Assessing Vegetation Pattern Using Moderate Resolution Imaging Spectroradiometer (MODIS) Images Along The Western Coastal Area Of Bangladesh

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Introduction

Globalization has been reported as one of the major drivers of change and degradation of coastal ecosystems and associated diminishing services. NRM bodies will also need to take into consideration the climate change impacts to coastal communities and the already associated drivers of coastal change. The coast of Bangladesh is known as a zone of vulnerability. It is prone to natural disasters like cyclones, storm surges, and floods. The extraction of vegetation information from satellite images is based on interpretation factors such as color, texture, tone, pattern, and association. Many sensors provide imagery for producing VI (e.g., Normalized Difference Vegetation Index or NDVI) calculated from the bands in the visible and near-infrared regions. A good technique that has the potential to improve vegetation classification is the fusion of remotely sensed data with multiple spatial resolutions. The efficient integration of remote sensing information with varying temporal, spectral, and spatial solutions is necessary for accurate vegetation mapping. High NDVI values (about 0.6 to 0.9) correspond to dense vegetation such as that found in temperate and tropical forests or crops at their peak growth stage.

Abstract

The coast of Bangladesh is known as a zone of vulnerability. It is prone to natural disasters like cyclones, storm surges, and floods. Moderate Resolution Imaging Spectroradiometer (MODIS) images with spatial resolutions ranging from 250 to 1 km are primarily used to assess vegetation dynamics and processes at a large scale. Using pixel-based maximum likelihood classification (MLC) on these data can produce products with an accuracy ranging from 63% to 82%. The classification of Land use and Land cover of the Western coastal area of Bangladesh shows that there are eight different sectors: water, dense vegetation, grassland, flooded vegetation, agricultural land, shrub land, built-up area, and bare land. Using MODIS, greater than 6000 and 5374 pixels represent dense and sparse vegetation areas respectively. The NDVI found that the sparse vegetation of the western coastal area is increasing, but the site's dense vegetation is decreasing from 2003 to 2022. This study validates the importance of a thorough understanding of the related concepts and careful design of the technical procedures, which can be utilized to study vegetation cover using remote sensing images.

Key words

Vegetation mapping, remote sensing sensors, image processing, image classification, western coastal area, Bangladesh.

Study Area

The majority of the coastal area of Bangladesh lies within the delta of the Ganges–Brahmaputra–Meghna River system. The coastline of Bangladesh is 710 km long. The coastal zone covers an area of 47,201 square kilometers and was inhabited by 36.8 million people as of 2001, increasing 8.1 million from a century earlier. The coastal population is projected to grow to about 43.9 million in 2015 and 60.8 million in 2050. The zone has diverse natural resources, including coastal fisheries (especially in the Bay of Bengal), forests, salt, and minerals.

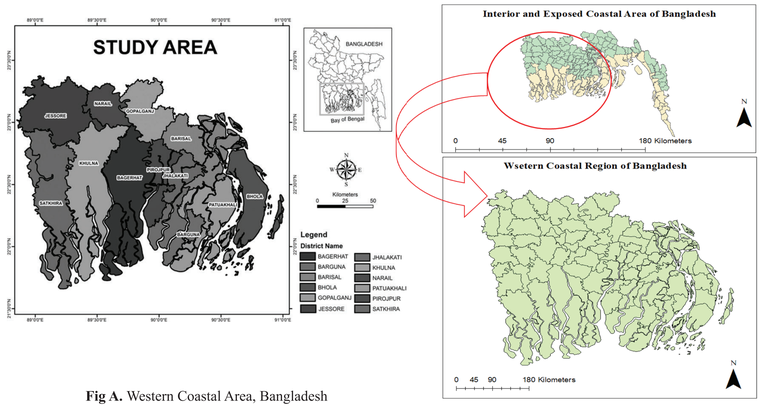


Fig A. Western Coastal Area, Bangladesh

Methodology

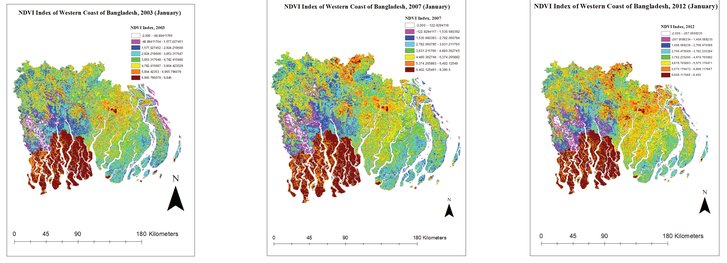
The MODIS VI products (MOD13) provide consistent, spatial and temporal time series comparisons of global vegetation conditions that can be used to monitor the Earth's terrestrial photosynthetic vegetation activity in support of phenologic, change detection, and biophysical interpretations. Gridded vegetation index maps depicting spatial and temporal variations in vegetation activity are derived at 16-day and monthly intervals in support of accurate seasonal and inter-annual monitoring of the Earth's terrestrial vegetation.

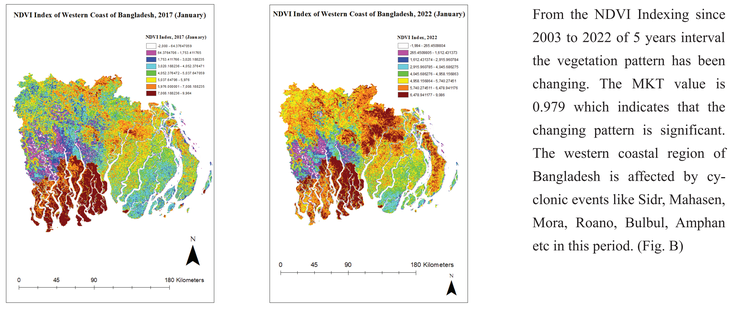
The NDVI is a normalized transform of the NIR to red reflectance ratio, ρNIR/ρred, designed to standardize VI values to between −1 and +1. It is commonly expressed as:

NDVI = (NIR-Red)/(NIR+Red)

NDVI values range from +1.0 to -1.0. Areas of barren rock, sand, or snow usually show shallow NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs, grasslands, or senescing crops may result in moderate NDVI values (approximately 0.2 to 0.5).

Vegetation Pattern of Western Coastal Area of Bangladesh for 2003, 2007, 2012, 2017, 2022





From the NDVI Indexing since 2003 to 2022 of 5 years interval the vegetation pattern has been changing. The MKT value is 0.979 which indicates that the changing pattern is significant. The western coastal region of Bangladesh is affected by cyclonic events like Sidr, Mahasen, Mora, Roano, Bulbul, Amphan etc in this period. (Fig. B)

Nonmiss	Test Stat	Std.Dev.	MK-Stat	p-value
5	4	4.082483	0.979796	0.327187

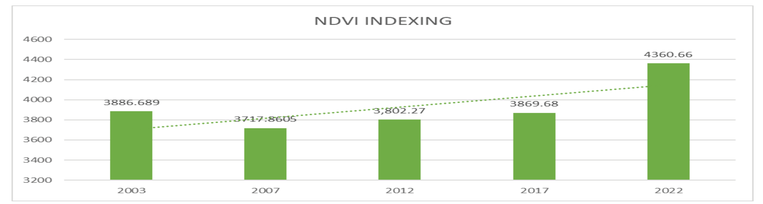
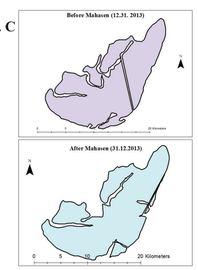


Fig. B

Fig. C



Tropical storm Mahasen was a less powerful event with winds peaking at about 85 km/hr. It struck ten central west-coast districts on 16 May 2013, affecting about 1.5 million people. The storm was responsible for 10 deaths and damaged over 150,000 houses (IFRC, 2013).

Before Mahasen, the area of the selected spot is 213545416 m (sq) and after Mahasen the area is 192328519 m(sq). Due to soil erosion the land area is decreasing. And the soil erosion happened due to less vegetation of this area according to ESRI 2020 classification. (Fig.C)

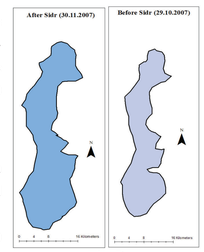


Fig. D

After Sidr the area of the selected spot is 416331478 m(sq) and before Sidr the area is 346091642 m(sq). The area is increased after the cyclonic event Sidr. And it is different from the after and before situation of Mahasen. According to ESRI 2020 LULC classification the area is dense vegetative and because of vegetation cover the area is protected as well as the plant conserve the soil. (Fig. D)

Conclusion

In an applied context, using ecological enhancement methods to facilitate the colonization of hard coastal structures by species that moderate microclimate and limit rates of deterioration could offer potential engineering benefits alongside any associated biodiversity gains. Identifying and promoting how and to what extent the organisms colonizing engineered structures provide practical benefits or services to people, such as meeting planning requirements for ecological enhancement, or improving the durability of construction materials via bioprotection, should be a research priority if managers and engineers are to be expected to include habitat provision in the design of their structures.

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