

Propagation of erosion zone on Cua Dai Beach in Central Vietnam

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1. INTRODUCTION

Propagation of beach erosion on Cua Dai Beach in Central Vietnam under the mode of longshore sand wave has been observed. The propagation speed of the erosion zone is 54 m/y. In addition, propagation of the erosion zone was simulated using analytical solution proposed by Hoang et al. (2015). Comparison between measured data and analytical results was performed. Based on the comparison, the effect of coastal structures on the excessive erosion at Cua Dai Beach was figured out.

2. STUDY AREA AND DATA COLLECTION

This study focuses on a part of the left coastline adjacent to Cua Dai River mouth, which is usually known as Cua Dai Beach (Figure 1).

Landsat images from 1990 to 2016 were used for the analysis. All the images were rectified to the same coordinate system as can be seen in Figure 2. Data processing in this study is similar to what have been done by Duy et al. (2016).

3. SIMPLIFIED MODEL FOR BEACH EROSION

Larson et al. (1987) introduced a simple model for river delta formation with sediment supply from the river. This model was derived from one-line model based on some assumptions such as small angle of wave breaking crest to local shoreline and constant breaking wave height along the coastline. The governing equation of this model is presented in the following equation:

$$\frac{\partial y}{\partial t} = \varepsilon \frac{\partial^2 y}{\partial x^2} \quad (1)$$

In which, y : shoreline positions; x : longshore coordinate with the origin at the river mouth; t : time; ε : diffusion coefficient. Shoreline evolution on both sides of Cua Dai River mouth is first simulated with the

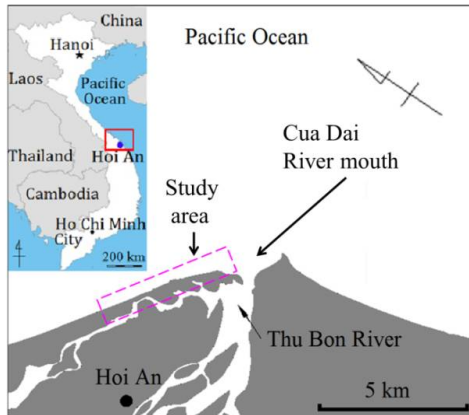


Figure 1. Study area

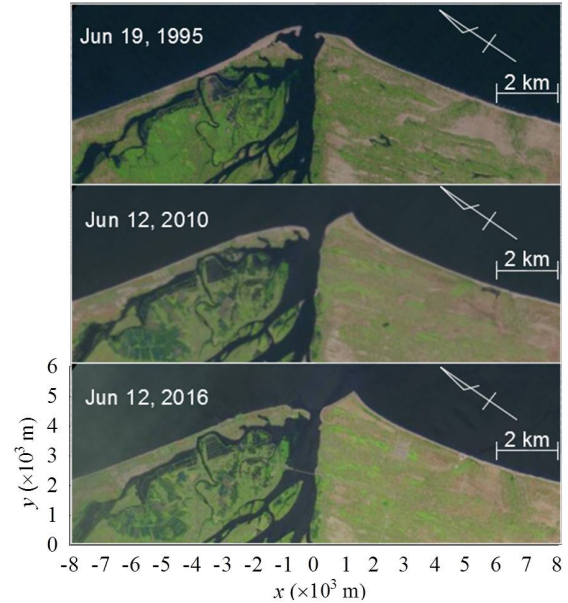


Figure 2. Coordinate system

formation process based on alluvial sand supply from Thu Bon River:

$$y = \frac{q_0}{D} \sqrt{\frac{t}{\pi \varepsilon}} e^{-x^2/(4\varepsilon t)} - \frac{q_0}{D} \frac{|x|}{2\varepsilon} \operatorname{erfc}\left(\frac{|x|}{2\sqrt{\varepsilon t}}\right) \quad (2)$$

In which, q_0 : sediment supply rate from the river, $D=D_B+D_C$ (D_B : berm height, D_C : depth of closure), erfc : complementary error function.

However, the analytical solution of Larson et al. (1987) is only for delta formation process (Eq. (2)). Hoang et al. (2015) introduced another analytical solution for beach erosion due to reduction of sediment supply to the beach. The erosion is simulated using Eq. (3). Since Eq. (1) is linear, linear superposition is applied in Eq. (3) to combine the effects of Eq. (2) and the reduction term (the second term on the right side of Eq. (3)) to express the beach erosion process.

$$y = \frac{q_0}{D} \sqrt{\frac{t}{\pi \varepsilon}} e^{-x^2/(4\varepsilon t)} - \frac{q_0}{D} \frac{|x|}{2\varepsilon} \operatorname{erfc}\left(\frac{|x|}{2\sqrt{\varepsilon t}}\right) - \left\{ \frac{R \cdot q_0}{D} \sqrt{\frac{(t-t_0)}{\pi \varepsilon}} e^{-x^2/[4\varepsilon(t-t_0)]} - \frac{R \cdot q_0}{D} \frac{|x|}{2\varepsilon} \operatorname{erfc}\left[\frac{|x|}{2\sqrt{\varepsilon(t-t_0)}}\right] \right\} \quad (3)$$

In which, t_0 : starting time of sediment reduction, R : reduction rate of sediment supply from Thu Bon River. Input values for variables in Eq. (3) are taken from Duy et al. (2016).

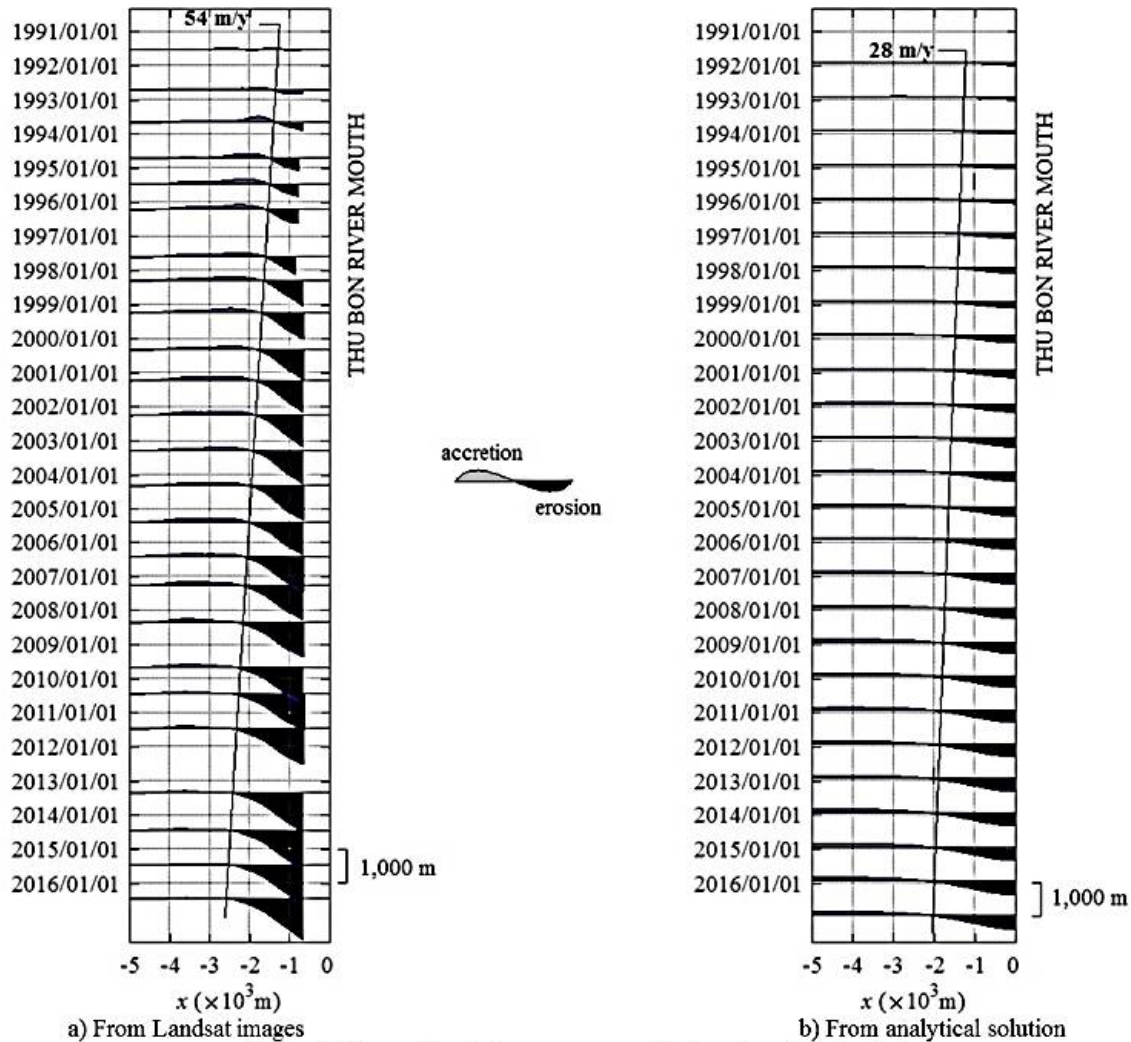


Figure 3. Comparison between measured data and analytical solution

4. RESULTS AND DISCUSSION

Figure 3 shows the shoreline changes with reference to the shoreline position in 1990. In which, Figure 3a was obtained by using the shoreline positions extracted from the Landsat images while Figure 3b was plotted with the simulated shoreline positions by using Eq. (3). As can be seen from the figure, measured propagation speed of the erosion zone based on Landsat images (54 m/y) is about double the propagation velocity obtained from analytical results (28 m/y). This indicates more severe erosion in reality. Countermeasures such as seawalls along Cua Dai Beach are the main reason of this excessive erosion (Nagasawa et al., 2016).

5. CONCLUSION

Propagation of erosion zone on Cua Dai Beach has been studied using Landsat images and analytical results. In reality, the erosion zone's propagation speed is 54 m/y. The excessive erosion at Cua Dai Beach is being caused by countermeasures along this beach and this conclusion well agrees with the idea of Nagasawa et al. (2016).

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