CHAPTER 218

SEA DIKE EROSION AND COASTAL RETREAT AT NAM HA PROVINCE, VIETNAM

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ABSTRACT

Nam Ha Province is situated on the coast of the Red River Delta, immediately east of the mouth of the Red River. The coast of the delta is very dynamic in which large quantities of sediment are supplied by wet season run-off. However, in Nam Ha province the coast is retreating such that successive lines of dikes have been abandoned and a unique 'managed retreat' strategy is underway with double lines of dikes along large parts of the province's coast. This paper reviews and describes the possible causes of the erosion problem and highlights the uniquc way in which the local coastal engineers are adopting, out of necessity, the classical retreat strategy. Other impacts of the problem such as environmental and socio-economic impacts are also reviewed. Based on the qualitative first order analyses a strategy has been defined towards a sustainable development of this coastal area.

SITE DESCRIPTION

The Delta of the Red River is located in the northern part of Vietnam (Figure 1). The Thao River rises in the Dai Ly Lake in China. In Vietnam, near the town of

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Viet Tri, the Thao River becomes Red River and receives flow from two other major contributories: the Da River and the Lo River. The Red River Delta has the classical triangular form downstream of Viet Tri. East of the Red River the Thai Binh River flows onto the Red River Delta. The Red River catchment area is about 155000 km^2 and reaches into China and Laos, resulting in an average annual discharge of 137 * 10^9 m^3/year, and a total estimated sediment load of about 72 * 10^6 t/year to the Gulf of Tongking (World Bank, 1994). The sediment is discharged through a large number of branches over a coastline with a length of some 165 km (as the crow flies). The enormous amount of sediment in general leads to accretion in the coastal areas for which the growth of the Red River Delta itself is the most outstanding proof and example. However, despite this fact there are local stretches of coast on which serious erosion problems are reported. Two provinces where such erosion problems exist are the provinces Thai Binh and Nam Ha. Surprisingly both provinces are directly located at Cua Balat, the mouth of the main branch of the Delta: the Red River itself (Figure 2).

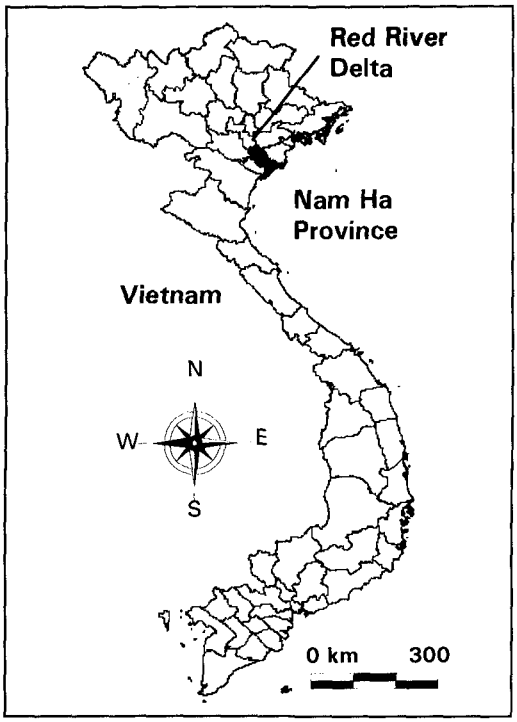

Figure 1 *Vietnam*

Nam Ha province is bound by the Red River in the north-east and by the Day River in the south west. The coast length is about 60 km and generally faces E to SE. The province has three coastal districts which are separated by branches of the Red River (Figures 2 and 3). One of the branches, Ngo Dong River was dammed in 1955. The middle district, Hai Hau district, experiences a serious consistent widespread erosion. About 75% of the total of 25 km coastline of Hai Hau district is retreating.

The coastline of Hai Hau district is being protected by dikes. In front of the dikes is a very gentle sloping beach. The slope of the beach varies along the coastline from 1:40 on eroding beaches to 1:200 in other places. The beaches consist of very fine sand with an average grainsize of about 80 μm. Measurements show an increase of the grainsize on the eroding sections of the coast.

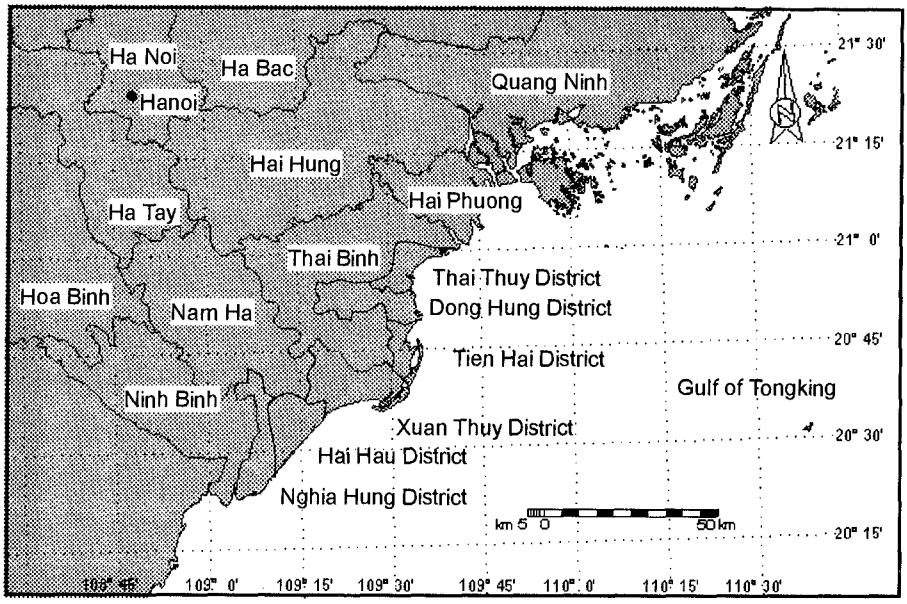

Figure 2 *Red River Delta Provinces and Coastal Districts Nam Ha Province*

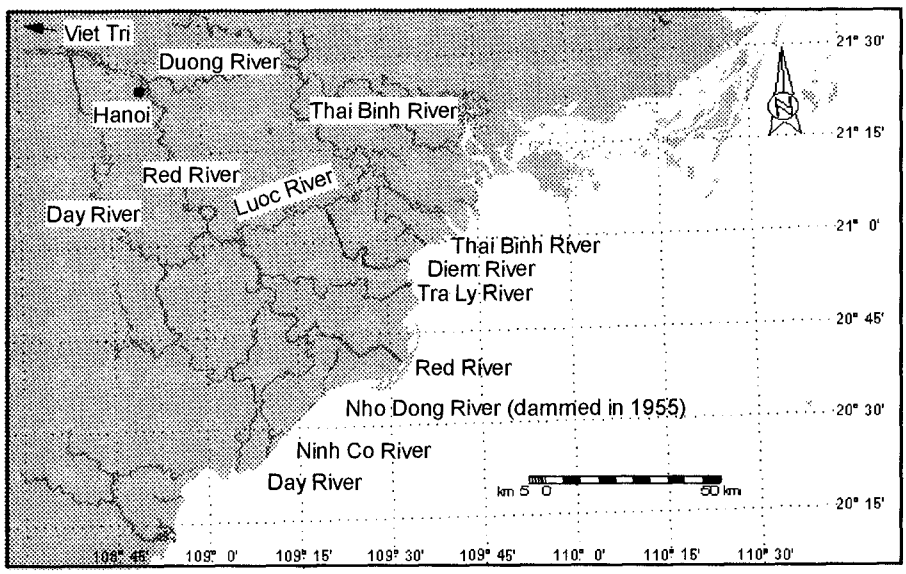

Figure 3 *Red River Delta River Branches*

HISTORIC SHORELINE DEVELOPMENT

The coastline development this century (from 1905 to 1992) in Nam Ha province is presented in Figure 4. It can be seen that the development of the coast is irregular. Near the mouths of the Red River (right hand side of the figure), the Ninh Co and the Day River (both on the left hand side of the figure) progressive sedimentation has led to accretion. This results in shoreline developments in these areas of 2.5 km to 6.5 km in seaward direction over the 87 year period. However, in Hai Hau district the development is just the opposite. Over the last 87 years a strip some 16 km long and about 2.5 km wide was lost to the sea. This is a time averaged shoreline retreat of about 29 m/year. It appears from this figure, which is based on maps, that the erosion at Hai Hau district started in the beginning of the century and seems to be slowing down after 1966. This indicates that the damming of the adjacent Ngo Dong River in 1955 is not the main reason of the consistent erosion problems.

LOCAL RESPONSE STRATEGY

The present coastal defence at Hai Hau district consists of a double dike system (Figure 5). These parallel dykes, with a separative distance of about 250 m, are constructed along 75 % of the Hai Hau coastline. The area between the dykes has been split into sections alongshore in the range of 500 to 3000 m long. The beach in front of the first dike reaches to about MSL. The slope of the dike is about 1:2 (v:h) and is protected by pitched limestone rock of about 30 cm diameter placed on a clay layer. The crest height is approximately 4 m above MSL. The dike body itself consists of clay and sand. On heavily attacked sections the toe of the dyke is reinforced with cement grouting.

Since the erosion is progressing continuously the first defence line is becoming weaker every year. During extreme events the first dike is therefore at some points not strong enough to withstand the attack. In

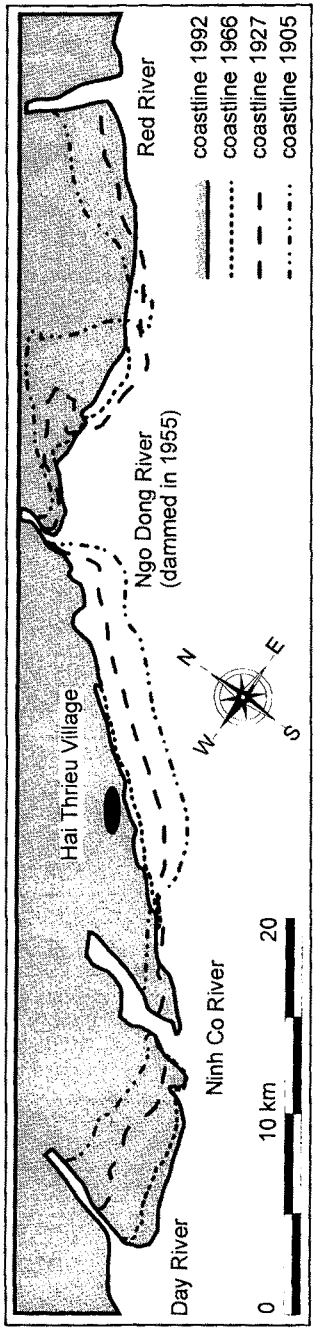

Figure 4 *Shoreline Development*

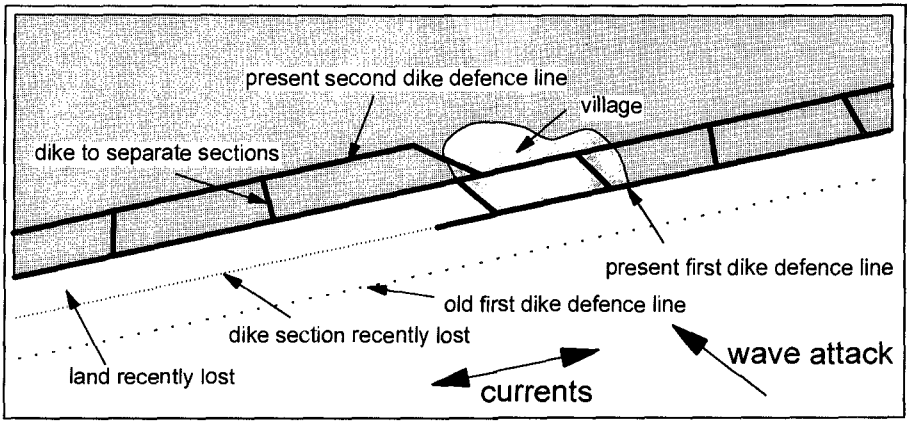

Figure 5 *Double Dike System*

order to prevent inundation the second defence line has been built. When the first dike fails the section behind the first dike is inundated and the second dike becomes the new first dike. Every time the first dike fails a section of land is lost to the sea since there are no resources to repair the old dike. In response to such a breakthrough a new second dike is built behind the new first defence line. On average every ten years a dike section is lost to the sea. This is a typical example of a managed retreat strategy although the Vietnamese authorities are forced by the circumstances. Beside the weakening of the dikes by the continuous erosion, the strength of the first defence line itself is in general insufficient due to problems such as funding and practical construction problems (such as accessibility of roads and availability of vehicles). This results in generally weak dykes, which are also too low, causing severe overtopping problems and revetment instabilities.

As the retreat of the coastline is known for many years evacuation plans are readily available. These plans are started on average every 2-3 years in case of high flooding risks. For maintenance and construction of the sea defences the authorities mobilise local inhabitants. As in the whole country the population has to invest a number of days per year in the community. The national average is about 10 workdays per year. In villages endangered by the erosion able bodied workers are required to work 40 days per year on dike repair, maintenance and construction.

ENVIRONMENTAL BOUNDARY CONDITIONS

The meteorological conditions of the area can clearly be divided into a summer (July and August) and winter (October to March) monsoon period. During the summer monsoon period moderate winds (average force: 3 Beaufort) from south western directions prevail. In winter the predominant wind direction is north east (average

wind force about 4 Beaufort). The summer monsoon period is also known as the 'wet season'. During this season 80% of the yearly run-off is discharged through the Red River system. Peak discharges are to be expected towards the end of the wet season or at extreme storm or typhoon events. On average two typhoons per year hit the coastline of the northern provinces of Vietnam. The typhoon season starts in May and lasts till October with the highest activity in the months July and August.

Similarly, the wave climate is also strongly influenced by the monsoon periods which is typical for this region of the world. The average deep water wave height in the summer months is about 1.5 m (coming from SW directions) whereas the average deep water wave height in winter is about 2 m (NE directions). However, during storms and typhoons the deep water significant wave height can develop to 10 m.

The characteristic range of the diurnal tide at spring tide is about 2.4 m. Currents along the coast are mainly tidally driven with a significant (seasonal) influence of wind and waves. During the last 30 years water levels (astronomic tide plus wind set-up) up to 3.00 m above MSL have been reported in bays and inlets along the shallow coast.

QUALITATIVE MORPHOLOGICAL ANALYSIS

The morphological system of the Red River Delta is very dynamic. During the wet summer monsoon season 80% of the annual sediment load is discharged to the Gulf of Tongking resulting in huge deposits near the River mouths. As the prevailing wave and wind direction is south west most of the sediment will be deposited on the eastern side of the river mouths (Figure 6). Wave conditions in the summer season can

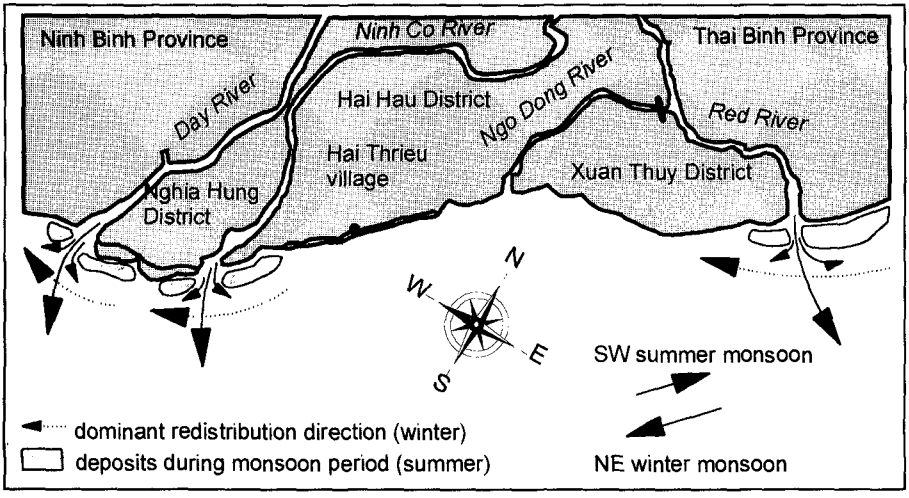

Figure 6 *Sediment Deposits and Redistribution Along the Shore*

be characterized as 'moderate' resulting in some redistribution of sediment in north-eastern direction. However, during the remainder of the year wind and wave conditions from north-eastern directions prevail. Compared to the summer monsoon the north-east monsoon is somewhat stronger and more persistent resulting in higher longshore sediment transports. During the winter season a substantial part of the fresh deposits will therefore be transported further offshore or be redistributed along the shore in south-western direction. The beach sections between the river mouths (beyond the direct influence of the river mouths) are therefore dependent on the redistribution mechanisms of deposited sediment from the nearest river branches.

Up to 1955 the Hai Hau district beaches were nourished by the Ngo Dong River in the north and the Ninh Co River in the south. The net sediment transport is directed to the south-west so the main source of sediment was the Ngo Dong River. With the damming of the Ngo Dong River the main sediment source was blocked resulting in erosion south of the River mouth. From then on the beaches of Hai Hau district had to be nourished from either the Red River or the Ninh Co River mouth (Figure 6). However, due to the shape of the Red River mouth hardly any nourishment took place from the north-east. Nourishment from the Ninh Co River could only develop during the summer months. From the coastline development graph (Figure 4) it can be seen that indeed some nourishment took place resulting in a stable or accreting development of the southern beaches of the Hai Hau district.

However, the erosion of the Hai Hau coastline did not start after the damming of the Ngo Dong River. The erosion started at the beginning of the century or even earlier. The reported erosion rates of 29 m/year over a length of 16 km indicate the Ngo Dong River must have been a major branch of the Red River. A possible explanation would be that at the end of the 19th century the Ngo Dong River lost its importance as a major branch of the Red River. This process, which can either be a natural development or a result of man made channelling works, redirected the discharge to, most probably, the present Red River mouth. The discharge through the Ngo Dong River diminished which allowed the damming in 1955. Damming would have never been possible when the Ngo Dong River was still a major branch of the Red River. This hypothesis of the historic development and importance of the Ngo Dong River is still under investigation.

QUALITATIVE PREDICTION OF THE SHORELINE DEVELOPMENT

Based on the above described hypothesis of the morphological system a prediction of the shoreline development can be made. When no action is taken the coastline will retreat at same pace for the coming years. On a longer timescale it is expected that the accreting coast of the Nghia Hung District will, due to the changing coastline orientation, develop an increasing nourishing effect on the Hai Hau coastline.

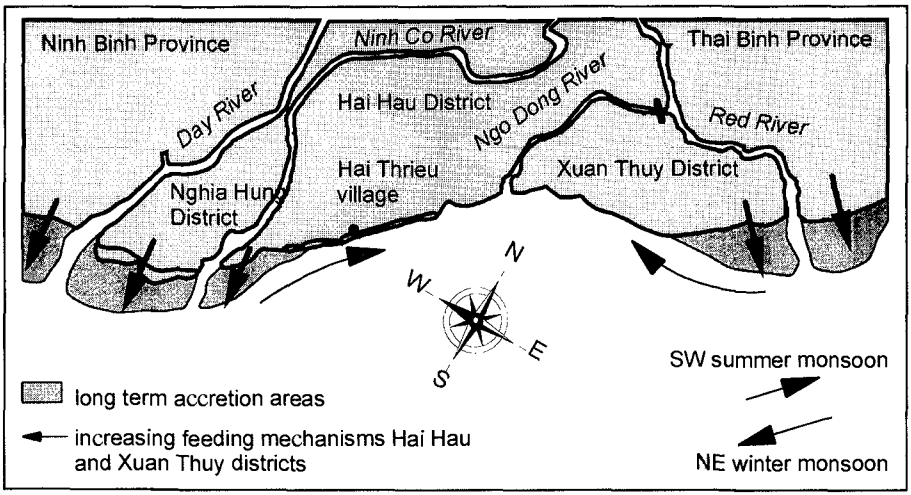

Figure 7 *Qualitative Prediction of Long Term Coastline Development*

The accretion near the mouths of the Ninh Co and Day River will slow down and the retreat at Hai Hau will decrease (Figure 7). This effect will develop along the coast starting in the south of the district.

SOCIO-ECONOMIC IMPACTS

Within Vietnam the Red River Delta (16,000 km^2) is the most densely populated region with 1,700 inhabitants per square kilometre. This is also among the highest population densities on arable land in the world (VVA, 1996). The erosion at Hai Hau district causes significant socio-economic impacts. The land in the coastal strip is completely in use for agriculture, aquaculture and salt production. Further, because of the progressing retreat, a number of villages are at risk being located directly behind the sea defence. Hai Thrieu for instance is a commune of which part of the 8000 inhabitants live between the first and second sea defence. At present the second dike is being reinforced as the authority reluctantly have to abandon the first dike in case of a breakthrough. Moving this part of the village requires resources and will include a social problem since practically all the land is presently in use. A more general problem of the coastal region is salt intrusion via overtopping of dikes. In this way storms and typhoons can impact a strip of 750 m wide along the coast with salt (eg. typhoon Wayne, 1986). It takes years after such an event before the original crop yield can be reproduced.

STRATEGY TOWARDS SUSTAINABLE DEVELOPMENT

Based on this qualitative analysis of the erosion at Hai Hau district a number of measures and preliminary strategies can be defined. However, an integrated approach is recommended which includes not only technical aspects but also socio-economics, planning and institutional matters in order to achieve a sustainable development. This Coastal Zone Management approach needs to include more investigations and studies on the mentioned fields in collaboration with the responsible Vietnamese authorities and the local people. The key study would be, in succession on this first qualitative analysis, the extensive investigation of the morphological development. A sound understanding of the processes and developments will result in a quantitative prediction of the shoreline development. This will form the basis for all further strategy decision making.

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