

## Spatio-temporal changes of world largest mangrove forest (Sundarbans)

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### Abstract

Mangrove forests are found along coastlines in the tropics and subtropics of the world (FAO, 2010). The Sundarbans is the largest contiguous mangrove forest of the world, it covers 10,000 km<sup>2</sup> area, of which 62% are placed in Bangladesh and the remaining 38% in India (Ghosh et al., 2015). Sundarbans mangrove forest is the hotspot for biodiversity and provide wide range of ecosystem services (Payo et al., 2016). About 7.5 million people are directly or indirectly dependent on these ecosystem services for livelihood and socio-economic well-being (Kibria et al., 2018; Ortolano et al., 2016). Recognizing the importance and uniqueness of Sundarbans, the United Nations Educational, Scientific and Cultural Organization (UNESCO) declared it as a World Heritage Sites. However, Sundarbans is decreasing at an alarming rate due to anthropogenic and climate change reasons. In this study, we explored the Land Use Land Cover (LULC) changes of Sundarbans from 1975 to 2020.

To complete the study, Landsat Satellite images with less than 10% cloud cover were collected from 1975 to 2020. All images were acquired between December and January from United States Geological Survey (USGS). After atmospheric and radiometric correction the study area was extracted from mosaic images. The maximum likelihood classification (supervised) was performed on Landsat images (study area) of four time periods over 45 years (1975, 1990, 2005 and 2020). The classification was assigned to dense forest, moderate dense forest, sparse forest, barren land and water body. For accuracy assessment, collected 100 Ground Control Points (GCPs) were verified with Google Earth historical images for the study year 1990, 2005 and 2020. As no ground truth information of study areas are available for the time period 1975. Hence, random points were generated for accuracy assessment and verified using visual interpretation keys and field based information. After that, the causes of periodic change patterns were discussed in terms of human impacts (i.e. agricultural and industrial activities) and natural calamities (i.e. cyclonic storms and sea level rise).

The findings of the study revealed that the dense forest decreased by giving an annual rate of 1.3% from 1975 to 2020. The decreasing rate of dense forest was highest from 1975 to 1990. Moderate and sparse forest increased from 1975 to 2020, however, these two types of forest decreased from 1990 to 2005. The water body always increased gradually by giving an annual rate 0.58% from 1975 to 2020, but, the increasing trend was highest for the last 15 years (2005 to 2020). The study investigated that the area of water body increased mainly for erosion of offshore islands and sea-facing coastlines, and might be for sea level rise. Even ecologically the Sundarbans is a single unit the LULC was different between Bangladesh and Indian part. Dense and moderate dense forest were highest in Bangladesh part of Sundarbans compared to Indian one. However, sparse forest was highest in Indian Sundarbans than Bangladesh part. The reason was fact that the tract of most cyclonic storms were toward Indian part of Sundarbans. Bangladesh part of Sundarbans increased sparse area in 2020 compared to previous year, this was due to the hit of strong cyclonic storms in 2019. The study found that

the maximum barren land located near to borderline between forest and human habitat, which indicated that the accessible zones were affected significantly by human activities.

The study concluded that the density of the Sundarbans mangrove forest decreasing significantly, where, dense forest turned into moderate dense and then into sparse forest. These changes were due to anthropogenic activities and climate change reasons. Plantation in the barren areas, and control access of local communities might be effective tools to conserve Sundarbans mangrove forest.

**Keywords:** Sundarbans mangrove, Spatio-temporal changes, Forest density, Anthropogenic disturbances, Cyclonic storm

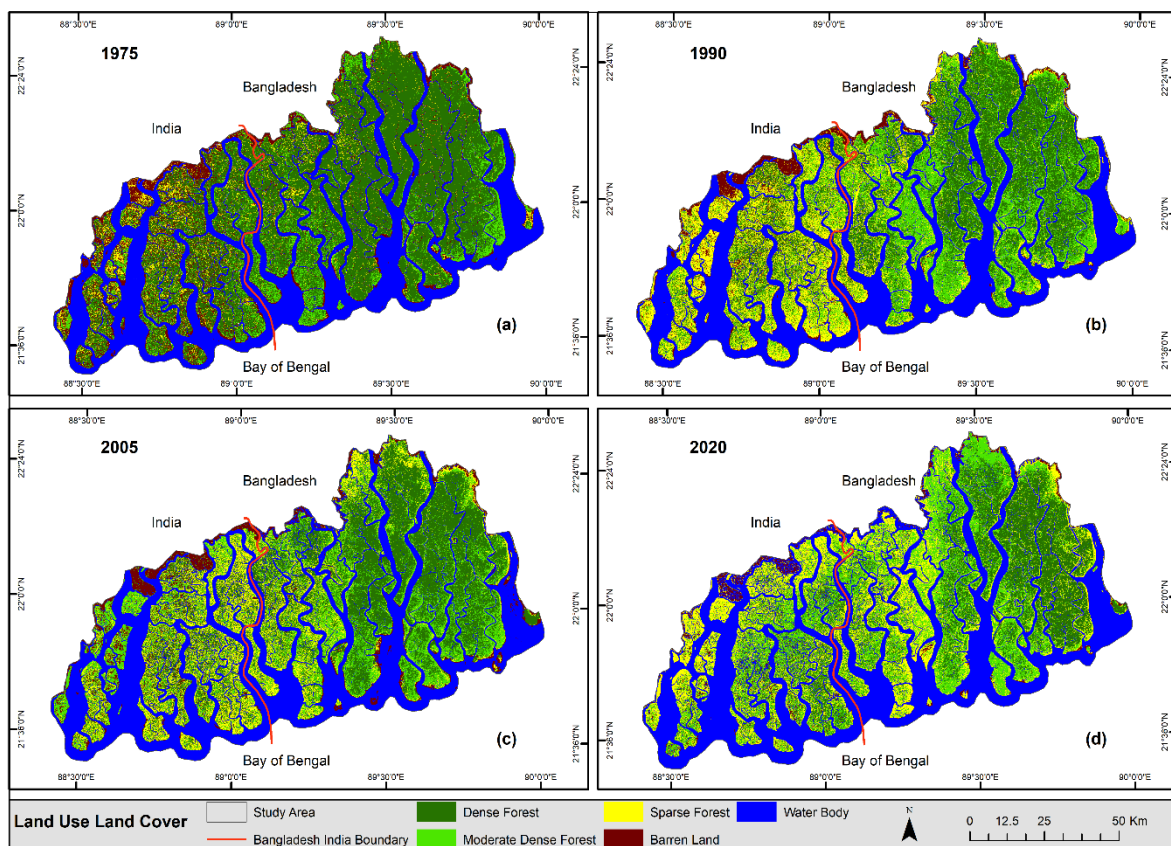


Figure: LULC change of Sundarbans from 1975 to 2020