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INVESTIGATION OF THE APPLICABILITY OF THE MICROWAVE IMAGE TO COMPLEMENT THE OPTICAL IMAGE FOR THE PREPARATION OF A COASTAL CONFIGURATION MAP

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ABSTRACT

The coastal area, being the transition zone between the sea and land, is a country's most diverse and dynamic zone in terms of its environment and economy. A variety of economic activities revolve around this region. Mapping the dynamic coastal configuration is an essential tool for sustainable coastal zone management. Satellite remote sensing offers excellent resources for monitoring and mapping coastal zones. Microwave remote sensing images, in tandem with optical remote sensing imagery, can be used for mapping coastal configurations. However, both images have some limitations. In this context, the present article explores the integrated use of microwave images to supplement optical images to overcome these limitations and generate a coastline configuration map.

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INTRODUCTION

The coastal zones, which are found where the ocean and land meet, are crucial for maintaining biodiversity, controlling climate, and safeguarding resources (Yuan et al., 2022). Mapping the dynamic coastal configuration is a very essential tool for coastal zone management. Effective and sustainable management of a coastal area heavily depends on reliable, accurate, and consistent mapping (Bishop-Taylor et al., 2021). Satellite remote sensing is an outstanding source for researching and mapping dynamic coasts over extended geographical regions and throughout time. Satellite remote sensing images are widely used for mapping. Based on sensors, satellite images could be optical images or microwave images (Pech-May et al., 2022). Microwave remote sensing images are increasingly being used in natural resources management applications in tandem with optical remote sensing imagery (Das et al., 2019; Li et al., 2017). Both optical images and microwave images can be used for mapping coastal configurations.

Optical pictures operating in visible and near-infrared wavelengths typically have an excellent or moderate spatial resolution, ranging from 30 meters to 1 kilometer, depending on the sensor setup, which is good for coastal monitoring (Chaouch et al., 2012). Although different geological features like water, vegetation, clouds, and ground cover can often be recognized from optical images, their clarity could be impaired by rain or clouds (Pech-May et al., 2022; Fu et al., 2020). Therefore, these photographs are only usable when the scene is recorded without any clouds (Chaouch et al., 2012). Microwave sensors, on the other hand, function at longer wavelengths and are not impacted by weather or solar radiation, resulting in weather-independent images providing an attractive alternative (Pech-May et al., 2022), still having limitations for their spatial resolution and complex processing techniques (Oliveira, 2019). In this context, to overcome these limitations and improve mapping, image fusion is becoming more popular in remote sensing due to improved imaging systems and the ability to combine pictures from several sensors to improve comprehension (Rahman 2010).

Ultimately, the integration of microwave and optical pictures may combine the rich spectrum and spatial information of optical images with the backscattering polarimetric qualities of microwave images, which is very important for the precise mapping of coastal zones (Yuan et al., 2022). The abundance of supplementary data derived from remote sensing can significantly support attempts to precisely identify land use and measure minute variations in the landscape for sustainable management (Joshi et al., 2016). Therefore, the current work was aimed at validating the data layers generated from optical images for the preparation of the map of the coastal configuration in previous times and the generation of coastal morphology data layers from microwave images and validating them based on the validated data layers of optical image.

MATERIALS AND METHODS

Study area

The study area was selected based on the availability of satellite images matching the tidal conditions required for the study. Details in this respect are given later. The study area geographically belongs to 91º 03' 20'' E, 22º 52' 45.51'' N and 91º 10' 28.29' E, 22º 46' 18.52' N and occupies an area of 764,265 hectares. The study area is shown in Figure 1. It belongs to the eastern part of the Meghna estuary. In respect of the geo-morphological changes, the area is highly active (Ahmed et al. 2018). Both erosion and accretion are casual occurrences in this area. It is one of the most significant and active estuaries in the world, surrounded by several deltaic islands (Ali et al., 2007; Alvee et al., 2018).

Data used

In the earlier study (2018-2019), application of optical satellite images to reveal the dynamics of coastal geo-morphological features was investigated. The data used for that study is shown in Table 1. For the present study, a microwave image of the Sentinel 1 satellite has been used. The date of the image is August 18, 2018. This image is of high tide (4.82 m).

Table 1. Satellite images used for the study in 2018-2019

Date	Satellite/Sensor	Satellite over-pass time	Tide table time	Tidal height (m)
22-04-2019	Landsat OLI	10.18 AM	09:51 AM	0.33
03-12-2018	Sentinel 2	10:31 AM	10:25 AM	5.06
24-01-2019	Landsat ETM	10:13 AM	10:25 AM	0.17
02-05-2017	Sentinel 2	10:31 AM	10:30 AM	1.85

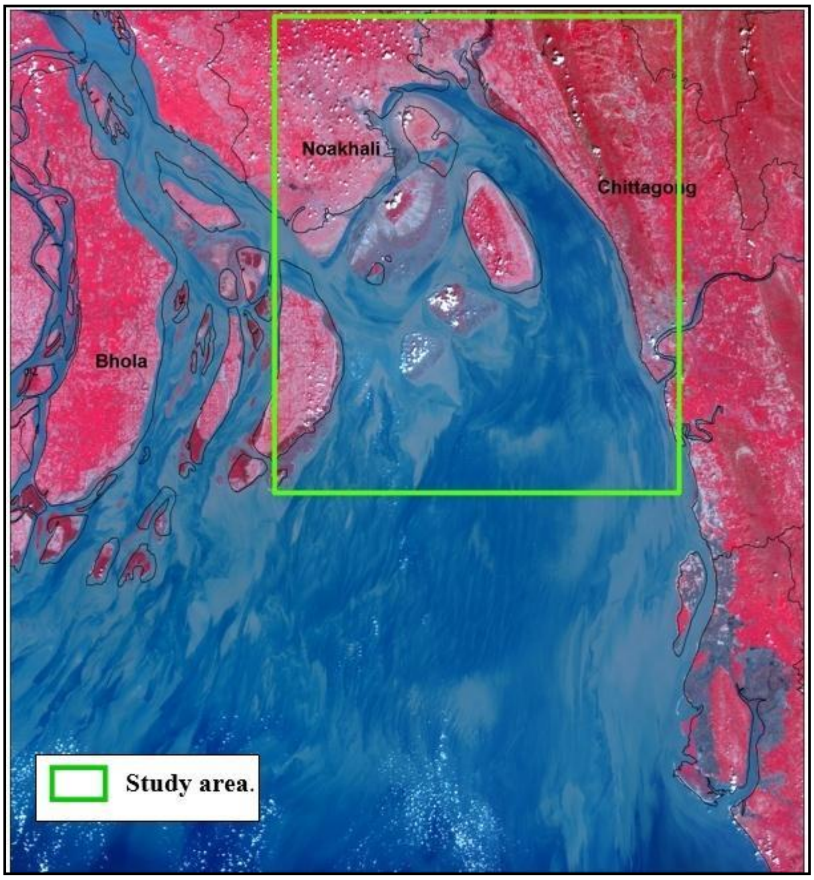

Figure 1. Study area

Image generation:

Sentinel 1 compressed image files were downloaded from the Copernicus Open Access Hub. The files were decompressed to get microwave images. The microwave images were geo-referenced using the Sentinel 2 image as a reference image.

Study area extraction:

The study area is covered with two frames of the Sentinel 1 satellite. The frames were mosaiced, and images of the study area were extracted using a pre-generated Area of Interest (AOI).

Comparative analysis of the coastal geo-morphological features in optical and microwave images:

The coastal geo-morphological features obtained from the optical image in the last were superimposed on the microwave image for this comparative analysis.

RESULTS AND DISCUSSION

It is seen in Figure 2 that the islands that are identified using the optical images are not all confirmed in the microwave image. The number of identified islands on the optical image in the study area is 15, but on the microwave image, two landmasses that are identified as islands are not visible (marked by '4' in Figure 2). Thus, the interpretation of a microwave image with an appropriate tidal condition alone with an optical image is necessary to identify the island. It is seen that, when compared with a microwave image, the interpretation of a high-tide coastline using an optical image is erroneous in some places, as marked by '2' in Figure 2. The vice-versa is also observed in places marked by '1' and '5' in Figure 2. The interpretation of a high-tide coastline using an optical image is confusing in some places (marked by '3' in Figure 2) when compared with a microwave image. The microwave image used for the study is a high-tide condition image. Therefore, the analysis was carried out by superimposing the high-tide coastline obtained from the optical image in the last year. Figure 2 shows the superimposed map. In this figure, representative places are marked for comparative analysis.

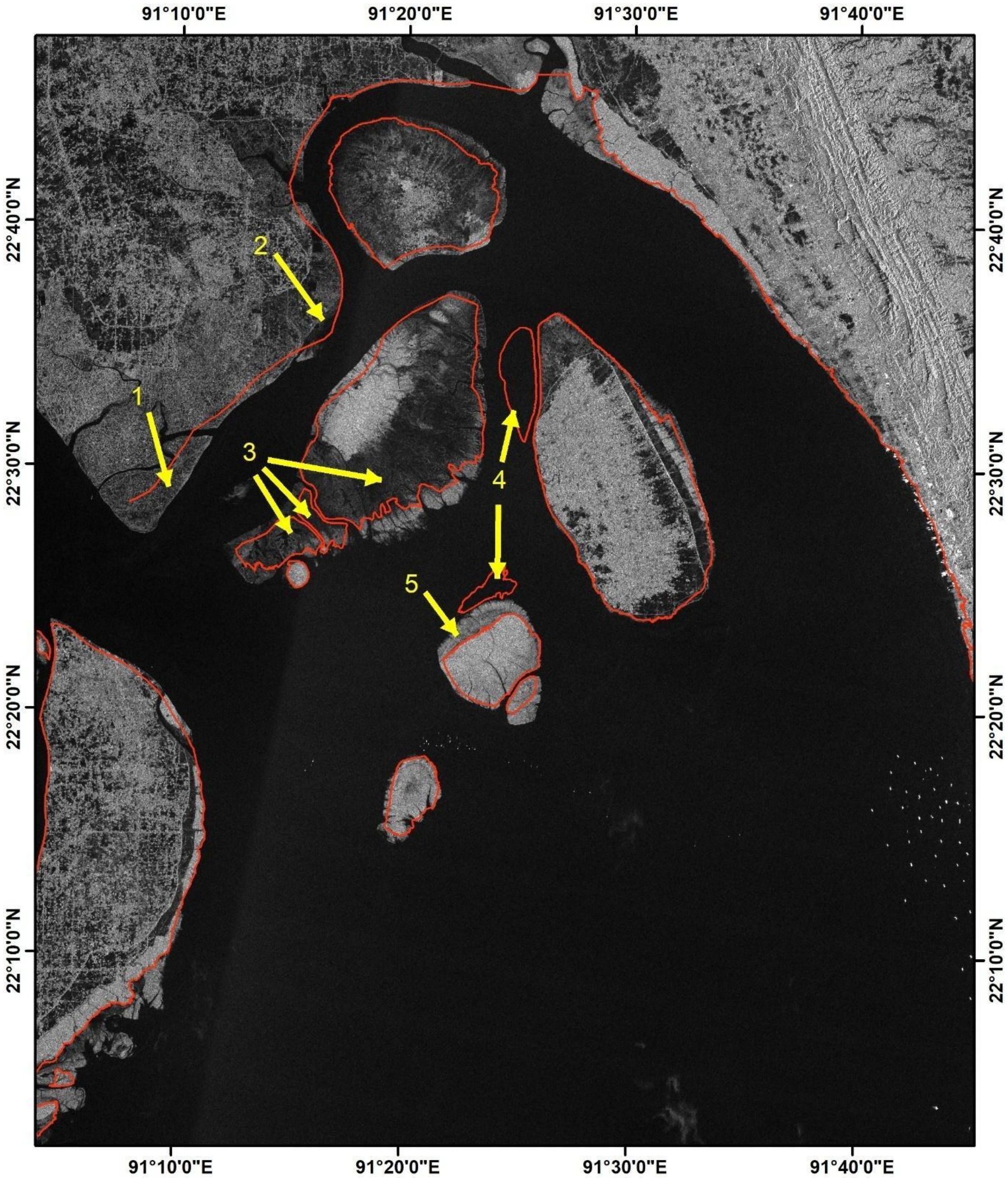

Figure 2. High-tide coastline derived from an optical image superimposed on a microwave image.

CONCLUSION

Microwave images can add value to the identification of coastal geo-morphological features using satellite images, as they increase the frequency of having images with appropriate tidal conditions. However, the causes of miss-interpretation to identify coastal geo-morphological features both in optical and microwave images need to be analyzed. This may be addressed in future study.

CONFLICT OF INTEREST

There is no conflict of research interest

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