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DETECTION OF SHORELINE CHANGES ALONG YANGON RIVER USING GEOSPATIAL APPLICATION

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Abstract

In nature, the shoreline is one of the rapidly changing linear features of the coastal zone which is dynamic. Based on geospatial application, this study analyzed coastal processes and depth assesment for western channel of the Yangon River.NDWI(Normalized Difference Water Index),MNDWI (Modified Normalized Difference Water Index), NDSSI ((Normalized Difference Suspended Sediment Index) maps were produced using band ratio equation using images of Landsat LT 5 TM, LE 7 ETM and LC8 OLI for 1995, 2005 and 2018. These Landsat images were radiometrically and geometrically corrected, and multi-temporal post-classification analysis was performed to detect land cover changes, extracting shoreline positions to estimate shoreline changes of the Yangon River. Hydrographic survey data were transformed to bathymetric map using interpolation function in GIS. In order to integrate with topographic data, topo values were extracted from DEM (Digital Elevation Model) and merged with bathymetric data to get a relief map. In this research paper, the NDBI index (Normalized Difference Built up Index) produced for land cover maps. According to these indexes, the shoreline area is retreated to the western part of the area and sediment deposition is also found in this area.

Keywords: *geospatial; change detection; land cover; shoreline*

Introduction

The coastal area is a highly dynamic environment with the many physical processes, such as tidal flooding, sea level rise, land subsidence, and erosion-sedimentation (Lipakis et al., 2008).These factors play an important role in the changes of shoreline and coastal landscape. Therefore, Multi-dated of shoreline mapping is considered to be a valuable task for coastal monitoring and assessment. The shoreline is the contact line between land and a body of water.

Changes of water table, it is difficult to define and capture. Remote Sensing plays an important role in the detection and extraction of shoreline. Therefore, the images containing visible and infrared bands have been widely used for shoreline mapping. The advantages of using remote sensing may include large ground coverage of satellite images, the multi-temporal or the extending long period of the satellite data archives. Major data sources include of Landsat TM, LE 7 ETM and LC8 OLI. In addition, post-classification comparison proved to be an effective technique because multidated datasets are independently classified, thereby minimizing problems arising from atmospheric correction and/or sensor degradation. In order to analyze the coastal processes and develop predictive models, rates of shoreline changes are required. Analysis of different remote sensing images of Landsat LT5 TM, LE 7 ETM and LC8 OLI satellite along the Yangon River has identified areas of erosion followed by beach accretion. Numerous studies were carried out to evaluate the shoreline change along Yangon River.

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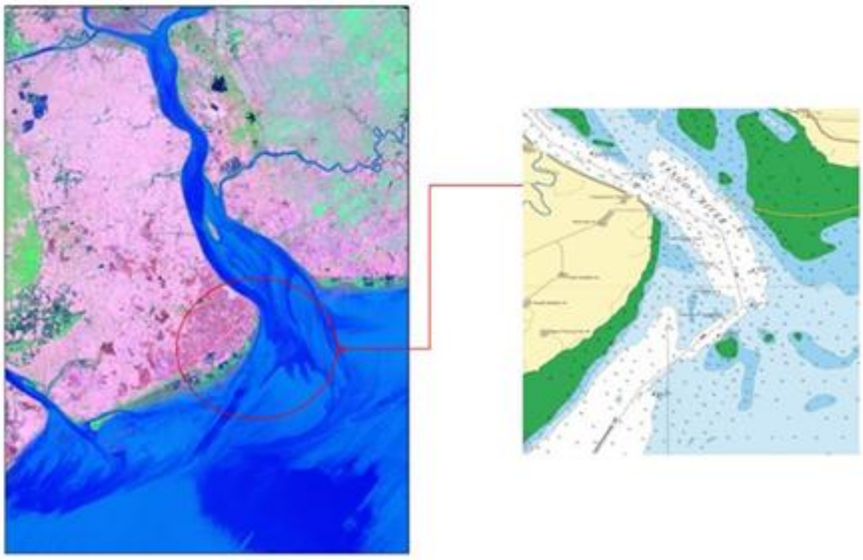
Study Area

The study area is located in the mouth of Yangon River, which is also main entrance to Yangon Port. The Yangon river, about 40 km long (25miles), formed by the confluence of the Bago and Hlaing rivers entering into the Gulf of Mottama of the Andaman Sea. In the study area, tides influence the coastal processes and morphologic conditions are complex and high sedimentation and river morphology changes caused the shallow sounding depth problem. The sedimentation in Yangon River depends on seasonal variations in freshwater discharge and tidal amplitudes.

According to the Tide Information from Myanmar Port Authority, during the monsoon, freshwater with sediment concentrations of 1 g/l, or less, cause unidirectional, seaward flow. In the dry season, salinities reach 20% and sediment concentrations rise to 6 g/l. Yangon River itself and other six rivers and creeks disposed 49 million ton per year. Thus, it is necessary to identify these coastal morphological processes. In this study, the detection of the shoreline changes were anlyzed using some RS(Remote Sensing) & GIS (Geographic Information Systems) techniques for navigation channel improvement in outer bar area of Yangon River.



Source: Myanmar Port Authority

Figure 1 Location of Study Area

Aim and Objectives

1. To investigate the erosion/accretion areas, patterns, and its rates along Yangon River through employing shoreline extraction techniques,
2. To address the impact of the shoreline variations on land management.

Materials and Methods

This research paper used primary and secondary data. Cloud free satellite data of Landsat LT5 TM, LE 7 ETM and LC8 OLI and DEM (Digital Elevation Model) with spatial resolution of 30 m for the year 1995, 2005 and 2018 corresponding to the study area of Yangon area were downloaded from the USGS website (http:www.usgsearth explorer) to quantify the NDSSI index for suspending sediment and to analyze its variations in tidal influences.

As a secondary data, sounding and depths data were provided by Starhigh Asia Pacific Pte., Ltd, a company carrying out dredging contract with MPA (Myanmar Port Authority) currently. NDWI (Normalized Difference Water Index), MNDWI (Modified Normalized Difference Water Index) and NDSSI (Normalized Difference Suspended Sediment Index) that created band ratio method using Landsat images of LT 5, LE 7 and LC8 for 1995, 2006 and 2018. Hydrographic survey data were transformed to bathymetric map using interpolation function in GIS. In order to integrate with topographic data, topo values were extracted from DEM and merged with bathymetric data to get a relief map. Spatial statistical analysis was also used to identify the relationship between water depths and sediment concentration. According to the equations from Xu, H. 2008 and Hossain, AKM., et al., 2010, the NDBI (Normalized Difference Builtup Index), NDWI (Normalized Difference Water Index), MNDWI (Modified Normalized Difference Water Index) and NDSSI (Normalized Difference Suspended Sediment Index) are calculated by these equations.

$$\mathrm{NDBI} = \frac{\mathrm{P\ SWIR} - \mathrm{pNIR}}{\mathrm{P\ SWIR} + \mathrm{pNIR}}$$

$$\mathrm{NDWI} = \frac{\mathrm{P\ Green} - \mathrm{pNIR}}{\mathrm{P\ Green} + \mathrm{pNIR}}$$

$$\mathrm{MNDWI} = \frac{\mathrm{P\ Green} - \mathrm{PSWIR}}{\mathrm{P\ Green} + \mathrm{PSWIR}}$$

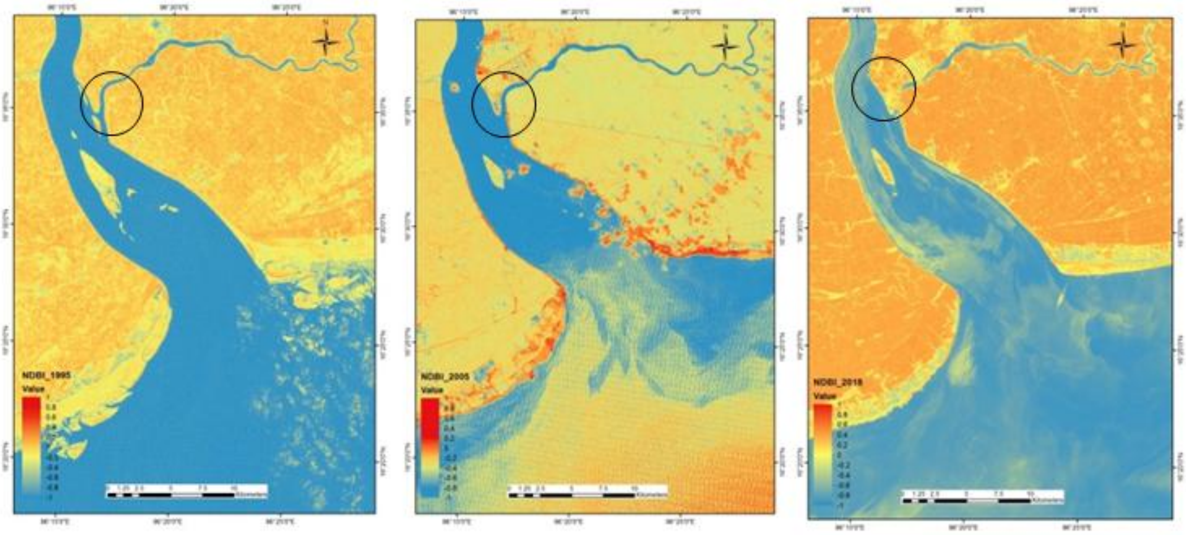
$$\mathrm{NDSSI} = \frac{\mathrm{P\ Blue} - \mathrm{pNIR}}{\mathrm{P\ Blue} + \mathrm{pNIR}}$$

Where, ρB, ρGreen, ρNIR and ρSWIR are the reflectance values of Landsat 5/7 TM/ETM+ B and 1, Band 2, Band 4 and Band 5 and Band 2, Band 3, Band 5 and Band 6 for Landsat 8 respectively.

Analysis and Results

Land Cover Classification and Change Detection

Land Cover Classification is extracted from NDBI (Normalized Difference Built up Index). The value of NDBI value range from -1 to +1 where higher values indicate the more built up area and lower values indicate on built up area. The accuracy assessment of all land cover maps ranged from 0.7 to 1.0 for the producer and user accuracies as well as for the overall accuracy of the study area. In addition, the agriculture and urban area are increased that led to the undeveloped area through the extension of land towards the sea.

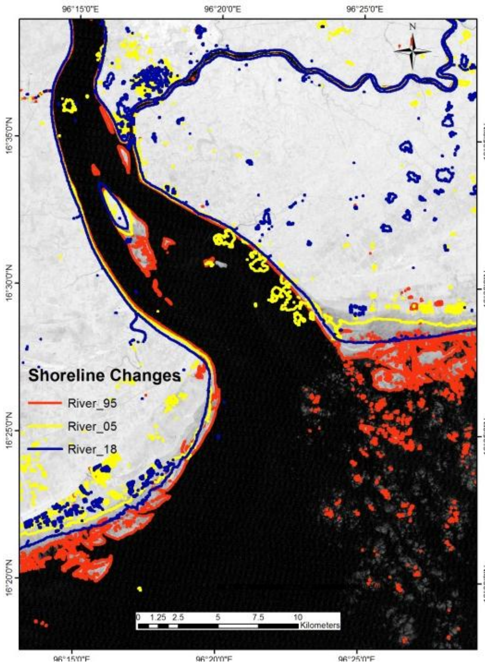


Source: Extract from Landsat images (LT5, LE7 and LC8)

Figure 2 Land Cover Changes Yangon River Area (1995, 2005, 2018)

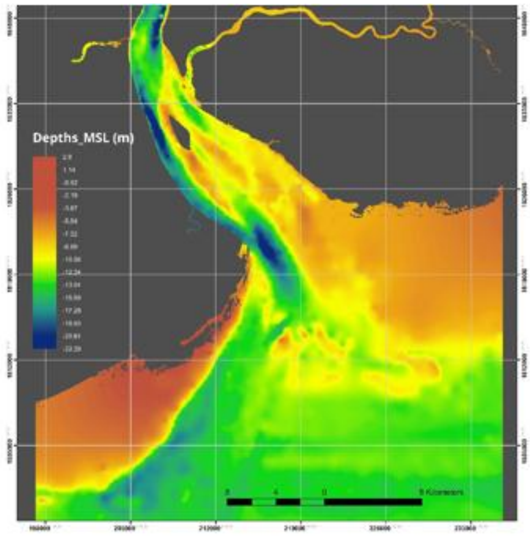
Shoreline Extraction of Yangon River

After correction of the images, a final binary image was obtained by applying the two techniques. The comparison of the shoreline at different years shows that the shoreline has retreated considerably between 1995, 2005 and 2018 due to the erosion process. Moreover, NDWI and MNDWI create for the delineation of the shoreline area. MNDWI results is more detectable open water because of the greater positive values than NDWI, as it absorbs more shortwave-infrared (SWIR) wavelengths than near-infrared (NIR) wavelengths. Moreover, built-up features have negative values and soil and vegetation have negative values, as soil reflects more Short wave Infrared (SWIR) wavelengths than near- Infrared (NIR) wavelengths. The retreat of the shoreline area is extracted by overlaying of index maps of the study area. And also this step results in overlaying the land cover with all of its categories. The binary images were processed in ArcGIS10.1 software to extract the shoreline. Firstly, each image was converted from raster to vector (feature class) with two main polygon features; water and land. Secondly, the two polygon layers were overlaid to estimate shoreline erosion/accretion pattern sediment areas in each period (1995, 2005 and 2018) along the shoreline at Yangon River.



Source: Extract from Landsat images (LT5, LE7 and LC8)

Figure 3 Shoreline Extraction and Changes in 1995, 2005, 2018

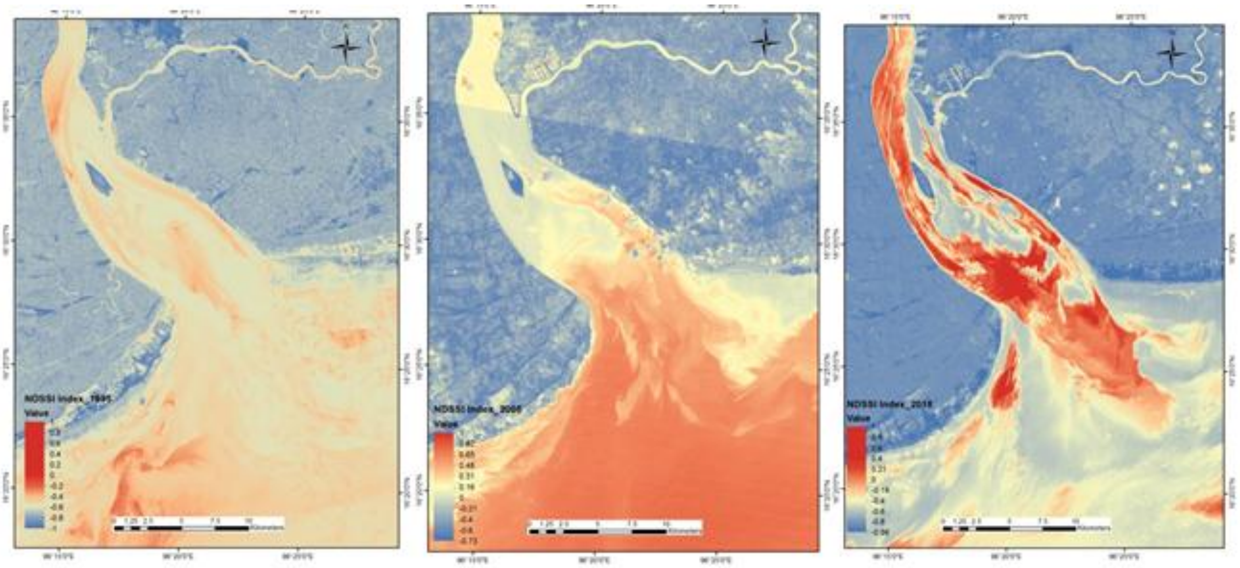


Source: created by Survey data and DEM

Figure 4 Bathymetry Map

Normalized Difference Suspended Sediment Index (NDSSI)

It has been studied band 1 (Blue band/~ 0.450-0.515 microns) and band 4 (Near-infrared/~0.750-0.900 microns) for Landsat TM/ETM imagery and band 2 (Blue band/~ 0.452-0.512 microns) and band 5(Near-infrared/~0.851-0.879 microns) for Landsat 8 OIL that are most sensitive to water and water turbidity. These characteristics have been observed for water with different levels of turbidity of the Yangon River (Figure 5). To achieve the capability of turbidity data of the study area, we calculated NDSSI (Normalized Difference Suspended Sediment Index).The values of NDSSI ranges from -1 to +1 where higher values indicate the presence of more clear water and lower values indicate the presence of more turbid water or land. According to the NDSSI index maps (1995, 2005 and 2018), the suspended sediment is more and more deposited in the southwestern part of the Yangon River mouth.



Source: Calculate from Landsat Images

Figure 5 NDSSI output (1995, 2005, 2018)

Conclusion

Shoreline and land cover changes have been investigate Yangon River mouth using Landsat images acquired in 1995, 2005 and 2018. This data was geo-referenced by a digital topographic map, and then corrected atmospherically and radio-metrically. Land cover changes were detected through NDBI (Normalized Difference Built up Index). According to the Bathymetry Map, the eastern part of the Yangon River area is slightly higher than the western part of the area. Moreover, the urban development and the construction of the Industrial Zone are also located in this area. This area is also influence by the tidal affect. These results are shown that the coastal protection work within Yangon River to decrease the maximum shoreline retreat during the period from 1995, 2005 and 2018. Due to the silting of the western navigation channel, it is limited of the sea-going vessels to Yangon Port. According to the NDSSI index of 1995, 2005 and 2018, the sedimentation of the study area always increased that is affected to the insufficient water depth for navigation pass through the Yangon River. The shallow sounding depth problem is caused by several conditions due to the high sedimentation and river morphology changes.

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