, Bachlongvy: 6.0 days).

- **Thunderstorm**

Thunderstorms usually appear at the beginning of the rainy season with strong winds, heavy rains, thunders and lightening. The average days of thunderstorm are lowest at Bachlongvy island (23.2 days) and highest in midland provinces (77.0 days).

1.5. Hydrology

The systems of rivers and springs in the project site are dense yet uneven with the density of river grid averaging at 1.0-1.9 km/km² in Quangninh and 0.5-1.0 km/km² in provinces of the Red River Delta. Most rivers pour water to the sea, dissecting the coast into many sections of 15-20 km in length.

The systems of the Red River and the Thaibinh River annually bring 122,109 m³ of water and 120.106 ton of alluvia via 9 main estuaries, namely, Day, Ninhco, Balat, Traly, Thaibinh, Vanuc, Lachtray, Namtrieu and Dabac. Muddy sand of those systems is originated from products of weathering with particle sizes of 0.1 to 0.3 mm, i.e. fine and very fine. The flow rate of muddy sand is great, particles are entrained in suspension state and therefore, changes of riverbeds are very complicated and sensible to any minor changes resulted from natural and human acts.

Characteristics of main rivers are as follows.

1.5.1. Red river system

The main flow of the Red river is 1,130 km. Its total basin is 143,700 km² (including that of the Da river), more than 50% of which belong to China and Laos. Counted from the Thao-Da confluence (in Phutho) to Balat estuary (Namdinh) (238 km), the Red river has such branches as the Duong river (64 km) that transfers water from the Red river to the Thaibinh river, the Luoc river (72 km) that transfers water to the Vanuc river, the Traly river (964 km) that is the left branch to pour water to the sea, the Dao – Namdinh river (31.5 km) that brings water to mix with that of the Day river then discharge to the sea, and the Ninhco river (51.8 km) that is a branch to the sea.

The total water volume of the Red river in many years is 114,109 m³, the amount of sandy mud is 112 million ton. In Hanoi, the average flow rate is approximately 2,710 m³/s, the highest 22,200 m³/s (20 August 1971), and the lowest 350 m³/s (9 May 1960). The water level changes drastically. In details, the average is 504 cm; the highest value is averaged at 642 cm, highest at 1.413 cm (22 August 1971), lowest 230 cm (April 1958); The lowest value is averaged at 405 cm, highest 1,012 cm (August 1971), lowest 173 cm (27 March 1956).

The biggest branch of the Red river is the Da river, which has the annual volume of 56.109 m³ of water and 80.3 million ton of sediment. The flow rate measured at Hoabinh station is 1,690 m³/s as average over many years, 17,200 m³/s (9 July 1964) as the highest, and 174 m³/s (4 May 1980) as the lowest; Its water level is averaged at 1.588 cm; The average of upper water level is 1,742 cm but the highest level is 2,361 cm (19 August 1971) and the lowest 1.288 cm (April 1958); the lower level is averaged at 1,494 cm with the maximum of 2,070 cm (August 1971) and minimum of 1,241 cm (29 April 1958).

1.5.2. Thaibinh river system

The Thaibinh river is a complicated grid with many branches, many tributaries and confluences of branches such as Kinhthay, Kinhmong, Dabac, Han, Cam, Vanuc, etc. Its pours water to the sea via two main estuaries, namely Vanuc and Namtrieu. Estuaries such as Lachtray and Thaibinh became small as a result of sedimentation. The water regime of the Thaibinh river is the same as the Red river yet the total flow and alluvia are lower. Its average volume at Phalai is 826.109 m³ and 1.2 million ton of sandy mud. The flow rate of the Kinhthay river is highest 114 m³/s, and lowest at 47 m³/s, and 1,140 m³/s when tide reaches the highest level. The water level at

stations of the Cam and Kinhthay river is highest at 444 cm (July 1986), lowest at 20 cm (April 1969). On average, the Thaibinh river system annually receives 32% of water and 27.5 million of sandy mud from the Red river via the Duong and Luoc rivers.

1.5.3. Nhue – Day river system

The basin of the Nhue – Day rivers in the southwest of the Northern Delta is on the right of the Red River. The Day river is a branch yet it has its own basin with main tributaries such as Tich, Thanhha, Hoanglong and Vac on the right and Nhue, Chau, Sat, Dao Namdinh as well as connection with Ninhco river via Quanlieu canal on the left. The basin is long and pie-like, covering almost all provinces of Hanoi, Hanam, Ninhbinh, and a part of Hoabinh.

The Day river is 237km long, crossing over Hanoi, Hanam, Namdinh, Ninhbinh and pouring water to the sea via Day estuary. The Nhue river is 74km long with a basin of 1,070 km², taking water from the Red River via Lienmac sluice. The Nhue river also discharges water for Hanoi and Hadong city and pours water to the Day river at Phuly town.

The Red river supplies approximately 85-90% of water of the basins of the Nhue and Day rivers. In the drought season from November to May, water of the two main flow in the basin is mostly supplied from the Red river (the Nhue river takes water via Lienmac sluice, the Dao river takes water from the Red river than pours to the Day river).

The flow regime of the Day river depends not only on climatic factors but also the water regime of the Red river and the tidal regime of the Gulf of Tonkin. The flow of the Nhue river is dependent mostly on the open/closing of regulating drainages such as Lienmac and Thanhliet sluices taking water from the Tolich river and others on the main axis of the river.

1.5.4. Hydrology of the coastal areas of Quangninh

Quangninh has 24 rivers and springs of more 10 km in length. They originate from 500-1.300m high zones of Dongtrieu range, and mostly flow to the sea in the NE-SW direction. Small rivers in coastal areas pour water to the Gulf of Tonkin at right angles to the coastline. It flows in the NW-SE direction from Mongcai to Campha and in the N-S direction from Hoanhbo to Yenhung. Because of terrain, a major part of rivers are short and narrow with very limited alluvia, high upstream slope and saline downstream intrusion (due to semi-diurnal regime). Floods frequently occur in the rainy season with water rising quickly and also lowering quickly after rains. The drought season quickly begins in November. The total flow of 13 main rivers is 7,567 million m³. The annual average of flow module is 20 to 30 l/s/km².

1.6. Geohydrology

The project area is on Hanoi Depression with thick Kainozoic sediments as on Quangninh Folded Mesozoic zone with karst structure. In the Quaternary sediments there are strata of pebble and sand of Lower Pleistocene (QI), Mid-Pleistocene and Upper Pleistocene (QII-III) of Hanoi formation and Holocenic pebble and sand stratum of Thaibinh formation QIV2-3 which contains good water. As assessed with the method of dynamic nature reserve simulation, the reserve of groundwater in the

Northern Delta is approximately 6 million m³/day. Groundwater is found almost everywhere but unevenly with the reserves closely related to rainfall, evaporation, water levels of rivers, lakes, and the sea. Mountainous regions have poor reserve and in the dry season, water quickly runs out.

1.7. Marine Hydrology

1.7.1. Tide

The tidal regime from Quangninh to Ninhbinh is complicated as it is influenced by coastal topography and inshore waves. From Mongcai to Doson, tide is dominant. In general, it is even diurnal tide (one flood tide and one ebb tide in a day) and on going southerly, difference from the sea level at Hondau occurs but inconsiderably with the tidal level averaging at 3 to 4 m. The tide is highest in May, June, July, October and November and lowest in March, April, August and September. In Summer, tide reaches its peak in the afternoon. In contrast, tide is highest in the morning. The tidal flow varies from 0.1 to 0.3 m/s in inshore zones far from estuaries, 0.9-1.5 m/s inside estuaries. Tidal influences on inland are far, approximately 180-190 along the Red river.

1.7.2. Waves

In coastal areas of provinces in the Northern Delta, waves are regulated by tropical monsoon. In the period of SE monsoon, wind speed is high then waves are more and stronger than that of the SW monsoon. In Fall and Winter, waveless days usually account for 10%, swells and waves grade V (2-3.5 m high) makes up 20-30%. In Spring and Summer, waveless days is double (approximately 20%), and waves higher than grade V reduce to 10-20% but in days of storms, waves are many fold stronger.

The region of Quangninh is shielded by islands and suffers weaker waves. The hydrological regime of the inshore water has close relation with the deep sea and consequently, salinity is high with lesser change over seasons than that of the coastal area in the south. In the coastal areas from Haiphong to Ninhbinh, strong waves usually coincide with the E and SE winds with amplitude dependent to wind intensity and direction. On approaching shoals, they cause surfs, which not only strongly disturb water but also attack coasts and beaches.

1.7.3. Sea current

In the Gulf of Tonkin, the sea current has low speed, maybe up to 3-4 m/s in case of strong wind. It runs clockwise in Spring – Summer and counterclockwise in Fall-Winter. The North-South sea current along the coast of the gulf is called cold current and the South-North current along Hainan island (China) into the gulf is called hot current.

1.7.4. Sea temperature

In Winter, the region of Quangninh – Haiphong has the average temperature of surface layer in the range of 15-17⁰C, increasing from hollow to deep water. Temperature rises to 29-30⁰C in Summer in both bottom and surface layers, decreasing from inshore to offshore and from hollow to deep water. The difference of temperature in the surface and bottom layers is inconsiderable as it is no more than 0.2-0.5⁰C.

The average temperature of water in the surface layer in Haiphong – Ninhbinh is 17 to 27⁰C, frequently high in Summer (27-30⁰C), decreasing from inshore to offshore and from hollow to deep water. In opposite, in Winter the temperature falls to 15-20⁰C and increasing from hollow to deep and from inshore to offshore water. The average of temperature is 1⁰C from the surface to the bottom layers, 1-2⁰C from day to night in Winter and 2-3⁰C in Summer.

1.7.5. Sea salinity

The average salinity of sea water is 25-30‰, gradually increasing from inshore to offshore, from surface to bottom with almost no variation in the bottom layer. As a result of inland hydrology, salinity of inshore increases in the drought season and decreases in the rainy season. At the places with no estuary, salinity is stable. In the rainy season, the average salinity in Hanoi bay is 28.2‰ (surface layer), 28.62‰ (bottom layer). On other zones, it is 25.1-30‰. Particularly, in the dry season, salinity is high at both surface and bottom layers, approximately 28.5-30‰.

In the regions of many estuaries pouring water to the sea, those include Vanuoc, Hoa (Thaibinh River), Diemdien, Lan, Traly, Balat and Day, salinity may vary quickly in a large range. The 30‰ iso-salinity line runs 20 – 30km far from the coastline that corresponds to the depth of 20-30m.

1.8. Trend in Change of Air Quality and Air Pollution

(To be added by DSI and SEA Team: about 2 pages)

1.9. Trend in change of Surface Water Quality and Pollution

(To be added by DSI and SEA Team : 2 pages)

1.10. Trend in Change of Groundwater Quality

(To be added by DSI and SEA Team: about 1 page)

1.11. Mineral Resources

In the project area there are the biggest coal mines in Vietnam. Besides, there are other mines scattering in the provinces.

- Coal: found much in Quangninh with 29 giant basins of 3.5 billion ton. The annual exploitation is 25-30 million ton. Brown coal is found in Neogene's sediments from Khoaichau (Hungyen) to Tienhai (Thaibinh) with a reserve estimated at billion ton.
- Non-metallic minerals have high potentials, particularly raw materials for production of construction materials. Those include kaolin of various kinds, limestone, sand, dolomite, pujan, and granite, etc. Big reserves include 65

million ton of stone at Hoangthach and Vanchanh (Haiduong) and 1 billion of limestone in Ninhbinh, etc.

- Metals: bauxite is found at Loson, iron at Kinhmon, mercury at Chiling and Nhoquan, antimony at Bache and Nhoquan, titanium at Binhngoc but the reverses are small.
- Minerals include mineral sand containing precious metals. For instance, mineral sand at East Traco, Hacoï estuary, Tienyen contains ilmenite. The same at Den islet, Thu islet, Namthinh shoal (Thaibinh) contains ilmenite (30-40%) and zirconium (10-12%), which can be industrially exploited.
- Sources of mineral waters are found at Tienhai, Kimboi, Campha, naturally hot water is found at Kenhga and Thuongsung (Ninhbinh), Duyenhai (Thaibinh), Quanghanh, Tamhop, and Tienyen (Quangninh).

1.12. Soil Quality

Soil at the Northern Delta is influenced by alluvia from rivers and the sea with changes due to vegetation cover and cultivation. Alluvia of the Thaibinh River have the origin of earth in the Northeast with light mechanical components and light brown color and pH KCl of 4-5. It is nutritionally poor and furthermore, due to slow sedimentation and long inundation in water, acid sulfate is formed. The alluvia of the Red river has the origin of earth from China and the Northwest region. It is rich at nutrients (humus 1-2%, nitrogen 0.1-0.3%, phosphate 0.07-0.15%, calcium 5-10mg/100g of soil), pH KCl: 5-7, with heavy mechanical components. On reacting with sea water, this kind of soil show neutral or slightly alkaline. Those two kinds of alluvia are critical factors to the acid sulfate features of soil:

- Acid sulfate soil: mostly found in downstream banks of the Thaibinh river. This is mainly distributed from Hoa estuary to Diemdien estuary. Its characteristics include the existence of acid-forming layer (Jarosite) at the depth of 40 to 80 cm, which contains much grey and yellow alum. The dissolved SO₄ is 0.24-0.35% in the surface layer and 0.5% in the acid sulfate layer. Its pH is 4. Contents of nutrients are very low and decreasing by depth. Since mechanical components are light, the effect of acid sulfate is not as severe as in the Mekong Delta. Since it is not easy to wash away alums, this kind of soil is used for cultivating rice and some crops.
- Soil is saline due to tidal inundation or capillary attraction with salinity increasing from inland to the sea. Based on Cl⁻ content of 0.05-0.35% and the ratio of Ca⁺⁺/Mg⁺⁺ around 1, it is grouped into mangrove soil of slight, medium and heavy salinity. Mangrove saline soil alongside estuaries from Balat to Thaibinh has Cl⁻ of 0.25-0.35%, high contents of humus (1-3%), nitrogen (0.1-0.2%), and phosphates (0.05-0.1%) with exchangeable Ca of 3-7 ldl/100g and exchangeable Mg of 6-12 ldl/100 g.
- Alluvia from the Thaibinh river the influence decreasing in the North to South direction, then at Diemdien it is replaced by alluvia from the Red river. In general, land use possibility is limited. Only neutral or slightly acidic alluvial deposits are suitable for cultivation (trees, fruit trees, subsidiary crops, vegetable and wet rice). Sulfate acid soil is acidic (pH 3-5) is only suitable for wet rice. Midland soil with salinity of 0.5‰ can be used in aquaculture. The

medium saline soil can be used for cultivating sedge and the heavily saline one is suitable for *Aegiceras*, *Brugueira* species, etc. Concerning to soil quality, there are some attentive matters as follows:

Investigations of many research institutes found bad imbalance of N:P:K (1.0:0.3:0.1), i.e. the content of potassium is too low when compared with those of nitrogen and phosphates. In general, farming land in the North Vietnam's Plain is degrading since fertilization fails to supplement the nutrients that crops take away annually (1 ton of humus, 50 kg of nitrogen, 50 kg of phosphates, 0.1 ton of potassium for 1 ha of farming land) washing away of nutrients. It is noteworthy that the amount of fertilizers used per one hectare is very low and worse still, due to wrong use of dosage, ratio, with poor methods at wrong growth periods, nutrients have caused accumulation of NO_3 in vegetables, water eutrophication, and pH change towards soil acidification.

Farming land from protective dikes inwards become poor as it no longer receives alluvia. Diking along rivers help protect from floods but plans become separated and particularly, it is impossible to take full use of million tons of alluvia rich of natural nutrients and humus.

Soil is washed and eroded much in Quangninh and Phutho provinces, where bare hills and mountains accounted for 40.3% of the natural surface area. The whole terrain is sloping and rainfall intensity is the highest in North Vietnam. Studies by the Forestry Research Institute indicated that one hectare of red soil with a slope of 18-20° without cultivation is washed 173 ton of soil, 442 kg nitrogen, 123 kg phosphates, and 2,088 kg potassium. Erosion and washing are two critical causes that turn mountainous land to be exhausted, degraded and no longer arable because of shortage of nutrients, humus, nitrogen, phosphates and potassium.

1.13. Natural Disasters and Environmental Incidents

1.13.1. Storms and tropical low pressures

According to statistic data from 1980 to 1997, 26 storms landed provinces in the Northern Delta, the highest wind speed was higher than 50m/s (Wendy, 9 September 1968 – *Table 3.7*). In the period of 1996 to 1999, the number of storms and tropical low pressures tended to reduce with 12 occurrences in 1996, 5 in 1997 and none in 1998 and 1999 as influenced by El Nino (the rainy and stormy season came late and ended soon without storm landing). The second storm in 1997 caused heavy rain and strong wind over a large area that covered almost all provinces in the region. Strong wind was measured at 25 m/s with gusts of over 35m/s at Coto, 26m/s with gusts of over 28m/s at Baichay, 24m/s and 32m/s at Cuaong and 30m/s and 33m/s at Yenhung. In 2007 3 storms landed coastal provinces (Ninhbinh and Namdinh), causing big damages to local economy and inhabitants through their intensities were limited.

1.13.2. Flood and water inundation

Statistic data shows that in the second half of the last century, floods of the Red River were more with larger scale and shorter cycle. Floods in 1971, 1945, 1969, 1996 have the peaks of 14.8m, 13.22m and 13.38m, respectively. That is higher or equal to the regulatory flood level of 13.6m in Hanoi. The floods in 1971 with the cycle of 200-250 years each and the floods in 1945 with the cycle of 100 year each are considered big

floods. Extreme floods in the Red River has the cycle of 1,000 each with the flow rate of 45,000-51,000m³/s (1.19-1.35 fold as high as the flow rate in 1971) at Sontay.

Most regions in the Northern Delta have dike-inward altitude 5-7 m lower than the water level of rivers and consequently, in flood seasons, 50% of the area must be drained with pumps. 97% of area, which is protected with dikes, have altitudes lower than 9.1 m, i.e. lower than the alarming degree 1 (9.5m in Hanoi) and 72% are lower than 3 m, compared with the level of 4-4.5 m in case of flood-tide in combination with water rising due to storms. During the 4th storm in 1996, although the wind is of grade 9 to 10 only, the sea level rose while flood water in rivers was at alarming degree 3 and consequently, many sections of dikes in Haiphong, Thaibinh, Namdinh were almost overflowed. In case of overflowing and break of dikes, thousands of hectares will be inundated by sea water.

In 1998, heavy rain and rising water flew over and broke the dike of Dabac district (Hoabinh), sweeping away many houses and schools at Tienyen (Quangninh), damaging 1,000 m of sea dike, causing extreme traffic jams. Recently (1995-1999), flash floods frequently occurs at Tanlac district,(Hoabinh) with higher frequency and worse destruction. The regions of Nhovien and Nhoquan (Ninhbinh) have been damaged by flash floods of the Hoanglong river. Particularly, the flood in early October 2007 caused water logging over thousands of hectare and houses in districts of Nhoquan and Giavien (Ninhbinh province), leaving serious damages to economy and environment of the two districts.

Two provinces, Hanam and Namdinh, are the depressed region of the Northern Delta, and therefore easy to be inundated when drainage of rainwater is poor or the water level of rivers is high. At present, the dike system as well as Hoabinh hydroelectric dam helps provinces in the Red River Delta less inundated and flooded in.

1.13.3. Sedimentation, erosion and land slide

Changes in natural conditions as well as human impacts cause sedimentation and erosion and change in terrains of rivers. Reduction of upstream forests shortens the time of water accumulation, boosting erosion in basins and as a result, the amount of sandy mud flowing to rivers increases. The amount of sandy mud settled at Balat estuary is estimated at 30 million ton per year, creating warps raising same by 5-20 m per year. Activities such as building reservoirs, breeding ponds and dikes, etc. are causative of impacts on the natural balance of riverbeds, forming warps raised or eroded in a manner not followed any terrain rule.

- Hoabinh reservoir has basically changed the hydrological and hydraulic regimes. Sandy mud has eroded riverbeds of the Red River system, particularly the Da River where the erosion depth is 6,5m right behind the dike, 4,5m at the distance of 5km and 2.1 m at the distance of 11-12km. In parallel with riverbed erosion is horizontal blowing-off of banks that threaten the dike section of Hoabinh town, transferring gradually downstream and eroding many sections of dikes of the Da River. The earth continues to break and slide at Thinland town. The total erosion counted from the dike to Trungha is 61,445,000m³.

1.13.4. Drought

The most recently drought occurred from March to late May 2003. Hoabinh hydroelectric plant became lacking of water for operation, thousand hectares of crops died, hundred thousands of families faced with myriad difficulties because of shortage of water for living.

1.13.5. Earthquake

In the project site, the occurrence and intensity of earthquake are low. The earthquake in 1983 was measured at 3-4 Richter. In April, 30, 2007 a slight seism of 3 Richter occurred in Hanoi.

2.MAIN CHARACTERISTICS OF BIOLOGICAL RESOURCES

2.1. Forests

The distribution of forests in the project site is shown in *Figure 4*

(*To be added by DSI*)

2.1.1. Flora in forests

Natural forests are distributed in mountains and hills in provinces of Phutho, Hanoi, Vinhphuc, Ninhbinh, Quangninh, and Haiduong. From the altitude of 700m upwards there are types such as: tropical wet evergreen forest, semi-deciduous forest with dry and rainy seasons, and forest on limestone mountains. The regions with altitude lower than 700m may have types such as low mountain subtropical wet evergreen forest, coniferous – broad-leaved forest, forest on limestone mountains and on granite mountains.

Forests in the basin of the Da river (Hanoi, Phutho) have the species composition typical for the Northwest of Vietnam, being rich and abundant with valuable wood (*Pentace tonkinensis*, *Chukrasia tabularis*, *Garninia fragraeoides*, etc) and medicinal plants (*Bulbous aralia*, *Polygonum multiflorum*, etc.). Quangninh province currently has 150,000 ha of forest with the dominance of semi-deciduous and deciduous forests and with precious wood such as *Garnicia fragraeoides*, *Pachudia cochinchinensis*, *Pinus merkusiana* and some subtropical species such as *Castanea vulgaris* and *Castania*, etc.

The groups of high values include anise, cinnamon in Quangninh, elemi and pine in Hoabinh; The oil containing group including *Vernicia montana* is found in Nammau, Binhlieu, Tienyen and Mongcai (Quangninh); many precious woods are gathered in Halung forest (Hoanhbo); The group of quick regeneration and growth includes *Castania*, *Canarium*, *Liquidambar*, etc. in Chiling (Haiduong); the group of medicinal and edible trees is also diverse.

At present, 12 provinces in the project site have 7 national parks (NP) and nature reserves (NR). The largest ones are:

- Cucphuong National Park, 22,200 ha, located in Ninhbinh, Hoabinh anh Thanhhoa provinces.
- Tamdao National Park, 36,883 ha, located in Vinhphuc, Tuyenquang and Thainguyen provinces.

- Bavi National Park, 7,377 ha, located in Hanoi City
- Catba National Park (now Catba Biosphere Reserve) 13,200 ha, located in Catba island, Haiphong City.
- Halong Bay Biosphere Reserve 43,400 ha, located in Quangbinh province.
- Xuanthuy National Park 7,680 ha, located in NamDinh province.
- Nghiahung Natural Reserve 7,600 ha located in Namdinh province

Location of the protected areas as shown in *Figure 4*

Figure 4: Protected Areas in the Red River Delta

(to be added by DSI)

Cucphuong National Park amid 3 provinces of Ninhbinh, Hoabinh and Thanhhoa, has typical features of tropical rain forests. It is influenced by monsoon with 3 wood layers, 1 shrub layer and 1 forest floor. The 35-40m high wood layer includes *Parashorea*, *Ficus retusa*, *Dracontomelum duperreanum*, *Sapindus oocarpus*, *Amoora gitantea*, etc. The 30 m high wood layer includes *Castanopsis*, etc. In thin broad-leaved forests in limestone mountains of Tamdiep, Hoalu and Giavien districts etc. there are wood species such as *Pentace tonkinensis*, *Chukrasia tabularis*, *Garninia fragraeoides*, etc. and species of Orchidaceae, Dioscoreaceae, Nephrolepsidaceae, etc. The species composition is very diverse. In primeval forests more than 2,000 species of 221 families, 987 branches are observed. Forests on limestone mountains have 1,937 species, 229 families of 4 orders.

Catba National Park (now Catba Biosphere Reserve) includes 13,200 ha of forests (accounting for 60% of the surface area of the island). That is tropical evergreen rain forest. Forests on limestone mountain sides have wood trees such as *Allospondias lakonensis*, Proteas. Particularly, in the pure forest at Trungtrang village the precious and rare *Nageia fleury* is found. The total number of vegetation species observed in Catba is 839, belonging to 498 branches, 169 families (Tran Ngoc Ninh, 1997).

Nghiahung Natural Reserve is located at coastal region of Nghiahung district – Namdinh province. Its geographic coordinate: 19°56' – 20°00' N and 106°07' – 106°12' E. The site covers 12km of coast line bordered by the Day river to the West and Ninhco river to the East (*Figure 5*). This site has been suggested by Department of Forestry to be a natural reserve but it is not approved by the government. Area of the NR is 7,600 ha. The main ecotypes in the Natural Resource (NR) are planted mangrove forest with a dominant tree of *Kandelia candel*.

Xuanthuy Natural Reserve is located at Giaothuy district – Namdinh province. Its geographic coordinate: 20°11' – 20°16' N and 106°30' – 106°37' E (*Figure 6*. Note: *Figures 5 and 6: from Google*).

On August, 06, 1988 the Government of Vietnam (GOV) has suggested the Xuanthuy NR to be a first Ramsar Site of Vietnam. On September 20, 1988 Office of International Important Wetland Areas has officially approved Xuanthuy NR to be a Ramsar Site with an area of 12,000 ha. On September 05, 1994, the GOV has decided to establish the Xuanthuy NR (Decision N 4893/KGVX) with an area of 7,100 ha. On

October 01,1995 the People Committee of Namdinh province has set up a Management Board of Xuanthuy NR.

Xuanthuy NR is located at a coastal area at the Red river Mouth (Balat Mouth, *Figure 6*). The NR includes sandy beach and saline swamps. In the NR the highest area is 3.0 m above sea level (ASL) and the deepest site of the sea is – 6 ASL.



Figure 5: Estuaries and surrounding areas of the Day and Ninhco river, where is location of Nghiahung NR

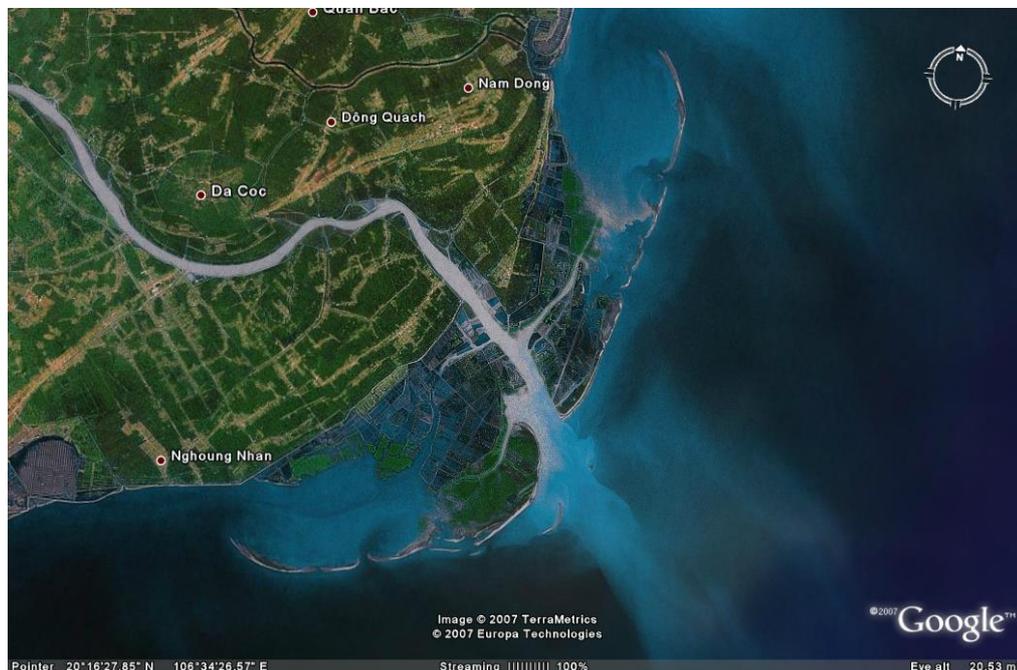


Figure 6: Location of Xuanthuy Nature Reserve

In the NR there are 14 ecotypes. The ecotype which has highest biodiversity value are saline swamps and natural mangrove forests. The dominant mangrove tree is *Kandelia*

candel. The others are *Sonneratia caseolaris*, *Aegiceras corniculatum*, *Acanthus ilicifolius*.

Tienhai Nature Reserve is located in the province of Thua Thien-Hue and occupies an area of 12,500 hectares. It was decreed by the Government of Vietnam on 05 September 1994. Tienhai Nature Reserve is located at the mouth of the Red River, immediately north of Xuanthuy. It consists of 2 sandy islands, Vanh Island with an area of 2,000 ha and Thu which has an area of 50 ha. Vanh Island is separated from mainland by a deep channel. The banks of Vanh are covered by mangrove, most of which is enclosed by ponds. It supports 12 habitat types, most important are sand dune, reedbed and mangrove. Intertidal mudflats are important habitat for feeding shorebirds.

Thaithuy Proposed Nature Reserve is located in the province of Thua Thien-Hue and occupies an area of 13,696 hectares. It is bordered by Traly river to the south and by the Thua Thien-Hue river to the north. The proposed reserve is bisected by the Diemho river. To the South of Thua Thien-Hue river mouth are extensive areas of mudflats. To the West are salt pans and adjacent to Traly is a region of aquaculture ponds. It contains the largest remaining tract of old-growth mangrove forest in the Red River Delta. About 400 hectares of natural mangrove forest dominated by *Sonneratia caseolaris* remains at Thaithuy. Most of the mangrove forest consists of plantation of *Kandelia candel*. The mangrove plantation is about 2,888 ha. It supports 4 main habitat types. This proposed nature reserve supports several globally threatened and near threatened waterbird species over winter and on passage.

2.1.2 Fauna

Fauna in Cucphuong National Park a very rich species compositions with many rare and precious ones. There are 60 species of wild animals, 4 entomophagous species, 18 dermoptera species, 1 manis species, 3 primate species, 15 rodent species, 15 carnivorous species, 4 artiodactyl species with rare and precious species such as *Pyganthris nemareus* L., *Panthera pardus*, *Selenarctos thibetanus*, *Antelope*, *deer*, *Capreolus capreolus*, *Herpestes*, *Mustella*... 140 bird species are observed, including the noteworthy species such as *Pavo muticus imperator*, *Lophura diardi*, *nightingale*, *Motacilla flava flava* ...; 36 reptile species including *Gecko gecko* L., *Varanus nebulotus*, *Morelia*, *Bungarus*, *Ancistrodon conotortrix*, *Tropidomotus natrix* ... and 20 amphibian species, mostly toad and frog.

Fauna in Catba Biosphere Reserve have 38 mammal species of 9 phyla, 17 families with rare and precious ones such as *Trachypithecus francoisi poliocephalus*, *Macaca artoides*, *Macaca mulata*, *Felis bengalensis*, and *Panthera pardus*, etc.

Presently forests are shrinking in acreage, wood reserve and biodiversity as a result of overexploitation, not to say annual fire as well as shifting and wandering custom of some ethnic minorities.

Fauna in Nghiahung NR

In this NR there are a number of bird species, in which 8 species belong to World Wide Threatenable Group: *Tringa guttifer*, *Limnodromus semipalmatus*, *Calidris pygmeus*, *Laurus saundersi*, *Pelecanus philippensis*, *Egretta eulophotes*, *Therskiornis melanocephalus* and *platalea minor*.

The NR is located at the Day and Ninhco river estuary, where is an area of growth fish crab, shrimp and other marine animals. This area plays an important role for local aquaculture and salt production.

Fauna in Xuanthuy NR

The NR is an important habitat for migratory water birds. In 1994 over 20,000 individuals of water bird species have been observed. In the area 9 bird species belong to the World – Wide Threatenable Group have been recorded: *Platalea minor*, *Egretta eulophotes*, *Tringa guttifer*, *Larus saundersi*, *Pelacanus philippensis*, *Calidris Pygmaeus*, *Mycteria Leucocephala*, *Limnodromus semipalmatus*, *Vanellus cinereus*. Xuanthuy NR has 26% of the total individuals of *Platalea minor* of the World (Pedersen and Nguyen Huy Thang, 1996).

Xuanthuy NR is also an area for fishery development. In 1997, total aquacultural production of Xuanthuy district was 200 ton of shrimps, 50 ton of crabs and 1,200 ton of mussels. This area has also potential of eco-tourism development.

Due to high importances of forests ecosystems in protection of the environment (conservation of biodiversity, prevention and control of flood, protection of soil, surface and ground water resources, prevention of climate change etc.) and socio-economic development all plans for infrastructural, urban, industrial, agricultural, tourist development should avoid encroachment into the forest areas, especially into the buffer and core zones of the above protected areas. This is an important matters needed to be greatly concerned during setting up Master Plan as well as Sectoral Plan for socio-economic development in the Red River Delta Region.

2..2. Biological Resources in Plains

2.2.1. Terrestrial flora and fauna

The flora in plains is strongly developed, diverse and rich. Popular groups include food crops, industrial crops, fruit trees, medicinal plants, grass (for breeding), ornamental trees, etc. The area of urban tree coverage in project area is estimated at 0.3-0.5 m² per capita. Halong, Hanoi, Haiphong cities have the tree coverage of about 0.3-0.5 m² per capita, which is the highest in those urban regions yet it is far lower than many cities in Asia or Europe (more than 2 m² per capita).

Domestic animals include cattle, poultry and pets. Wild species are mostly small animals, amphibians, reptiles and insects. In the plains of Haiduong and Hungyen 236 fauna species and 283 flora species were specified. Use of fertilizers and pesticides as well as overexploitation has strongly changed species composition. Many species are endangered such as *Belostoma indica Vitalis*, *Streptopelia chinensis*, and *Rana tigrina*.

2.2.2. Aquatic organisms

Based on analysis of plankton and zoobenthic samples collected from 14 locations at some rivers of the Red River Delta, 66 species of phytoplankton, 24 species of zooplankton, and 20 species of zoobenthos are recorded by the Environmental Protection Center (VESDEC) of the Vietnam Environment and Sustainable development Institute (VESDI) in May 2007. The number of aquatic groups mentioned as above are less than available in the nature. Almost of them are common

species and largely distributed in rivers of flat delta . There are some brackish water species in rivers impacted by estuarine waters at Haiduong and Ninhbinh.

2.3. Bioresources at Mangrove Forests

According to a research of the Institute of Ecology and Biological Resources (2000) from Mongcai to Haiphong, 7 main species (namely *Escoecaria*, *Aegiceras*, *Limnanthemum*, *Rhizophora stylosa* Griff, *B. gymnorrhiza*, *Avicennia corniculatum*, and *Ipomoea pes-caprae*) form the coastal belt. In the regions of estuaries of Ong and Luc, the tidal warps are small and the flora is poor. In Quangyen – Haiphong, wetland trees are diverse with good growth, forming broad forests. The forests at some regions are pure, for instance, grounds of *Avicennia corniculatum*, and *Brugueira gymnorrhiza* with trees of 3-4 m high, 10-20 cm in diameter. From the South of Doson to Ninhbinh, though the alluvia ground is thick, the development of forest is disabled by widely varied salinity and strong influence of wind and waves and the number of species is very limited, including some species such as *Juncus geradi*, *Limnanthemum*, *Aegiceras*, *Avicennia corniculatum*, *Rhizophora stylosa* Griff, *Brugueira*, *Acanthaceae*, *Spondias cytherea*. Being exploited many times, natural forests were replaced by newly planted grounds of *Aegiceras* *Brugueira*.

In 2000 the total surface area of wet forests is around 47,000 ha (Quangninh: 27,000 ha, Haiphong: 11,000 ha, Ninhbinh: 1,000 ha). Now (2009) there is no official data of the reduction of mangrove forests in the project area.

Mangrove forests are objectives to be well conserved during socio-development planning for the Red River Delta, due to they have great biological potentials and environmentally importances:

- *Those are the places for numerous terrestrial and aquatic species to live and form unique and rich ecosystems of tropical coasts with 10-15 flora species, 40-45 fish species, 10-12 crustacean species, 6-10 mollusk species and many zooplankton species.*
- *Mangrove forests help condition climate, maintain dissolved oxygen, salinity, pH, and creating protective zones for many species. They play the role of habitats of migrant species, conservation of biodiversity and beauty of landscape. The alluvial ground of Conlu (Namdinh) is a habitat for 150 bird species, including 10 rare and species, mostly migrant birds. The ground may host as many as 25,000 birds in the period from November through May.*

2.4. Fishes

2.4.1. Fish composition in estuary

80% of fish species in estuaries of the Northern Delta are represented the fish community of the Gulf of Tonkin. From Doson to Day estuary it was observed 233 species of 71 families of 18 orders. Perciformes is the main structure with 33 families and 120 species, Clupeiformes includes 5 families and 21 species, of which many are important seafood such as *Ilisha ditchoa*, *Dussimieria*, *Anchoviela*, *Hilsa Sinensis*, *Setipinna*, *Chaetodipterus faber*. In addition, *Pleuronectiformes* exists with 18 species.

Species of families such as Priacanthidae, Pomacentridae, Chaetodontidae, etc. living in coral reefs and some Elasmobranchia species, representatives for Exocoetidae, Menidae, Sphyrnidae, Stromateidae, Scombridae... living in the upper water offshore are also observed in this estuarine region.

The following data on the present fish compositions in the Red River Delta are adapted from a study, conducted by the Institute of Ecology and Biological Resources in 2007.

2.4.2. Fish composition in fresh water area

According to a research the Institute of Ecology and Biological Resources (IEBR) in 2007, the identified fish species collected in the Northern Delta are given in Appendix.

- At the Nhue and Day rivers

About 53 fish species were identified at the Day and Nhue basin. Most of them belong to Carp spp. The species having high economic value are: *Cyprinus carpio*, *Carasius auratus*, *Pinibartus caldwelli*, *Anthorhodeus dayeus*, *A. Tonkinensis*.

In this river basin there is one of 33 inland water fish species recorded in the Vietnam Red Book (2000). It is *Squaliobartus Curiculus* (T - level) (C, chủy in Vietnamese).

- At the Cau river

89 fish species of 6 orders, 20 families have been recorded in the Cauriver basin. Most of them are native ones, only *Trichogaster Trichopterus*, *Oreocronis niloticus* and *O. mossambicu* are exotic (from other countries). Most of species belong to carp family (50% of the total species number)

There are 2 species belong to the Vietnam Red Book (2000): *Onlychostoma laticeps* (V-level) (C, Sỡnh in Vietnamese) and *Squaliobarbus curculus* (T - Level).

In the total species there are 12 species of cultured fish, eg Trám Cá, Trôi Án, Trôi Mrigan, Mì hoa, Mì Tráng, ChĐp, R« phi v»n, R« phi ẽen, Chim Tráng, Tr^a phi (in Vietnamese)

In the recent years, amount of caught fish is reduced due to the environmental conditional and overfishing.

- At the Red river

From Viettri to the estuary about 64 fish species have been indentified in which 12 species are cultured ones.

In the Red river basin there are 3 rare fish species recorded in the Vietnam Red Book (2000): *Clupanodon Thrissa* (Linnaeus, 1758) (V - level), *Squaliobarbus Curiculus* (T - level), *Hemibagius Elongatus* (Giinther) (V - level).

- At the Thaibinh river

In this river basin from Phalai to the estuary 62 fish species have been identified. They included 50 natural species and 12 cultured ones. There are 2 rare species recorded in the Vietnam Red Book (2000): *Clupanodon Thrissa* (Linnaeus, 1758) (V - level) and *Squaliobarbus Curiculus* (T - level).

2.5. Marine Biological Resources

The island biota in the sea of Quangninh and Haiphong has diverse species composition and high biodiversity. Rare and precious species are found in both terrestrial and aquatic biota. Bamun National Park has 242 vegetation species of 94 families, 27 animal species (bat, squirrel, muntjac, chamois, otter, yellow monkey, etc. Catba National Park has 745 higher vegetation species, 115 wild animal species, of which up to 20 species are listed in the Red Book. Around Catba island there are 28 mangrove forest species, 108 phytoplankton species, 51 zooplankton species, 200 zoobenthos species, 46 coral species, 105 sea fish species, 21 bottom fish species and some migrant bird species, sea turtle and dolphin. Some important communities in the sea of Quangninh - Haiphong include:

Seaweed: This subtropical seaweed biota (sea temperature of 20-25⁰C) include 74 species of 27 families, 16 orders of phyla, namely Rhodophyta with 30 species, Phaeophyta with 21 species, Chlorophyta with 13 species, and Cyanophyta with 10 species. Many species are sources of rare and precious genes and highly valuable (used as medicinal materials, food, or production of agar, alginate or fertilizer). Noticeably, 2 species are listed in the Vietnam Red Book, namely *Codium repens*, and *Caulerpa racemosa*.

Coral: 137 coral species of subclasses of Octocoralia and Hexacoralia are observed, of which reef-building corals have 119 species of 42 orders and 12 families, accounting for 80% of species. Coral is mostly distributed in Halong Bay and Baitulong bay, around Catba, Bachlongvy island and Coto archipelago with the number of species and size of reef increasing with the distance from the coast. Coral reefs exist in the depth up to 6 to 7 m, growing best at the depth of 2 to 4 m.

2.6. Overall Evaluation of Influences of Natural Factors on Socio-Economic Development in the Project Red River Delta

- (i) The Red River Delta is one of the big agricultural land of the nation. It is also rich of resources and minerals, particularly coal and construction materials with large resources, and aquatic produce of high economic value. Currently, many provinces of the Northern Focal Economic Zone (Hanoi, Quangninh, Haiphong, Bacninh, Haiduong, Hungyen, Hanam, Vinhphuc) have good conditions for strong development of industrialization and modernization.
- (ii) The Red River Delta has a long coastline with many out-of-the-wind regions of deep water and less sedimentation, i.e. convenient for ports and waterway transport development.
- (iii) The project site has a dense river system, i.e., good for developing inland waterways.

In addition to those advantages, characteristics of the nature and quality of environmental components can impact the construction and operation of socio-economic development projects.

- Tropical monsoon climate with cold Winter can affect human health.
- Disadvantage of temperature, humidity, salinity, heavy rains and high solar radiation can damage technical facilities

- The difficult terrain rifted by high mountains in Phutho, Vinhphuc, Quangninh, or the water-logged and muddy terrain in depressions of Hanam, Namdinh, Thaibinh province will lead many difficulties to develop infrastructural projects
- Climate may change unfavorably: First, that are increases in temperature, frequency and intensity of storms, raining scope as a result of storms, etc.; the sea level at Hondau is rising 0.3cm per year and it is estimated that in 2010, it will be 15 cm higher than that of 1990. The recovery of upstream forests and coastal mangrove forests are very low. The tendency of increases in factors of storms and floods require higher safety level of transport projects.
- The reduction of natural forests in Quangninh, Vinhphuc, Phutho, Hanoi and Haiduong as well as coastal mangrove forest has led to shrinking coverage of vegetation, worsening climate-related impacts, increasing erosion, sedimentation and flash flood. Those are long-term factors to traffic activities.

3. SOCIO-ECONOMIC CHARACTERISTICS OF THE RED RIVER DELTA REGION

The project area accounts for all part of the Red River Delta, a part of the Northeast (Quangninh) province. Those are ones of the most important regions in the economic, cultural and social development of Vietnam.

The Northern Focal Economic Zone, including Hanoi, Haiphong, Quangninh, Haiduong, Hungyen, Bacninh and Vinhphuc is the dynamic zone for socio-economic development in the North. With the population of over 16 million (18.6 % of Vietnam), the zone annually contributes about 18 % of the country GDP (*ask DSI to give more accurate data*) In recent years (2001 – 2008) provinces in the Project area have obtained high economic growth rate (8-12% per year, according to reports by the provinces). As a result of industrialization and urbanization, a large area of farming land and forests has been converted into urban or residential land.

Some information of economic growth of the provinces is outlined below.

• Industrialization

In the period of 2001 – 2008, the industrial growth of provinces in the project provinces was 15 – 30% (higher than the average of the nation). Nevertheless, industrialization is not even, Hanoi, and provinces such as Quangninh, Haiphong, Hungyen, Haiduong, Vinhphuc maintained high growth rate (over 20% per year) and the industrial GDP accounted for high percentage (over 40%). Meanwhile, provinces such as Thaibinh, Ninhbinh, Namdinh, Phutho, Hanam are still basically agricultural (industrial GDP contributes <30% of the province GDP).

Industrialization promoted the development and expansion of industrial parks in cities, districts and town such as Campha, Halong, Uongbi, Dongtrieu (Quangninh province), Thuynghuyen, Anduong, Kienthuy, Anhai (Haiphong), Haiduong city, Chilinh, Namsach, Camgiang (Haiduong province), Myhao, Vanlam (Hungyen province), Dongvan, Phuly (Hanam province), Giavien, Tamdiep, Ninhbinh city (Ninhbinh province), Namdinh city (Namdinh province), Thaibinh city (Thaibinh province), Vietri city (Phutho province), Vinhyen city, Phucyen town (Vinhphuc province),

Longbien, Hoangmai, Thanhxuan, Socson, Gialam, Donganh, Chuongmy and Hoaiduc districts (Hanoi City).

**Figure 8: Map of Present Landuse in the Red River Delta
(to be added by SDI)**

Urbanization

In the last decade, urbanization in the project province occurred speedily. The urban population increased to more than 35% (2008, higher than the nation's average) from 24% (1995). A series of town were upgraded to cities (including Thaibinh, Phuly, Ninhbinh, Haiduong, Hungyen, Bacninh and Vinhyen from 1995 to 2009), boosting the number of cities in the project area to 12/12 provinces. In addition, the project area has 8 towns and some teens townships.

Urbanization creates favorable conditions for socio – economic growth but also imposes heavy pressures on the environment.

• Transport

The project area has the most developed traffic network when compared with other regions in Vietnam. That is an advantage for economic activities.

- Inland road

The road system links all communes to centers of districts and provinces. Main national roads include:

- National Road 2: linking Hanoi with the Northeast and the Northwest regions.
- National Road 5: linking Haiphong ports with Haiduong, Hungyen and Hanoi city.
- National Road 18: linking Mongcai border gate with Halong city and Haiduong and Bacninh.
- National Road 10: linking coastal provinces, namely Quangninh, Haiphong, Thaibinh, Namdinh, and Ninhbinh provinces.
- National Road1: linking Southern provinces with Hanoi city.
- National Road 21: linking Hanam, Namdinh with coastal districts of Namdinh provinces.
- National Road 6: linking provinces in the Northwest region with Hanoi.

- Railways

In the project area there are has 3 railways: the North-South, the Hanoi – Haiphong and the Hanoi – Quangninh and Hanoi – Laocai.

- Waterways

The Northern Delta is the place of the biggest ports in North Vietnam and also the hub of international transport toward other nations in the world.

The biggest ports include Cuaong, Cailan (Quangninh), Dinhvu, and Chuave (Haiphong). The system of waterways in the project area is relatively convenient, still

waterway transport is not yet developed due to sedimentations and shortcomings of technical infrastructure.

- Airways

In the project site there are 2 international airports, namely Noibai (Hanoi) and Catbi (Haiphong) and some small airports.

• Agriculture, Forestry and Fishery

The project area is a focal zone for development of agriculture and forestry in Northern provinces. Cultivation (rice, maize, Copland, vegetable and fruits) and breeding (cattle and poultry) are strongly developed in Hungyen, Haiduong, Namdinh, Thaibinh, Ninhbinh, and Hanam provinces.

Fishery (aquaculture and fishing) is well developed in coastal provinces (Quangninh, Haiphong, Thaibinh, Namdinh, and Ninhbinh). In the period of 2001 – 2008, the growth rate of agriculture was 3 – 4% per year, and fishery 4 – 8% per year.

Forestry is an important economic sector in Vinhphuc, Phutho and some districts of Hanoi, Haiphong, Ninhbinh, and Quangninh. Nevertheless, both the area and quality of forests (mountain forests and mangrove forests) are declining. That is a pressure on the natural environment in general and the environmental quality.

• Places of scenic beauty and historic relics

The Red River Delta is a region, containing the highest number of the classified cultural, historic and religious sites in Vietnam. Therefore, the Master Plan should carefully consider on protection of the places of scenic beauty and historic relics. Some places of scenic beauty and historic relics in the region are indicated below.

- Natural famous landscapes and caverns

- Halong Bay includes 1,969 islands, numerous famous caverns and clean beaches. Halong Bay is named by UNESCO as a World Heritage and a World Biosphere Reserve.
- Beaches and tourist sites in Traco, Baichay, Dason, Catba, Cathai, etc.
- Places of scenic beauty include the former capital of Hoalu, Vanlong – Giavien, Tamcoc - Bichdong (Ninhbinh), Kemtrong, Ngudongson and Mt. Cam (Hanam) with limestone caverns linking each others;

- Historic, cultural and religious relics

In the project site there are many relics in which great historic, cultural, religious and aesthetic values are concentrated. Those include the Temple to Hung Vuong (in Phutho), Conson pagoda, Kiepbac temple (in Haiduong), the ancient port town and Hien town, the temple to Pham Ngu Lao (in Hungyen), Keo pagoda (in Thaibinh), Dichlong pagoda and cavern, the temple King Dinh Tien Hoang, Baidinh mount and pagoda, Phatdiem Stone Church (in Ninhbinh). Especially, in Hanoi over 1,200 temples, pagodas and historic sites were registered. The major sites are Badinh Square, one Pilar Pagoda, Tranquoc pagoda, Ngocson Temple, Giong temple, Tayphuong Pagoda, Huong pagoda etc.

Alongside the coast of Haiphong – Quangninh there are historic relics existing together with traditional festive activities such as Bachdang gate, Yentu pagoda,

Cuaong temple, etc. In almost all provinces there are relics of ancient architectures and artifacts, pagodas, temples, steles, etc. which are attractive destinations full of historic legends and national culture.

SUGGESTIONS

From the above identified characteristics of the natural environment and socio-economic conditions of the Red River Delta towards to sustainable development of this region integration of environmental consideration into preparation of a Socio-Economic Master Plan is strongly requested. To comply the criteria of sustainable development the following suggestions of the SEA consultant should be carefully considered during setting up the regional as well as sectoral master plan.

- (i) Avoid encroachment of any kind of projects in urban, industrial, transport, agricultural, water resource, aquacultural, tourism development into core zones of the natural reserves (National Parks, Nature Reserves, Biosphere Reserves, World Heritages). At buffer zones of the natural reserves or at the wetland areas (mangrove forests, saline swamps, lakes, reservoirs) only some small scale projects in resettlement, agricultural, aquacultural, transport, water resources and tourism development may be planned but with careful environmental assessment.
- (ii) Avoid encroachment of any kind of projects into the classified cultural, historical sites and their surrounding area.
- (iii) Avoid change in natural hydrological regimes and water quality of the main rivers in the Delta.
- (iv) Minimize encroachment of urban, industrial, resettlement, tourism, recreation development projects into agricultural and residential lands to avoid impacts on food security and local socio-economy.
- (v) Minimize impacts of wastes generated by development projects on the air, water, land environment, wild lifes and public health. To mitigate these impacts preliminary calculation of waste loading capacity of each ecological zone, consideration of waste management of each project and cumulative impact assessment are required during preparation of the Master Plan.
- (vi) Avoid to over exploit the natural resources, particularly, forests, river and ground waters, mineral and fish resources.
- (vii) Strongly prevent the natural disasters, especially, consequences of global climate changes created increased flood, sea level rise, draughts and typhoons.

To well integrate economic growth, environmental protection and social security from the beginning phase of Master Plan Preparation a SEA should be conducted with the active participation of the planners from the related ministers and sectors and the environmentalists.

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Le Trinh, Ass. Prof., Dr., SEA Consultant for the Red River Delta Master Plan