Analyzing Shoreline Changes along Lake Malawi Using Geospatial Tools

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Introduction

- Shoreline defined as the line of contact between land and the water body, is one of the most important linear features on the earth's surface, which has a dynamic nature (Winarso, 2001)

- Lake Malawi, one of the world's most significant freshwater lakes, has faced substantial challenges due to water level fluctuations.

- These fluctuations, driven by climatic variations and anthropogenic activities, have profound impacts on the lake's shoreline, affecting both natural ecosystems and human communities.

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- Optimized management of the shores and environmental protection for stable development requires observing the shorelines and their variations.

- There has been lack of an up-to- date information of the Lake Malawi shoreline changes.

Objectives

Main Objective:

- To analyze the shoreline changes along Lake Malawi from 1993 to 2023 using geospatial tools.

Specific Objectives:

- Identifying trends of shoreline expansion and contraction at selected sites.

- To assess the proximity of buildings to the shoreline over time

Significance of the study

- This study provides critical data for understanding the impacts of climate change on water resources and ecosystems, particularly in terms of shoreline erosion and habitat loss.

- Offers valuable historical data for better planning and management of coastal zones

- The findings contribute to climate resilience by informing sustainable water resource management and ecosystem conservation efforts.

Methodology

1. Study Area

- The study focuses on the shoreline of Lake Malawi, specifically within the Mangochi District.

- This area was chosen due to its significant exposure to water level fluctuations and its impacts on local communities.

2. Site Selection

- Six sites along the Mangochi District shoreline were selected as study sites using purposive sampling.

- These sites were chosen based on their current land use, and vulnerability to shoreline changes.

STUDY SITES

Map of Malawi Showing
Location of Study Site
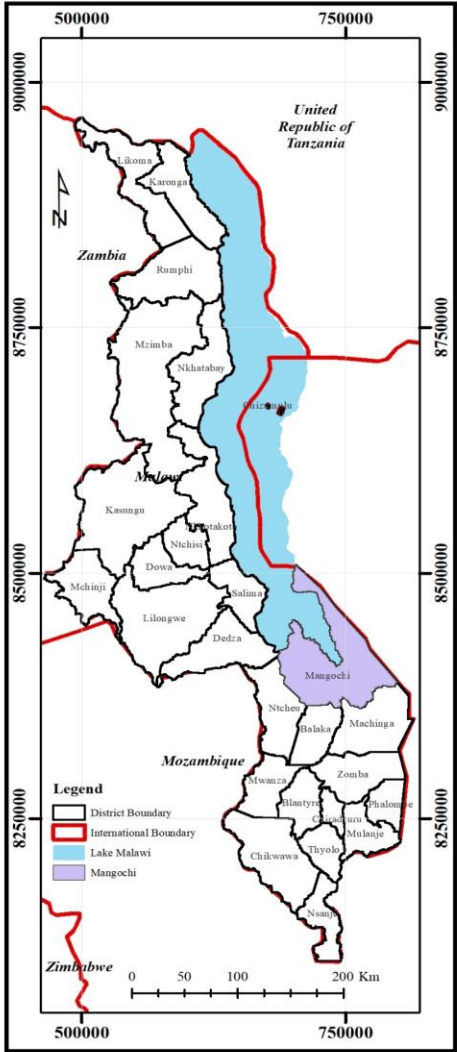
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3. Data Collection

- Landsat satellite imagery (TM,ETM+ and OLI) was collected for the years 1993, 1998, 2003, 2008, 2013, 2018, and 2023.

- This data, spanning 30 years in 5-year intervals, was sourced from the United States Geological Survey (USGS) Earth Explorer. https://earthexplorer.usgs.gov/

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4. Shoreline Extraction

- Shoreline extraction was performed using the following techniques:

Normalized Difference Vegetation Index (NDVI): NDVI was calculated for each image to distinguish between water bodies and vegetated land.

NDVI is defined as: $\text{NDVI} = \frac{(NIR - Red)}{(NIR + Red)}$

Tasseled Cap Analysis:

- This analysis was used to transform the original Landsat bands into indices representing brightness, greenness, and wetness.

- The wetness index, in particular, helped in identifying water bodies.

Results

- The study's findings provide a detailed analysis of the shoreline changes of Lake Malawi in the Mangochi District over a 30-year period (1993-2023).

1. Expansion and contraction of the shoreline

- The analysis of Landsat satellite data at 5-year intervals revealed significant temporal dynamics in the shoreline of Lake Malawi.

- Both expansion and contraction of the shoreline were observed, indicating a highly dynamic nature of the lake's shoreline.

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- Data from 2003 showed the most significant expansion in the shoreline, suggesting a notable increase in water levels during this period.
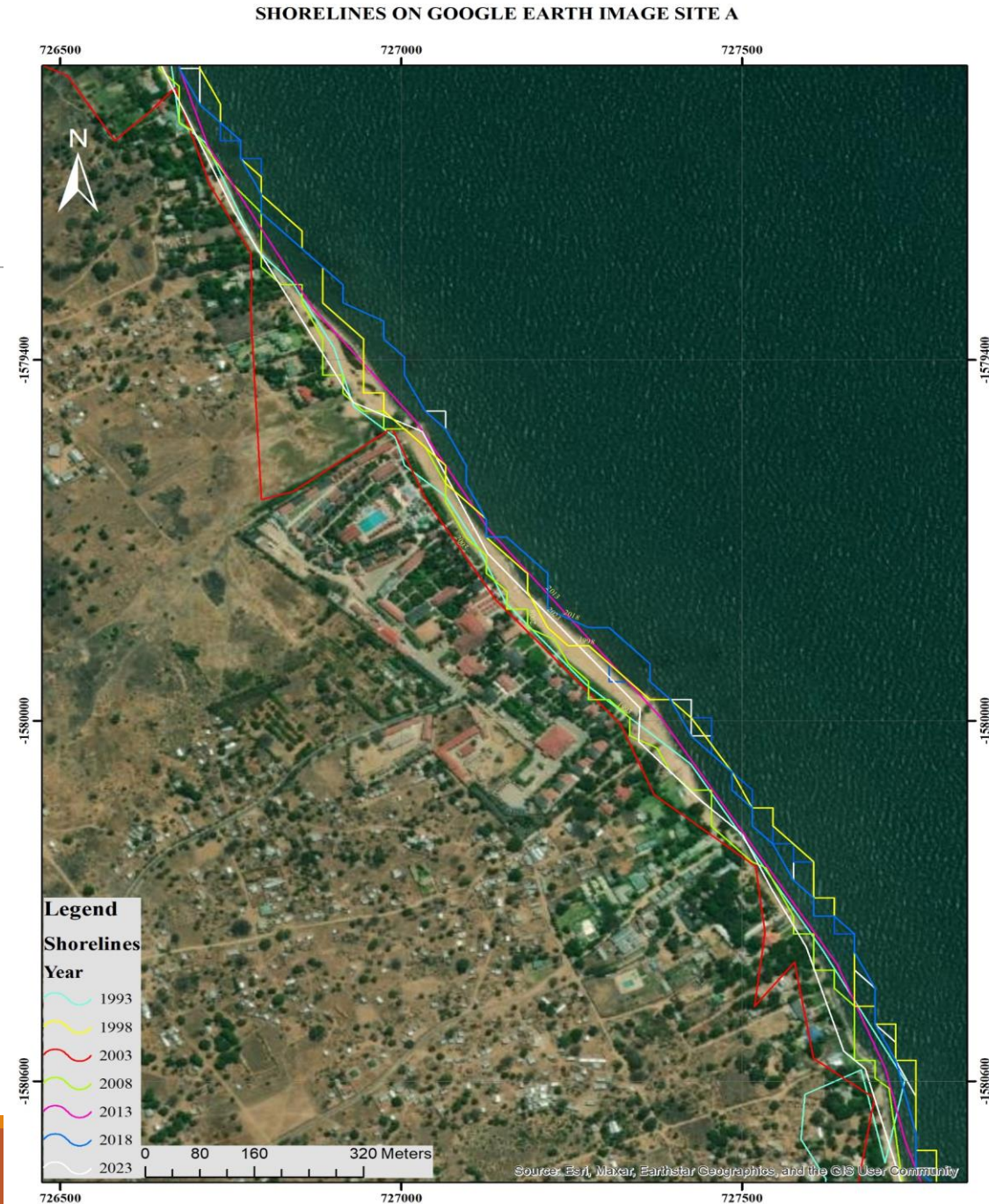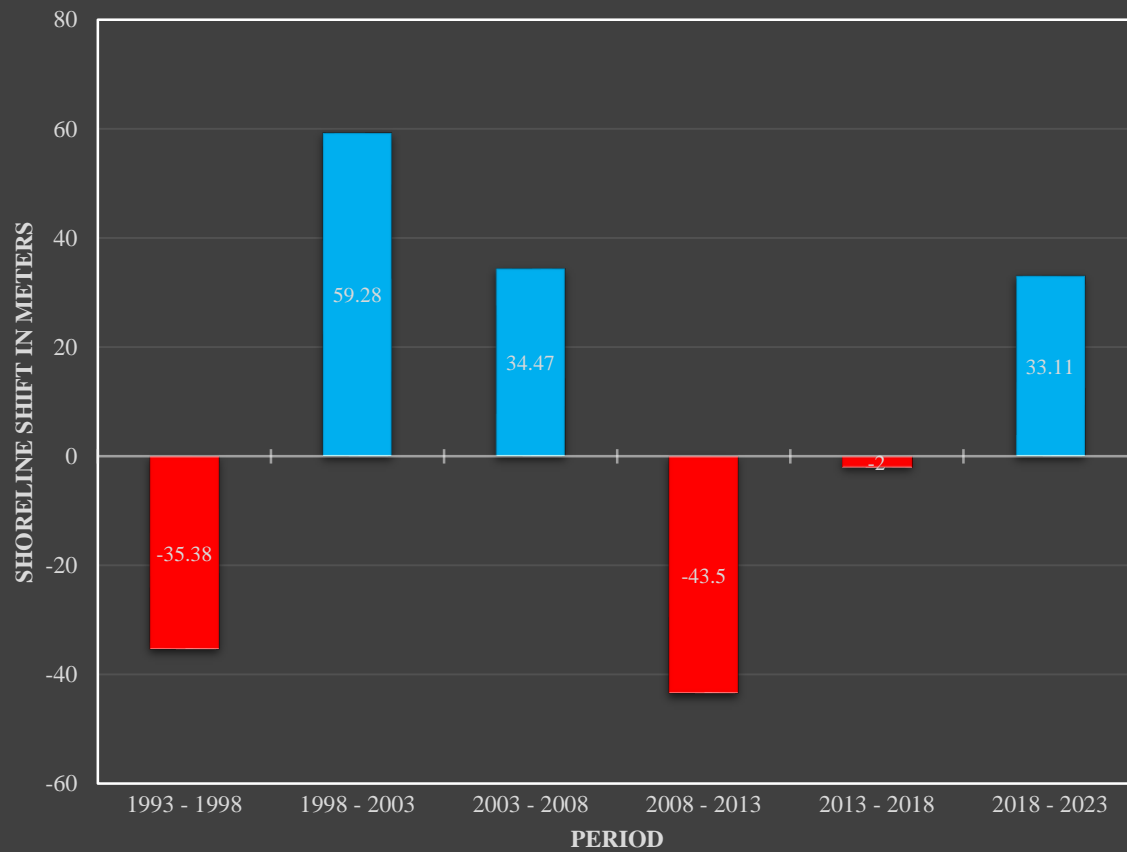
SHORELINES ON GOOGLE EARTH IMAGE SITE A

Legend
Shorelines
Year
- 1993
- 1998
- 2003
- 2008
- 2013
- 2018
- 2023

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
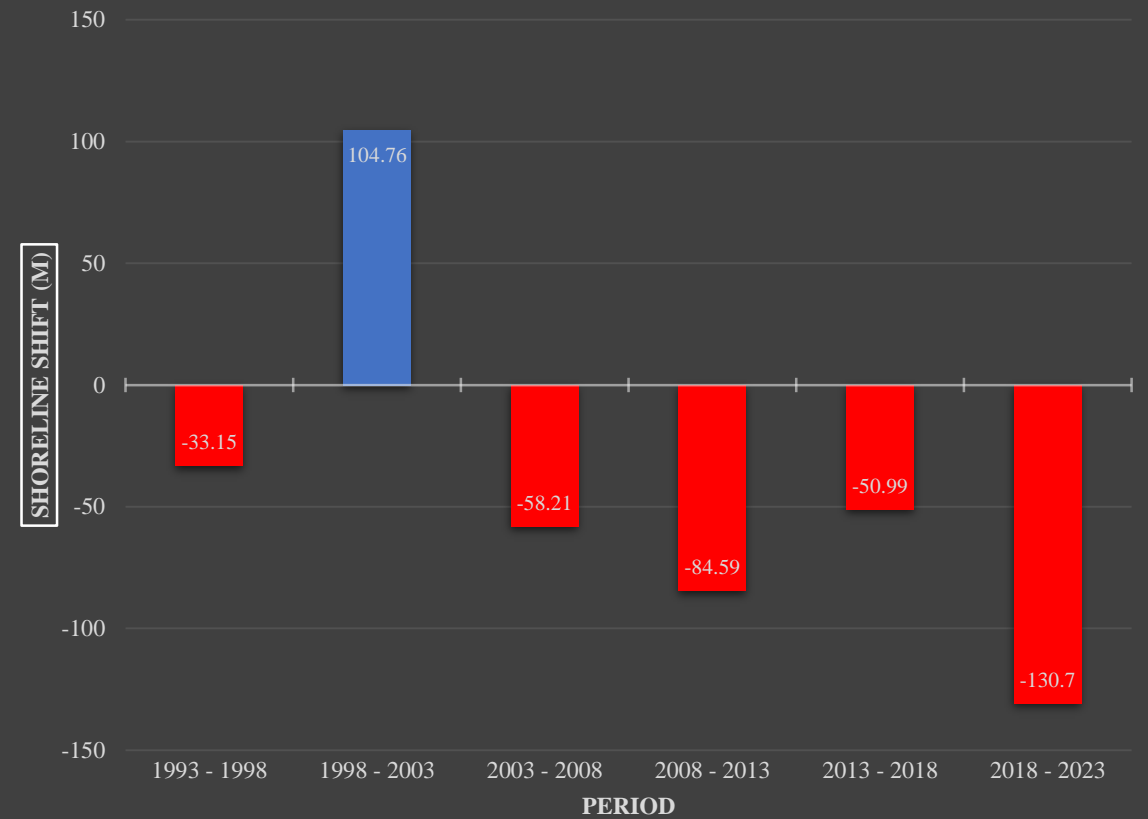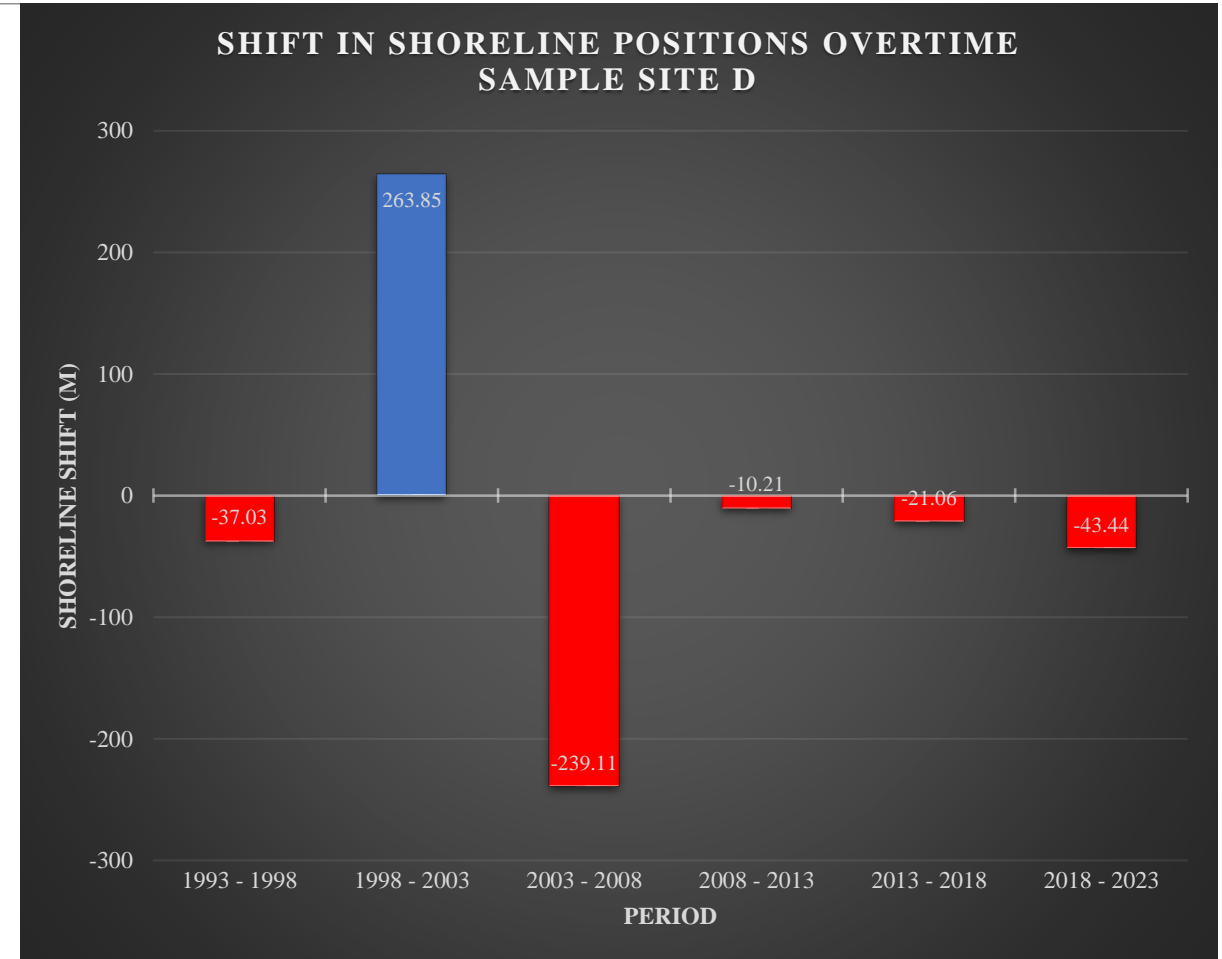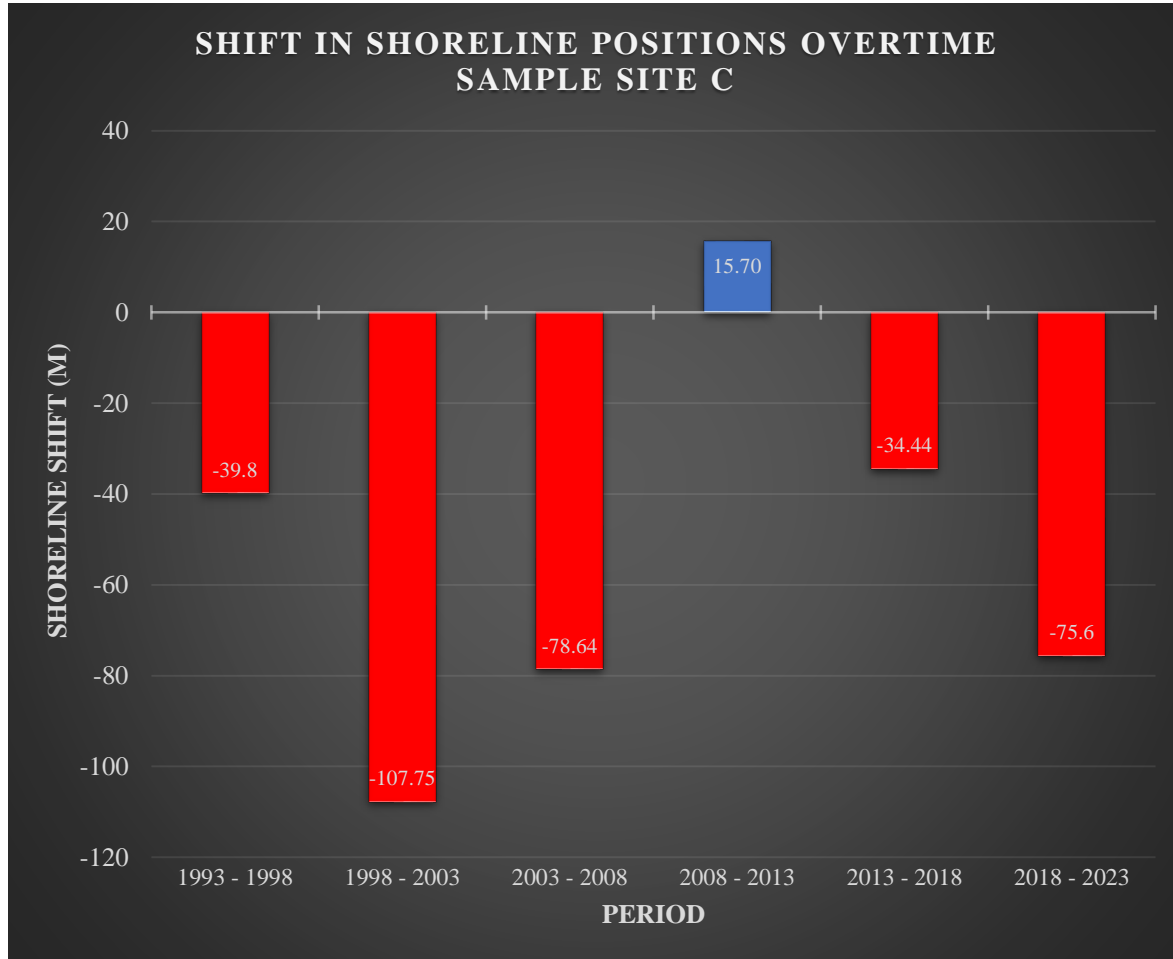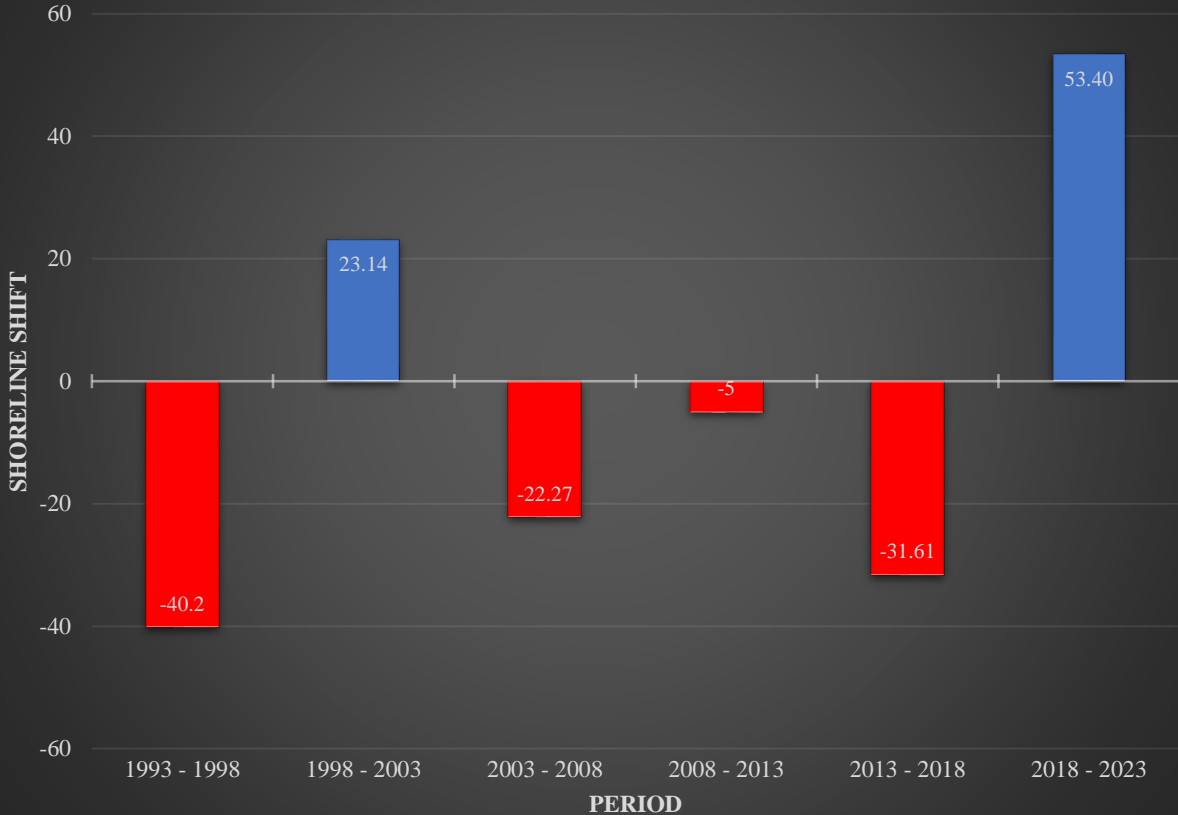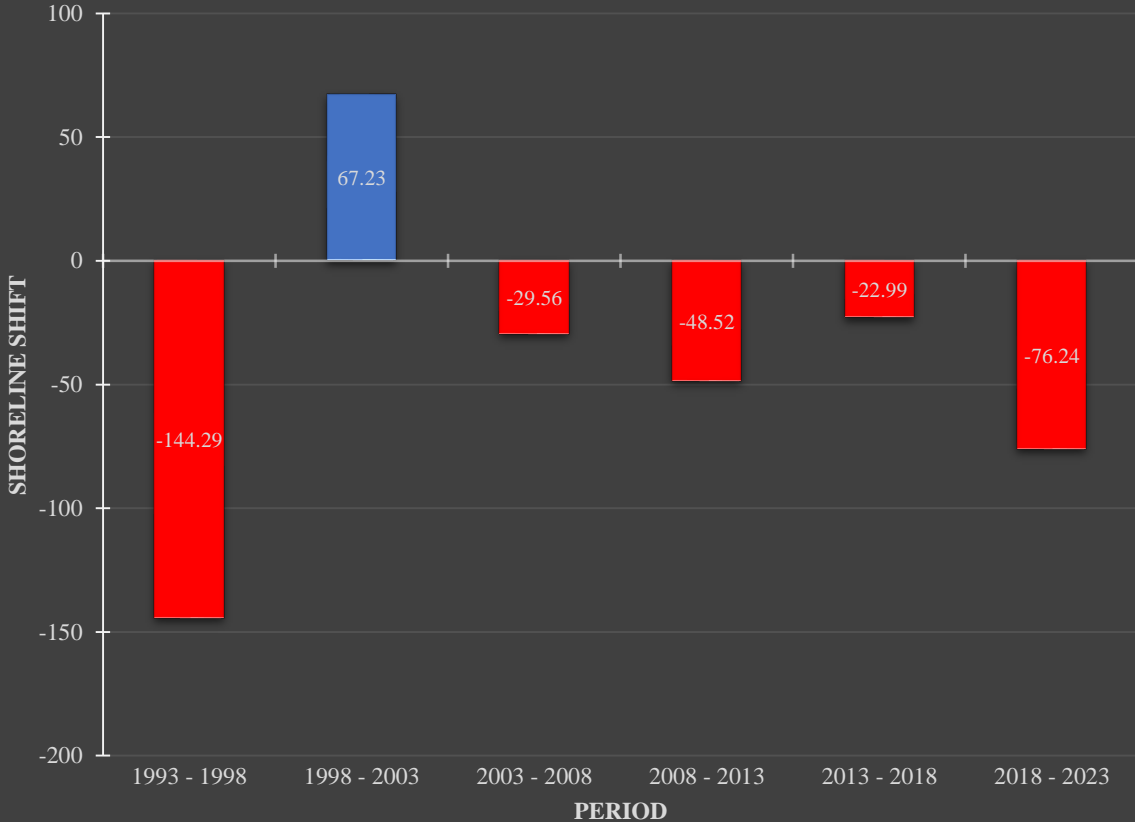
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2. The proximity of buildings to the shoreline over time

- The study observed that many buildings along the lake were constructed without considering historical shoreline data.

- As a result, these buildings are now located in areas that were previously part of the shoreline.
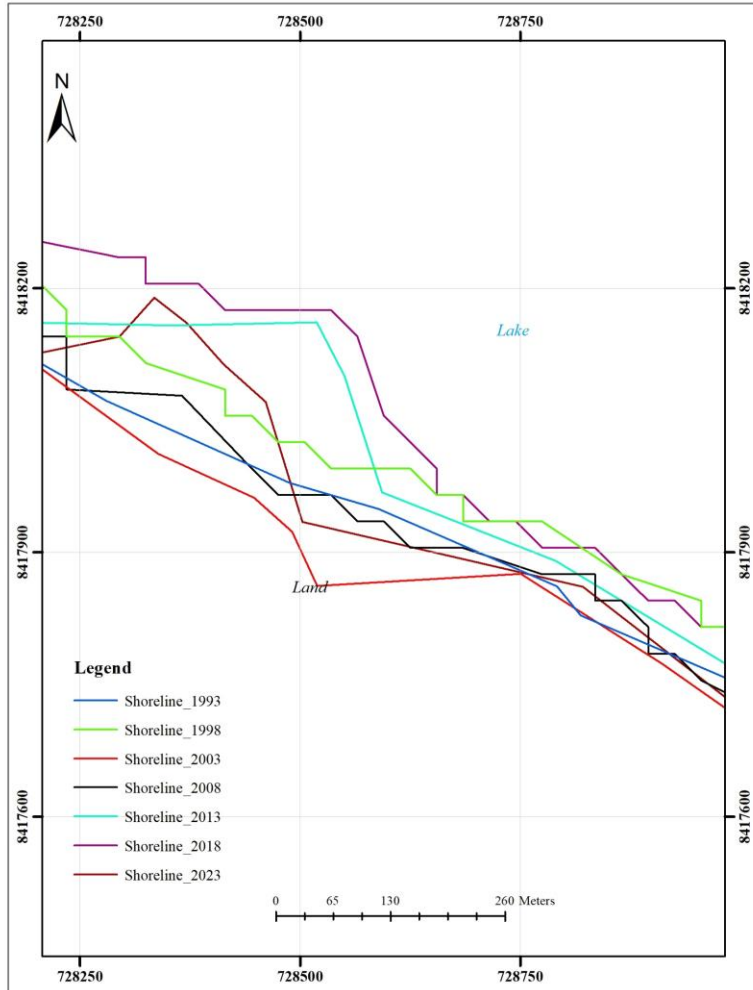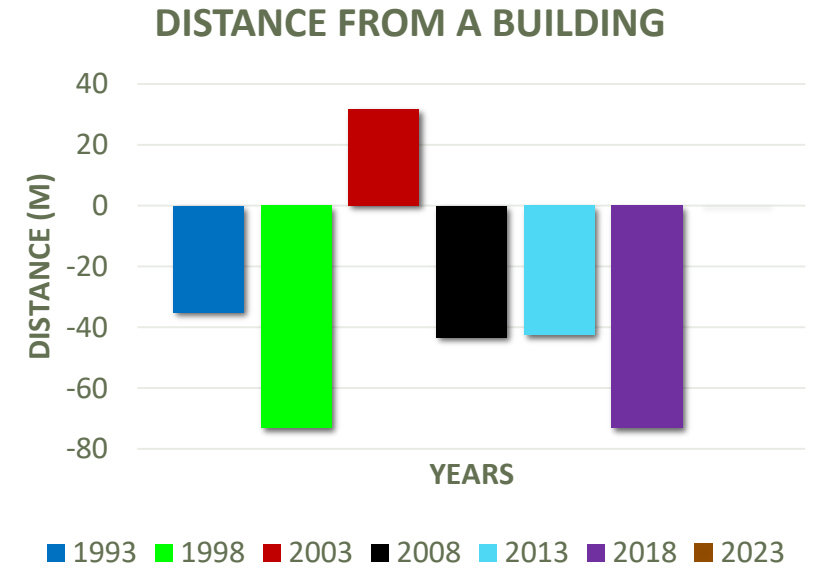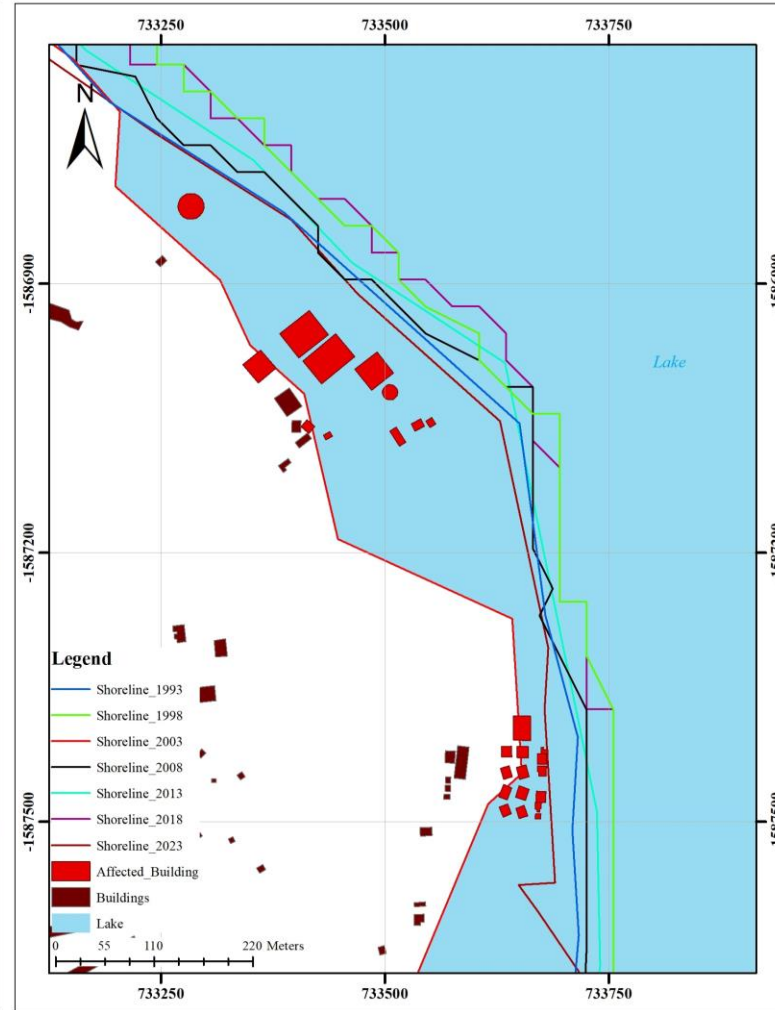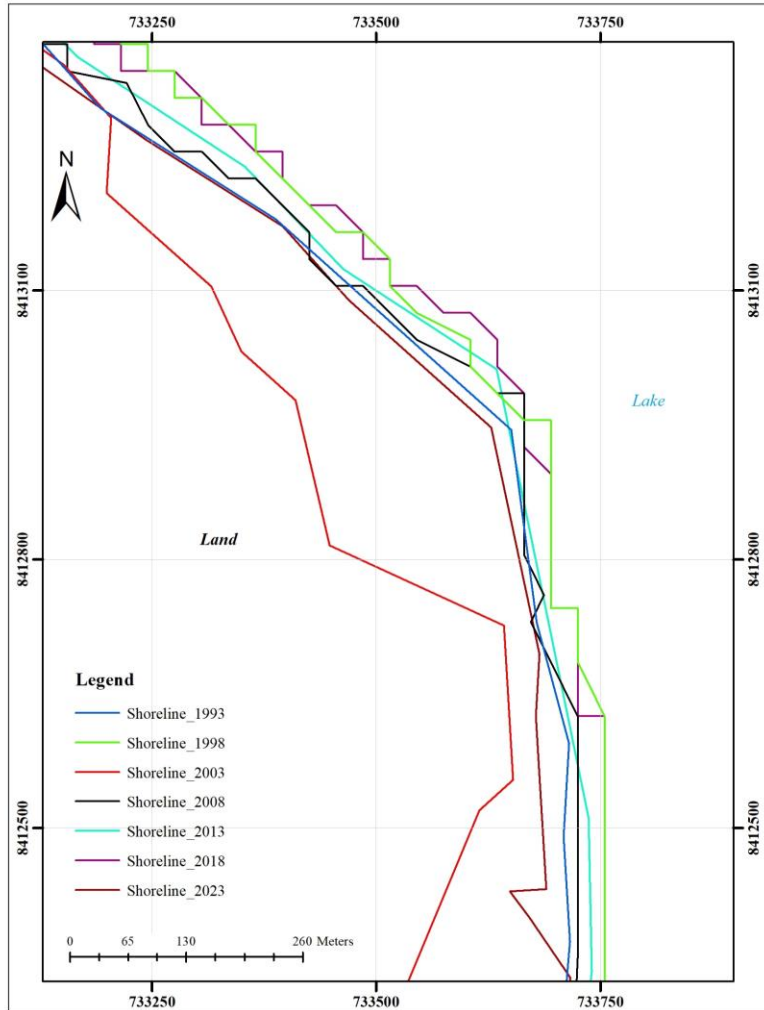
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SHORELINES AND AFFECTED BUILDINGS SAMPLE SITE A
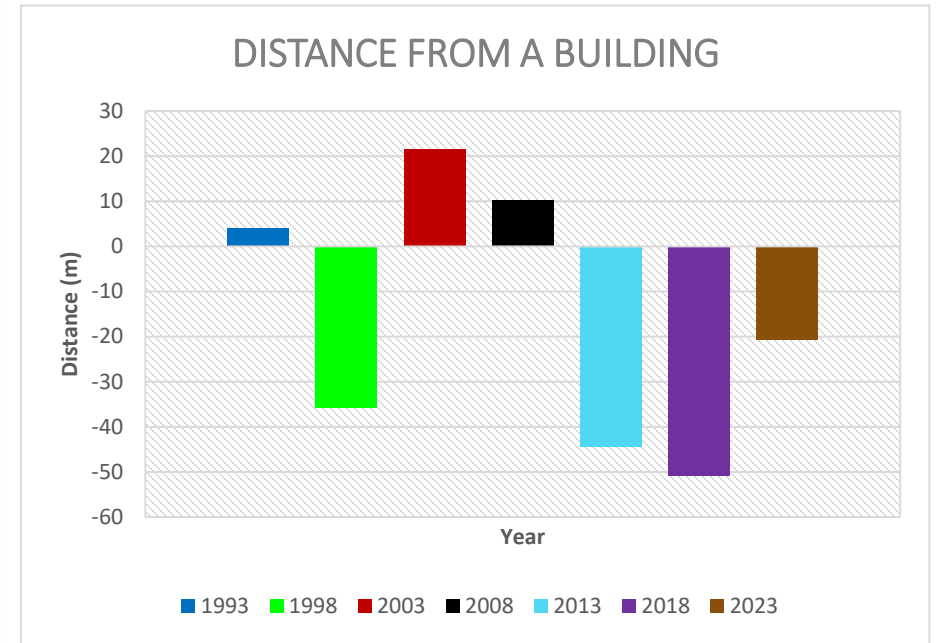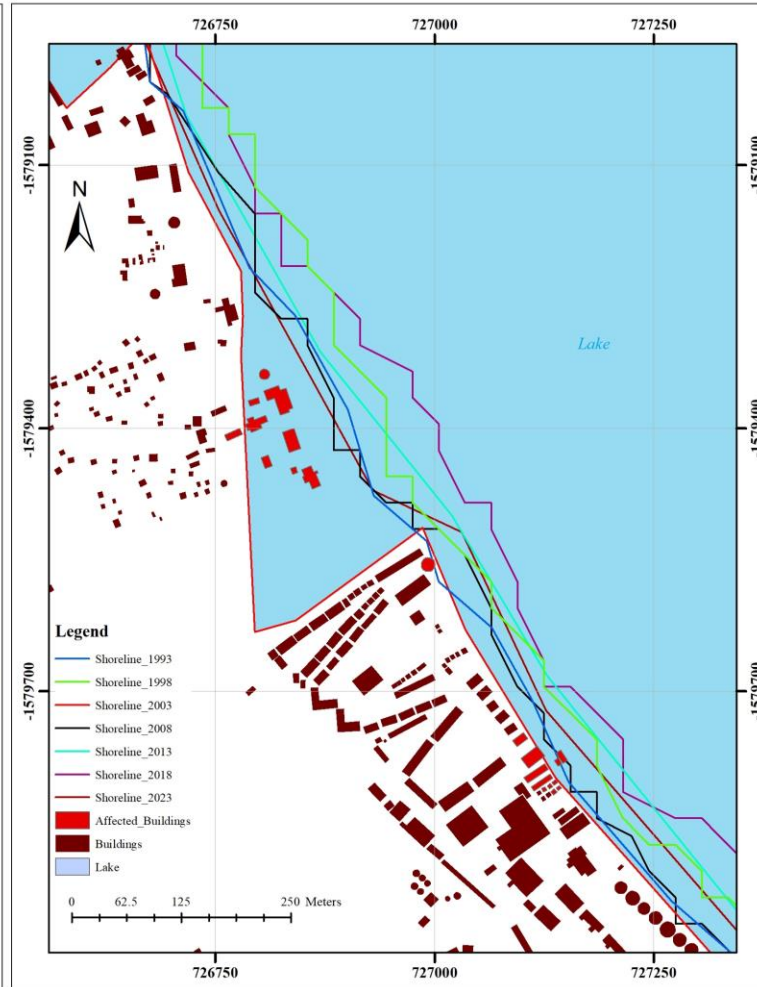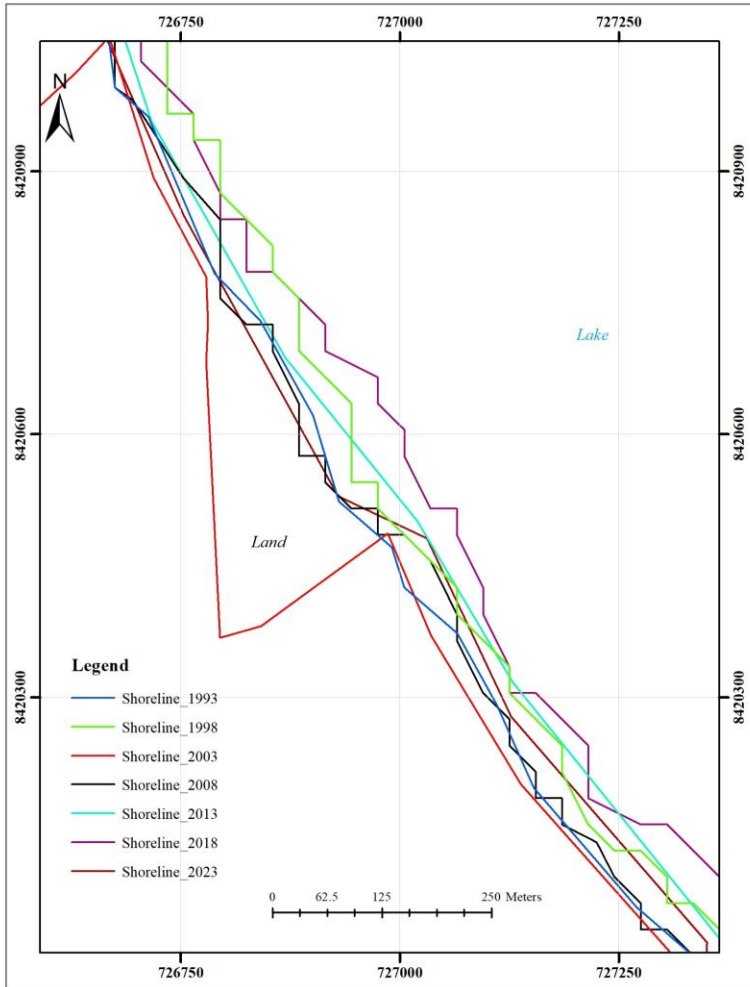
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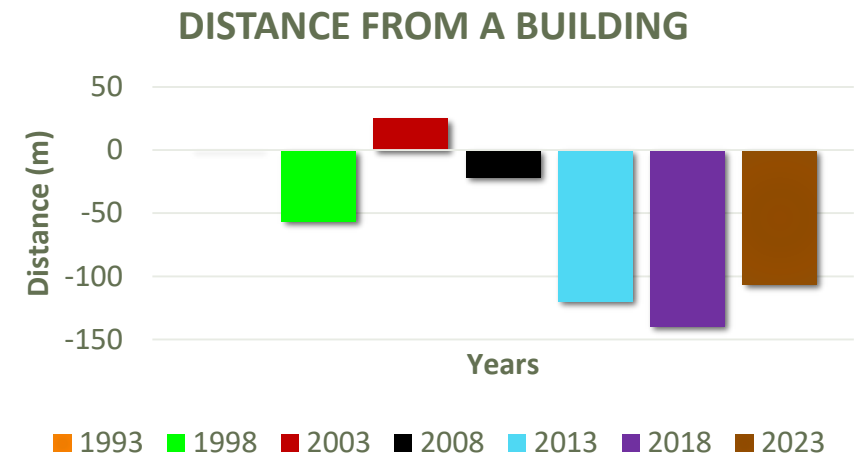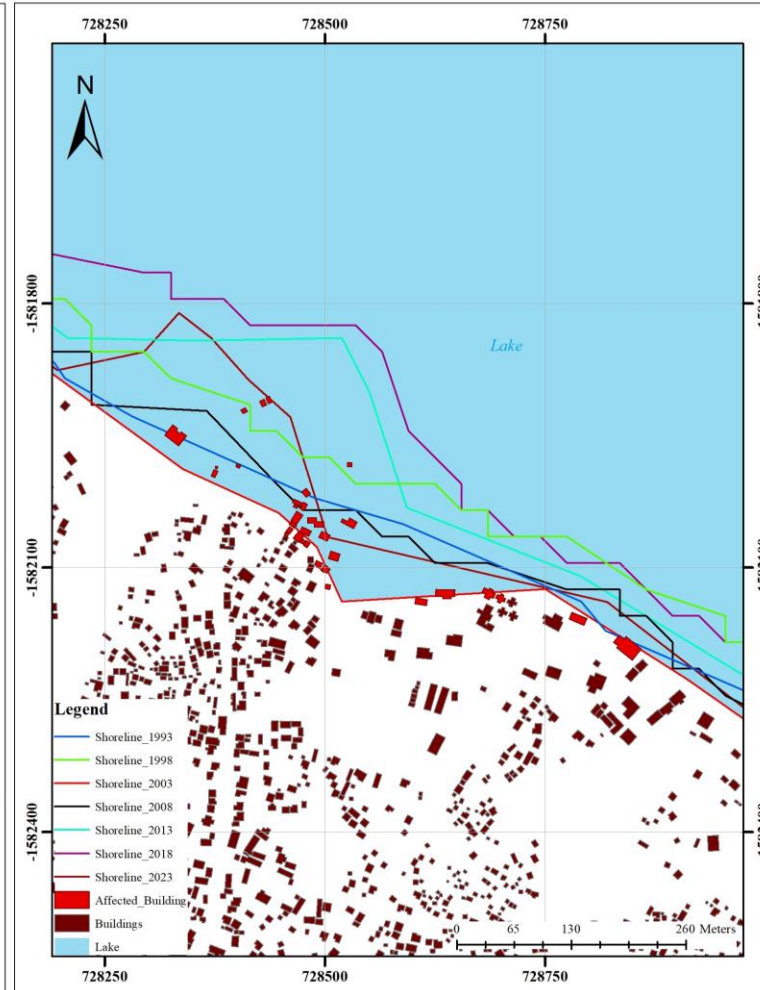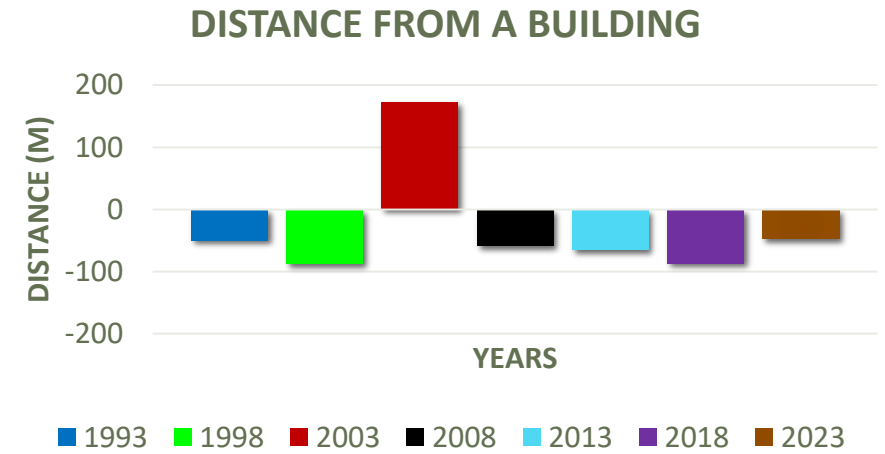
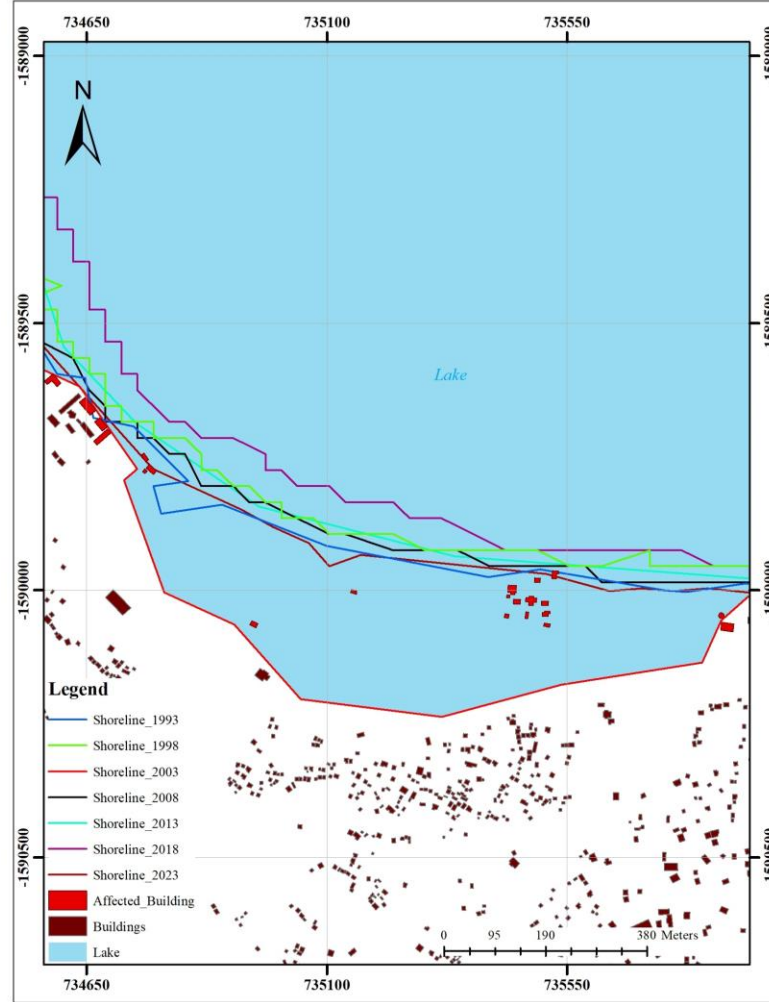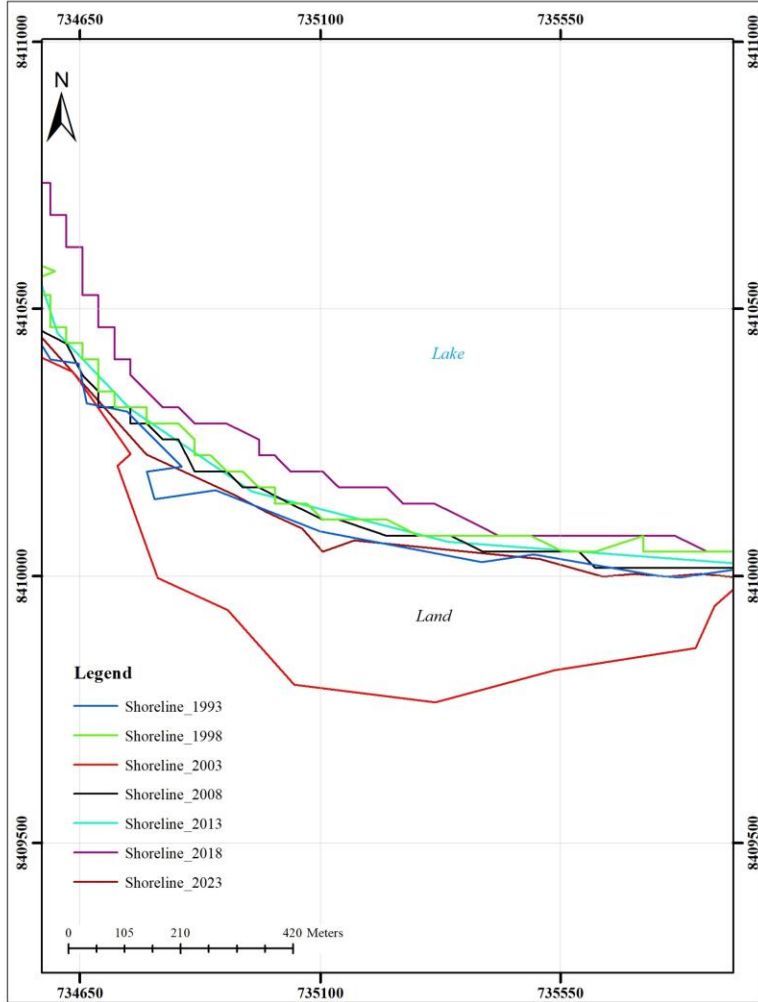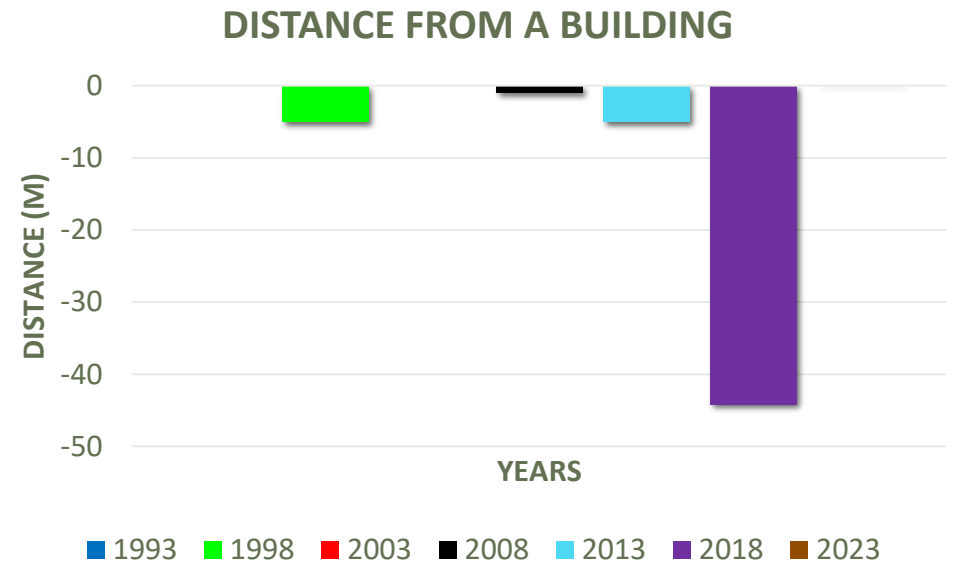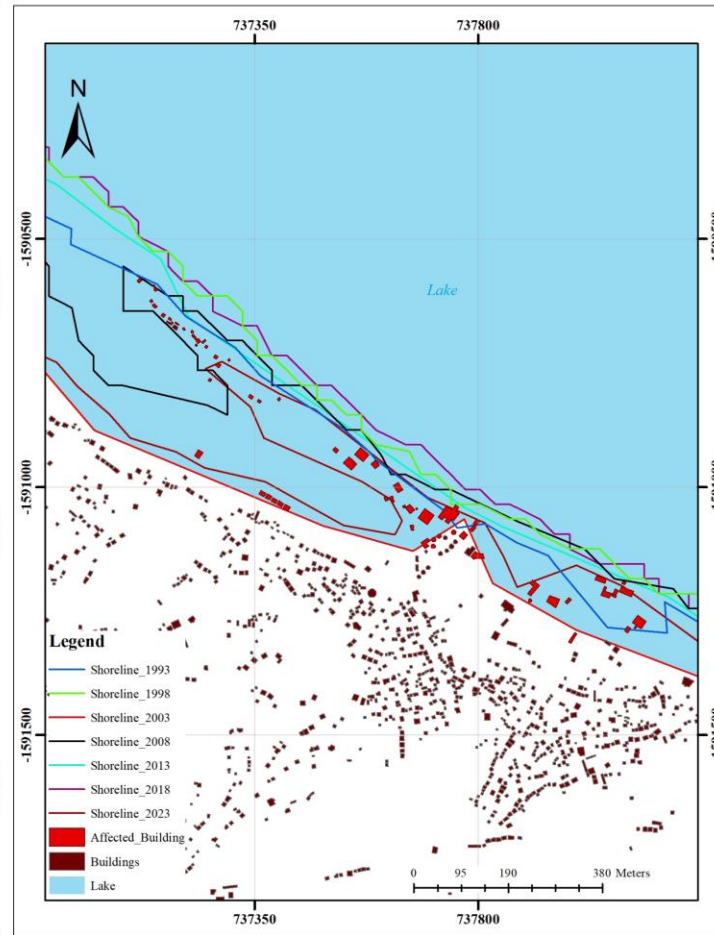# Cont'd

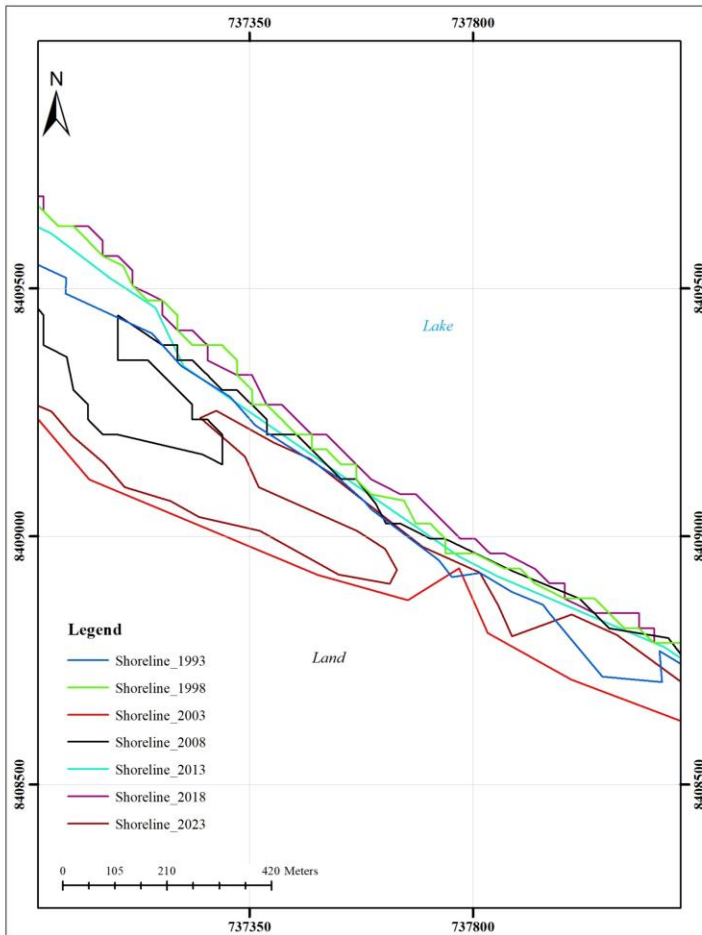SHORELINES AND AFFECTED BUILDINGS SAMPLE SITE C
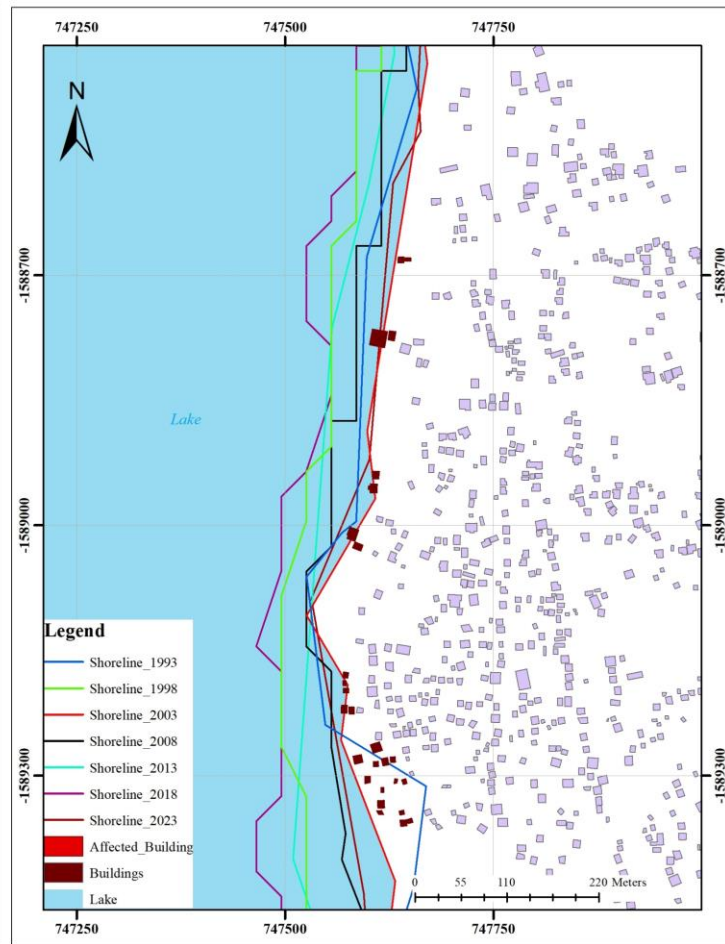
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SHORELINES AND AFFECTED BUILDINGS SAMPLE SITE D

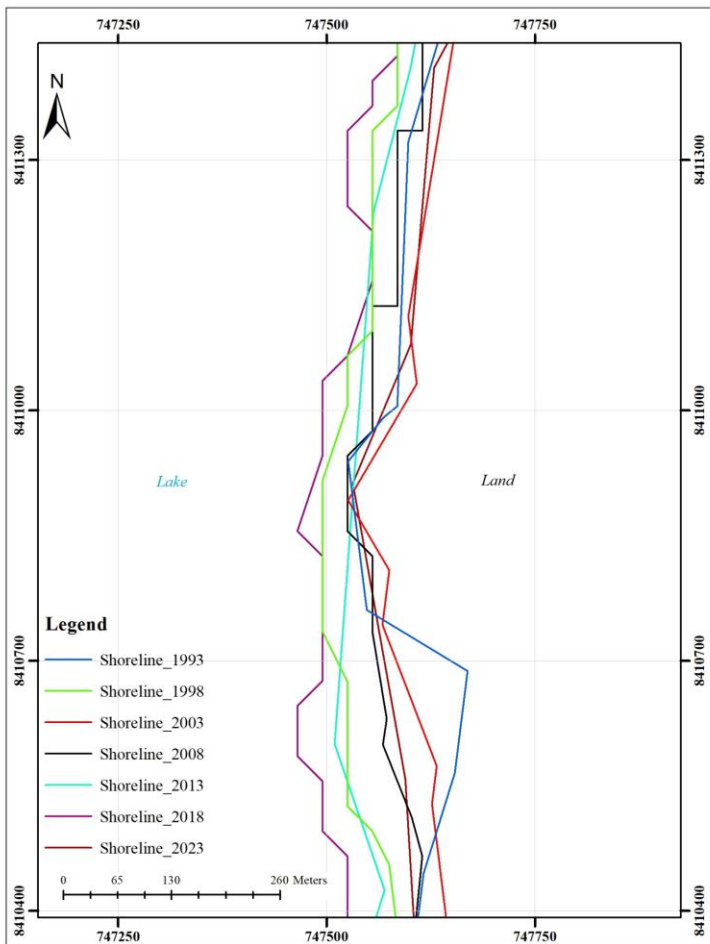# Cont'd

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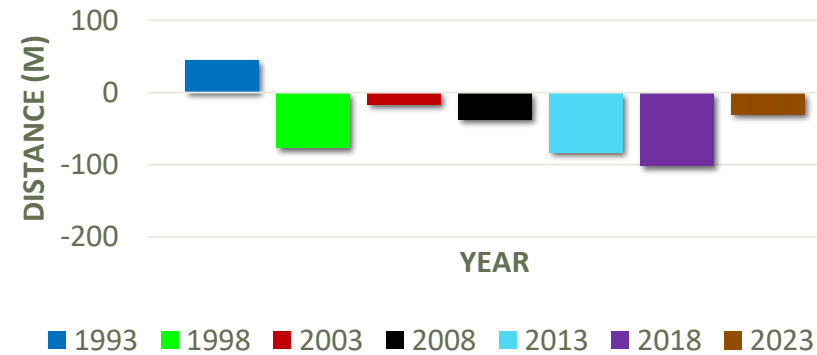
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SHORELINES AND AFFECTED BUILDINGS SAMPLE SITE F

Conclusion

- The study of shoreline changes along Lake Malawi, specifically in the Mangochi District, has revealed significant fluctuations over the past 30 years.

- One of the critical findings is the impact of these shoreline changes on the built environment.

- Many buildings constructed without considering historical shoreline data are now situated in areas that were once part of the lake.

- This has posed significant challenges for local communities and underscores the importance of integrating historical shoreline data into future planning and development.

Recommendation

- A comprehensive coastal zone management plan that integrates historical and current shoreline data can help to ensure that development activities are aligned with the dynamic nature of the shoreline, thereby reducing the risk to infrastructure and human settlements.

References

- Winarso G., (2001). The potential application remote sensing data for coastal study. Singapore. 22nd Asian Conference on Remote Sensing. Singapore. Refer from: http:// gisdevelopment.net/aars/acrs

THE END
THANK YOU !!!