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Satellite Detection of Shoreline Changes in the Sunderbans Mangrove Forest (1973–2006)

Background

Mangrove forests are fragile coastal ecosystems and the zonation of mangrove species depends on the level of inundation, salinity and freshwater inflow etc. They are vulnerable to global climate change and sea-level rise in addition to anthropogenic and natural causes. In many deltas, mangrove vegetation is threatened due to coastal erosion, reduced freshwater inflow from the hinterland and the increasing level of salinity.

Sea-level has been rising 1.7–1.8 mm/year over the last century and the rate has increased to 3 mm/year in the last decade (Church *et al.,* 2004; Holgate & Woodworth, 2004; Church & White, 2006). Sea-level rise is contributing to coastal erosion in many places of the world (Rosenzweig *et al.,* 2007).

The objective of this study is to assess the nature and pattern of changes in mangrove shorelines. The study area is located in the eastern part of the Sunderbans in Bangladesh which is part of the largest tract of continuous mangrove forest in the world.

Materials and methods

The Sunderbans mangrove forest is located in the southern part of the Ganges River Delta. It extends about 80 km from the Bay of Bengal and is bordered by the Baleshar River in the east and the Hoogly River in the west. About two-thirds the Sunderbans lie in Bangladesh with the remaining one-third in India. The ground within the forest is flat and the elevation seldom exceeds 1.5 m above mean high tide level. The main tree species are Sundri (*Heritiera fomes)* and Gewa (*Excoecaria agallocha)*. Other species include Keora (*Sonneratia apetala),* Passur (*Xylocarpus moluccensis),* Baen (*Avicennia officinalis),* Kankra (*Bruguiera cylindrica),* Dhundal (*Xylocarpus granatum)* and Golpata (*Nypafruticans)*.

Landsat Multi-spectral Scanner (MSS) data of frames 147/045 (20 Feb 1973) and 148/045 (21 Feb 1973), and Thematic Mapper (TM) data of frame 137/045 (5 Dec 2006) were used in this study. Geometric distortions among the ortho-rectified imageries were checked. All the scenes were classified using the maximum likelihood algorithms of supervised classification. Classified Landsat MSS scenes of 1973 were joined together to form continuous image mosaic. The classified images of 2006 were overlaid to generate shoreline changes.

Results and discussion

Landsat images of the Sunderbans are presented in Fig. 1. MSS image mosaic is visualized in bands 2, 3 and 1, and TM image in 3, 4 and 2. In this colour combination, forest appears in green, sea-water in purple and accreted shores in white. The Landsat image of 1973 was used as background and the classified vector layer of 2006 was superimposed to visualize shoreline changes (Fig. 1c).

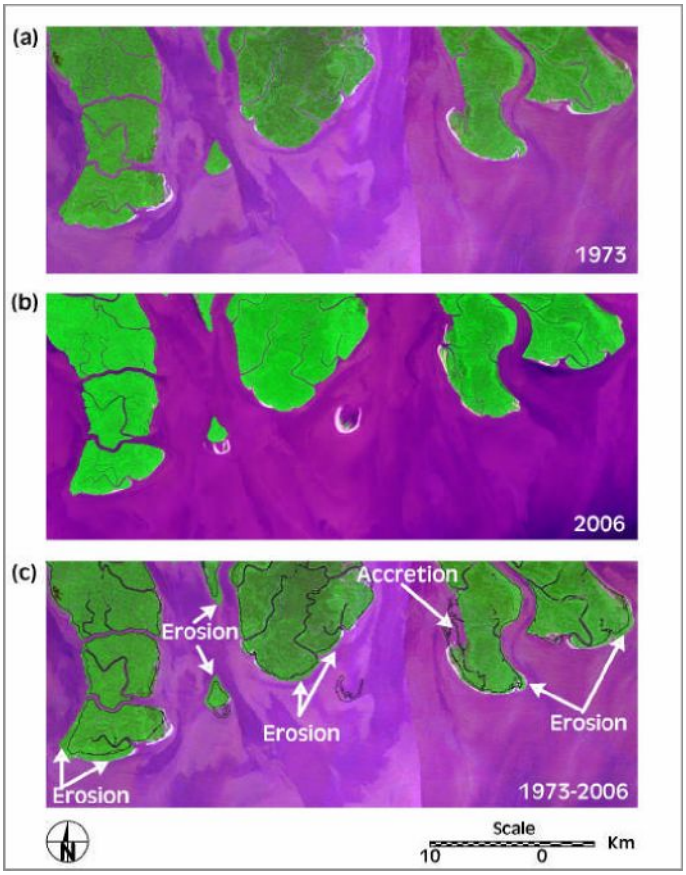

Fig. 1. Satellite images of the Sunderbans (a) 1973 Landsat MSS, (b) 2006 Landsat TM and (c) overlaid images

The overlaid classified images are presented in Fig. 2. Changes are vivid in the peripheral zone of the mangrove forests. Coastal erosion is detected in many parts of the forest. In some places, the extent of erosion was up to 0.9 km (a, Fig. 2). Land accretion and forest succession are also noticed in some places. This phenomenon is concentrated in some sheltered localities and not as widespread as coastal erosion. Change statistics reveals that 8610 ha of forests were eroded away and 7130 ha were accreted forests.

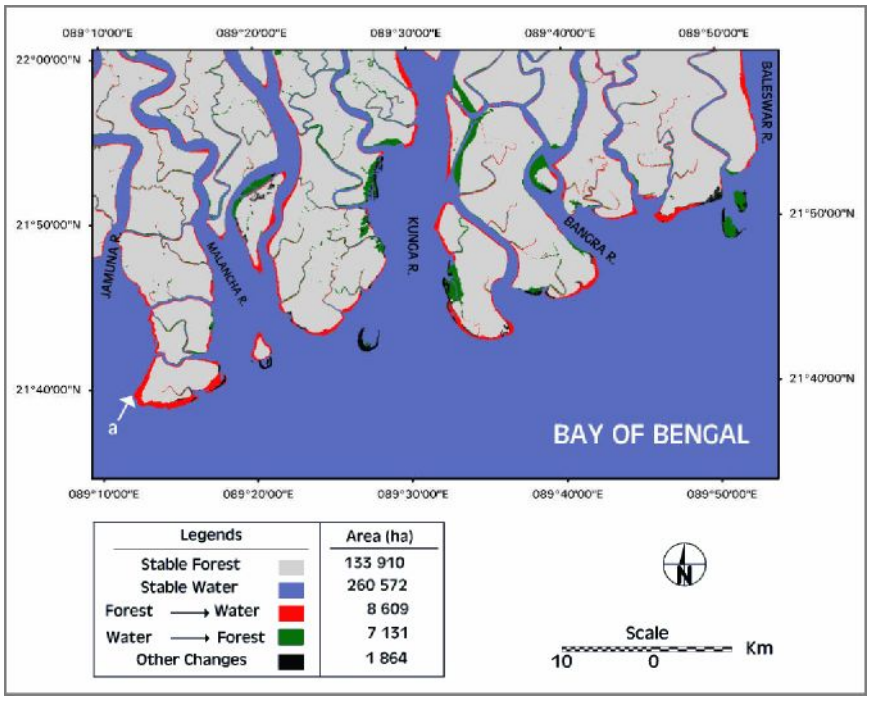

Fig. 2. Changes in the aerial extent of the Sunderbans (1973–2006)

Shoreline changes in the Sunderbans in India and Bangladesh have been reported earlier by Giri *et al.* (2007). According to the investigation, from 1973–1990, the area of accreted mangrove forests (2930 ha) equaled that of eroded mangrove forests (3160 ha). However, from 1990–2000, the rate of erosion (4150 ha) was seven times that of accretion (590 ha). Results of this study showed slightly higher rate of erosion (8610 ha) than accretion (7130 ha) from 1973–2006.

Conclusion

This study showed that the shoreline of the Sunderbans forest is dynamic, and is experiencing both coastal erosion and accretion. The former is widespread in many parts of the coastline bordering the Bay of Bengal. Shoreline retreat of up to 0.9 km was observed. Accretion was evident in the more sheltered parts of the delta.

It remains unclear how much of the coastal erosion in the Sunderbans is linked to the global warming and sea-level rise. Other factors such as geological and anthropogenic induced land subsidence and changes in sediment supply may also contribute to the observed shoreline changes.

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