A Multi-Sensor Approach to Enhance the Prediction of Mangrove Biophysical Characteristics in Chilika Lagoon and Bhitarkanika Wildlife Sanctuary, Odisha, India

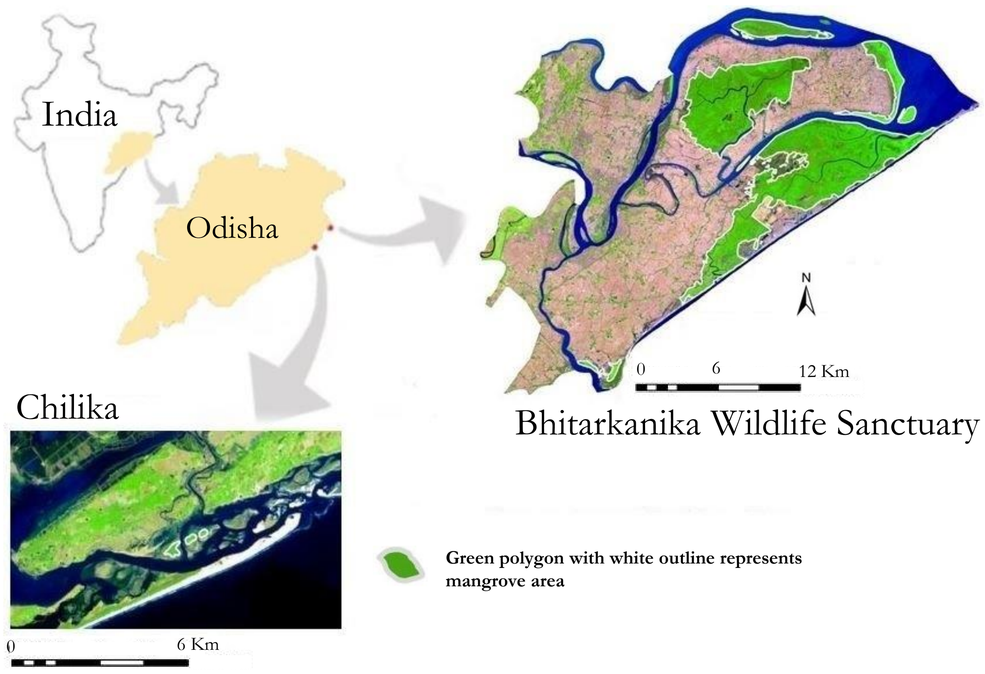
Abstract

Across the globe, mangroves play a major role in coastal ecosystem processes mitigating erosion and serving as barriers against storm surges. India holds approximately 5% of the world's mangroves, over half of which are along its east coast. Situated in the state of Odisha, Chilika Lagoon and Bhitarkanika Wildlife Sanctuary sustain mangrove sites of local importance in need of effective management. This study demonstrated the use of Terra, Landsat, and Sentinel-1 satellite data for spatio-temporal monitoring of mangrove health for both sites. Several indices including Normalized Difference Vegetation Index and Enhanced Vegetation Index, were examined to develop biophysical prediction tools and derive a 17-year time-series (2000 to 2016) of leaf chlorophyll (CHL), Leaf Area Index (LAI), and Gross Primary Productivity (GPP). Parallel to this assessment, a long-term (2000 to 2016) analysis of meteorological factors such as precipitation and temperature was completed to determine an association between these parameters. The correlation between meteorological parameters and mangrove biophysical characteristics enabled forecasting of mangrove health and productivity. A historical analysis of land cover maps was produced using Landsat 5 and 8 data to determine decadal changes in mangrove area estimates between 1995 and 2017. This analysis was used to predict land use land cover change or fragmentation of Bhitarkanika mangroves. Based on IPCC data availability, the soft prediction map for 2050 showed the probability of mangrove risk to disturbance in the eastern part of Bhitarkanika. This study revealed the advantages of using a multi-sensor approach to monitor mangrove health and inform monitoring protocols.

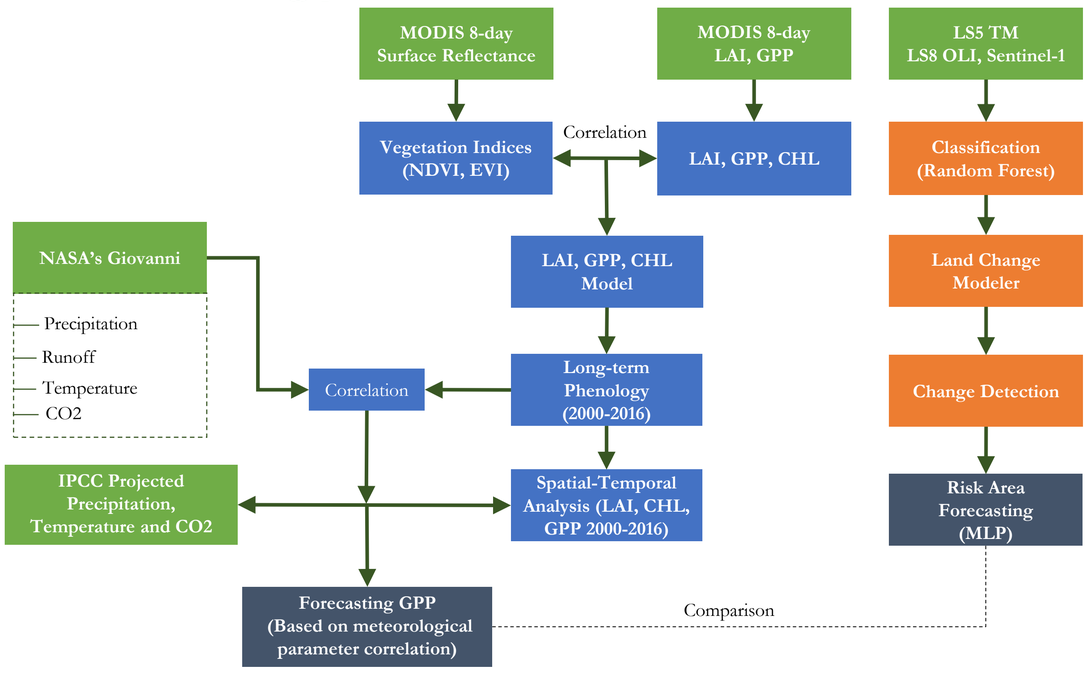
Objectives

- **Analyze** long-term (2000-2016) spatio-temporal variability of biophysical parameters (GPP, LAI, CHL) using MODIS surface reflectance data
- **Produce** a biophysical forecasting tool by utilizing 17 years of time series MODIS derived LAI, CHL and GPP data and meteorological data derived from NASA's Giovanni and IPCC meteorological projections
- **Create** a mangrove extent forecasting tool using Landsat 5 TM and Landsat 8 OLI data in Land Change Modeler on TerrSet

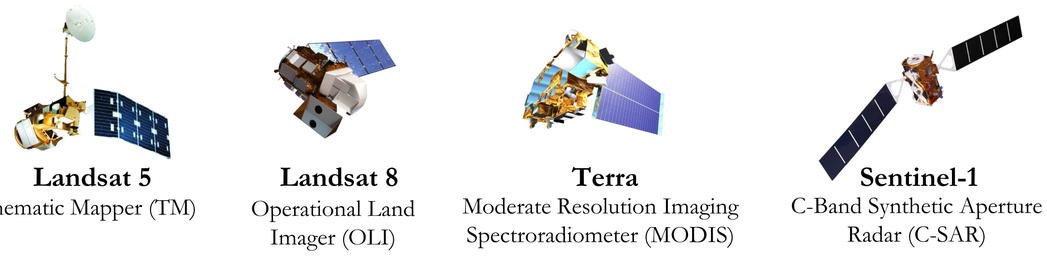
Study Area



Methodology



Earth Observations



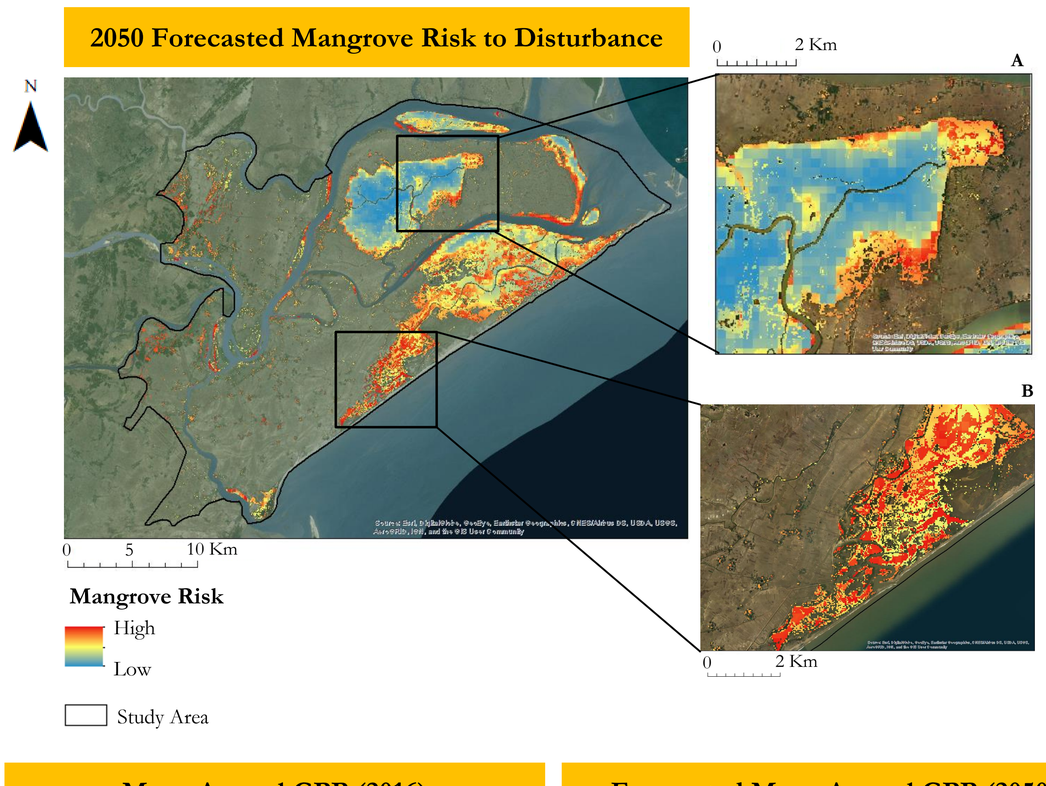
Landsat 5
Thematic Mapper (TM)

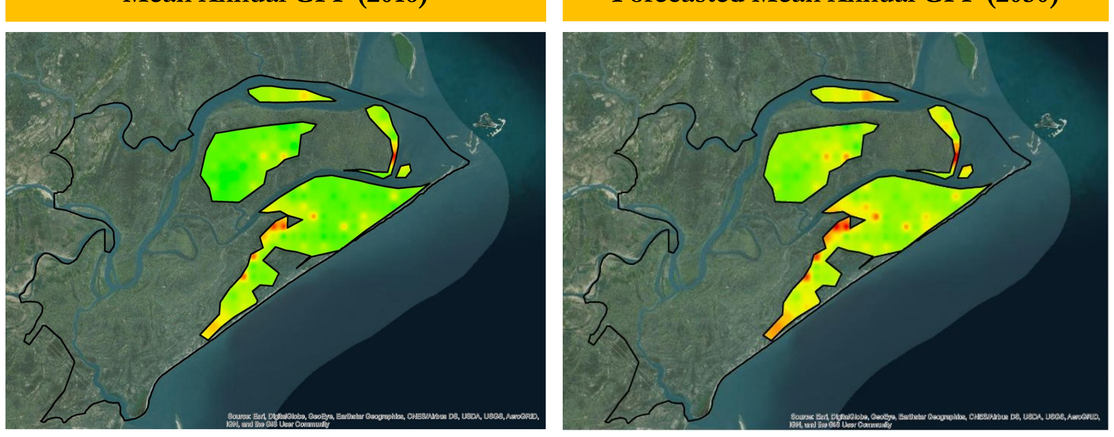
Landsat 8
Operational Land Imager (OLI)

Terra
Moderate Resolution Imaging Spectroradiometer (MODIS)

Sentinel-1
C-Band Synthetic Aperture Radar (C-SAR)

Results





Conclusions

- Despite conservation efforts, the current extent of dense mangrove in Bhitarkanika Wildlife Sanctuary is projected to decrease up to 10% by the year 2050.
- A comparison between the classification for 1995, 2004, 2017 and the projected classification for 2050 indicates that dense mangrove extent decreased while open mangrove and agriculture extents increased.
- The mean annual GPP forecasted for 2050 was 7.7% less compared to the mean annual GPP for 2016.
- By 2050, patches of mangrove along the south-west and northern coast of Bhitarkanika Wildlife Sanctuary are projected to decrease in GPP are also at a higher risk of disturbance.

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Eastern India Ecological Forecasting III