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Satellite and Geographic Information System-Incorporated Multi-Platform Monitoring of Coastal Erosion on the Northwestern Coast of Sri Lanka

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Introduction & Aim

- Coastal erosion, caused by natural factors such as sea-level rise and wave action, as well as human activities such as construction and deforestation, results in the degradation of shorelines, leading to the loss of land and habitats.
- In Sri Lanka's Kalpitiya region, coastal erosion has affected 15 tourist attractions and destroyed a 50-meter stretch of beach, significantly altering landforms such as dunes and cliffs. Therefore, the northwest coast of Sri Lanka was selected as the study area for this research.
- The objective of the study is to delineate shoreline changes along the northwest coast of Sri Lanka and to calculate the erosion rate of sand dunes using Geographic Information System (GIS) and Remote Sensing (RS).

Method

This study used Geographic Information System (GIS), Remote Sensing (RS), and the Digital Shoreline Analysis System (DSAS) to analyze shoreline changes along the Mannar-Puttalam coast. Data, including satellite images and Digital Elevation Model (DEM) images from USGS and Google Earth Pro, were collected for specific years.
The research was divided into two analyses:

- Primary Analysis: Included Topographic Wetness Index (TWI), Contour Maps, and NDVI Maps, providing insights for future predictions.
- Secondary Analysis: Focused on shoreline delineation to assess erosion and deposition rates over time in vulnerable regions.

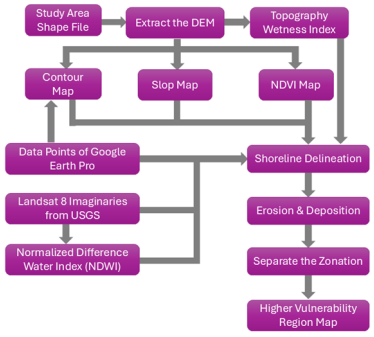


Figure 1: Flowchart of the Methodology.

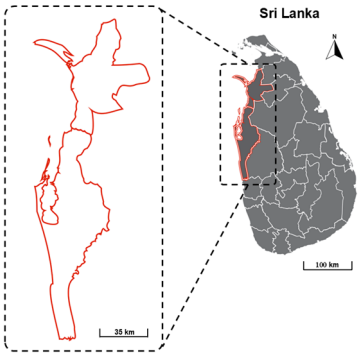


Figure 2: Map of the Study Area.

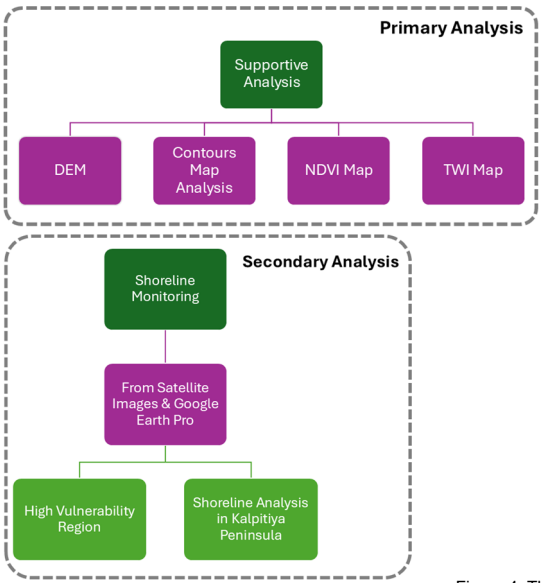
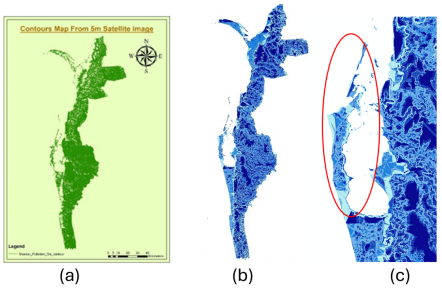


Figure 3: Primary and Secondary Analysis Methods.

Figure 4: The path for Identifying Erosion and Deposition Rates.

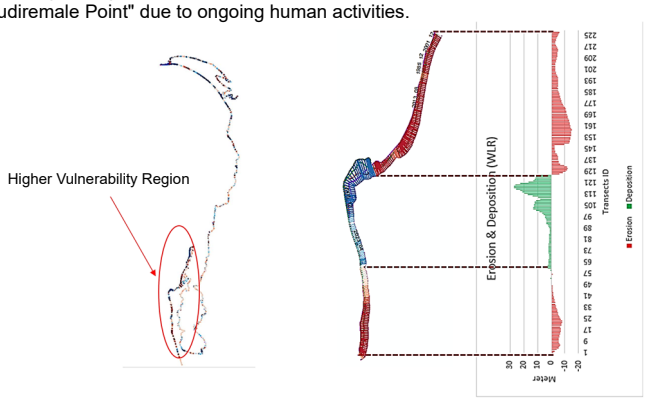
Results & Discussion



(a) (b) (c)

Figure 5: (a) Final Contour Maps from 5 m Resolution, (b) Final TWI Map, (c) Identified Low TWI region.

The contour lines were analyzed to better understand the coastal geomorphology, particularly the cliffs. The TWI values in the Kalpitiya Peninsula are relatively low, indicating a high likelihood of erosion in the area. Future erosion is expected at "Kudiremale Point" due to ongoing human activities.



(a) (b)

Figure 6: (a) Map of Regions with Higher Vulnerability to Erosion, (b) Erosion and Deposition Graph Based on WLR.

On the northwest coast of Sri Lanka, the Kalpitiya Peninsula was identified as a high-vulnerability region. Approximately 69% of the area experienced erosion, while 30% underwent accretion. The Erosion Potential Rate (EPR) parameter was used to calculate these rates, revealing erosion rates of up to 13.48 m/year and deposition rates reaching 25.36 m/year, indicating significant vulnerability in the region.

Conclusion & Recommendations

This study successfully delineated shoreline changes along the northwest coast of Sri Lanka and calculated sand dune erosion rates using GIS and RS. The WLR analysis identified that approximately 69% of transects in the vulnerable region are prone to erosion, while 30% show accretion.To mitigate these impacts, the implementation of geotechnical structures such as seawalls, revetments, groynes, and bulkheads is recommended in high-erosion and high-deposition zones. These measures should be informed by assessments of soil type and coastal geomorphology. A key observation at "Kudiremale Point" highlights the risk of erosion due to continuous removal of coastal vegetation. While no significant erosion has been observed yet, proactive measures are crucial to prevent future damage and maintain the stability of this area.

References

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