

**Shoreline management Plan for Yanbu coast, Western coast of Saudi Arabia**

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**Abstract**

A comprehensive study was carried out on the Yanbu coast to evaluate the potential for erosion and accretion pattern. From 2004 to 2019, Google Earth engine was used to collect satellite-imaging data, considering changes in the coastal zone caused by natural or human-induced events. At five-year intervals, the image was analyzed with Q-GIS, and the delimited shoreline shapefile was compared to a recent image to show the Yanbu coast's erosion and accretion behavior during the previous two decades. Shoreline changes were computed and assessed, followed by the implementation of a recommended shoreline management plan for the entire coast. These studies will help the area develop a comprehensive shoreline management plan as well as a coastal zone management plan.

**Keywords:** *Shoreline management plan, Yanbu, Erosion, Accretion*

**1. INTRODUCTION**

Exposure to various concepts and definitions of coastal areas in general, with various names or forms, on a global or local level, aids in project management, as well as in evaluating the methods of developing coastal areas globally and locally consciously, as the concept of the coastal zone for each experiment directly affects the methods. Coastal erosion is caused by natural causes such as wind and waves and the same has become a major coastal zone problem in the Yanbu coast, western coast of the Saudi Arabia. Only a few research on coastal erosion on the Saudi Arabian Red Sea coast have been undertaken (Sheikh, 2011, Alharbi et al., 2016, Alharbi et al., 2017). Yanbu is a major port city on the eastern Red Sea littoral, some 160 kilometers west of Al Madinah and 300 kilometers northwest of Jeddah. It is one of the Kingdom's largest and oldest marine ports (Figure 1). The conclusion is that the region's population is rapidly increasing, resulting in fast urbanization and high-value land. In 2016, the city's population was estimated to be at 76000 people. The Yanbu shoreline has been eroding and accumulating for decades. The dynamic

behavior of the shoreline along the coastline may be seen in satellite images. The dynamic nature of the coast, which is known for industrial and port operations, necessitates a thorough shoreline management plan for the future. As a results, a study was conducted to identify possible erosion and accretion sites along the Yanbu coast, as well as to develop a coastal zone management plan based on the coast's erosion/accretion characteristics.

Coastal zone management plan can be used to address this problem by analyzing the erosion/accretion problem and formulate a management plan. The temporal changes of the shoreline from 2003 to 2020 show that the dynamics of this coastline are mainly controlled by human activities, which led to the

accretion of land towards the sea. The present study focuses to identify potential erosion and accretion zones in Yanbu coast using satellite images and make coastal zone management plan based on this erosion/accretion nature of the coast. Since Yanbu coastline famous for industrial and port activities, the dynamic nature of the coast requires detailed shoreline management plan for the future.

## 2. MATERIALS AND METHODS

### 2.1. STUDY AREA

Yanbu is a major port city on the eastern Red Sea coast, some 160 kilometers west of Al Madinah and 300 kilometers northwest of Jeddah (Fig. 1). This almost 80-kilometer-long region, which is mostly flat, includes both Yanbu Al-Balad or Al-Bahr (Old Yanbu) and Yanbu Al-Sinaiyah (Industrial Yanbu – Fig. 1).



Fig. 1 Study Area

As a result of this, the region's population is rapidly increasing, resulting in fast urbanization. In 2016, the city's resident population was at 76000. (RCJY, 2016). The city is mostly recognized for its industrial activity and is becoming a popular tourism destination. In 1975, an industrial city was built to the south of Yanbu's historic city. A number of development and urban growth initiatives have recently been brought to the city. This young metropolis has grown into a hub for contemporary industry and contributes significantly to the kingdom's gross national revenue. The raw oil and liquid natural gas pipelines are provided by Yanbu Industrial City. (Niang et. al, 2020).

## 2.2 DATA COLLECTION AND ANALYSIS

From 2004 to 2019, satellite-imaging data was obtained using Google Earth, taking into consideration changes in the coastal zone caused by natural or human-caused factors. The analysis of this area is based on the aforementioned 5-year period of satellite photos, as well as the erosion and accretion components, as shown in the following figure (Fig. 2)



Fig. 2. Accretion pattern of Yanbu coast

The QGIS software used to dereference and delineate the shoreline at regular intervals and identify the potential erosion and accretion zone in this region. Radical changes have occurred in the Yanbu coast, where these changes can be observed compared to the images captured through Google Earth.

## 3. RESULTS & DISCUSSION

The image was analyzed using Q-GIS at five-year intervals, and the delineated shoreline shapefile was compared to a recent image to indicate the Yanbu coast's erosion and accretion nature during the last two decades. The Yamnbu coast's potential and erosion zones are depicted in this coastline analysis (Fig.3) (Nofal and Abboud, 2019). The map depicted changes in the shoreline from 2014 to 2019. Because the coast is longer, several section analyses are required to completely comprehend the shoreline change. The shoreline change map is split down into sections and discussed in the sections.

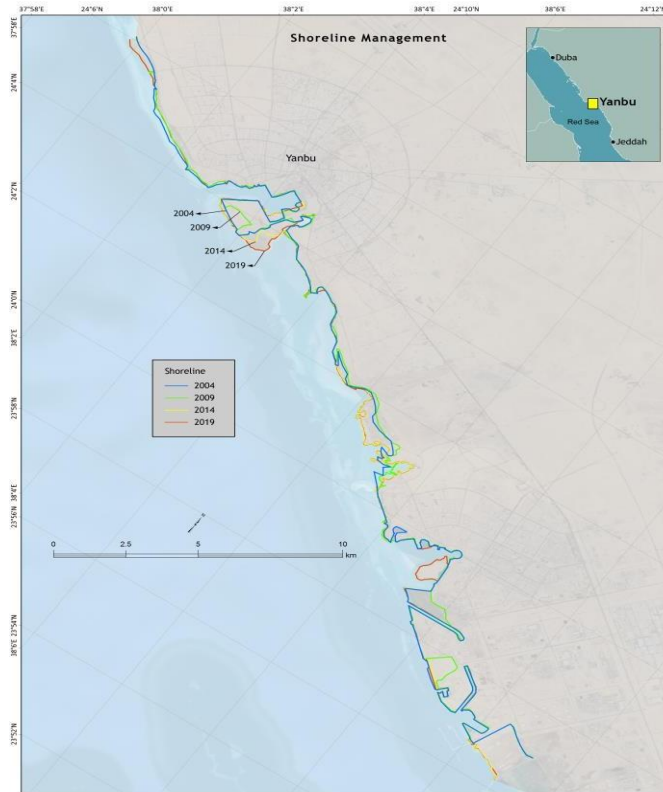


Fig.3. Shoreline change (2014-2019) map of Yanbu coast

### 3.1 NORTH SECTION

From 2004 to 2019, the northern portion of the Yanbu shoreline experienced rapid accretion (Fig. 4). Environmental activities have caused natural accretion. The extensive environmental study was necessary to determine the sediment transport directions. The sediment dynamics are more prominent in this place since there is a Sharm (creek) on the north side of the location.



Fig. 4. Yanbu coast northern region, erosion and accretion pattern

Fig. 5. Yanbu coast region erosion and accretion pattern



### 3.2 YANBU COMMERCIAL PORT REGION

From 2004 through 2019, this region represents the erosion/accretion trend. The pattern depicts man-made accretions on the commercial port's southern side (Fig.5). The shoreline on the southern side of the Yanbu commercial port accreted substantially after 2014, and the pattern of accretion indicates artificial activities such as land filling as part of the port expansion. (Spalding et al., 2014, Hariri, 2012).

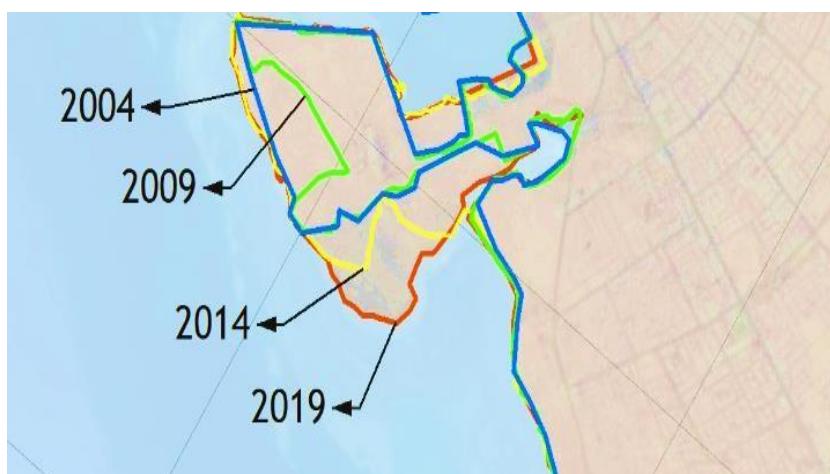


Fig. 6. Yanbu commercial Port region erosion and accretion pattern

### 3.3 YANBU COMMERCIAL PORT SOUTHERN REGION

Due to natural and intense human activity, the southern coastline zone of Yanbu commercial Port has a high rate of erosion and accretion (Fig.6). The northern half of the image shows substantial accretion between 2014 and 2019. However, because to human activity, the geomorphology in the southern section of the image has changed significantly. There is no inland waterbody in this region in 2014, and there will be none until 2019, when human activities such as dredging will result in the construction of an inland



waterbody. As a result, the erosion and accretion pattern in this region is a combination of natural and manmade activity.

### 3.4 SHORELINE MANAGEMENT PLAN FOR YANBU COAST (SMP)

The assets and infrastructure that provide a wide range of social and economic advantages to the region are the focus of the short-term risk management strategy for this area. The suggested strategy can be executed once modifications are made based on a thorough analysis of the environmental impact assessment (EIA). The proposed concept was realized by constructing defensive structures along the natural erosion/accretion sector. In areas where anthropogenic activities predominate, certain changes to beach filling and dune management are necessary (Spalding et al.2001, Torte2014). The table 1 shows the proposed shoreline management plan.

**Table. 1. Shoreline management plan for Yanbu coast**

| Sl. No. | Location                                  | Policy and Approach   |
|---------|---|---|
| 1.      | North section:                            | <ul style="list-style-type: none"> <li>• This region's sand dunes must be managed.</li> <li>• Coastal defense is not advised in this area.</li> <li>• Sand mining at a medium level is recommended.</li> <li>• Because a coral barrier protects the shore, no SMP is necessary.</li> </ul>  |
| 2.      | Yanbu commercial Port region:             | <ul style="list-style-type: none"> <li>• Develop a long-term beach management strategy to deal with the anthropogenic activities</li> <li>• Manage beach filling in the southern side of the Yanbu port</li> <li>• Detailed study of Environmental Impact Assessment (EIA) required for beach filling</li> </ul>  |
| 3.      | Yanbu commercial Port southern region (I) | <ul style="list-style-type: none"> <li>• An increase in the rate of accretion is proposed by adding more coastal defense systems.</li> <li>• To address the long-term trend in beach accretion, develop a long-term shore management strategy.</li> <li>• Increase the effectiveness of existing fortifications and undertake shoreline management</li> </ul> |

|    |  |   |
|----|--|---|
| 4. | Yanbu commercial Port southern region (II) | <ul style="list-style-type: none"> <li>• Keep sand filling processes to a minimum.</li> <li>• Beach filling requires a comprehensive Environmental Impact Assessment (EIA).</li> <li>• Develop a long-term shoreline management strategy to address the long-term trend of beach filling caused by anthropogenic activities.</li> </ul> |
|----|--|---|

#### 4. CONCLUSION

This research examines the examination of shoreline change along the Saudi Arabian coast at Yanbu, utilizing images at various years (2014 to 2019) to analyze temporal changes using GIS methods. Shoreline changes were calculated and analyzed, with a proposed shoreline management plan for the entire coast's execution. The study also highlights the complexities of the Yanbu coast's shoreline dynamics, which are complicated by uneven seasonal changes and anthropogenic

activity in coastal regions, both of which significantly modify the shoreline. The study was undertaken with restricted resources and time constraints, and the objectives were defined and fully analyzed. The research has a broad scope, allowing it to examine all environmental factors that impact shoreline and coastal zone changes. These studies will allow the development of a comprehensive shoreline management plan as well as a coastal zone management plan for this area.

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