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Assessing Shoreline Dynamics under Macro to Meso-tidal Conditions through Integrative low-cost Remote Sensing Technique

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Coastal erosion, a critical issue in shoreline management, arises from a combination of natural dynamics and anthropogenic influences. In macro to meso-tidal regions, this phenomenon is particularly pronounced due to the interplay of sea level fluctuations, erosive wave action, and sediment displacement. Significantly, this erosion poses a direct threat to the stability and integrity of coastal dunes, which are vital for protecting inland areas and maintaining ecological balance on these beaches. This study addresses this issue by analysing shoreline changes over the past decade at three unmanaged Northwest beaches of Ireland: Enniscrone, Streedagh, and Dunmoran. Utilising open-source satellite imagery, the research employed the CoastSat and DSAS tools to extract data on shoreline movement to tackle coastal erosion or accretion. Acknowledging the errors in satellite-derived shoreline data due to high tidal variations, the study further validates its findings with field data. This validation was performed using two contrasting technological approaches: a high-cost LiDAR-equipped drone (DJI Terra drone and DJI Zenmuse L2 Lidar) and a low-cost DJI Phantom 4 RTK drone with a standard camera. The comparison of data from these diverse sources reveals crucial insights. Firstly, the study validated shoreline changes detected by satellite imagery, ensuring the consistency and reliability of observed trends across different remote sensing platforms. Additionally, the comparison between high-cost and low-cost drone data was instrumental in assessing their respective efficacies in capturing coastal topography. The high-resolution LiDAR data offered detailed 3D models of the coastal landscape, allowing for precise measurements of dune morphology and erosion patterns. In contrast, the standard camera on the low-cost drone provided broader, less detailed views but was surprisingly effective in identifying larger-scale changes and erosion hotspots. The study highlights the potential of integrating various remote sensing techniques for coastal monitoring, which provides a cost-effective and accurate way of assessing the coastal erosion in Macro to Meso-tidal beaches.