RISING SEA LEVEL: A CASE STUDY FOR UNDERSTANDING THERMAL EXPANSION AND ITS IMPACT ON COASTAL VULNERABILITY IN GUATEMALA.

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INTRODUCTION

Sea level rise is one of the most critical consequences of climate change, directly affecting coastal communities and marine ecosystems. In 2023, the Pacific of Guatemala experienced a significant increase in sea level, associated with record sea surface temperatures (SST) and the transition from La Niña to El Niño. This study analyzed sea level anomaly and its relationship with oceanographic variables, This study highlights the impacts of sea level rise (Yu, J. T. (2007)).
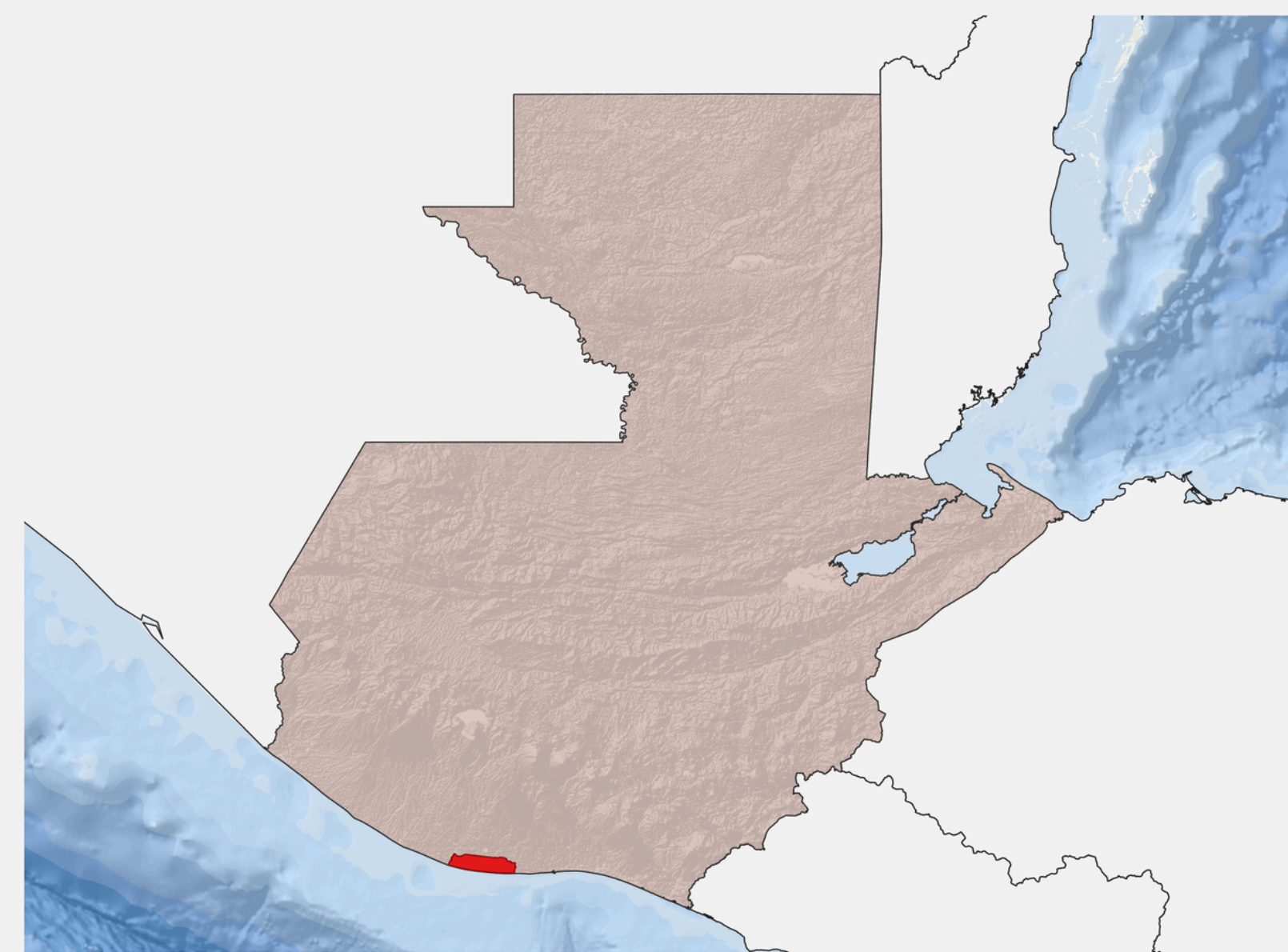
Photo Prensa Libre: Walter Nájera/Facebook

METHODOLOGY

DATA USED:

- Satellite data from the RADS mission (Radar Altimetry Data System).
- Variables analyzed: Sea level anomaly (SLA), Sea Surface Temperature (SST), Sea Surface Temperature Anomaly (SSTA), Oceanic Niño Index (ONI), geostrophic currents, and salinity.

STATISTICAL ANALYSIS:

- Shapiro-Wilk normality test (non-normal distributions, $p < 0.05$).
- Spearman correlation to measure the relationship between variables.
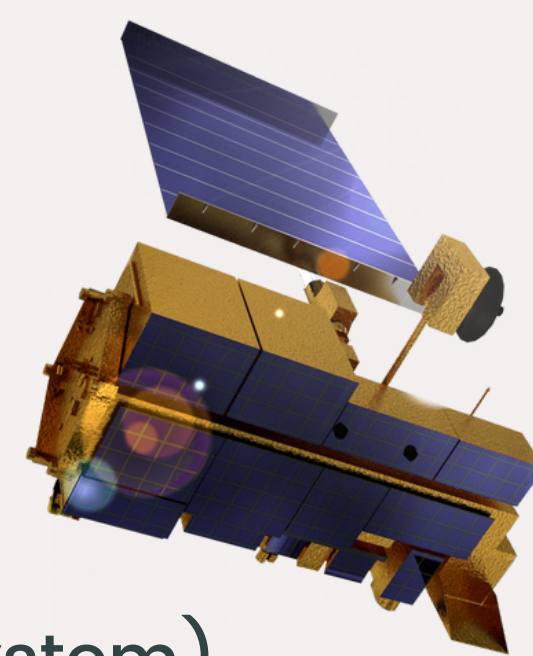
RESULTS

RECORD TEMPERATURES IN 2023:

- SST in the Pacific of Guatemala reached values between 27.28ºC and 30.90ºC, exceeding historical averages (1990-2021).
- For the observed variations in sea level, the effect presented by surface temperature is increased by complex interactions with other oceanic-environmental factors

SEA LEVEL RISE:

- In June 2023, an increase of 15-25 cm in sea level was recorded in Sipacate, Escuintla.

SIGNIFICANT PATTERNS:

- SST: High positive correlation with sea level anomaly (0.81, $p < 2.2e-16$).
- Geostrophic currents and salinity: Negative correlations (-0.28 and -0.36, respectively).

DISCUSSION

Due to the ocean being a complex system, variations in different climatic factors are related to observed changes in sea level (Bergant et al., 2005). In this analysis, SST was the main variable correlated to SLA and the other variables analyzed. Therefore, the main focus was in determining the relationship between SST and SLA ($R^2 = 0.631$, p-val = 2.2e-16).

The direct relationship observed between SST and SLA (Figure 1) can be mainly explained by thermal expansion. As there occurs an increase in temperature, the seawater molecules expand, resulting in an increase in its volume, its density decreasing simultaneously and therefore the sea level rises.
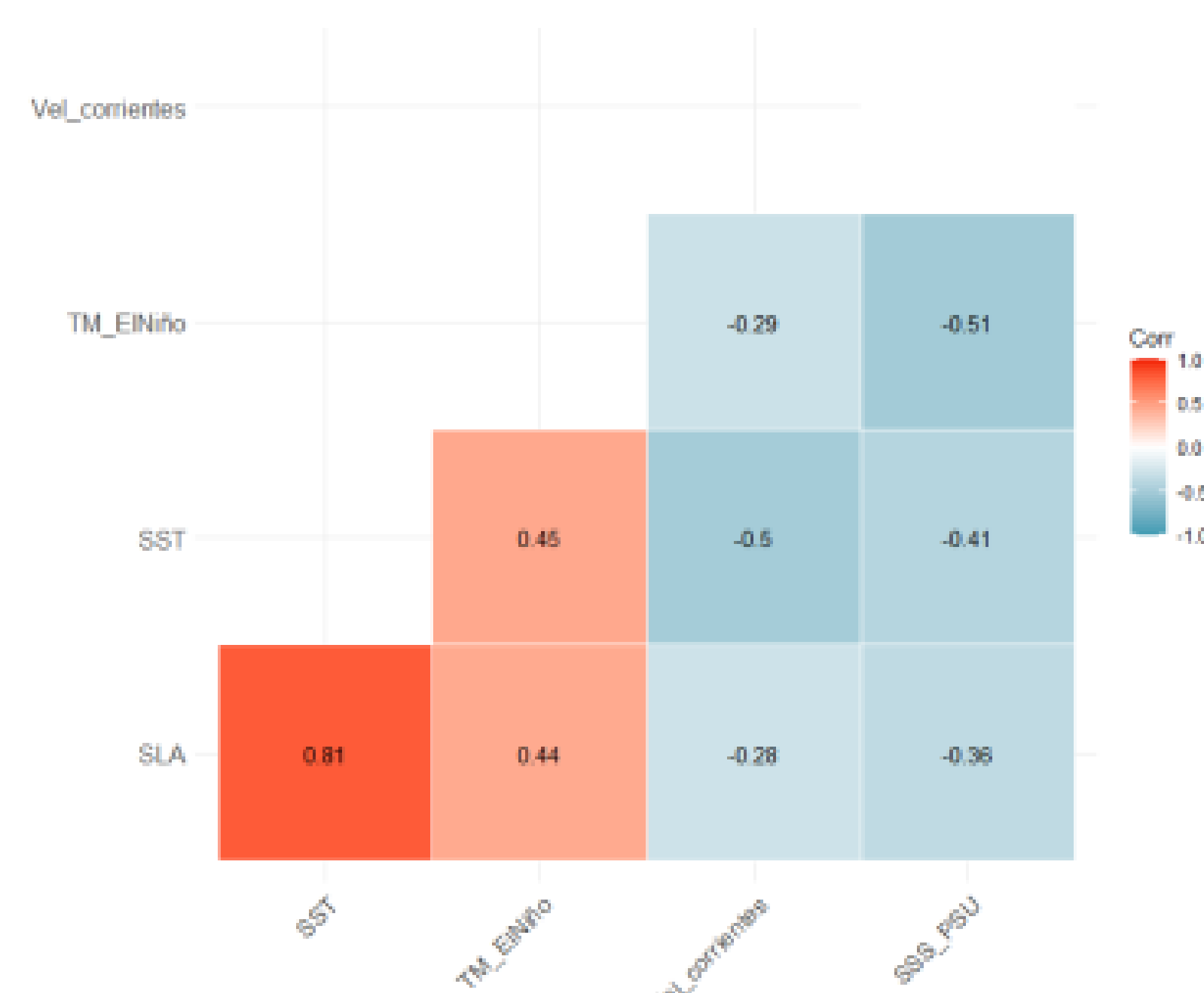
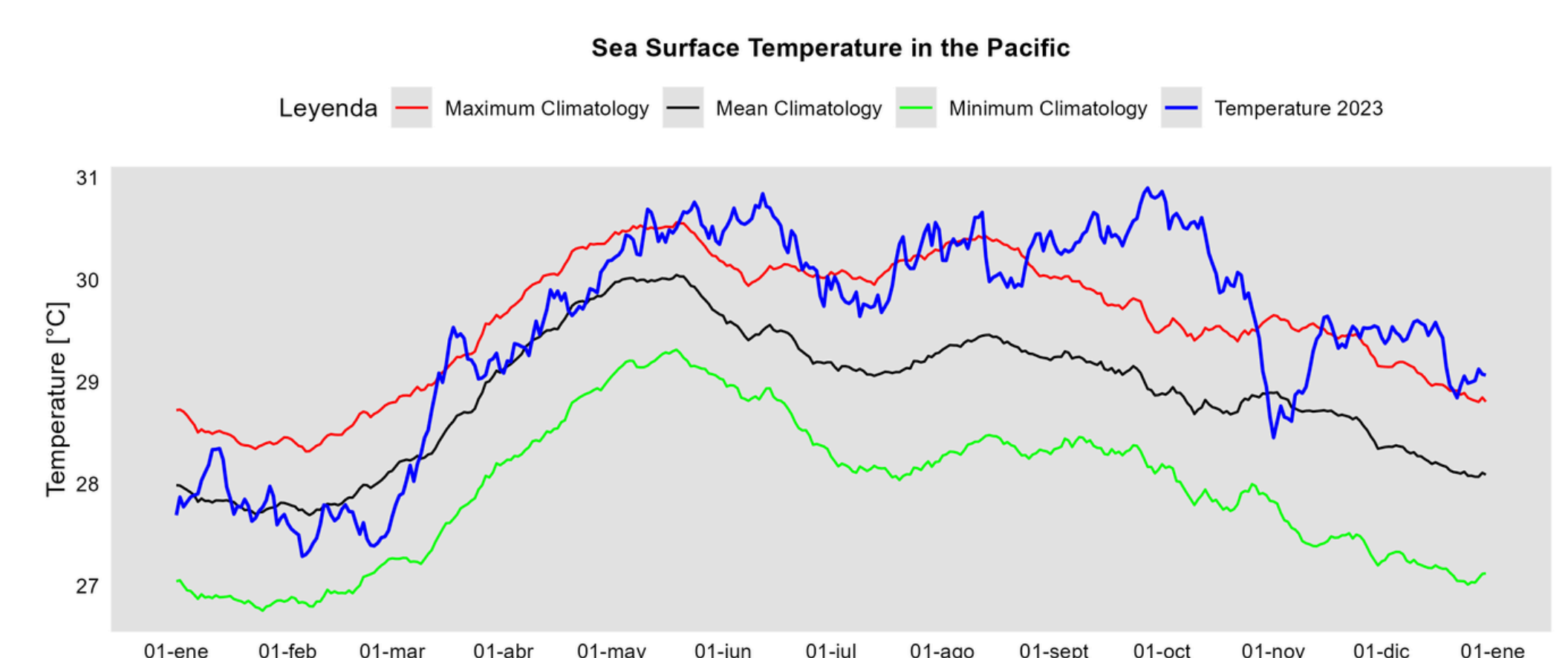Figure 1 .Spearman Correlation analysis for the SLA and thee variables analyzed.
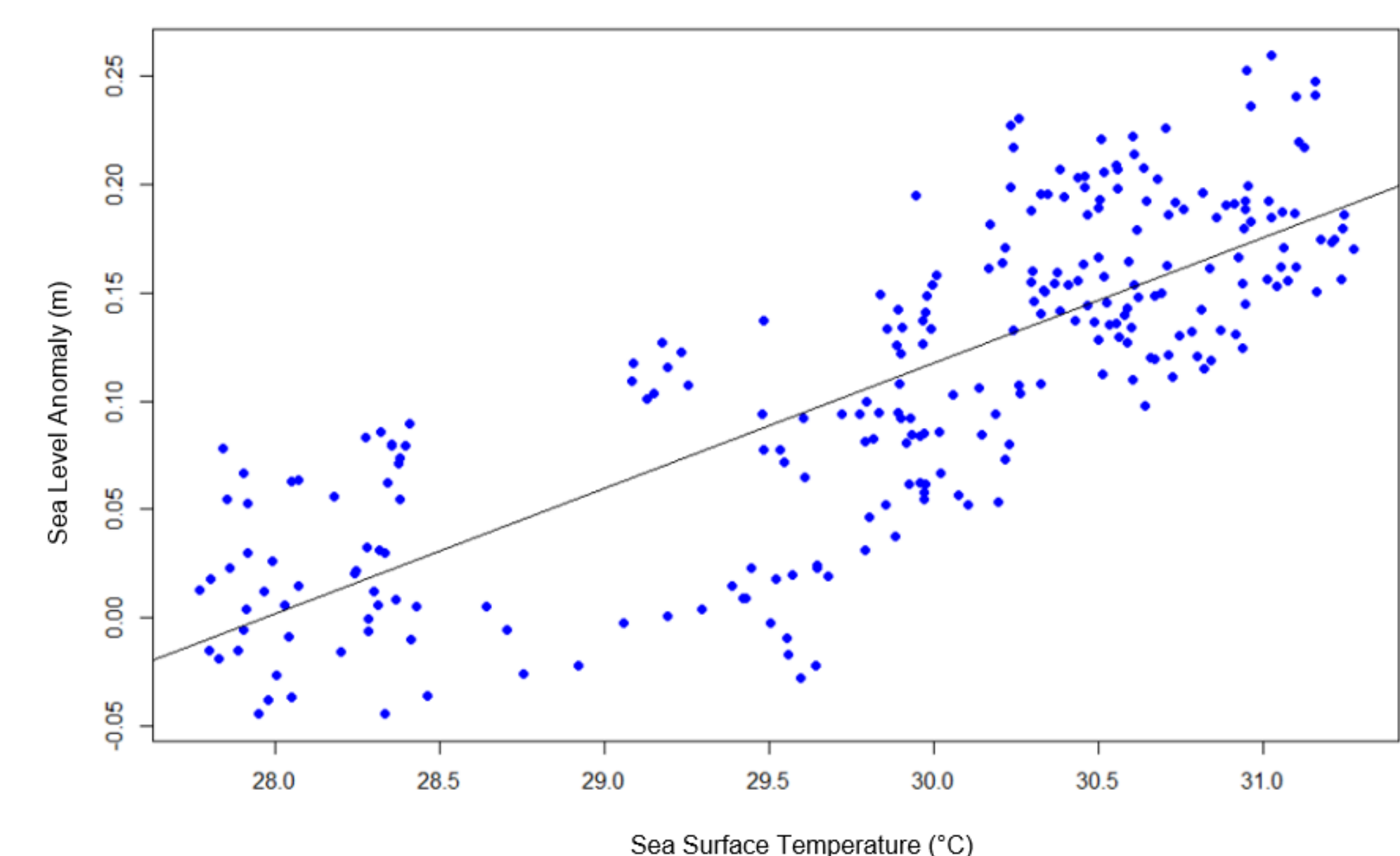
Figure 2. Sea Surface Temperature vs Climatology

Figure 3. Correlation SST Vs SLA

CONCLUSION

1. The 2023 sea level rise was directly related to high sea surface temperatures and the strong El Niño phase.
2. Coastal communities in the Guatemalan Pacific are highly vulnerable to these events, requiring adaptation and mitigation strategies.
3. This study contributes to understanding the impacts of climate change on marine and coastal ecosystems, supporting SDGs 13 and 14.

RECOMMENDATIONS

1. Implement early warning systems for extreme sea level events.
2. Strengthen the resilience of coastal communities through climate change adaptation programs.
3. Promote ongoing research on the impacts of climate change on marine ecosystems.

REFERENCES

1. Bergant, K., Susnik, Strojan, M., & A., a. S. (2005). Sea level variability at Adriatic coast and its relationship to atmospheric forcing. Annales Geophysicae
2. Yu, J. T. (2007). Changes of water temperature and harmful algal bloom in the Daya Bay in thenorthern South China Sea.