A SHORELINE ANALYSIS USING DSAS IN NAM DINH COASTAL AREA

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ABSTRACT

Shoreline change in Nam Dinh province in Vietnam is a chronic problem. Based on the 87-year historical data from 1905-1992, the shoreline change in Nam Dinh is re-analyzed using the ArcView extension entitled DSAS (Digital Shoreline Analysis System). The computational results show that there is beach erosion in Hai Hau and beach accretion in Nghia Hung and Xuan Thuy. Annually, shoreline retreat 25-26 in Hai Hau and beach advances 12-20m in Nghia Hung and 37 m in Xuan Thuy. DSAS shows its advantages comparing to the traditionally manual shoreline analysis.

1. INTRODUCTION

Since the beginning of the previous century, coastal evolution has occurred remarkedly in Nam Dinh Province. The coastal area limited by Red river and Day river has shown the most server beach erosion and accretion. Specifically, beach erosion and beach accretion can be seen in Hai Hau and Nghia Hung-Xuan Thuy districts, respectively.

Although the coastal problem has been known quite along time, the combat against the coastal erosion is not successfully setup. To analyze the coastline evolution based on historical data in this area, we divide the studied area into three regions as shown in Figure 1:

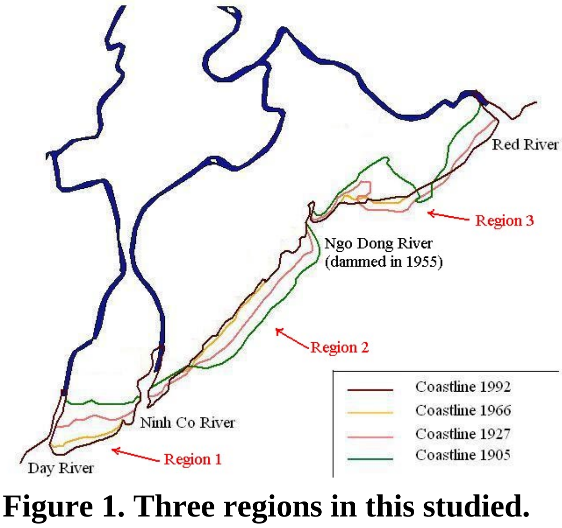


Figure 1. Three regions in this studied.

1) Region 1: From Day River to Ninh Co River (~ 8 km),
2) Region 2: From Ninh Co River to Ngo Dong River (dammed in 1955) (~ 19 km),
3) Region 3: From Ngo Dong River to Red River (~ 5 km).

2. THE NATURAL CONDITIONS IN NAM DINH

At the studied area, there are some river mouths, such as Day River in the south west, Ninh Co River, and Red River mouths in the north east.

Two wind seasons are available in Nam Dinh coast. The winter north east and east monsoon begins from October and lasts until March next year, and the summer south, south-east and west-east monsoon during the remaining months.

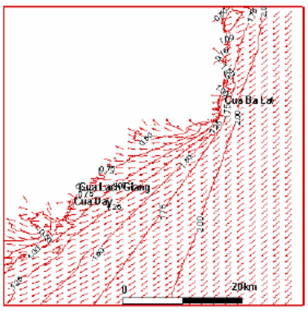
The tide plays an important dynamical role in the coastal and estuarine areas. The large amplitude of the tide of up to 4 m together with small beach slope create a wide wave breaking zone, influencing the coastal sediment transport processes and the stability of coastal structures. During flood tide, waves can propagate without breaking until the surface of the revetment. The tide also creates high current speed near the coast and at river mouth. The maximum tide during winter together with high waves cause serious coastal erosion and induce the instability of the river dikes.

The wind setup at the coast mainly appears during winter under the north – east monsoon for a long duration. Results of 40 years observations (1962-2002) shows that wind setup during north – east monsoon in combination with high waves is 50 – 80 cm. The storm surge can be as large as 2m.

The mean offshore wave height is 1.2 m. The maximum offshore wave height is 6 m. The highest waves observed during storms have the height of 7 – 8 m.

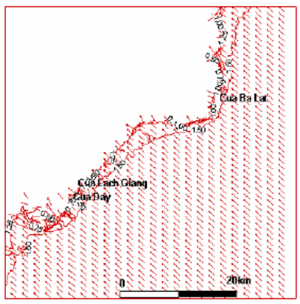
During the transition period of April and May, the offshore waves change their directions from north – east to south. During October and November, the change is wave direction is reversed. During these transition periods, waves are significantly weaker than that of winter and summer.

From numerical model, the wave propagation in this area with respect to different wind conditions are shown below (Ca *et al.* 2006) the incoming wave direction is showed in the following figures:



a)

b)



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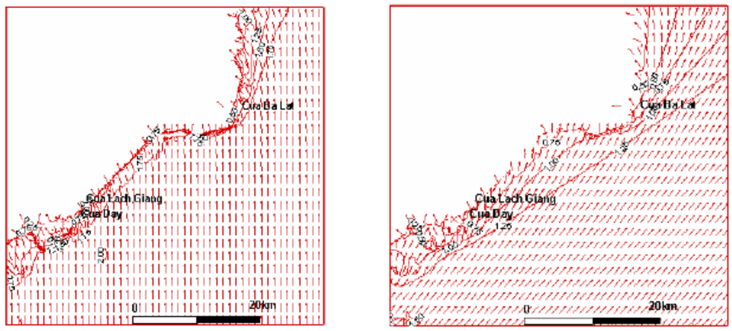

d) e)

Figure 2. Wave field for representation wave: a) NE, b) E, c) SE. d) S, e) SW

3. METHODOLOGY

3.1 Shoreline data analysis

Among many standard methods for shoreline analyses, two methods are selected in this paper, namely the End Point Rate and the Linear Regression, to calculate the rate of change for comparing results together. Following the DSAS tutorial (Thieler *et al*. 2003), these two methods can be described as follows.

The End Point Rate (EPR) is calculated by dividing the distance of shoreline movement by the time elapsed between the earliest and latest measurements (i.e., the oldest and the most recent shoreline). The major advantage of the EPR is its ease of computation and minimal requirement for shoreline data (two shorelines). The major disadvantage is that in cases where more than two shorelines are available, the information about shoreline behavior provided by additional shorelines is neglected. Thus, changes in sign or magnitude of the shoreline movement trend, or cyclicity of behavior may be missed.

A Linear Regression (LR) rate-of-change statistic can be determined by fitting a least squares regression line to all shoreline points for a particular transect. The rate is the slope of the line. The advantages of linear regression include:

1) All the data are used, regardless of changes in trend or accuracy;

2) The method is purely computational;

3) It is based on accepted statistical concepts; and

4) It is easy to employ.

3.2 DSAS

DSAS stands for Digital Shoreline Analysis System written by Thieler *et al.* (2003) using Avenue for ArcView extension. The purpose of this extension is to extend the normal functionality of the ArcView geographic information system to include historic shoreline change analysis. The application extension is designed to efficiently lead a user through all the major steps of change analysis in a clearly organized and attractive user interface. This extension to ArcView contains three main components:

1) to assist a user to define a landward baseline,

2) to generate orthogonal transects at a user defined separation, and

3) to calculate rates of change.

4. DATA

It is commonly unavailable long-term historical data for shoreline changes. This is particularly true for the case of Vietnam. Fortunately, historical data for shoreline changes at Hai Hau beach is available 1905 to 1992 as shown in Figure 3 (Vinh *et al.* 1997). The 87-year shoreline change at Hai Hau is selected as the DSAS input for the shoreline analysis.

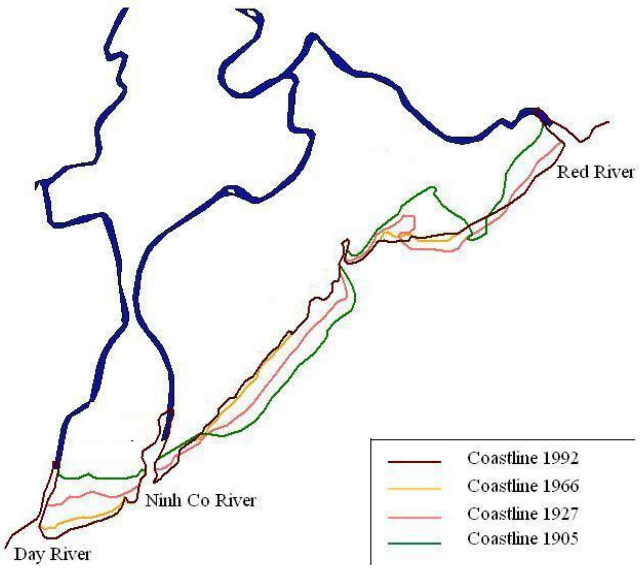

Figure 3. Coastlines in Nam Dinh Province from 1905 to 1992.

5. RESULTS

For shoreline analysis, the transects (i.e. the normal of shoreline) referenced to the baseline should be established. As Hai Hau beach is divided by three small rivers, it is impossible to adopt DSAS directly. Hai Hau beach therefore is separated as three regions (Nghia Hung, Hai Hau and Xuan Thuy) in which 329 transects could be setup as shown in Figure 4. The transect spacing is 100m.

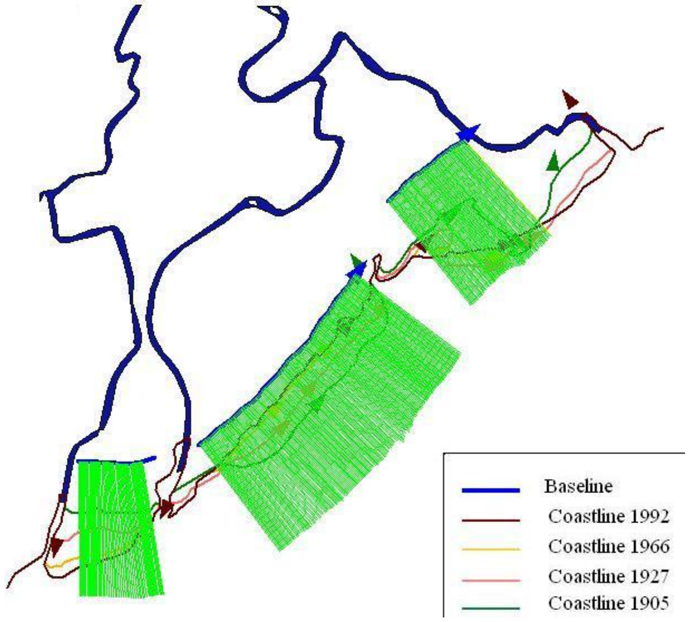

Figure 4. Transects along baseline.

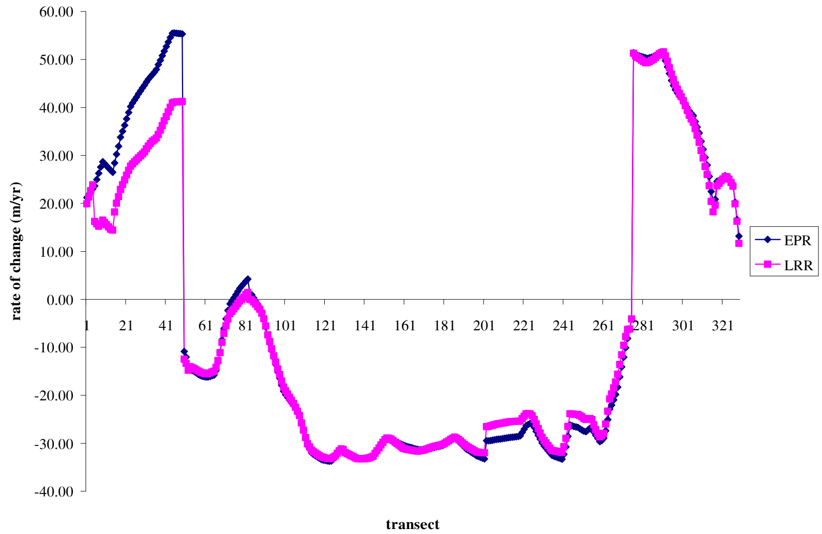

Figure 5. The rate of change of Nam Dinh Beach.

Based on the transects established from DSAS in Figure 4, the shoreline rate of change using EPR and LP can be computed and illustrated in Figure 5 and Table 1. In Figure 5, it is clear that the positive rate of change in Nghia Hung and Xuan Thuy show the beach accretion. In contrast, the negative rate of change in Hai Hau indicates the beach erosion. Specifically, it is on average about 25-26m shoreline withdrawal annually and 5183m for 87 years from 1905-1992 in Hai Hau. On the other hand, there is beach advancement about 12-20m/year and 1660m from 1905-1992 in Nghia Hung. Similarly the beach progress averagely

37m/year and 2049m from 1905-1992 in Xuan Thuy. Form the beach evolution in this area, it seems that Hai Hau beach tends to vary and reach its equilibrium planform.

Comparatively, two methods EPR and LP give the same computed results of rate of change for Hai Hau beach except some small difference (10m/year) in Nghia Hung. The computational difference probably due to the fact that only the last and earliest coastline in EPR method is used. With this, it would produce larger error in EPR comparing to the LP. The tendency of shoreline change in the EPR is not able to be demonstrated against the LP method.

Table 1. Computational results of the rate of change by EPR and LR.

	Region 1	**Region 2**	**Region 3**
EPR (m/yr)	20.25	-26.86	37.95
LR (m/yr)	12.89	-25.94	37.45

6. CONCLUSION

Based on the extension of ArcView entitled DSAS, the 87-year shoreline changes is quantitatively re-analyzed. Following results can be obtained:

A series of 329 transects which is quite time consuming in standard manual methods is automatically generated using DSAS.

With two standard shoreline analyses (EPR and LP), the shoreline evolution is confirmed by the rate of change. There are 25-26m shoreline withdrawal annually in Hai Hau and 12-20m and 37m beach advancement in Nghia Hung and Xuan Thuy respectively.

With adequate data available, DSAS which is useful for the coastal management can be adopted to perform shoreline analyses in other provinces Vietnam.

7. REFERENCES

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