RESEARCH STATUS AND CALCULATION VARIABLE SPEED COASTLINE IN CUA DAI - HOI AN CITY

Lê Ngọc Hành, Nguyễn Văn An, Trương Phước Minh, Nguyễn Thị Diệu

Geography Department, University of Pedagogy - Danang University
Lien Chieu, Da Nang, Viet Nam
Email: hanhlespdn@gmail.com; anuranus0209@gmail.com; truongphuocminh@gmail.com;
dieunguyen77@gmail.com;

Abstract

In the recent years, Cua Dai beach has been strong erosion. It has been huge impact on the landscape and tourism activities in the area. This research was carried out with the object building the maps the current state of the shoreline by remote sensing. Through the image ratio formula used to calculate the shoreline, researchers reconstruct the shoreline in the time from 1989 to 2015. On that basis, we conduct building sections to calculate the speed of accretion and erosion of shoreline using the DSAS tool. The research results showed that the Cua Dai shoreline with strong fluctuations over period. The area of erosion full-stage is 90ha and area of accretion is 38.84ha. Shoreline change rate is also a large difference between the time and during the period from 2010 to 2015, the erosion rate was very strong with about 4ha per year. Calculated according DSAS tool showed the result the rate of accretion and erosion in quite detailed foot shoreline segments. These are references have practical significance, contributing to the planning, sustainable development in Cua Dai beach.

Keywords: Shoreline; change; accretion; erosion; rate

1. INTRODUCTION

The coastal area is a dynamic environment with many physical processes, such as tides, flooding, sea level rise, land subsidence, erosion, sedimentation [9]. The coastline around the world is changing rapidly as a result of the natural physical processes and human activities [8]. Natural factors as sources of alluvial, wave energy and sea level are the main causes of the changes coasts, while the man's activity was the catalyst that caused that imbalance situation, promote changes [8]. Erosion and accretion of coast is the result of active Geodynamics sea or combined Geodynamics rivers with it, frequently occur in the coasts around the world with different levels, intensity and various spheres of influence [2]. Erosion of coastal areas, estuaries are heavy natural disasters, complex movements caused great damage to persons, property, construction, social-economic and ecological environment. The study of shoreline changes and calculate the erosion, accretion is an important work in the management and monitoring of coastal coast, including many significant issues such as protecting and extending the shoreline and protection of marine resources .

With the rapid development of tourism since 1995, Cua Dai beach areas facing serious erosion. The construction of a series of hydroelectric plants on the upstream Vu Gia - Thu Bon rivers did shortage of sediment poured on. Moreover, the activities such as the exploitation of coastal mangrove forests, coastal structures also significantly affected the process of coastal erosion in this area. Therefore, the study of the current situation and calculate the speed erosion of Cua Dai beach is a necessary job in the current period.

Remote sensing plays an important role in collecting data space from an economic perspective. Today, with the full integration of Remote sensing and GIS to monitor and calculate the shoreline changes were executed quickly and effectively. In recent years, optical satellite imagery was used in shoreline mapping automatically or semi-automatically [9]. The absorption of infrared wavelength of water and the strong reflections of the vegetation and the soil make the shoreline mapping more easily [8].

Therefore, Electromagnetic Spectrum in visible wavelengths and infrared such as Landsat TM (Thematic Mapper), ETM + (Enhanced Thematic Mapper) and OLI (Operational Land Imager) has been widely used for mapping shoreline (DeWitt, et al., 2002). Braud and Feng (1998) have used Multispectral Image Processing Techniques to detect and identify Louisiana coast from Landsat Thematic Mapper image (TM) with resolution 30-meter. They found that TM Band 5 is the most reliable method [9]. Frazier and Page (2000) used methods of quantitative analysis to classify soil and water from landsat TM image in Wagga, Australia. This study also has shown that Electromagnetic Spectrum band 5 is the best band of Landsat TM to extract the shoreline. However using band 5 to mapping shoreline also exists some difficultys, that is defined threshold values to distinguish between soil and water. An alternative method is applied that is used ratio of band 4, band 2 and band 5, band 2. In this method, water and soil can be extracted directly [8]. In this paper, we present a semi-automatic method to extract shoreline in Cua Dai beach, Quang Nam province, Vietnam based on remote sensing and GIS. The paper will determine the threshold value of band 5 to distinguish soil and water and use ratio between the band 4, band 2 and band 5, band 2 to mapping shoreline. Base on this basis, we use DSAS tools to calculate speed of the process of erosion and accretion in study area.

2. RESEARCH METHODOLOGY

2.1. Essential research area

This study was conducted in Cua Dai beach, Quang Nam province, Viet Nam. Cua Dai is main estuary of Vu Gia-Thu Bon river systems. Cua Dai is a good place to build tourist resort with various types of entertainment: beaches, water sports. This area suffered strong fluctuations of weather, especially hurricanes, tropical depression. Wave caused by storms, tropical depressions transmitted into the area usually have north, northeast direction. In the Winter ,waves mainly have Northeast direction and in the near shore is East direction. The largest waves offshore are about 1.5 -3.0 meters high, in the coastal waves are always less than 1, 5 m. In summer, the wind direction had difference in the near and offshore. While the waves offshore have southwest direction, waves nearshore is East and South.

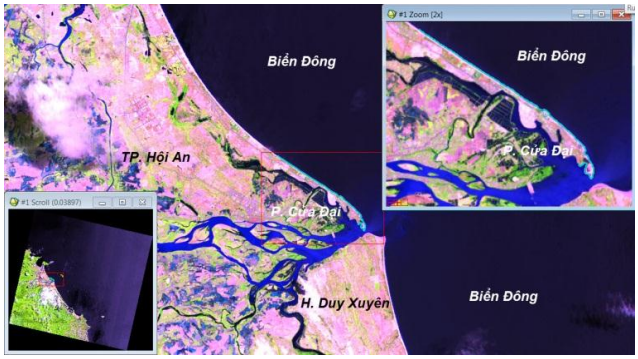

Figure 1. Location of the study area

2.2. Research data

In this paper, image data used is Landsat TM satellite images (Landsat 7) and Landsat OLI (Landsat 7) captured the study area in 4 years: 1989, 2000, 2010 and 2015, are retrieved from website :*http://earthexplorer.usgs.gov.*

Table 1. Information of images

Year	Code	Day	Sensor	Resolution
1989	LT51240491989137BKT00	17/5/1989	TM	30x30 m
2000	LE71240492000128SGS00	7/5/2000	TM	30x30 m
2010	LT51240492010131BKT01	11/5/2010	TM	30x30 m
2015	LC81240492015129LGN00	9/5/2015	OLI-TIRS	30x30 m

2.3. Research Methodology

Using these data, satellite images and maps collected during the research process and remote sensing software (ENVI), GIS (ArcGIS) and DSAS tools to mapping shoreline and calculate the speed of erosion and accretion. The process is performed as figure 2.

To mapping shoreline changes, the study was done in several stages were: Calibrate image, use formulas to calculate shoreline, image filtering, transferred from raster to vector. On that basis, we continue mapping the shoreline changes in diferent times, calculate the shoreline fluctuation and analysis the shoreline erosion, accretion.

From images were collected, we conduct to calibrate the parameters such as: name of band, wavelength, sensor types, pixel size and enhance the image quality. The purpose is to have image with full information and best quality to calculate the shoreline. In this paper, we used the Channel 2, Channel 5 and Channel 7 of Landsat TM; Channel 3, Channel 6 and Channel 7 of Landsat OLI to mapping Cua Dai shorelines in different time. Ratio of channel is a common method of calculation were used in multispectral images. The ratio of the channel is ratio of grayscale value of the pixels on the image and graysacle value of corresponding pixel position in another image. This division creates a new image called Image ratio. This stage aims to highlight objects of interest in the image. [7]

In this paper, we use histogram of band 5 to determine discrimination threshold of land and water. After that, Images classified are converted into binary format. The topic uses formulas ratio of B2 / B4 and B2 / B5 to delineate two layers of soil and water. Then, the paper using the GIS's formula to multiply these photos together to get preliminary image. Continue, we conducted filtering and transfer image from raster to vector.

After the shoreline have mapped, we conduct calculate the speed of erosion and accretion based on Digital Shoreline Analysis System tools (DSAS) which are integrated in the ArcGIS software ver 10.2. This tool helps us to statistic parameters relating to the process of erosion and accretion of the coast. In this paper, we use statistical method EPR to calculate process of erosion and accretion of Cua Dai through stages from 1989 to 2015.

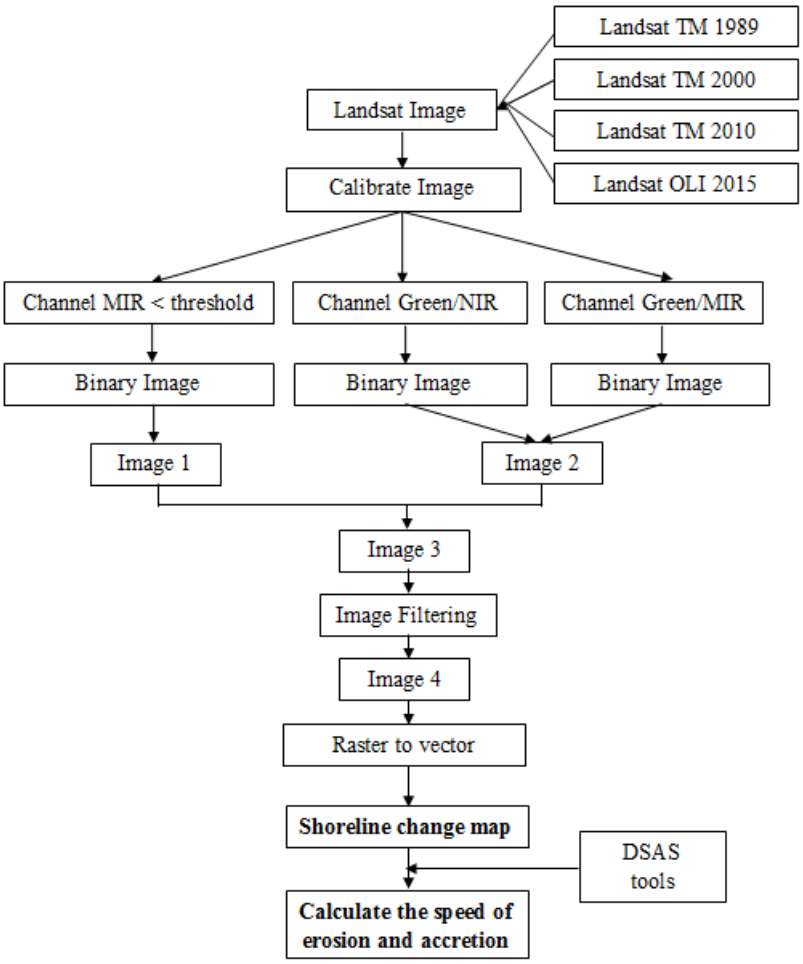

Figure 2. Flowchart of data processing

3. RESULTS AND DISCUSSION

3.1. Shoreline map in period 1989 – 2015

After converted data from raster to vector format, based on these images and ArcGIS software, we conduct to mapping shoreline for each phase 1989, 2000, 2010, 2015.

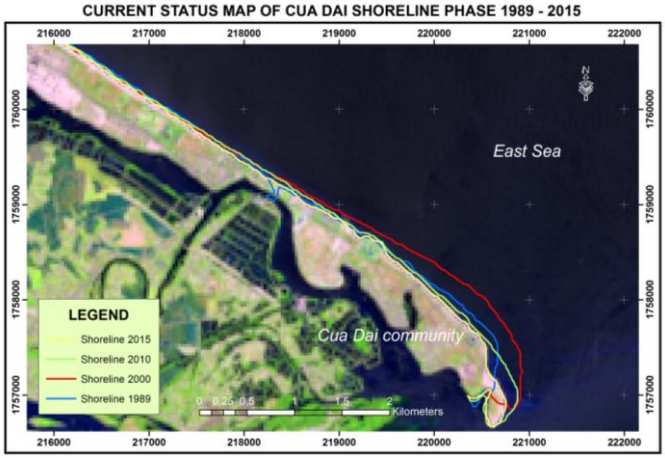

Figure 3. *Current Status Map of Cua Dai shoreline phase 1989 - 2015*

After have 4 shoreline maps of research area, we conducted overlay these maps together to have shoreline changes map through the stages: 1989-2000; 2000-2010; 2010-2015 and 1989-2015.

3.2. Analysis the accretion and landslide through the research phase

Statistical work was conducted based on DSAS tools are integrated in ArcGIS 10.2 . The data input of DSAS is the shoreline in different times and data base of shoreline (baseline). Baseline can be built by different methods: Create new objects which are created from the shoreline by buffer tools or can use the shoreline data base existing. In this study, we used the method to create buffer from shoreline map in 1989. Through that, the paper evaluated shoreline changes in these phases above based on the baseline which had been created. In the

study area, research has created 132 sections with interval 50 m per sections. Base on that, this tools can statistic parameters of erosion and accretion in area.

3.2.1. Developments of erosion and accretion through these phases

a. Phase 1989 – 2000

According to the results of the analysis in phase 1989 - 2000, Cua Dai shoreline happening two trends. Erosion in the northern and strong accretion in the southern region near the estuary. Accordingly, the erosion area is 60.9 hectares and accretion area is 7.9 hectares. Some region of study area have speed of erosion is 2.43 meter per year, besides that some region have accretion speed is 11.4 meter per year. The general trend of this period is accretion at a rate 5.7 meter per year which made Cua Dai beach is greatly expanded.

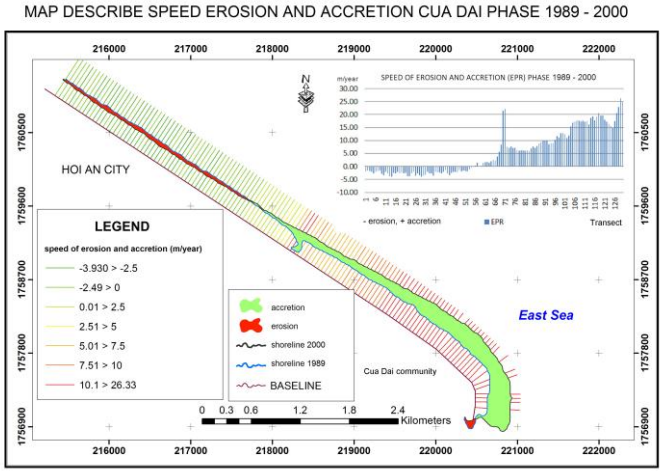

Figure 5. *Map describe speed erosion and accretion Cua Dai phase 1989 - 2000*

b. Phase 2000 – 2010

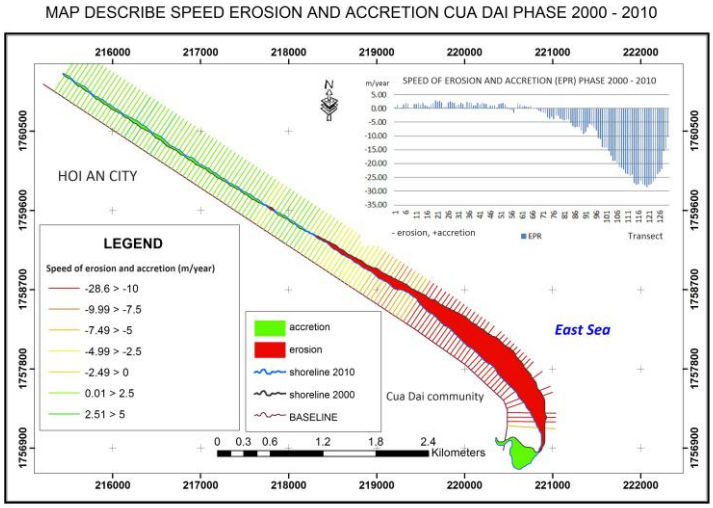

Figure 6. *Map describe speed erosion and accretion Cua Dai phase 2000 – 2010*

This stage has the reverse with phase from 1989-2000. Have strong erosion in the southern near estuary and the weak accretion in the Northern . The erosion area is 51.18 hectares and accretion area is 10.79 hectares. Some region of study area have speed of erosion is 12.93 meter per year, besides that some region have accretion speed is 1.32 meter per year. The general trend of this period is erosion at a rate 5.96 meter per year.

c. Phase 2010 – 2015

At this stage, almost Cua Dai beach only have erosion, accretion does not occur. Accordingly, the erosion area is 32.72 hectares and accretion area is 7.71 hectares. In several areas, this speed over 25 meter per year. Especially near estuary, this process takes place very strong. Speed erosion also occurred very serious in the beach area, the coast had close to the food catering business areas of this region.

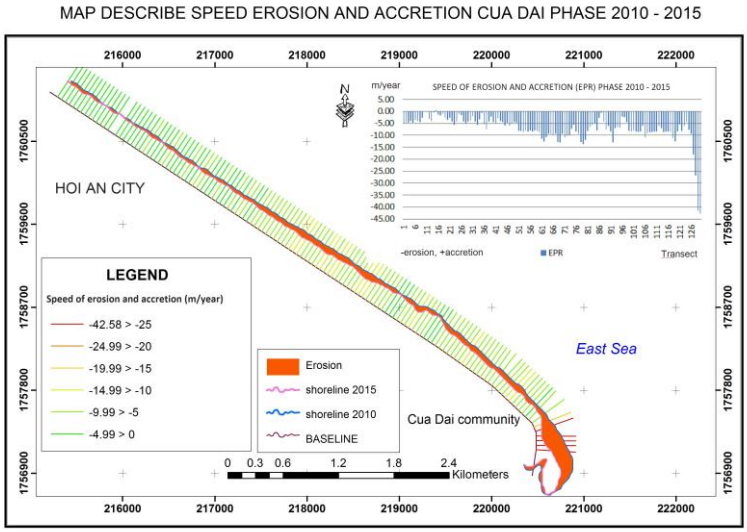

Figure 7. *Map describe speed erosion and accretion Cua Dai phase 2010 - 2015*

3.2.2. Evaluation of erosion and accretion in period 1989 – 2015

Overall, the process of erosion and accretion of Cua Dai beach, Hoi An was quite complicated, have significant changes in each stage. The period from 1989 to 2000, the process of accretion was the major trend. However the later stages, the process of erosion took place strongly. Especially from 2010 to 2015, this process was occurred very strong and serious impacts to business activities of regional tourism. From 2009 until now, Quang Nam province has many projects to restrict erosion in this area. However, until now not yet really effective methods.

3.3. Causes of changes Cua Dai shoreline

3.3.1. The increase of hurricanes and tropical depressions

The number of hurricanes and tropical depressions landfall of this area has increased in the last period and the rising sea levels relate to climate change. Storms and tropical depressions leads to increase strong winds and high waves. Result of it makes the process of erosion takes place very serious.

3.3.2. Rising sea levels

According to the climate change scenario, sea-level rise scenario of Vietnam's Ministry of Natural Resources and Environment, in 2100, sea levels in the Ke Ga-Ca Mau area may rise to 51 to 99 cm.

Table 1. Sea Level Rise (cm) according to different scenarios

Scenario	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low	8-9	11-13	17-19	22-26	28-34	34-42	40-50	46-59	51-66
Medium	8-9	12-14	17-20	23-27	30-35	37-44	44-54	51-64	59-75
High	8-9	13-14	19-21	26-30	35-41	45-53	56-68	68-83	79-99

Sea level rise makes seabed in the nearshore becomes deeper and sloping lead to increasing of waves energy. The final result makes the eroding shore.

3.3.3. Human activities and hydropower development

The main reason of abnormalities erosion in Cua Dai beach is due to the impact of ladder hydropower projects on the Vu Gia - Thu Bon river system with 50 projects. In these hydropower have some plant have capacity medium such as A Vương, Sông Tranh 2, Đăk Mi 4, Sông Bung 4,… Most hydroelectric do not have blowdown systems, so almost sediment are retained in the reservoir. This makes serious shortage sediment in Cua Dai area. Besides, other causes also originate from the dredging sediment in the downstream of Thu Bon river leading to the extraordinary erosion situation in reseach area.

4. CONCLUSION

From the results of the study shoreline changes from 1989 to 2015 and its impact on the activities of the people in the recent period, we offer some conclusions:

- Using remote sensing combined with GIS in the study shoreline changes bring highly effective, less time consuming and costs. We can get size and properties information of shoreline changes easily and fairly accurately.

- Based on remote sensing data in the times 1989, 2000, 2010 and 2015 , the paper was established current status map of Cua Dai shoreline. After that, we conducted overlay these maps together to have shoreline changes map in the stages 1989-2015. The topic evaluate and statistics of erosion and accretion levels by DSAS tools.

- The results showed that the process of erosion and accretion in this areas took place quite complex. Period from the 1989 to 2000, the accretion is major trend. However, in the later stages especially from 2010 to now, the process of erosion happening very serious in this region.

5. REFERENCES

[1]. Vu T.A (2010), "*Calculate changes of seabed topography in Cua Dai area (estuary Thu Bon River, Quang Nam) due to utral wave*" Sea Studies Collection , 2010, XVII: 18-29.

[2]. Nguyen T.T.H, Nguyen H.N, Nguyen P.T, Đin T.T, Vu T.T, Le H.H, Nguyen Q.P (2015), "*Research the hazard of shoreline erosion in the area from Sam Son Town to Quang Xuong District, Thanh Hoa Province"* Proceedings of GIS applications conference in 2015, Hà Nội.

[3]. Dang Đ.H, "*Evaluate shoreline changes in Thu Bon River estuary by Remote sensing-GIS technolog",* Journal of water resources and environmental engineering, Thuy Loi University.

[4]. Mai T.N, 2009 "*Investigate and assessment environmental resource of some coastal bays serve development economic - social and environmental protection*"

[5]. Pham T.P.T, Ho D.D, Dang V.T (2009), "*Sea level extracted from Landsat image"* Journal of Science and Technology Development, no 12 – 2009.

[6]. Vu.T.T.T, *Application of remote sensing and GIS technology to research erosion and accretion of coastal zone in Hai Phong,* The University of Science, Master thesis. Code: 60 44 55.

[7]. Tran T.V, Trinh T.B (2013), "*Monitoring geohazards in coastal by space technology",* Conference on Science and Technology 1st ,Hồ Chí Minh.

[8]. Ali Kourosh Niya, Ali Asghar Alesheikh, Mohsen Soltanpor, Mir Masoud Kheirkhahzarkesh (2013), *Shoreline Change Mapping Using Remote Sensing and GIS,* International Journal of Remote Sensing Applications Volume 3 Issue 3, September 2013.

[9]. Michalis Lipakis, Nektarios Chrysoulakis, Yiannis Kamarianakis, "*Shoreline extraction using satellite imagery*", Beach Erosion Monitoring.