Remote sensing based coastline extraction of west Africa coast and its application: shoreline analysis around Nouakchott Autonomy Port

Jiangkun Li¹, Guangsheng Wang², Musheng Yang¹, Yu Tong³, Titi Sui¹, Chi Zhang³

1. Key Laboratory of Coastal Disaster and Protection (Hohai University), Ministry of Education. Nanjing, Jiangsu, China
2. China Harbour Engineering Company Limited. Beijing, China
3. State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering Hohai University. Nanjing, Jiangsu, China

ABSTRACT

Coastline revolution is great important to the site selection and construction design of a modern port. Based on the remote sensing cloud platform, the present study investigated the change of the coastline of Nouakchott Autonomy Port in Mauritania in the past 38 years (1984-2021). Coastline extraction algorithm was developed which is suitable for the west coast of Africa. Technologies such as satellite remote sensing, geographic information system technology, pixel fusion technology, and the computer automatic segmentation method with water index as threshold parameter were involved in this coastline extraction study. Comparisons of the coastline movement between the satellite-derived shorelines and in situ shorelines proved that the present study can achieve sub-pixel accuracy (5 m) in the shoreline analysis. Results showed that the shoreline of the northern part of Nouakchott Autonomy Port goes forward in which the average movement is 348.5 m and the average linear regression rate is 9.7 m/year. By comparison, the southern part is eroded in which the average net shoreline movement is 243.4 m and the average linear regression rate is 6.8 m/year. Due to the interception effect on the coastal sediment by the port breakwater, the northern and the southern coastline show an opposite characteristics in erosion. This indicates there exists a high spatial heterogeneity in the shoreline evolution around the Nouakchott Autonomous Port project.

KEY WORDS: Coastline extraction; Shoreline analysis; Remote sensing; Nouakchott Autonomy Port

INTRODUCTION

It is widely known that the coastal area of West Africa has vital natural resources as well as habitats that provide critical ecosystem services. The coastal area of West Africa is home of about a third of the population in the region and generates 56% of its Gross Domestic Product (Alves et al., 2020). Coastal erosion is widespread in West Africa, with significant effects on coastal ecosystem functioning and livelihood support, which is likely to be exacerbated by global climate change and direct impacts from local human activities (Almar et al., 2022). Rafael Almar (2022) proposed that our ability to understand coastal changes has been limited by an incomplete understanding of the processes and the difficulty of obtaining detailed data. Recent advances in satellite techniques have made it possible to obtain rich coastal data sets. This provides a solid foundation for understanding the changes of natural environmental characteristics in the coastal zone, as well as improving climate change adaptation strategies for humanity.

It is of great theoretical and practical significance to fully grasp the change and development of coastline for the sustainable utilization, management and environmental protection of coastal resources. Monitoring and quantifying the change of the coastline is the basis and key of the current coastal management and research and future coastal planning.

Regarding the intersection area of sea-land interaction, the coastal zone has the characteristics of complexity and variability where the traditional methods of coastal monitoring (such as artificial in-situ survey, shore-based LiDAR and video imaging system) have limitations in time, space, cost, manpower and so on. Serving as a new technology, satellite remote sensing has the unique advantage of large area data acquisition and real-time dynamic monitoring, which is suitable for large-scale and long-term coastal monitoring. GEE (Google Earth Engine) platform (N. Gorelick et al., 2017) which was jointly launched by Google, Carnegie Mellon University and the United States Geological Survey in 2010, is a cloud-based geospatial processing platform for large-scale environmental monitoring and analysis. It provides rapid prototyping and result visualization (H. Tamiminia et al., 2020).

Based on GEE platform, this study develops a coastline extraction algorithm which is suitable for the west coast of Africa. By application, the coastline of Nouakchott Autonomy Port in Mauritania in recent 38 years (1984-2021) has been extracted and analyzed.

DATA SOURCE

The data used in this study comes from the satellite database of GEE platform, which provides geophysics, weather, climate and other geospatial data of Landsat and Sentinel 2 satellites, with a spatial accuracy of 30m and 10m respectively. In order to maximize the long-time series monitoring and evolution analysis of the coastline of the