# Long-term morphological change on Darang Coast, Vietnam

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**Abstract**

Phenomenon of accretion and erosion at the Darang River mouth has been observed to be severe for a long term. Based on the satellite images- Landsat images, the long-term evolution of this area from 1988 until now has been raised to discuss. The shoreline variation in the river mouth has happened in an unpredictable way; indeed, the adjacent areas in which at both sides of the river mouth have much changeable while the areas far from the river mouth have been seen to have minor change. This study applies even-odd method to analyze the variation of the shoreline at the Darang River mouth. The formation of both sides of the river mouth varied consecutively in the period from 1988-2015. The onshore/offshore retreat and advance of both sides represents the even portion while the odd portion represents the longshore sediment effects.

## 1. Introduction

Vietnam is not a big country in Southeast Asia but fortunately the country has a long coastline about 3620km stretching along from North to South. Alongside the coastline, there are many rivers pouring into the Pacific Ocean and the erosion of the areas contiguous to these river mouths has been detected to be a essential issue in recent years. So far, the sediment retreat and deposition of the Darang River mouth has been become one of the most urgent concerns of not only the local authorities but also the government. There were many researchers analyzing this area before and after the erosion became severe such as Huong et al. (2009), these studies discussed the mechanism seasonally and annually tophographical change and hydrodynamic states of the river mouth. The latest research related to the Darang River mouth was Hoang et al. (2015) utilizing the satellite images- Google images from 2009 to 2015 to analyze the morphological change of this river mouth. That study claimed the most serious erosion area was around the river mouth while other places seemed to be stable and had small amplitude of change.

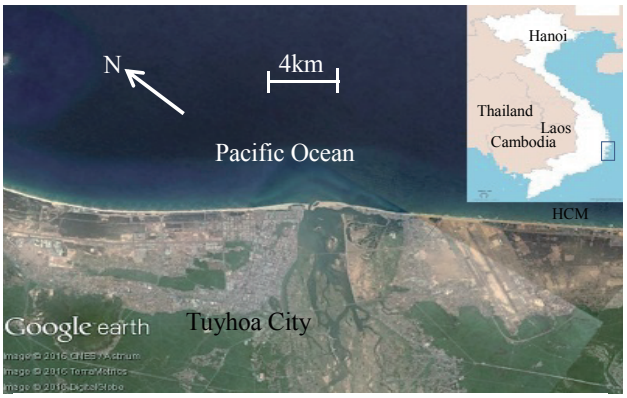


Figure 1. Study area

In this study, the Landsat images from 1988 to 2015 is used to survey the long-term morphology change at the Darang River mouth; however, owing to the sufficiency of the amount of data, this research also investigates the movement of the river mouth during the analyzed period and applies the even-odd method to discuss highly the variation of shoreline at the Darang River mouth.

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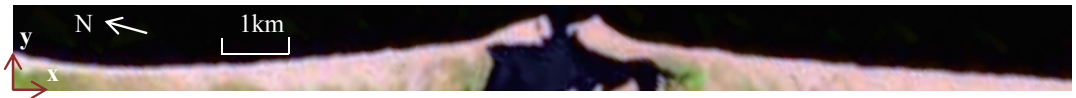
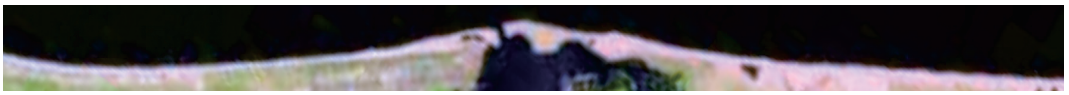
## 2. Study Area and Data Collection

The Darang River mouth is located in Tuyhoa City, Phuyen province, south central Vietnam, about 400km northeast of Hochiminh City. Figure 1 shows the location map of study area. Darang is the river mouth of the Ba River which has the catchment area of 13,900km$^2$ and 374km length.

In this research, Landsat Image obtained from U.S. Geological Survey (USGS) database from 1988 to 2015 is utilized. All the images had taken has been already rectified to the WGS-84 (World Geodetic System – 84). The method to detect the shoreline from the rectified images is depended on the peak of the gradient density which characterizes the difference between the color distribution sets of pixels. Due to the low resolution of the raw images about 15-30m per pixel, the utilization of these images must be considered strictly. Therefore, the data acquired can be used to discuss in the area in which remarkable change of magnitude exists as illustrated in Figures 2 and 3 but not in those where the changes are smaller than the resolution of the image.




(a) 1988-09-12



(b) 2002-08-10

(c) 2009-03-30

(d) 2015-06-30

Figure 2. Landsat images

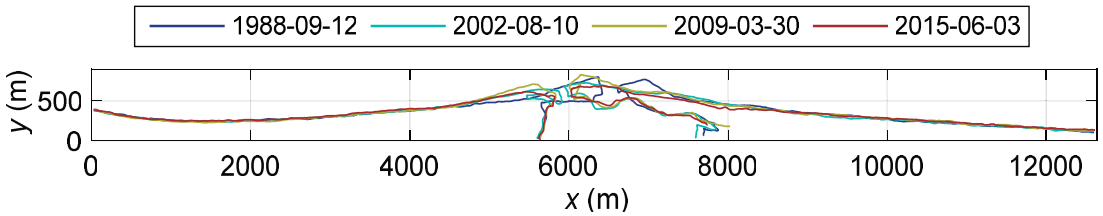



Figure 3. Shoreline position from 1988-2015

## 3. Result and Discussions

### 3.1 River Mouth Shifting

The shifting of river mouth plays an vital role in exerting the shoreline variation of the river mouth; therefore, the survey of location of the river mouth from 1988 to 2015 is needed. The position of the river mouth in each year can be found by means of specifying the location of the center point, $(x_c, y_c)$, as known as the narrowest point of river mouth. As shown in Figure 4, from the shoreline data, the definition of the

center point is able to be defined by taking the middle point between two points which are closest to each other from two sandspits respectively.

The movement of the river mouth can be seen clearly from Figure 5. It indicates that the location of the river mouth from 1988 to 1991 moved to the right direction then from 1993 until 2015 the river mouth position has been moving gradually to the left side of the river mouth and from 1995 there have been no signal to display the return to the location from 1988 to 1991.

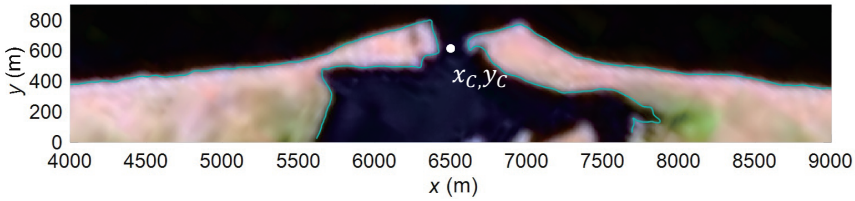
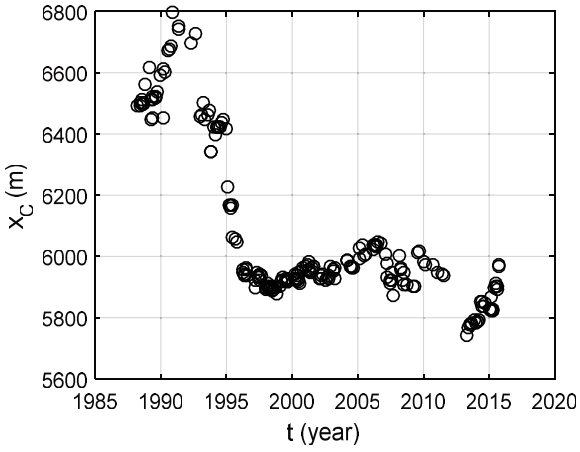
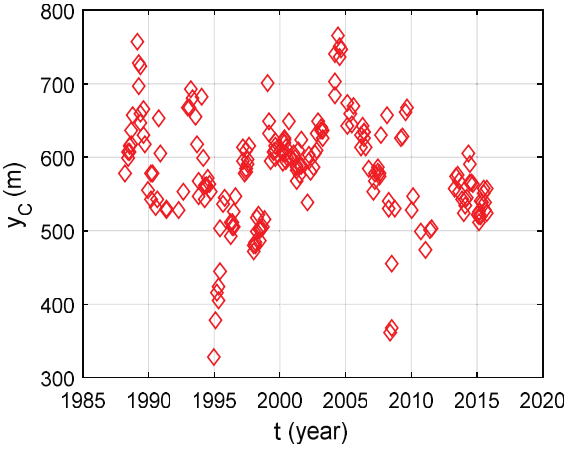



Figure 4. Center point location




(a) Temporal variation of $x_c$




(b) Temporal variation of $y_c$

Figure 5. Center point variation

### 3.2 Shoreline Change

Amount of shoreline accretion or erosion, Δy is evaluated and shown in Figure 6. The amount of shoreline accretion or erosion is obtained when subtracting value of all shoreline position data sets by the value of the first shoreline position data set. That calculation is expressed by Eq.(1)

$$\Delta y(x,t) = y(x,t) - y_0(x) \tag{1}$$

where $y_0$ is the first shoreline position data set on March 20, 1988.

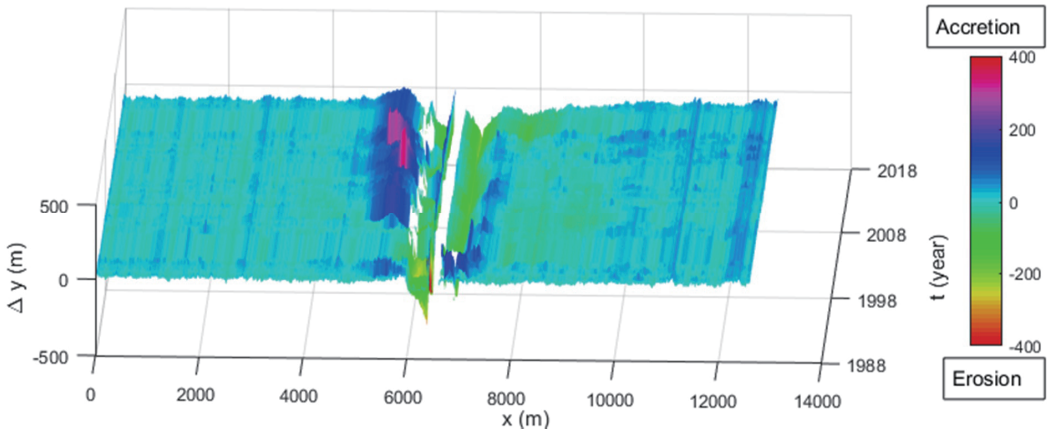



Figure 6. Shoreline accretion and erosion

From Figure 6, it is noticeable that the the erosion mostly focused on roughly 400m starting from the center of the river mouth to the both sides in the period from 1988-1995. Afterwards, due to the movement of the river mouth to the left side, the position of the river mouth has moved to another place causing the severe erosion in about 1km from the right side of the river mouth and rapid deposition on 1km area left side of the river mouth. Otherwises, the remainder of the study area has various variations and needed much data to acquire the noticeable differences but the existence of increasing trend can be seen from the Figure.

### 3.3 Even-Odd Analysis

The point of using even-odd method is to address how natural events and inlet or structure effects induces to the shoreline change. Owing to that, an independent time interval of shoreline variation is required with a separate assumption that the wave and wind climatology causing onshore/offshore and longshore transport is stationary in time (Walton, 2002). By Rosati and Kraus (1997), the total shoreline change $f(x') = y(x', t_n) - y(x', t_m)$ ( $t_n, t_m$ are the last and first shoreline data in the independent time interval) at an alongshore distance $x' = x - x_C$ from the inlet is composed of an even (symmetric) component, $f_E(x')$ and an odd (asymmetric) component, $f_O(x')$:

$$f(x') = f_E(x') + f_O(x') \tag{2}$$

where $f_E(-x') = f_E(x')$ and $f_O(-x') = -f_O(x')$. The even and odd components are extracted from the total (measured) shoreline change expressed by:

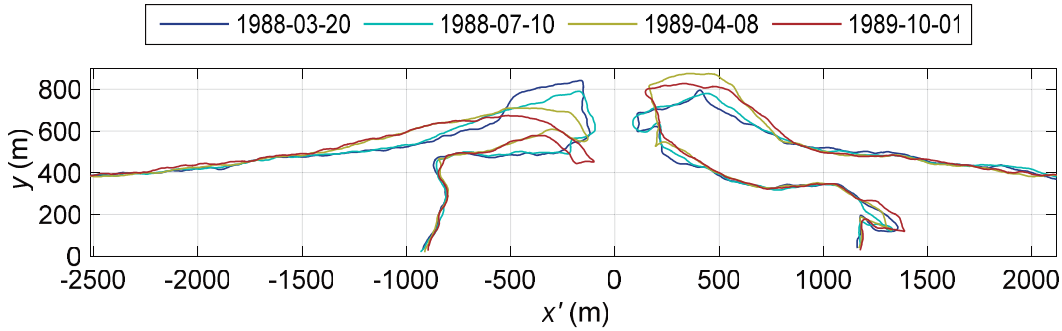
$$f_E(x') = \frac{f(x') + f(-x')}{2} \tag{3}$$

$$f_O(x') = \frac{f(x') - f(-x')}{2} \quad (4)$$

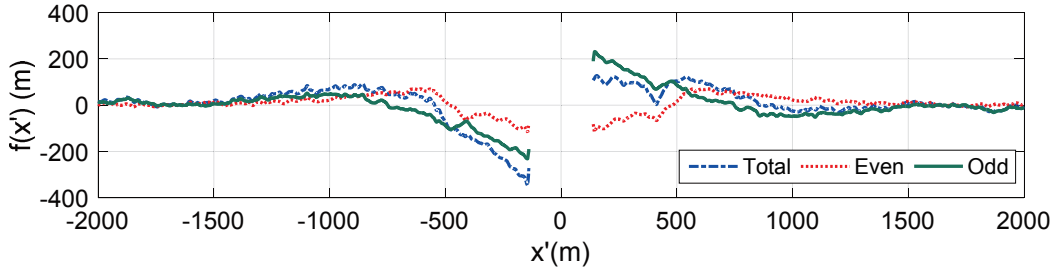
By the definition above, from 1988 to 2015, shoreline data in two periods from 1988 to 1989 and 1996-2004 are chosen to apply the even-odd method in order to express the change of shoreline and also the predominance process in the studied time.

**Period 1: 1988-1991**

During this period, the shoreline behavior is characterised by asymmetric shoreline position as seen in Figure 7(a). Indeed, the most changeable area in the left area is the area of roughly 1.5km from the river mouth whilst in the right side, the position has remarkable change is about 800m from the river mouth. Moreover, even though from both sides of the river mouth there are places that shoreline varies differently, but based on Figure 7(a), it can be marked that the the trend of shoreline variation in the left sandspit is reduction and that in the right sandspit is increase. As a consequence, the predominance of odd function can be detected in Figure 7(b).




(a) Shoreline position change

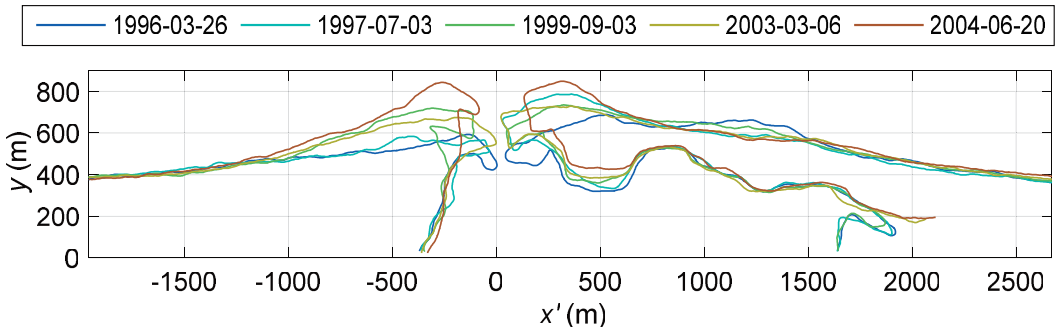



(b) Even-odd functions

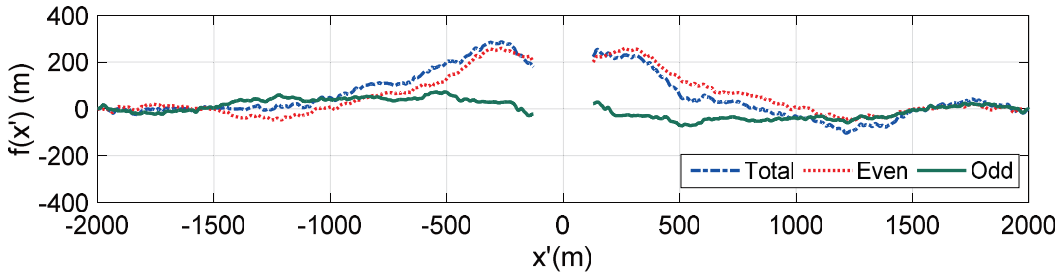
Figure 7. Shoreline position and even-odd functions during Period 1 (3/1988-10/1989)

**Period 2: 1996-2004**

The result from Period 2 in Figure 8 shows the influence of the river mouth shifting to the variation of area adjacent to the river mouth causing the offshore sediment advance in both sides. From Figure 8(a), the sandspits from two sides of the river mouth increases gradually from 1996 to 2004 by a large amount. And the movement of the river mouth is centralizing to the left sandspit also causing several eroded areas in the right sandspit. But the increase in shoreline in either left and right side of the river mouth can be noted to be the trend of this period. This leads to the predominance of even portion as shown in Figure 8(b).




(a) Shoreline position change




(b) Even-odd functions

Figure 8. Shoreline position and even-odd functions during Period 2 (03/1996-06/2004)

## 4 Conclusions

The erosion at the Darang River mouth has focused on the tip area of two sides of the river mouth. The change of shoreline is principally affected by natural events such wave, wind, sediment supply from river mouth. On the other hand, the location of the river mouth has been centralizing to be near the left sand spit causing the substantial deposition to both sides and the threat of closing the river mouth.

## References

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