Annual Chlorophyll-a Concentration & Sea Surface Temperature (SST) Analysis of The Bay of Bengal Using Satellite.

Abstract

In this study, the Bay of Bengal region's Chlorophyll-a concentration and Sea Surface Temperature (SST) were analyzed. For this study, monthly satellite data from January 2020 to December 2020 were reconstructed and analyzed. Some specific locations of the Bay of Bengal near the coastal region of Bangladesh were selected to analyze and compare the data. August had the highest Chlorophyll-a concentration (0.65 mg/m^3), while May had the lowest (0.19 mg/m^3). From January to May, the concentration gradually dropped; from May to August, it rose. Between January and July, the eastern coastal region had higher amounts of Chlorophyll-a, whereas, between August and December, the central and western regions had higher levels. The SST research showed that May had the highest temperature (30.3°C), while January had the lowest temperature (25.2°C). SST progressively rose from January to May, showed minor oscillations from May to October, and then started to fall. The Ganges-Meghna-Brahmaputra river discharge and upwelling processes can be the reason for the negative correlation between Chlorophyll-a concentration during those months. The Bay of Bengal region's ecosystem dynamics and climate processes are better understood from this study, which supports marine research and management.

1. Introduction

Chlorophyll is a pigment found in plants, algae, and some bacteria. It is the most vital pigment to sustain life on Earth. Chlorophyll absorbs light energy and carbon dioxide and converts them into chemical energy by a process called photosynthesis. There are several types of chlorophyll, but the most common ones in plants are chlorophyll-a and chlorophyll-b. Chlorophyll a,b,c, and Phaeophytin are commonly found in seawater. (Beebe *et al,* 2008). Phytoplankton are the main primary producer in the ocean.

Sea surface temperature (SST) is the measurement of the temperature of the ocean's top layer. We typically measure the first few meters below the water surface. It is a crucial parameter in understanding and monitoring oceanic and atmospheric processes, as it influences weather patterns, ocean circulation, and marine ecosystems. SST also plays an inevitable role in Earth's climate.

We have made analysis for the Chlorophyll-a and Sea Surface Temperature (SST) . We have taken level-3 data from Ocean Color Web (https://oceancolor.gsfc.nasa.gov/) for both Chlorophyll-a and SST analysis of the whole Bay of Bengal Region.

2. Materials and Methods

2.1 Study area

The study area, Bay of Bengal is a bay that forms the northeastern part of the Indian ocean. The area of Bay of Bengal is about 839,000 sq. miles (2,173,000 sq. km). It lies roughly between latitudes of 5° N and 25° N and longitudes of 79° E and 95° E. It is bordered by Sri Lanka and India to the west, Bangladesh to the north, and Myanmar and the northern part of the Malay Peninsula to the east. Several large rivers such as the Mahanadi, Godavari, Krishna, and Kaveri on the west and the Ganges and Brahmaputra on the north, flow into the Bay of Bengal. The Andaman and Nicobar groups, which are the only Islands, separate the bay from the Andaman Sea.

Figure-1: Map of study area of the Bay of Bengal

2.2 Data and Methods

Satellite data of Chlorophyll-a and Sea surface temperature (SST) were downloaded from Ocean Color Web (https://oceancolor.gsfc.nasa.gov/). Monthly data for the period of January 2020 to December 2020 was downloaded from (https://oceancolor.gsfc.nasa.gov/l3/) for the analysis.

2.3 Data Pre-Processing and Reconstruction

Monthly satellite data were reconstructed and processed for the Bay of Bengal region. There were some empty places in Chl-a dataset because of high cloud coverages in the months of pre-monsoon and monsoon resulting in a data emptiness in the months of June to October. Monthly maps were developed by SNAP and ArcMap software to analyze spatial variability. The datasets were geometrically binned to get an annual visualization of both Chlorophyll and SST. Some specific locations near the coastal region were selected to analyze and compare the data.

3. Result and Discussion

3.1 Monthly average of Chl-a

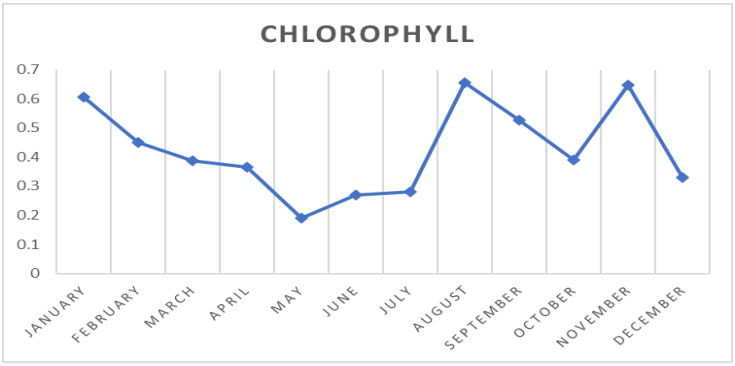

Figure-2a: Monthly average graph of Chl-a

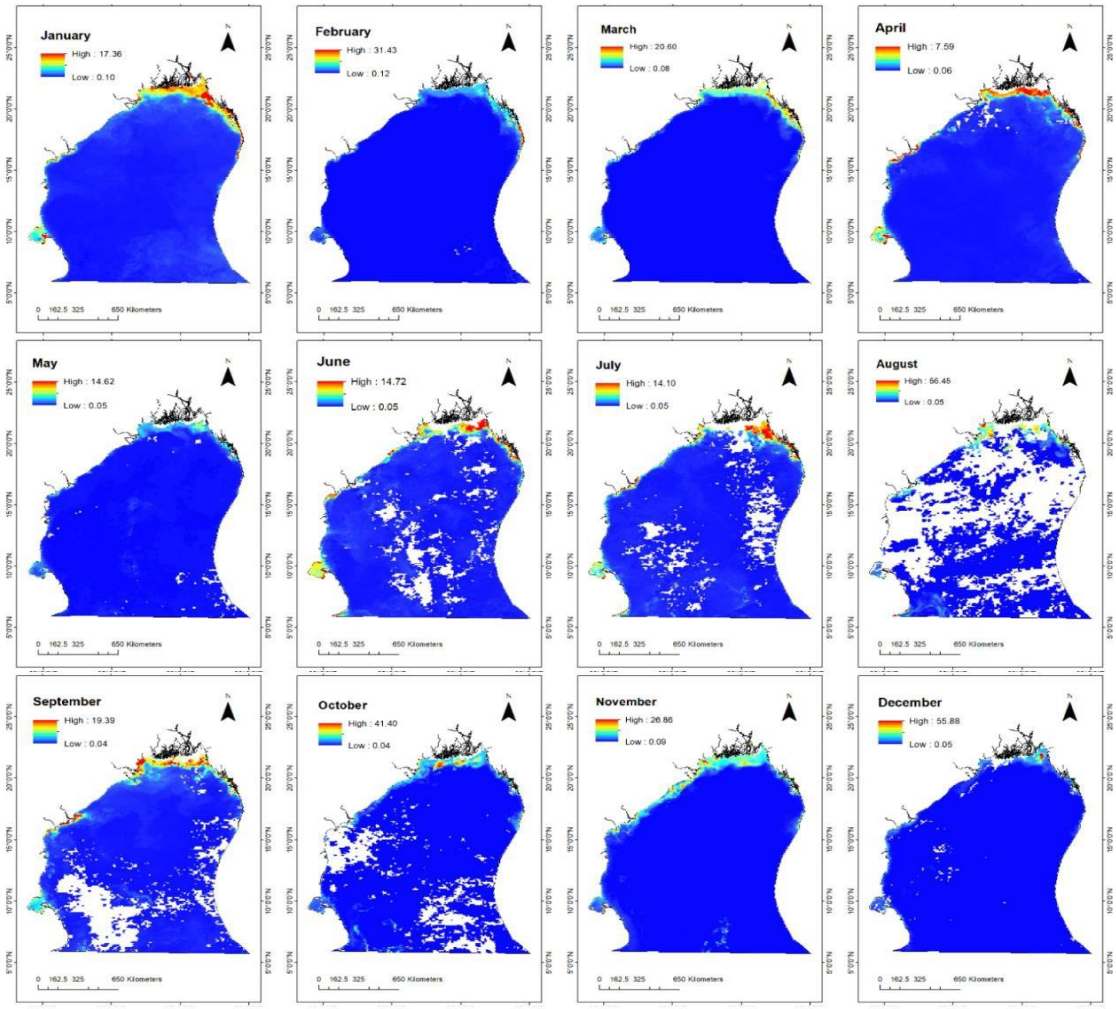

Figure-2b: Maps of monthly average of satellite obtained Chl-a concentration of 2020.

Figure-2a displays the monthly distribution of the average Chl-a concentration from January to December in the year 2020. The result indicates that the highest concentration of chlorophyll is found in August (0.65 mg/m3) while the lowest concentration is found in May (0.19 mg/m3). A gradual fall of chlorophyll concentration is observed from January to May, then a gradual rise is observed from May to August. A higher abundance of Chlorophyll in the eastern coastal part is seen from January to July. A higher abundance of Chlorophyll in the central and western part are observed from August to December.

Besides, we have constructed a map from monthly average satellite derived data of Chl-a concentration in Figure-2b. This figure displays the fluctuations of Chl-a over the year of 2020.

3.2 Monthly average of SST

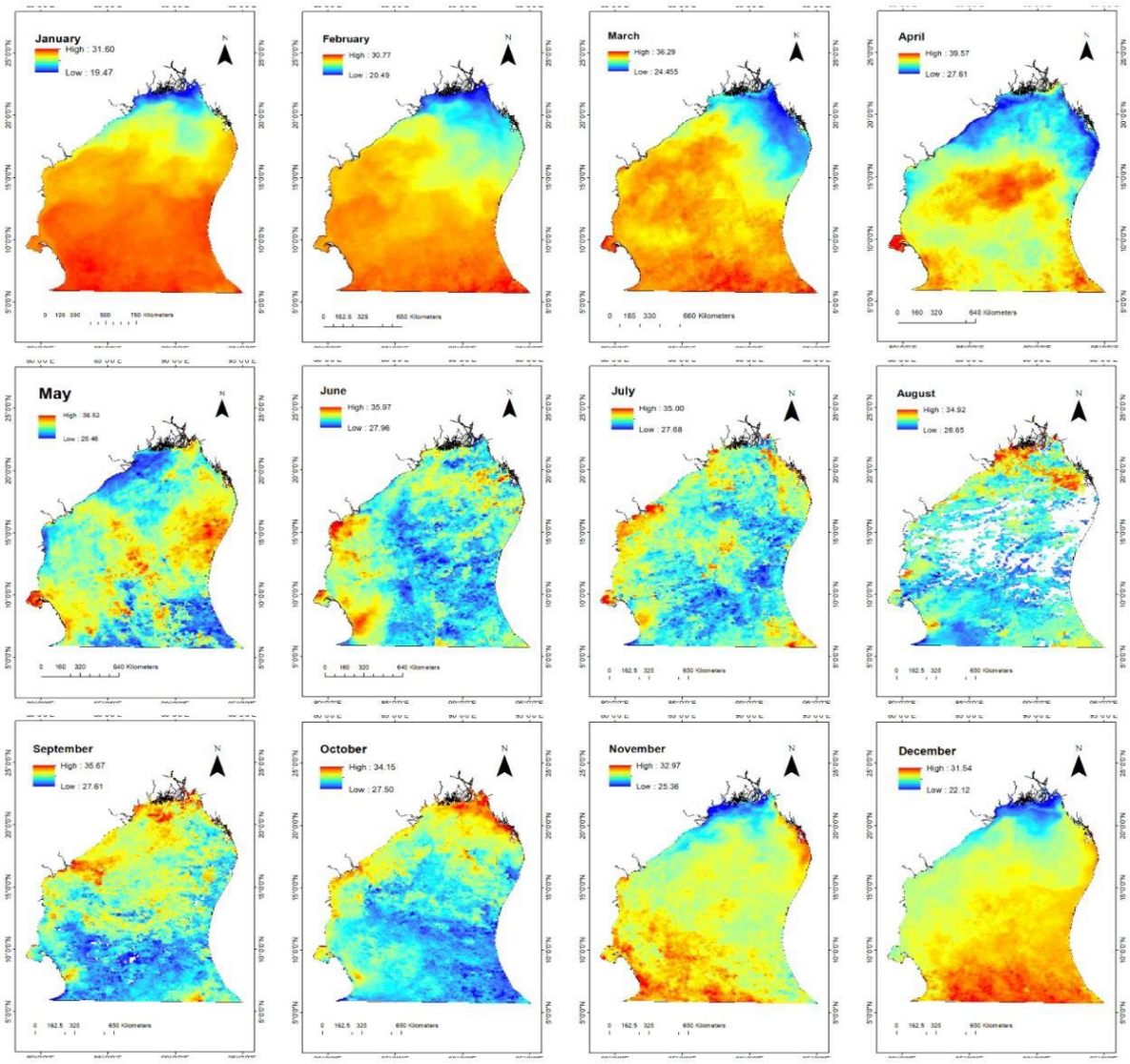

Figure-3a: Maps of monthly average of satellite obtained SST of 2020.

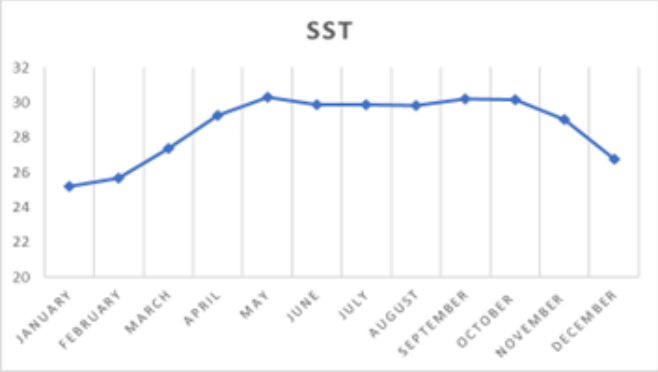

Figure-3b: Monthly average graph of SST

We have created a map from monthly average satellite derived data of SST in Figure-3a. The figure displays the fluctuations of SST over the year 2020.

Besides, Figure-3b represents the monthly distribution of the average SST from January to December. The result shows that the highest SST is found in May (30.3^{o} C) and the lowest SST is found in January (25.2^{o} C). SST is gradually rising from January to May. Then there are some slight rises and falls from May to October. From October, a gradual fall in SST is observed.

3.3 Correlation between Chl-a and SST

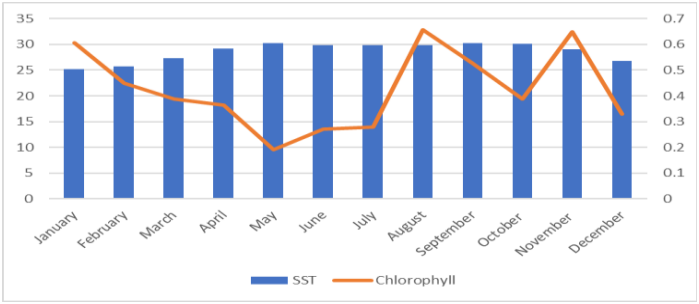

Figure-4: Monthly correlation between Chl-a concentration and SST

Figure-4 shows the monthly correlation between Chlorophyll-a concentration and SST. The graph shows a negative correlation between chlorophyll and SST from January to May and August to October. One probable reason for higher chlorophyll concentration in January can be the reason for nutrient enrichment because of upwelling and downwelling as cold water gets saltier and denser. The north-easterly wind pattern also contributes to the upwelling process. The GMB discharge can also be a cause of this phenomenon. No correlation was found for other parts of the Bay of Bengal because there was not much chlorophyll present in other regions.

3.4 Annual observation of satellite derived Chl-a and SST

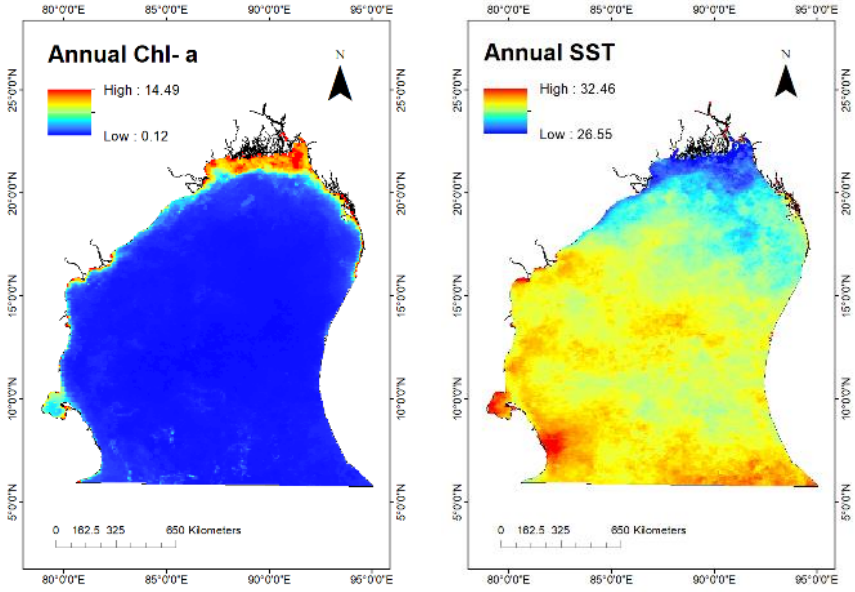

Figure-5: Maps of annual mean of Chl-a and SST of 2020

Figure-5 shows the annual mean of the Chlorophyll-a concentration and Sea Surface Temperature (SST) over the whole year 2020.From the figure, the annual fluctuation of the Chl-a is seen mostly in the coastal region and more noticeable in the northern part of the Bay of Bengal. The result shows that the annually averaged highest concentration of Chlorophyll is found 14.49 mg/m^3 while the lowest concentration is found 0.12 mg/m^3. Besides, the annual observation of SST indicates the annual mean of the highest SST is found 32.46^o C and the lowest SST 26.55^o C.

Conclusion

This study shows seasonal and regional fluctuations in Sea Surface Temperature (SST) and Chlorophyll-a concentration in the Bay of Bengal. Chlorophyll-a levels peak in August, which indicates a suitable environment for phytoplankton growth. These discoveries contribute to our understanding of the local ecological dynamics. This research offers useful information for the Bay of Bengal climate research and ecological management. To analyze long-term patterns and evaluate the effects of climate change on this crucial marine region, more investigation is required.

References

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