ASSESSING CORAL REEF CHANGES THROUGH SUPERVISED CLASSIFICATION AND ITS CORRELATION WITH SST AND CHLOROPHYLL-A: A REMOTE SENSING APPROACH.

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Introduction

Corals

- Colonial organisms,

- Composed of hundreds to hundreds of thousands of individual animals, called polyps (Barnes, 1987)

Coral bleaching

- Corals become white due to loss of symbiotic algae and photosynthetic pigments (NOAA, 2024)

Source: ScubaDiver - stock.adobe.com

*Source: Great Barrier Reef Foundation*

Remote Sensing for Coral Reef Monitoring

- Remote Sensing can help us to analyze the reef distribution on a high spatial resolution and temporal frequency.

- It can help us observe and monitor coral bleaching due to heat, ocean acidification, and other environmental parameter.

- It can help us monitor reef habitat destruction due to anthropogenic activities.
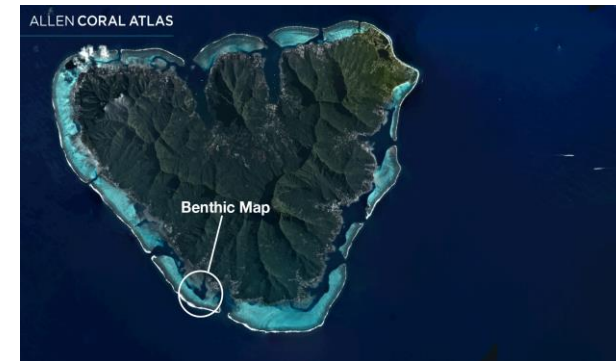
Allen Coral Atlas (2020): DOI: doi.org/10.5281/zenodo.3833242
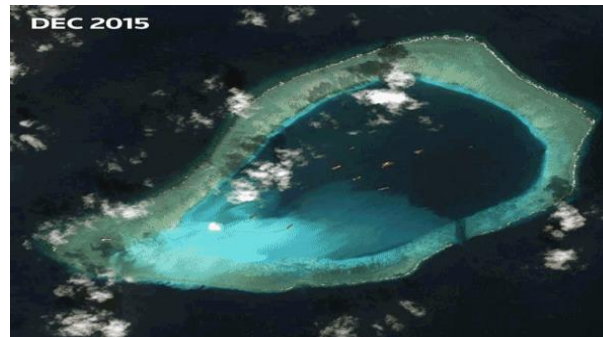
Reef Habitat Destruction over the years in South China Sea
Source: Reuters News

Objectives

The primary objective of the project is:

- To analyze the trends of coral reefs through supervised classification and time series analysis and correlating it with SST and Chlorophyll-A.

The secondary objectives of the project are:

- To make time series analysis of SST, and chlorophyll-A,
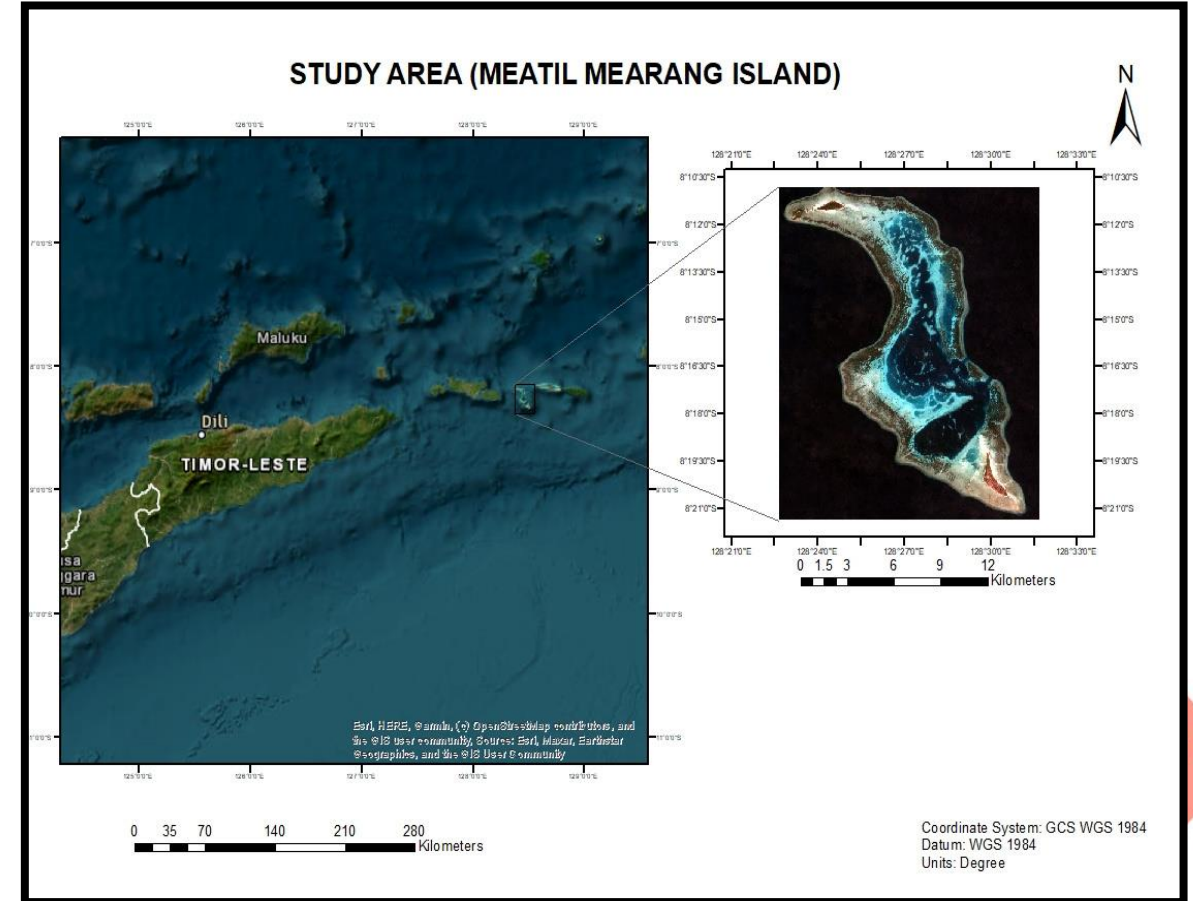
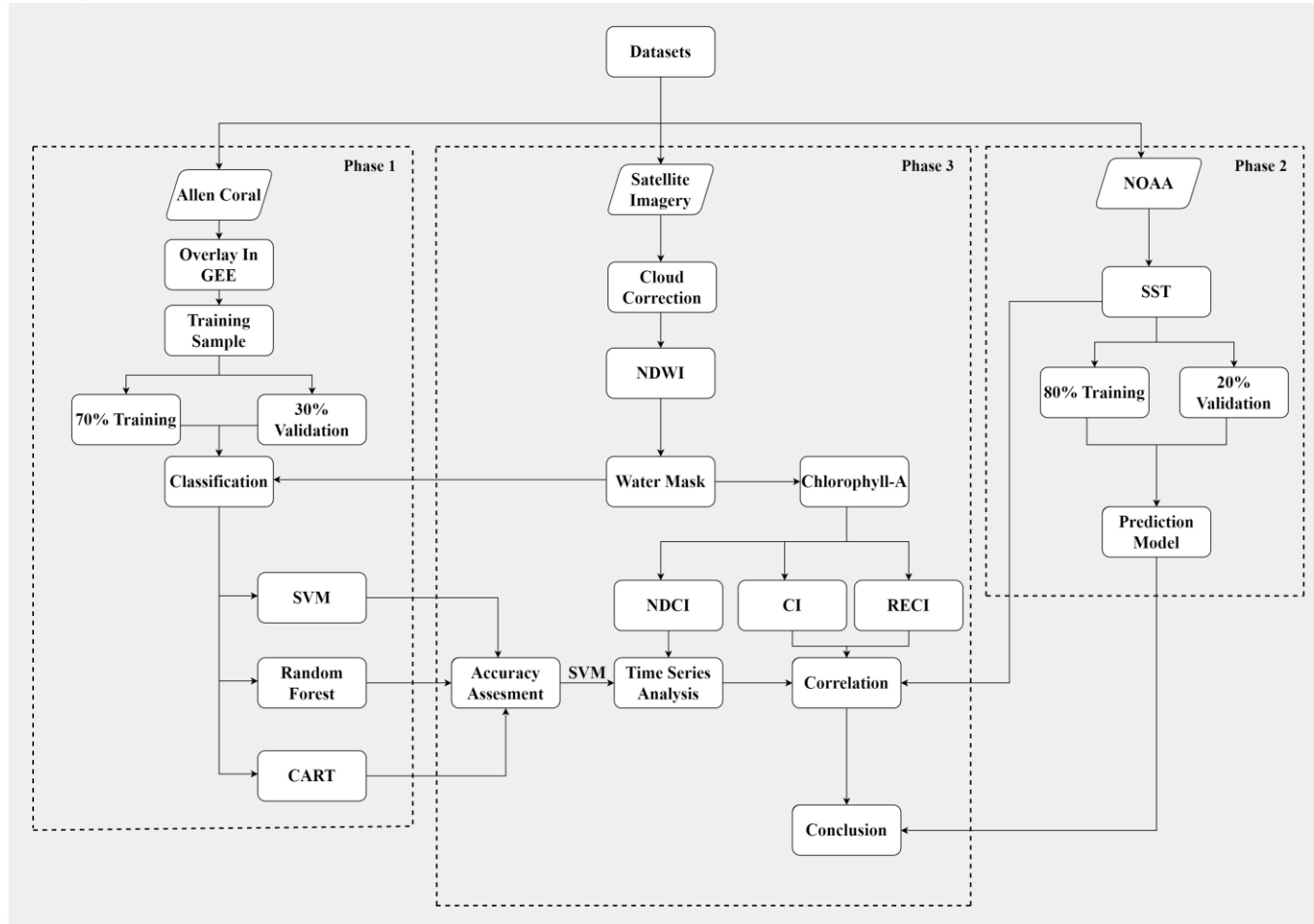- To build the prediction model of SST.

Study Area

- Inside the Coral Triangle,
- Nearer to the Timor-Leste,
- Name: Meatil Mearang Island
- Area: 323 km².
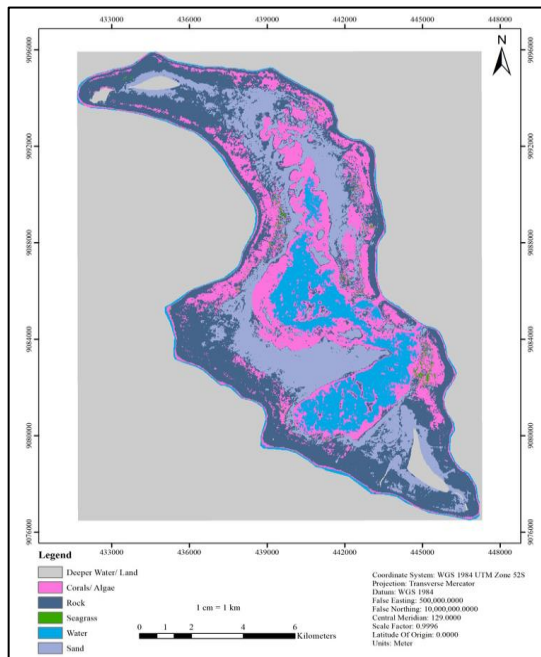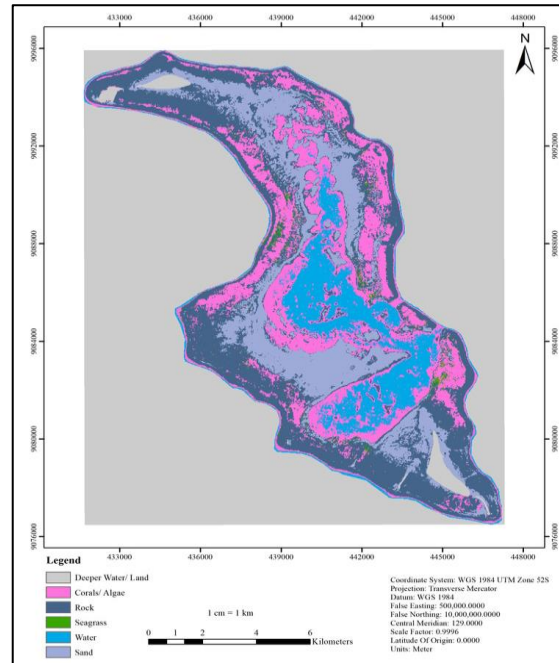- Rich in marine life but threatened by climate change and human activities.

STUDY AREA (MEATIL MEARANG ISLAND)

Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

Methodology
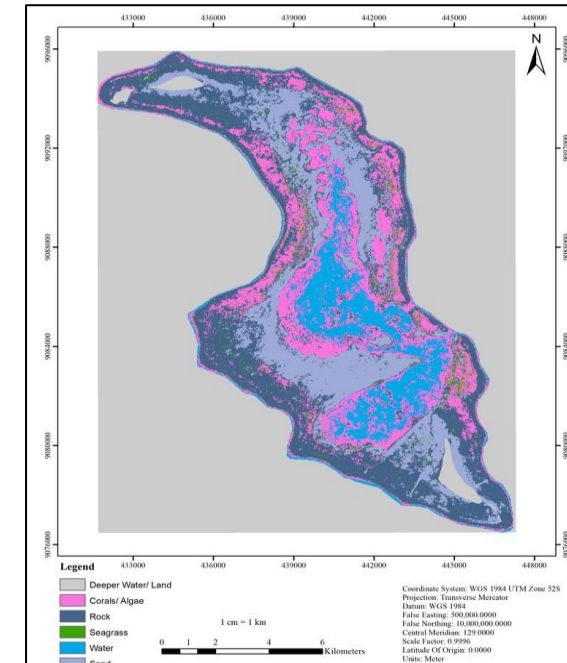
COMPARISON OF MAP

RF

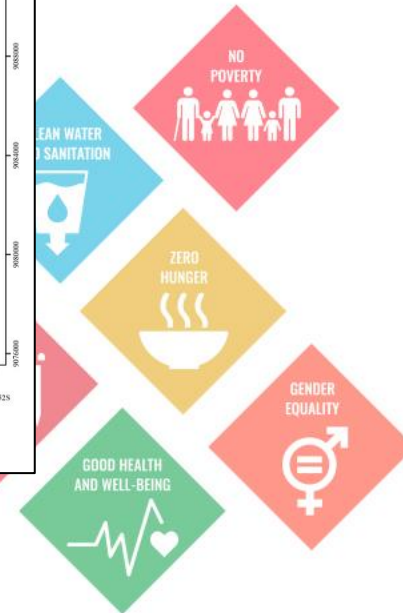The Overall accuracy was 89.84% and Kappa Coefficient was 0.86

SVM

The Overall accuracy was 91.81% and Kappa Coefficient was 0.9

CART

The Overall accuracy was 87.13% and Kappa Coefficient was 0.83

COMPARISON

Class	RF		SVM		CART	
	Producer Accuracy	Consumer Accuracy	Producer Accuracy	Consumer Accuracy	Producer Accuracy	Consumer Accuracy
Coral/Algae	0.9002	0.9113	0.9299	0.9061	0.7898	0.8966
Rock	0.9107	0.7375	0.853	0.8592	0.8559	0.7191
Seagrass	0.0869	0.6667	0.0869	0.5	0.6087	0.1647
Water	0.9974	0.9949	1	0.9961	0.9987	0.9974
Sand	0.9332	0.9611	0.9421	0.9367	0.8372	0.9538

Time Series

- **Time Period: 2016 - 2023 (8 years)**

- **Data Analysis:**

S.N.	Year	Area (km²)	Area (%)
1	2016	27.20	8.42
2	2017	26.77	8.29
3	2018	27.80	8.61
4	2019	27.81	8.61
5	2020	26.73	8.28
6	2021	29.80	9.23
7	2022	25.94	8.03
8	2023	31.06	9.62
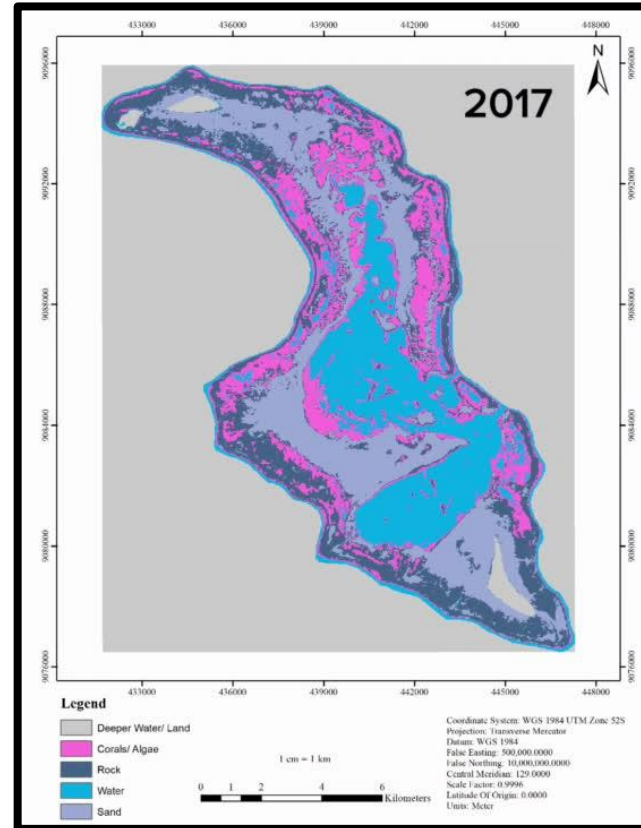
Sea Surface Temperature

- Used Google Earth Engine (GEE) to calculate the mean SST,
- Time Period: 1982 to 2023
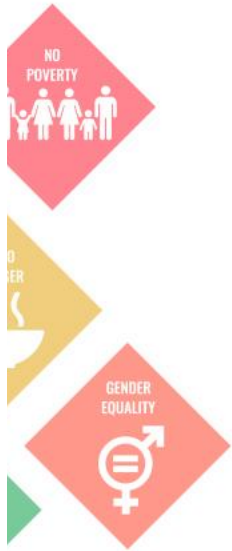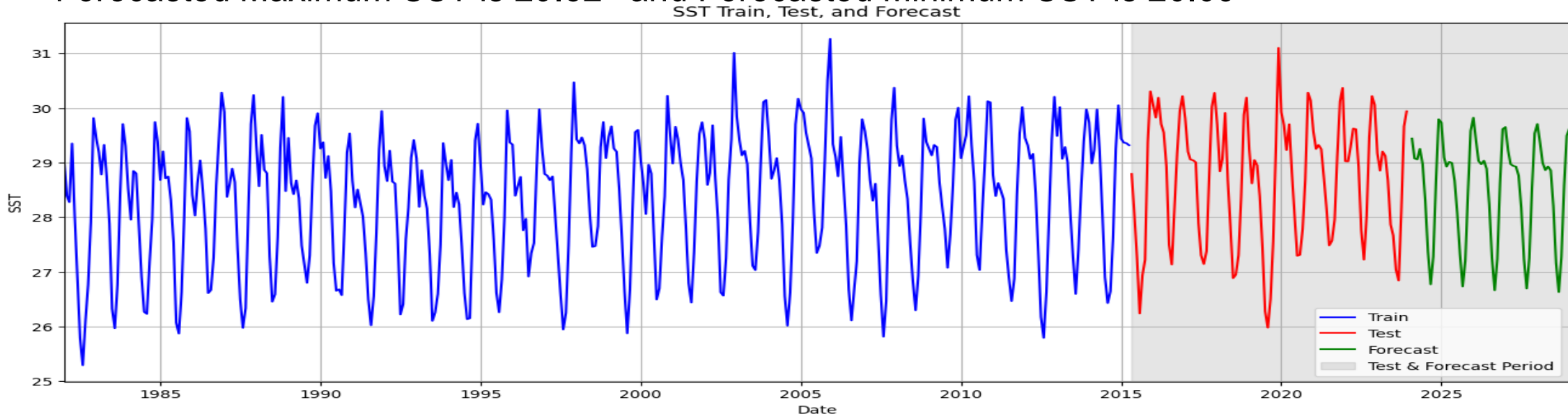- Data Used: NOAA Optimum Interpolation Sea Surface Temperature (OISST) dataset.

Sea Surface Temperature (SST)
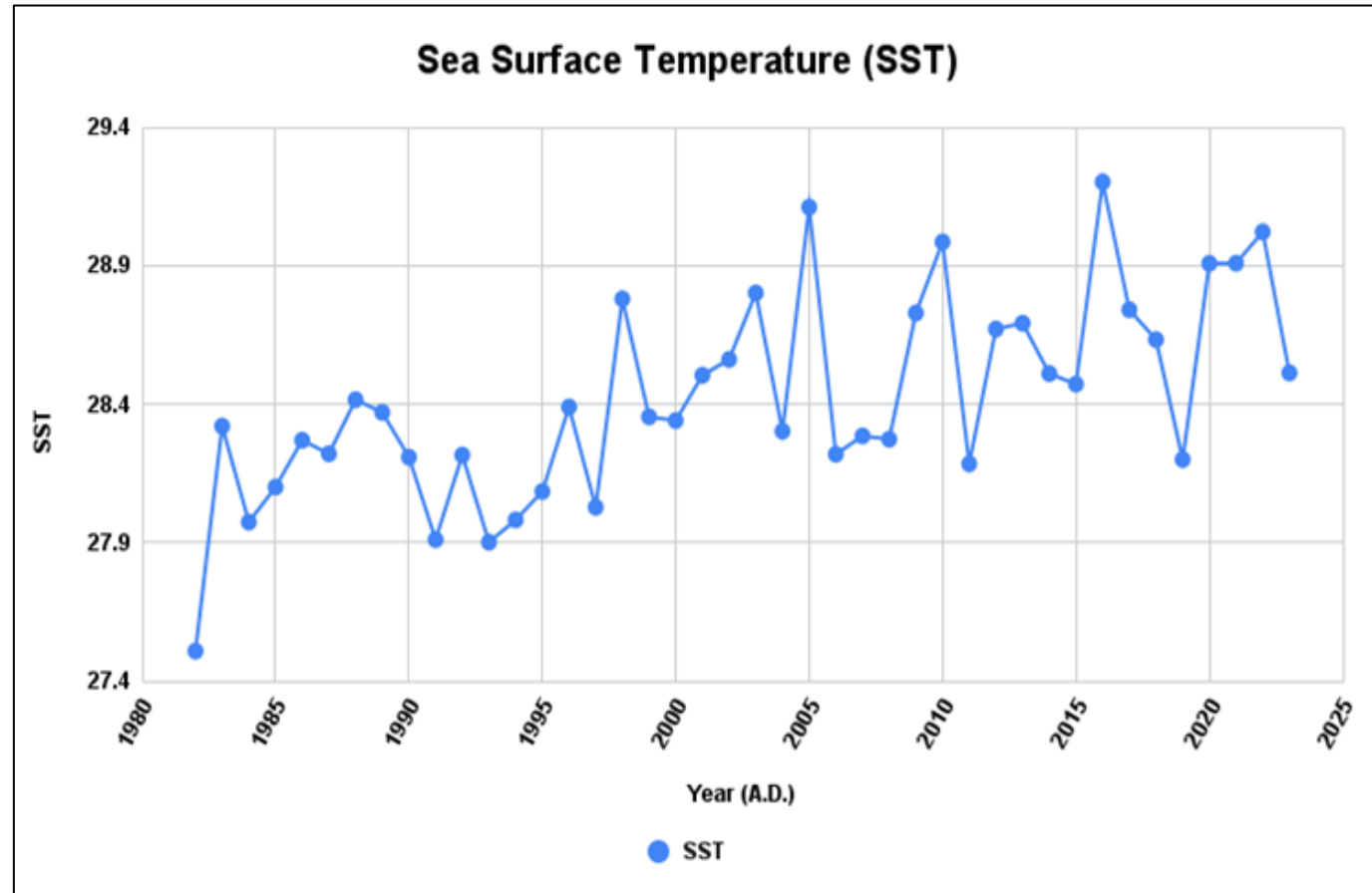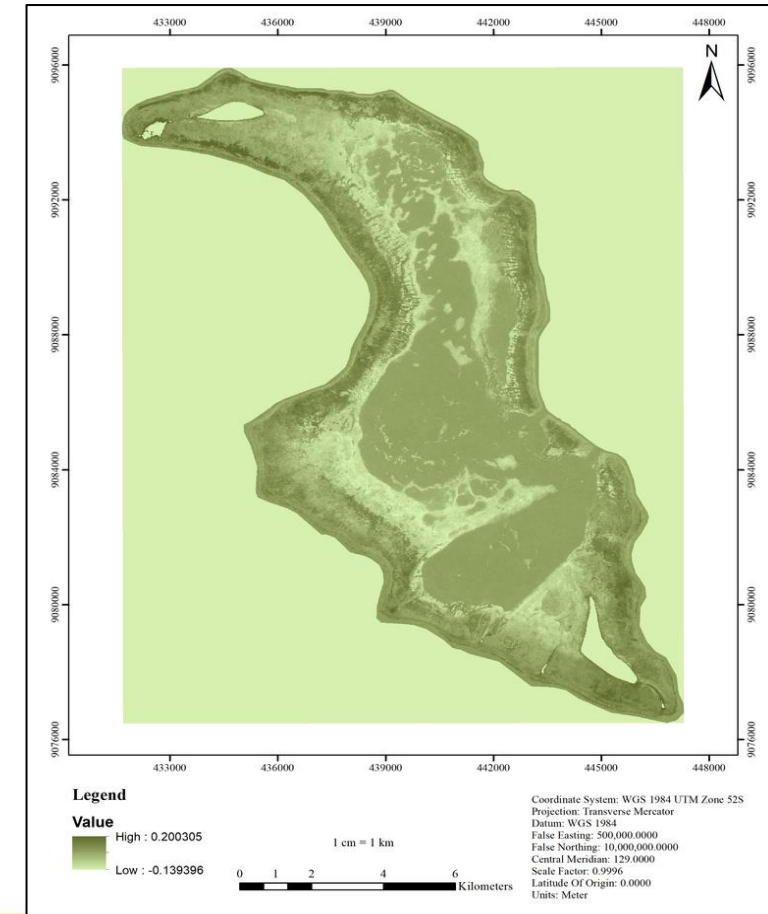
Prediction Model

- Autoregressive integrated moving average model for SST forecasting,

- RMSE of 0.5 and 1.44% error,

- Forecasted Maximum SST is 29.82° and Forecasted Minimum SST is 26.63°

Chlorophyll-A

- Change in concentration of chlorophyll-A is also an indicator of coral bleaching.

- Three different indices, NDCI, CI and RECI are calculated.

Correlation Analysis

- Pearson's correlation coefficient was used.
- Coral's weak negative correlation with SST and positive correlation with Chlorophyll-A

Class	Coral	SST	NDCI	CI	RECI
Coral	1	-0.27047	0.138267	0.220723	0.242855
SST	-0.27047	1	-0.06031	-0.05033	-0.04293
NDCI	0.138267	-0.06031	1	0.96053	0.920272
CI	0.220723	-0.05033	0.96053	1	0.992684
RECI	0.242855	-0.04293	0.920272	0.992684	1

Limitations

- Lack of in-situ data.

- Secondary source, Allen Corals is 60-90% accurate.

- Low resolution of datasets

Conclusion and Recommendation

- Negative correlation between corals and SST and weak positive with chlorophyll-A,

- SVM was found to be the best-supervised classification algorithm,

- SST forecast shows the future trends for SST.

- Use other factors too for coral mapping

- Use of high-resolution data can yield better results

- Remote sensing approach is best for large-scale monitoring

SDG 15: Life Under Water

References

- Allen Coral Atlas (2020). Imagery, maps and monitoring of the world's tropical coral reefs. Zenodo. DOI: doi.org/10.5281/zenodo.3833242

- National Oceanic and Atmospheric Administration. (2024). NOAA confirms 4th global coral bleaching event. Retrieved from https://www.noaa.gov/news-release/noaa-confirms-4th-global-coral-bleaching-event

- Barnes, R.D. 1987. Invertebrate Zoology; Fifth Edition. Fort Worth, TX: Harcourt Brace Jovanovich College Publishers. pp. 92-96, 127-134, 149-162.

- McFEETERS, S. K. (1996). The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. International Journal of Remote Sensing, 17(7), 1425–1432. https://doi.org/10.1080/01431169608948714

- Marco Agustín, L. C., Laura, F. R., Juan Sebastián, Z. S., Oscar, H. R., & Carlos, L. C. (2006). Correlation of chlorophyll a and total carotenoid concentrations with coral bleaching from locations on the Pacific coast of Mexico. Marine and Freshwater Behaviour and Physiology, 39(4), 279–291. https://doi.org/10.1080/10236240600976580

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Thank You!
Any Queries?

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