Integrating Mean Sea Level, Vertical Land Motion, and Seabed Morphology: Literature Review and Methodological Approach for Coastal and Environmental Monitoring

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Abstract

The ongoing and accelerated changes in the Earth's Mean Sea Level (MSL) present significant challenges for coastal management and environmental stability. This research emphasizes the critical need to correlate MSL, Vertical Land Motion (VLM), and Seabed Morphology (SM) to better predict and mitigate the impacts of these variations. By integrating geodetic, oceanographic, and remote sensing techniques, this interdisciplinary study aims to fill gaps in understanding how these parameters interact, especially in regions with distinct geological and environmental characteristics. This research aims to explore the current state of research on the relationship between mean sea level, vertical land motion, and bathymetry, identifying strengths, limitations, and gaps. As part of this effort, we introduce an approach for correlating these three parameters, which is still in the conceptual stage and expected to form the basis for future methodological development.

A comprehensive literature review highlights the influence of short- and long-term sea level variations, tidal forces, atmospheric phenomena, and geological factors on MSL and VLM. It underscores the importance of integrating satellite altimetry, GNSS, and gravimetric data with advanced acoustic systems like echosounders and bathymetric LIDAR to accurately monitor and analyze changes in seabed morphology. Additionally, the synergy between geodetic and oceanographic methods ensures robust data collection and reliable long-term monitoring of these dynamic processes. Understanding these interactions is essential for deciphering Earth's geological history, monitoring coastal evolution, and managing sediment systems effectively.

This methodology utilizes time series analysis, data processing, and mathematical modeling to correlate MSL, VLM, and SM. Advanced regression models and differential equations will help validate these relationships, focusing on tectonically active regions. The study aims to improve environmental change predictions, supporting policymakers and scientists in tackling sea level rise and land dynamics.