MONITORING SHORELINE CHANGE AT GO GIA RIVER

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ABSTRACT

Nowadays, shoreline change can be monitored and analyzed quickly and effectively using remote sensing and GIS technology. There are a lot of activities of ship transport on Go Gia river, one busy segment of Saigon river system. Such activities days after days certainly have impact to Go Gia riverbank and may cause erosion or deposition alongside. The aim of this paper is to assess the long-term changes of shorelines along riverbanks of Go Gia. Multitemporal Landsat images during the period of 1989-2014 were used. The erosion or deposition rates were calculated based on statistical methods in DSAS (Digital Shoreline Analysis System) tool.

Keywords: Landsat, remote sensing, GIS, DSAS, shoreline change

1. INTRODUCTION

Go Gia is a river lying between Long Tau and Thi Vai rivers, two main shipping waterways to enter Sai Gon port and Ba Ria - Vung Tau port respectively [Nguyen Viet Luong, 2011]. In the future, Go Gia area is one of the most promising places to construct a new port. Therefore, research on the change of river banks at this area in long-term time is very important to provide useful information for supporting such proposal.

Nowadays, remote sensing integrating with GIS technology is one of the most powerful tools to research most of fields, including monitoring shoreline change. Digital Shoreline Analysis System (DSAS), an ArcGIS extension, can quickly calculate the rate of change of shorelines based on history data by statistical methods [Thieler et al., 2009]. This tool now is used widely over the world from the United Stated [Hapke and Reid, 2007; Himmelstoss et. al., 2010] to Europe such as Turkey and England [Tuncay, 2011; Brooks and Spencer, 2010], from Afica such as Ghana [Frederick, 2011] to Asia like India and Bangladesh [Sheik and Chandrasekar, 2011; Sarwar and Woodroffe, 2013]. In Vietnam, the rates of change at Nam Dinh, Binh Thuan, and Kien Giang and Ca Mau province have been studied since 2008 [To and Thao, 2008; Pham Thi Phuong Thao et al., 2008; Hai Hoa Nguyen et al., 2010; V. Tran Thi et al., 2014]. DSAS can be not only applied for simple shorelines but also for river banks. Mekong river is the first area to be applied this tool [Lam Dao Nguyen et. al., 2010].

In this paper, the aim is to monitor the change of Go Gia river banks in long-term period of 1989-2014. The research just focuses on the right-side banks (direction from north to south) because this area is one of the highest elevations in Can Gio mangrove forest while the other part is low-lying. Landsat satellite images were collected to extract the banks of river in different time and DSAS tool was used to calculate the change rates of river banks over 26 years.

2. AN OVERVIEW OF THE STUDY AREA

The studied area is Go Gia river with 10 km in length from Ba Ngoi river to Cai Mep river. It is located at northeastern part of Can Gio District, Ho Chi Minh city, Vietnam. Can Gio borders Nha Be District to the north; East Sea (South China Sea) to the south; Dong Nai and Ba Ria- Vung Tau provinces to the east; and Long An and Tien Giang provinces to the west. Topographically, Can Gio mangrove forest is flat and low-lying in general, except the right-side of Go Gia area. The average elevation in this area is 1.5m [].

Climatically, this area is affected by tropical monsoon near the equator with two seasons: drainy one from May to November; and dry one from December to April next year [www.hochiminhcity.gov.vn/]. The south-southwest wind predominates during rainy season with the strongest wind in July and August while the north-northeast wind predominates during dry season with the strongest wind in February and March [Nguyen Viet Luong, 2011]. Generally, this study area is not in stormy zone. Regarding to precipitation, the average rainfall is approximately 1.300-1.400mm/year in Can Gio, and it is the lowest value in Ho Chi Minh city [Tuan and Kuenzer, 2012].

Hydrologically, there is a very complex river network in Can Gio. Freshwater from Sai Gon and Dong Nai rivers discharges to Dong Tranh and Ganh Rai bays (and goes out to the East Sea) via main branches such as Long Tau and Soai Rap rivers and subordinate branch such as Go Gia river. About tide regime, this region is impacted by mixed semi-diurnal tide with the wide range varying from 2m during mean tide to 4m during spring tides. The highest tidal amplitudes occur during October and November while the lowest is in April and May [Truong Thi Hoa Binh, 2008; Nguyen Viet Luong, 2011]. In drainy season, maximum current velocity at high tide near the surface is 1.27m/s and at the bottom is 1.07m/s. Strong current flows near right-side bank of Go Gia river at high tide and near left-side bank at low tide [Truong Dinh Hien, 2000].

3. DATA AND METHODOLOGY

3.1 Data

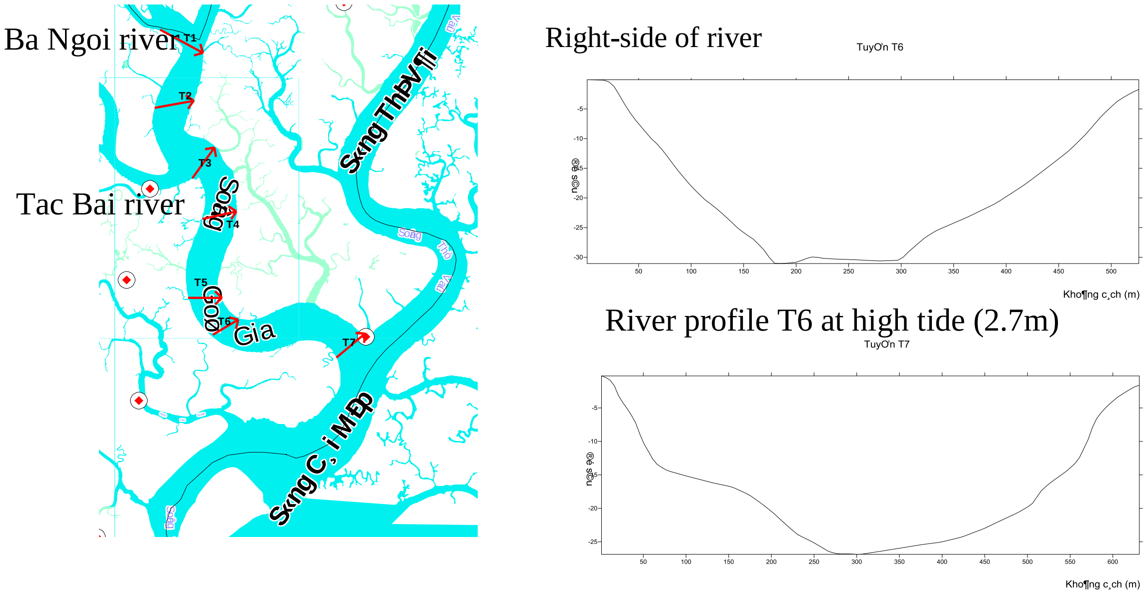
Landsat data source is from the website of United States Geological Survey (USGS). All images have the same projection of WGS-84, zone 48 and the same 30m resolution and they are listed in Table 1 (path 124, row 53). Data was chosen in the period of December to March next year to prevent significantly seasonal changes.

Tabe 1. List of Landsat scenes used to extract Go Gia river banks.

No.	Sensor	Date	Local Time	Water level (m)	Difference between water level at local time and mean water level 2.0m (m)
1	Landsat 4 TM	06/03/1989	09h40	1.8	+0.2
2	Landsat 5 TM	01/03/1996	09h15	2.4	-0.4
3	Landsat 7 ETM+	05/01/2002	09h56	1.4	+0.6

4	Landsat 5 TM	18/12/2009	09h58	0.8	+1.2
5	Landsat 8 OLI	03/03/2010	10h08	1.2	+0.8

The source of water level originates from WXTide32. Mean water level was calculated is 2.0m. In addition, river profiles were outlined based on data from a field trip in November 2013 (Figure 1).



Seven river profiles along Go Gia river River profile T7 at high tide (2.6m)

Figure 1. River profiles at Go Gia river.

3.2 Methodology

Band threshold was applied to extract waterlines from Landsat images at Go Gia river. In this study, band 6 for Landsat 8 and band 5 for the others are good to discriminate water from land. After considering the resolution of Landsat image, the difference between mean water level and actual water level of Landsat images (Table 1), and the river profiles, tide correction was neglected because horizontal gaps between the waterlines and mean water level were not higher than 0.5 pixel (15m) of Landsat resolution. As a result, waterlines from Landsat were assumed as river banks.

After having river bank data, rates of change were computed by using DSAS [Thieler *et al.*, 2009]. The process includes three main steps: (1) setting up baseline and shorelines/river banks; (2) choosing parameters for transects; and (3) calculating shoreline/river bank change rates. In DSAS version 4.0, the change rates are calculated based on some statistical methods, such as End Point Rate (EPR), Linear Regression Rate (LRR), and Weighted Least Squares Regression Rate (WLR). In this paper, only EPR and LRR result are shown.

4. RESULTS AND DISCUSSIONS

The studied area is devided into 2 regions by Tac Bai river: region 1 from Ba Ngoi river to Tac Bai river and region 2 from Tac Bai river to Cai Mep river (Figure 1).

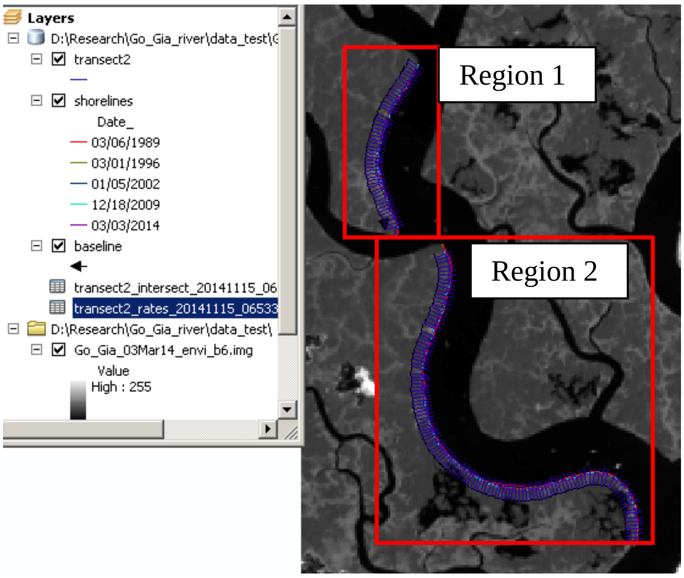
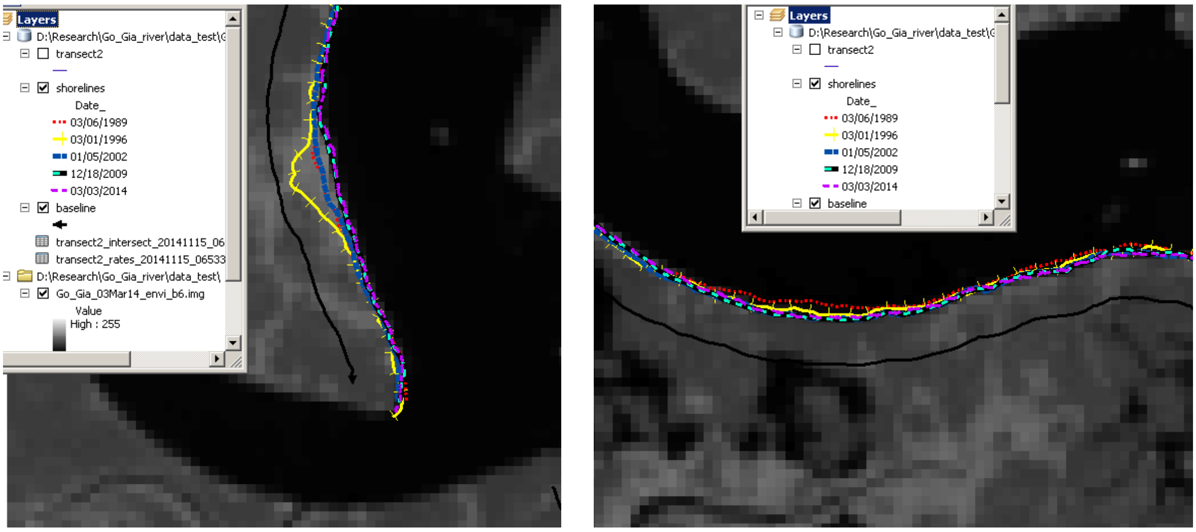


Figure 2. Transects for region 1 and region 2 along Go Gia river.

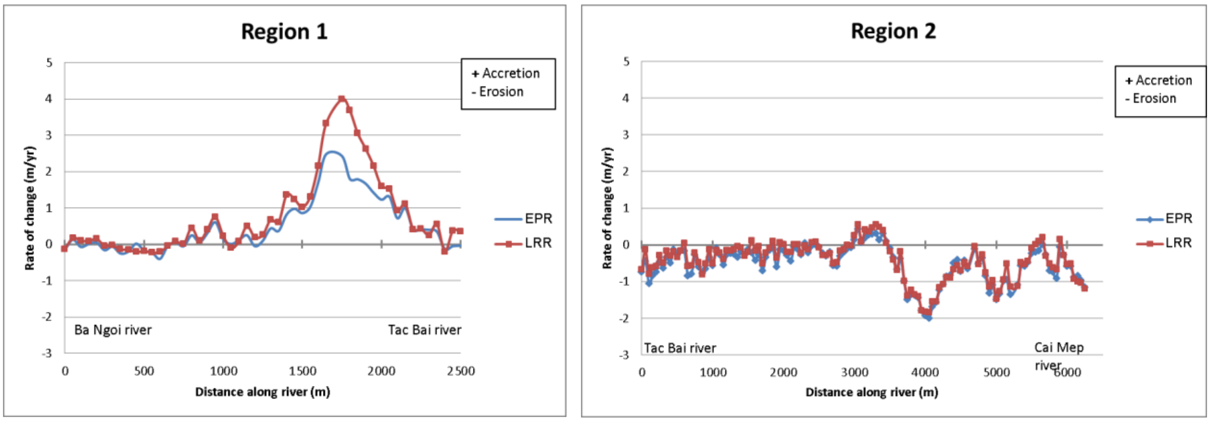
Before analyzing change rates of river banks qualitatively, an overview picture of 4 different periods was outlined and there were two significant changed segments (Figure 3). In region 1, serious erosion occurred near Tac Bai river during 1989-1996, however, the lost land were deposited from 1996 to 2002. After that, accretion process was continuing until 2009. During 2009-2014, river bank has been unchanged. In the middle of region 2, the right bank of river tended to erode more moderately than in the region 1 in the period of 1989-1996. Unlike the case in region 1, this segment was not retrieved but the bank of river has mostly been stable from that time until now.



a. Region 1 (near Tac Bai river) b. Region 2

Figure 3. Two erosion/deposition segments in Go Gia river during 1989-2014.

For analyzing the change rate of river bank on Go Gia river, 174 transects were set up along right-side bank. There are 50 transects for region 1 and 124 ones for region 2. Distance between transects is 50m. The change rate of river bank in region 1 and region 2 are shown in Figure 4. The positive rate means that river bank tended to deposition and the negative value means that shoreline tended to erosion.



a. The change rates in region 1. b. The change rates in region 2.

Figure 4. River bank change rates at Go Gia river.

In general, region 1 trends toward deposition while region 2 trends toward erosion although both magnitudes are very small. In region 1, annual rate of change is about +0.5 m/yr by EPR and +0.7m/yr by LRR. The highest rate of accretion is +2.5m/yr by EPR and +4.0m/yr by LRR at the segment where had a big problem of erosion recorded in 1996. It is not surprise because it had been recovery and deposited more after that. The net river bank movement varies in range of +45m to +60m to the water from 1989 to 2014. In region 2, it can be divided into two parts: the upper part is nearly stable while the down part tended to erosion. The maximum change rate is -2.0m/yr. This area is affected by strong tide current and some ship transport activities near the end of Go Gia river, where borders Cai Mep river to go to Ba Ria – Vung Tau port. Overall, average erosion rates in region 2 are about -0.5m/yr by EPR and -0.4m/yr by LRR.

Comparing the rates between two methods, they are nearly the same, except the place had a sudden change in the past in 1996. LRR gives higher rates than EPR method.

5. CONCLUSIONS

In summary, river banks of Go Gia river have a balanced trend with a little deposition rate in region 1 and a slight erosion rate in region 2 over 26 years in the period of 1989-2014. Although there were 2 serious erosion segments recorded in the past, these have been recovery and stable for a long time ago. Combining with other convenient natural conditions, this result can support the idea that choosing Go Gia area as one of the most ideal places to build a new port.

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