

Shoreline change analysis using Sentinel-2A imagery data in Ben Tre, Vietnam

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1. Introduction

- In the coastal area of Ben Tre province, there are 20 places where strong erosion and accretion occurs with a total length of about 56 km.
- Based on the spectral reflectance of land and water, the optical images provide a simple way to extract shorelines (Ouma et al., 2006; Sekovski et al., 2014)
- In this study, The modified normalized difference water index (MNDWI) and threshold segmentation method are used to extract coastline information from Sentinel-2A image. The Digital Shoreline Analysis System (DSAS) used to analyze the position change of the shoreline from 2016 to 2020.



Figure 1: Erosion occurs in Binh Dai district

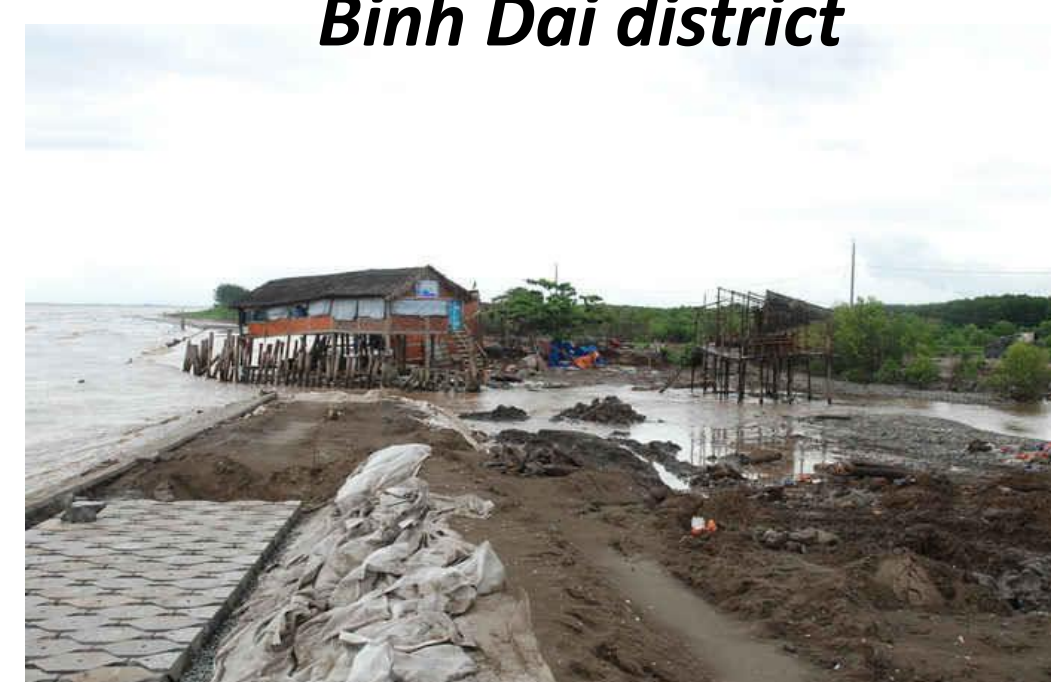


Figure 2: Erosion occurs in Ba Tri district

2. Study Area & Data



Figure 3: Map of the study area

- The studied coastal area is located in Ba tri and Binh Dai district. The tidal range oscillates with the highest value of 3.5 m during the day.
- The image data is obtained from the United States Geological Survey (USGS) with UTM/WGS84 projection. Resolution is 10 m visible and near-infrared (NIR) bands, 20 m short wave infrared (SWIR).
- The Sentinel-2A images are collected between March and April, when the Northeast Monsoon is active.

3. Methodology

Pre-Processing

- Sentinel-2A Level-1C satellite images are atmospherically corrected through the Sen2cor tool in SNAP. The geographic coordinate system is the World Geodetic System 84 (WGS 84) and the selected projection is UTM zone 48 North.
- For a resolution compatible with Green and NIR bands, the pan-sharpening is applied using Resample to increase the resolution of the SWIR band from 20 m to 10 m.

Extraction of the shoreline

- The shoreline information is extracted from Multi-Temporal Sentinel-2 Data using the spectral water index MNDWI.
- The MNDWI is expressed as follows (McFeeters, 1996):

$$MNDWI = \frac{(Green - SWIR)}{(Green + SWIR)}$$
- An optimal histogram thresholding is chosen as 0.2575 in this case, which is used to create binary images from MNDWI images.
- In order to evaluate the accuracy of the extracted coastlines, the shoreline results are overlaid on the Google Earth image with the corresponding time intervals.

- The net shoreline movement (NSM) and endpoint rate method (EPR) are used to analyze the erosion/accretion trend of the coastline.

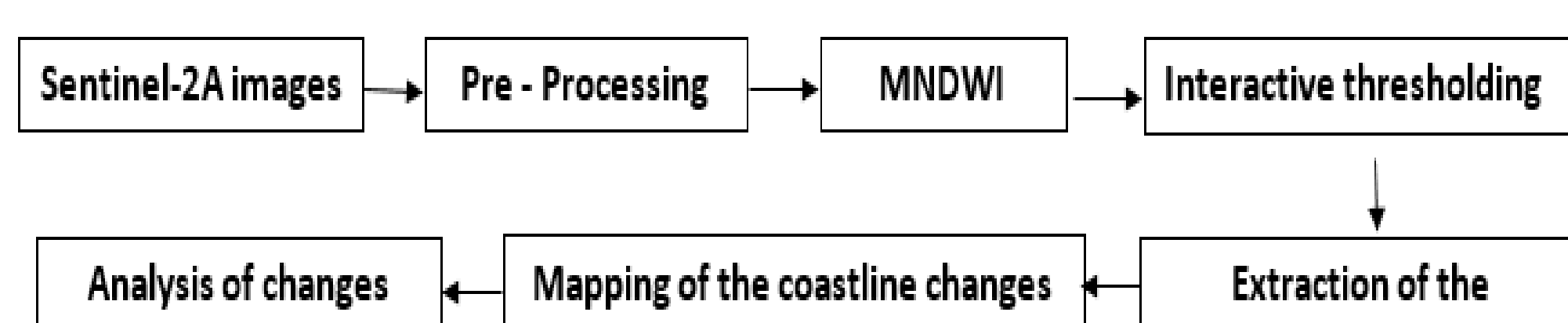


Figure 4: Processing workflow

4. Results

Period 2016-2018: The results of analysis of coastline changes show that the accretion trend clearly prevails in the study area (Figure 5).

- The average accretion rate in Ba Tri and Binh Dai districts is 12 m/year and 9m/year, respectively.
- In Ba Tri district, erosion occurs in Bao Thuan and An Thuy areas with an average erosion rate of 1.5 m/year, of which the highest erosion rate is 39 m/year. This observation is consistent with statistics, which show that a high tide in February 2017 caused a 50m landslide in coastal Bao Thuan.
- In Binh Dai district, erosion occurs in the Dai estuary (Thua Duc) with an erosion rate of 4 m/year.



Figure 5: The shoreline extraction result for the period 2016-2018

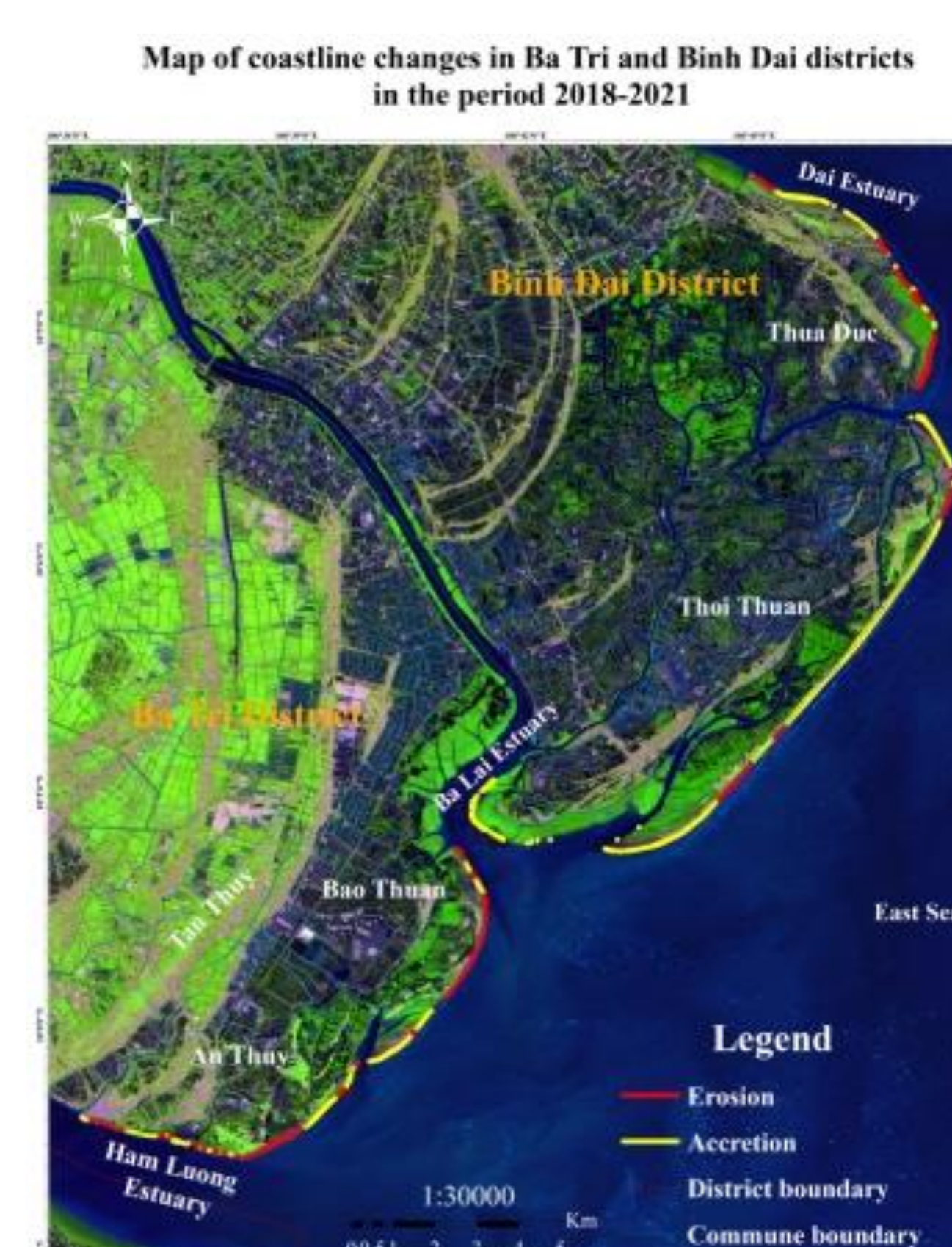


Figure 6: The shoreline extraction result for the period 2018-2021

Period 2018-2021: The results of analysis of shoreline changes show that there are alternating between erosion and accretion trends in the study area, but in general, the accretion trend still prevails (Figure 6).

- In Ba Tri District, the coastline has a similar rate of erosion and accretion. DSAS analysis results show that the average accretion rate is 5 m/year and the average erosion rate is 4 m/year. The place where the most obvious erosion occurs is in the Ham Luong estuary (An Thuy) and Con Nhan (Bao Thuan) area with the maximum erosion length of 17 m/year.
- In Binh Dai district, the accretion trend prevails with an accretion rate of 7 m/year, which is concentrated in the Ba Lai estuary (Thoi Thuan) and a section of the Thua Duc coast.
- Besides, erosion continues to occur the Dai estuary (Thua Duc) with an erosion rate of 5 m/year, which is an increase compared to the period 2016-2018.

5. Conclusions

- The results of the analysis of shoreline changes over two periods show that the accretion trend prevailed in the change of coastline morphology in Ben Tre province.
- The trend of erosion is increasing in both districts, in which the strongest erosion is in Bao Thuan, An Thuy (Ba Tri) and Thua Duc (Binh Dai).
- The method of extracting coastline information by MNDWI ratio imaging and interactive thresholding can be suitable for rapid assessment of shoreline changes in a large area.
- Sentinel-2A satellite images are useful data in supporting the monitoring of coastline changes that contribute to making reasonable plans for erosion and accretion in coastal areas.
- The analysis of factors affecting the trend of erosion and accretion in the coastal area of Ben Tre province will be carried out in further research.

References

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