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INFLUENCES OF SOME HUMAN ACTIVITIES ON THE COASTAL ENVIRONMENT OF THAI BINH PROVINCE, VIETNAM

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ABSTRACT

In order to meet the requirements of the industrialisation and modernization, the human activities for economic development are intensively carried out at the coastal zone of Thai Binh province. The main activities that have influenced the environment are constructing sea dykes and ploughing virgin soil, using chemical fertilizer and pesticide in agriculture, building and exploitation of shrimp ponds, the exploitation of mangrove forest. The environmental problems related to these activities include: the hazard of erosion and accretion, the potential of saline intrusion, the potential of water and sediment pollution of heavy metals, waste and pollution of toxic chemical compounds.

Keywords: accretion, erosion, water and sediment pollution

INTRODUCTION

Thai Binh is a province belongs to the Red River delta. It is well-known as a main rice resource for Northern part of Vietnam. Since 19th century the residents have filled some area at the coast in order to expand the agricultural land. Nowadays, the human activities for economic development at the region are increasing rapidly caused by industrialisation and modernisation policy of the government. In one hand, these activities make a lot of benefits. In the other hand, they also cause some serious problems related to the coastal environment of Thai Binh province. In order to contribute to solve the problems, the paper deals with the environmental problems related to ploughing virgin soil, using pesticide in agricultural activities, building and exploitation of shrimp ponds, the exploitation of mangrove forest. The location of Thai Binh province in Vietnam and administrative geographical map can be seen at Fig. 1.

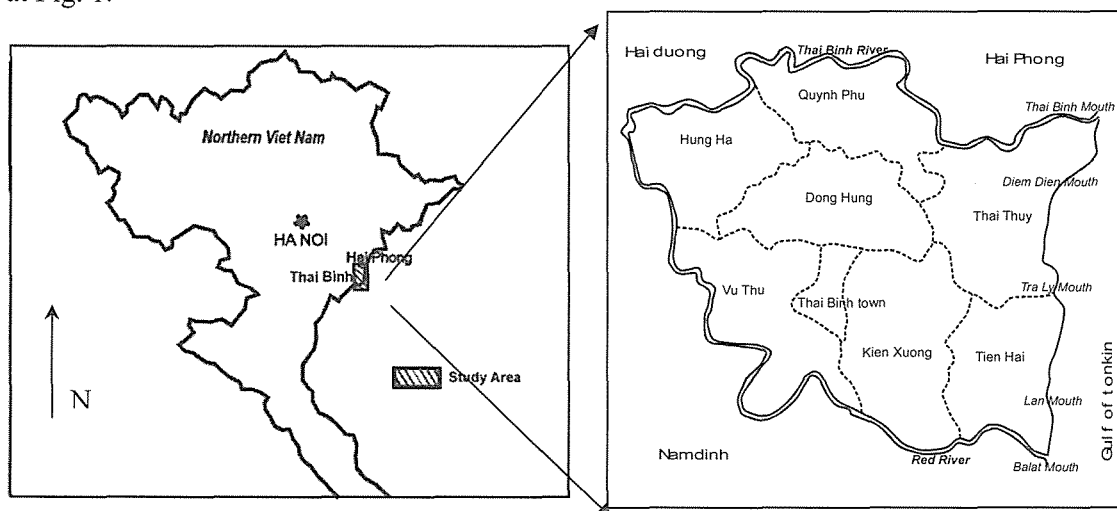


Figure 1. Location of the study area

Thai Binh is a coastal province with the area of 1508.5 km², ranges from 20°17' to 20°44' north latitude and from 106°06' to 106°39' east longitude. In the whole province the relief is very plain. The average absolute height is about 1-2m and the relief has a trend of lowering from north to south.

There are 5 rivers run through Thai Binh province, such as: Hoa river (or Thai Binh river) - a branch of Luoc river at the north-east, Luoc river - a branch of the Red River at north and north-west, Red River and Tra Ly river at the middle of the province. These rivers have created along the shoreline of 52km 5 mouths, including: Ba Lat, Lan, Tra Ly, Diem Dien and Thai Binh. Annually, billions cubic meter of water and millions tones of alluviums are transported to the Gulf of Tonkin. According to the monitoring data of over 45 years, 137 km³ of water and 64.5 million tones of alluviums are brought into the coast of the Red River delta each year, about 40% through the Ba Lat mouth.

The characteristics of the air temperature, rainfall, air humidity and average wind velocity of each month in the coastal zone of Thai Binh province are shown at Table 1.

Table 1: Temperature, rainfall, air humidity and average wind velocity at the coastal zone of Thai Binh

Month												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Temperature (°C)	15.9	16.7	19.5	23.1	27.1	28.4	29.0	28.2	26.9	24.8	20.7	17.7
Rainfall (mm)	27	24	51	70	152	212	249	328	382	225	85	29
Humidity (%)	85	88	91	90	86	84	83	86	88	86	84	85
Wind velocity (m/s)	3.4	2.3	2.1	2.3	2.3	2.2	2.4	1.8	1.8	2.0	2.0	1.9

The study area has two evident seasons. The rainy season (wet season) is from Mar to October with the rainfall of over 84.4% of the year. The average temperature is 27.4°C; the main direction of the wind is southeast. The dry season is from November to April next year. The amount of rainfall is very small, the average temperature is 18.9°C; the main direction of the wind is northeast.

The river mouths are clearly affected by dual tide. The average amplitude of tide reaches to 1.5m. Annually, there are about 176 days of strong tide with the increasing of water level of over 3m.

MAIN HUMAN ACTIVITIES AFFECTING THE COASTAL ENVIRONMENT IN THAI BINH PROVINCE

Building sea dykes for coastal reclamation

Building sea dykes for coastal reclamation was carried out since the beginning of 19th century in order to expand the agricultural land. So far, the activities can be divided into 3 stages.

- Stage 1: Being under the leadership of General Nguyen Cong Tru, building sea dykes created a new district (Tien Hai) and some parts of Thai Thuy district during the period from 1828 to 1830 (Fig. 2).

- Stage 2: carried out from 1892 to 1900. In this period, reclamations were mainly conducted in Tien Hai district. However, some dykes of the last period became inland dykes. This period was the strongest intensity of building sea dykes in the region. About 60 km of dykes were built during this period. It contained four segments: Long Thanh dyke (from Ba Lat to Lan mouth), Bach Long dyke (from Lan to Tra Ly mouth), Quan dyke (from Tra Ly to Diem Dien mouth) and the fourth segments from Diem Dien to Thai Binh mouth.

- Stage 3: from 1955 to 1980. This period can be divided into some sub-stages. Firstly, some segments of sea dykes along the shoreline from Ba Lat mouth to Thai Binh mouth were built (1955-1956). Then, sea dykes from Lan mouth to Thai Binh mouth were completed during the

period 1961-1966. After that, a few small sea dykes were also constructed in some areas such as: Nam Hung (1974), Dong Chau, Dong Long (1978) and Nam Phu, Thai Do, Thai Loc (1974-1975), Dong Tra (1980). The detail information about building sea dykes in the study area can be seen at table 2.

So far, there are about 152 km of sea dykes in the coastal zone of Thai Binh province. Over 80 km of sea dykes are adjacent to seawater.

Table 2: Sea dykes built during the period 1955-1980

Dyke	District	Year	Length (km)	Expanding area towards the sea (ha)
Thuy Tan	Thai Thuy	1961	4.5	340
Thuy Xuan	-	1964	7.5	400
Thuy Hai	-	1965	3.5	150
Thai Do	-	1966	6.6	600
Nam Cuong	Tien Hai	1960	4.2	270
Dong Minh	-	1968	5.1	217
Nam Phu	-	1975	9.6	450
Dong Tra	-	1980	5.0	300

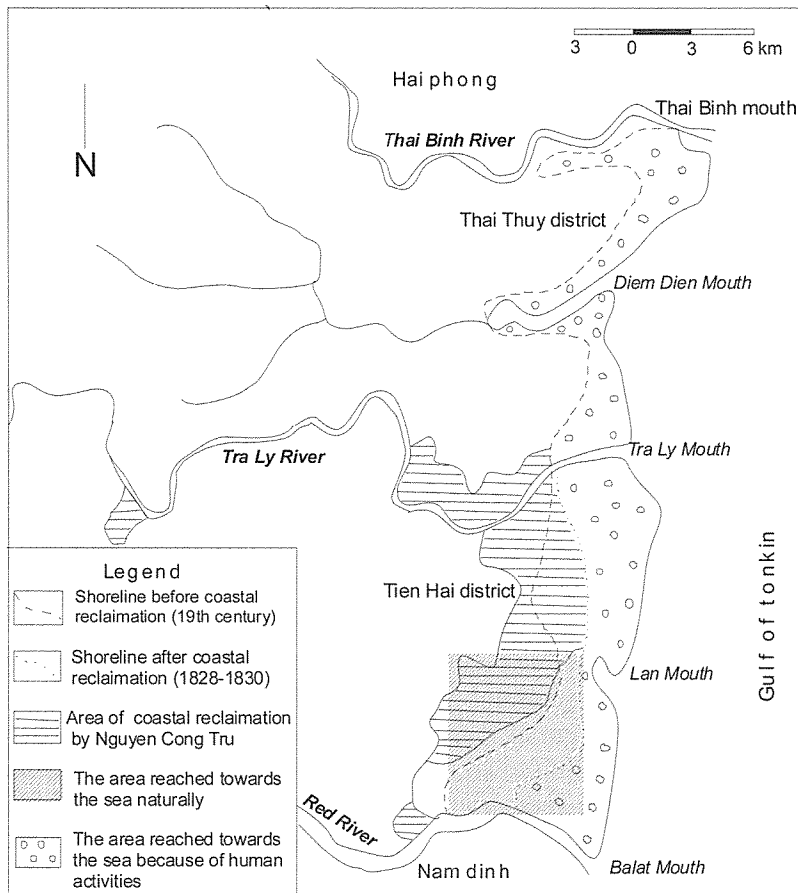


Figure 2. Sketch of building sea dykes for coastal reclamation (1828-1830)

Aquatic plantation and exploitation of mangrove forest

Building sea dykes for coastal reclamation have created the swamps with the coverage of mangrove forest. These swamps are rich in nutrients and very convenient for aquatic plantation, especially shrimp plantation. The natural procedure of aquatic plantation is still popular (over 20%). The area of each aquatic pond ranges from 1-2 ha to hundreds ha. Most

of aquatic ponds are larger than 40-50 ha. According to incomplete data, aquatic plantation caused the lost of over 1,000 ha of mangrove forest.

Because of large area of shrimp plantation and the lack of drainage culverts that's why the water exchange between shrimp ponds and the outside environment is very little. The organic wastes will be accumulated and make the pollution of water and sediment in the ponds, especially in some ponds that have the bottom situated lower than the culvert. This leads to the death of shrimp and fish in the ponds and caused a delay in producing activities of some aquatic ponds. In addition, these ponds are also a dangerous source of environmental pollution.

Beside aquatic plantation, a remarkable area of mangrove forest have been destroyed by storms and cutting for wood. Most of mangrove forests were cut for domestic wood and burning at brick ovens. A lot of forests was very seriously destroyed and became exposed lands, could not be regenerated.

Agricultural activities

As mentioned above, Thai Binh province has a very high density of population. The density of population reaches over 1,200 persons/km². It is only lower than Ho Chi Minh and Hanoi cities in Vietnam. The pressure of over population has made the problem of increasing food products become very urgent. The area of agricultural land can not be increased; therefore the farmer will strengthen to use a vast amount of pesticides and chemical fertilizers. After 1990, the government was not still exclusive in pesticide and chemical fertilizer management. Annually, a large amount of chemical fertilizer was used, about 40, 58 and 2.7 thousand tones of nitrogenous, phosphate, potassium fertilizers, respectively. It made the degradation of soil inland and it is also a dangerous source of pollution. In addition, the chemical toxic compounds from pesticide and chemical fertilizer can be transported to the coastal zone by surface and/or underground water that make the pollution of seawater and sediment.

Industrial and Municipal Waste

Along the Red River and Thai Binh river system, there are many big cities such as: Viet Tri, Hai Phong, Ha Noi, Nam Dinh and Thai Binh town. These areas concentrate a lot of population and industrial factories. Only Ha Noi City has 274 industrial factories, 540 service facilities and 3800 small industrial co-operatives. Because of old equipments and technologies, the amount of waste is very high and the waste is also often very harmful to the environment. Most of wastewater was not treated before flowing to the city's drainage system. The total of wastewater in Hanoi is about 300,000 m³/day, within that industrial wastewater is 85,000 - 90,000 m³/day. In Viet Tri city, the annual total of wastewater of industry and living is 21.8 km³. The most harmful wastewater was come from Super Lam Thao company (a company for potassium fertilizer and other agricultural productions) because the pH was too low (pH = 1-2), that causes the estimated amount of H₂SO₄ flows directly to Red River is over 200 tones in Viet Tri city. In it's turn, Thai Binh town also creates a large amount of waste, especially in two industrial zones (the north industrial zone includes the factories for jute, producing machines, cement, lime, etc; the south one includes the factories for textile, dying cloth, synthetic leather, medicine, beer, etc).

Although there was not any detail research in order to make an accurate and sufficient conclusion about the influences of industrial and municipal waste to the rivers and coastal zone in Thai Binh province. But the bad affects to coastal environment and resources will be the essential problems.

Some environmental problems caused by the influences of human activities

In fact, all of the natural processes, phenomena and environmental problems take place in the close and complicated interaction between nature and human activities. However, this paper concentrates on the influences of human activities that newly create or strengthen or minimize

or change the potential of activation, equilibrium state of natural processes and after that some environmental problems can be derived. In coastal zone of Thai Binh province, the main environmental problems are as follows:

Hazards caused by accretion and erosion

Generally, the accretion has made considerable benefits to coastal zone in Thai Binh province, includes expanding the land, making a convenient condition for the development of agriculture and aquatic plantation. However, the activities of building sea dykes make a significant change of river hydrological regime. The bottom accretion will increase and makes the river and channel beds shallower. In the other hand, the alluvium of the river will concentrate at the river mouth and causes the intensive accretion at the adjacent coastal zone. In coastal zone of Thai Binh province, the fastest accretion takes place at Ba Lat mouth and adjacent areas. The velocity of horizontal accretion towards the sea is 15-100 m/year (Fig. 3). The velocity of vertical accretion in the region also reaches 15-20 cm/year. About 30-40 km away from the shoreline, the velocity of vertical accretion is still very high (5-8 cm/year).

The accretion has caused the topography at Ba Lat, Diem Dien and Thai Binh mouths become shallower and change the direction of river flow. These make many difficulties for navigation. A typical case of change the direction of river flow happened at Ba Lat mouth. The direction of Red River flow was southeast in 1935. After that, during the period from 1935-1942 the direction of flow changed to northeast and since 1973 the direction of flow has turned back to southeast. Fig. 3 can show evidence that before 1965 there was only a shoal at the northeast of the mouth. But nowadays there are also some big shoals at the south-east direction.

The erosion does not distribute as widely as the accretion (Fig. 4) but it also caused a lot of damage to socio-economic in the region. The erosion in coastal zone started at the beginning of 1950s and has become very seriously since the end of 1970s and beginning of 1980s. The erosion usually happens due to strong tides, storms and northeast strong winds. In Thai Thuong, Thai Do communes (Thai Thuy district), Dong Long, Dong Minh, Nam Think communes (Tien Hai district) the erosion has intensively developed. The velocity of erosion is about 10-15 m/year. In Dong Long commune, there was a sand dune covered by pine-trees between the inland and the shoreline in 1982-1983. But nowadays the sand dune was completely destroyed and the area has become a tide flat with the width of over 200 m.

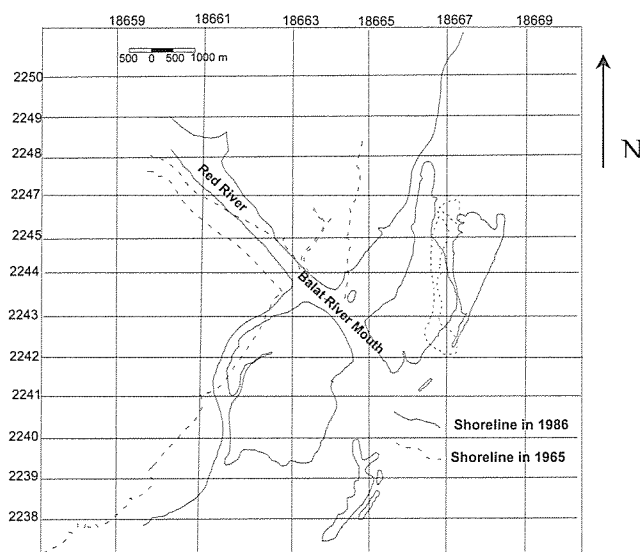


Figure 3. Shoreline at the Ba Lat mouth

(after topographical maps in 1965 and 1986 - calibrated by aerial photos taken in 1998)

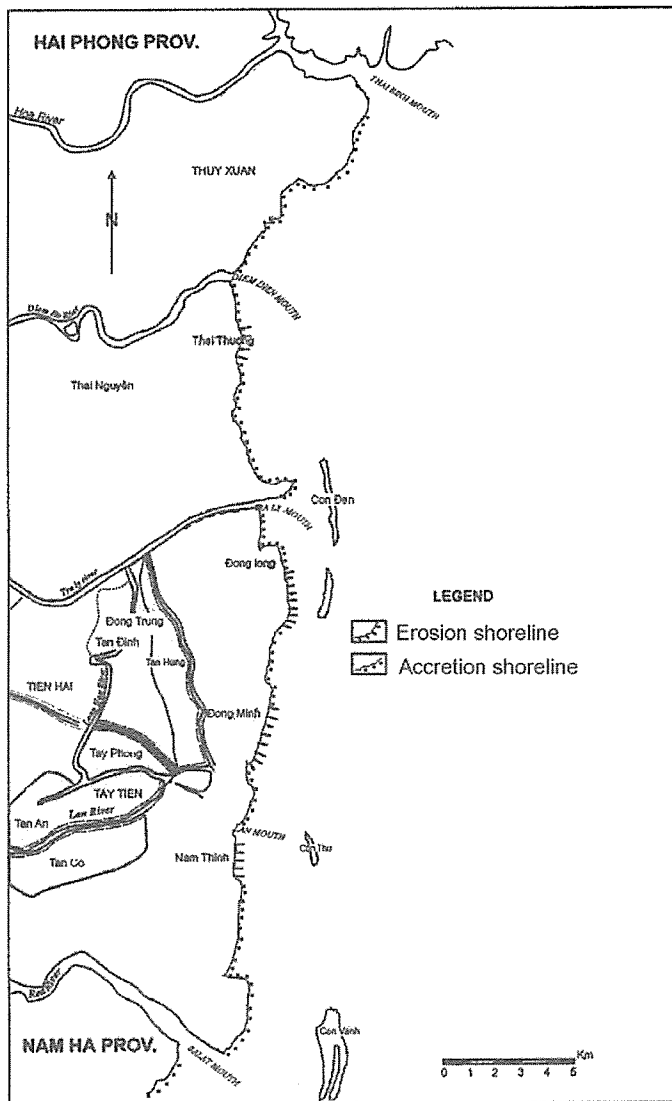


Figure 4. Distribution of accretion and erosion at the costal zone of Thai Binh province

Potential of saline intrusion

Saline water often intrudes into land by the rivers and channels nearby the sea due to tide. This process is closely affected by storms and increasing water level due to storm, morphology of river mouth and river discharge. In many coastal communes such as Thai Do, Thai Thuong, My Loc (Thai Thuy district), Nam Hong, Nam Phu and Nam Thinh (Tien Hai district) the agricultural land was degradation because of saline intrusion. The residents can only make a harvest each year in these areas. An important reason of saline intrusion was the change of river flow direction and morphology of river mouth. The area of saline intrusion was reached 6 km more towards the land due to the change of river flow at Ba Lat mouth in 1973. Binh Dinh commune (Tien Hai district) - a fertile agricultural land has become saline land since the end of 1973. The water salinity is now about 15-20‰. Because of lack of knowledge about saline intrusive process, the residents took the water from the channels in the region for irrigation and 4,800 ha of rice and vegetable field were lost in January 1974.

Potential of seawater pollution of heavy metals

The seawater in study area is specific by low content of many metals such as Cd, As, Sb, etc. However, some area that closely related to human activities, especially river mouths, the intensive increase of content of Cu (brass) and Zn (Zinc) can be found.

According to the pollution coefficient $T_{tc} = C_x / C_{tc}$ (C_x is the content of metal in seawater of study area, C_{tc} is the highest permissive content in seawater after Vietnamese Environmental Standard, 1995), some areas have had the potential of pollution of Cu and Zn (table 3). However, the potential of pollution of these metals is only local.

Table 3: Potential of seawater pollution of Cu and Zn

Element	Content (mg/l)	T_{tc} Coefficient	Area
Cu	0.013	1.3	South Thai Binh mouth
	0.023	2.3	East Ba Lat mouth
Zn	0.025	2.5	South-east Ba Lat mouth
	0.028	2.8	South-west Ba Lat mouth
	0.036	3.6	South-east Tra Ly mouth

The high content of Cu and especially Zn in seawater was able the results of accumulative process of the chemical toxic compounds that were transported by Red River and Thai Binh river from upwards lands.

In addition, the content of Pb (lead), Hg (mercury) in seawater are also quite high. T_{tc} coefficient of Pb is approximately 1.04 at Thai Binh and Ba Lat mouth. In most of study area, Hg content in seawater is equivalent to it's content in seawater of the world shallow sea. Though Hg content at Thai Binh, Ba Lat mouth is higher but according to Vietnamese Environmental Standard it will not make bad influences to the ecological systems in the region.

Potential of sediment pollution of heavy metals

Based on the results of analysis (Atomic Absorption Method), the shallow sea sediments in the study area have the potential of pollution of some heavy metals such as: Hg, Zn and Cu.

The average content of Hg in sediments ranges from $5.10^{-6}\%$ to $120.10^{-6}\%$, it is higher than the average content in the world shallow sea ($3.10^{-6}\%$) 1.6-40 times. The higher content of Hg concentrated in clayey muddy sediments and created a band of Hg pollution along the shoreline in coastal zone of Thai Binh province.

In most parts of the study area, the average content of Cu and Zn are equivalent to the content in the world shallow sea. Nevertheless, at Ba Lat mouth the content of Zn is remarkable increase, it is 20-45 times higher than the content in the world shallow sea. In addition, in the east of Thai Binh mouth, a remarkable increase of Cu content is also found. It reached to $11 \times 10^{-3}\%$.

The high content of these heavy metals in the sediments will have the potential of the bad affects to community health after food chain, especially the bottom animals - a source of food of the human (more detail at 3.5).

Pollution of waste and pesticide

So far, there was not any detail research on waste pollution in the region. However, according to the research at the field a comment can be referred as follows: the coastal zone in Thai Binh province is a suitable region for economic development and it is also an area of high density of population. Therefore, the study region has had to receive many sources of waste such as: municipal waste, hospitals, aquatic producing factories, exploitation, processing natural resources and a little waste from tourism activities. Most of waste sources were not treated (both solid and liquid waste) before elimination to the environment. So the problems

of waste pollution in the study area are very necessary to be detaily researched as soon as possible.

The coastal zone of Thai Binh province plays an important role in the Red River system. It is the main interactive region between the Red River system and the sea. It is also a region of intensive agricultural activities. The pesticide and chemical fertilizer used for agriculture have created many toxic chemical compounds that can not be completely disintegrated. Then these compounds were spread to the river water and caused the water pollution. For example the average content of pesticide in the river water is about 0.6-1.5 mg/l in the study area. After that, the absorption process will richen these toxic chemical compounds in the sediment causes the sediment pollution (as mentioned above).

The analysis of water and sediment at the river mouths of the Department for Science, Technology and Environment of Thai Binh province showed that the seawater has contained some pesticides such as Lindane, Aldin, DDE, Endrin and DDT. The average total of content is about 0.87 mg/l, it is much higher than Vietnamese Environmental Standard 1995 (0.05 mg/l). The contents of these compounds in the sediment are also very high (table 4).

Table 4: Content of some toxic chemical compounds in sediment and bottom animals at the Ba Lat mouth

Chemical compounds \ Receptor	Dry Sediment (mg/kg)	Bottom animals (mg/kg)
Lindanne	33.82	42.32
Aldin	4.85	-
DDE	0.07	14.86
Edrin	8.98	-
DDT	13.74	11.09

(Source: Department for Science, Technology and Environment of Thai Binh province)

According to table 4, the contents of toxic chemical compounds are very high. The content of Lindane in dry sediments at Ba Lat mouth was 33.82 mg/kg, Aldin - 4.85 mg/kg, DDE - 0.07 mg/kg, Endrin - 8.98 mg/kg and DDT - 13.74 mg/kg. Then these compounds were absorbed by the bottom animals that caused a high content of toxic chemical compounds in bottom animals. For example the content of Lindanne, DDE and DDT in the bottom animals were 42.32 mg/kg, 14.86 mg/kg and 11.09 mg/kg, respectively. By food chain the toxic chemical compounds can intrude into the human body and will cause many bad affects.

CONCLUSIONS

Based on the above results, some conclusions can be referred as follows:

1. In the coastal zone of Thai Binh province, river, sea and human activities have a close interaction. The human activities have broken the equilibrium state, strengthen or changed the regulation of activation of some natural processes.
2. The construction of sea dykes, ploughing virgin soil and the exploitation of mangrove forest for aquatic plantation contributed to change the direction of flow, create some areas of sufficient and lack of alluviums that caused the hazards of accretion and erosion.
3. The industrial activity inland may be the reason of the potential of seawater pollution of Cu, Zn and the potential of sediment pollution of Hg, Zn and Cu. The agricultural has caused the seawater and sediment pollution of pesticide. The content of toxic chemical compounds (Lindanne, Aldin, Endrin and DDT) in seawater, sediment and bottom animals are very high that can make bad affects to community health by food chain.

4. In the study area, the problem of waste pollution is serious and it is necessary to carry out a detail research as soon as possible.
5. So as to get the effective results about economic and environment, the plan for building new sea dykes should pay attention at taking the advantages of the natural processes in the region.

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