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DYNAMICS OF OCEAN WAVE - CURRENT INTERACTIONS AND THEIR INFLUENCE ON COASTAL ENERGY TRANSPORT PROCESSES

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ABSTRACT

Interactions between ocean surface waves and underlying currents play a crucial role in controlling the transport and redistribution of energy in coastal environments. These interactions modify wave propagation characteristics such as height, direction, and frequency, which in turn influence near-shore circulation patterns, sediment transport, and shoreline stability. This study investigates the dynamic coupling between waves and currents and examines how this coupling affects coastal energy transport processes under varying hydrodynamic conditions.

Using a combination of field observations, numerical simulations, and spectral wave analysis, the research evaluates changes in wave energy flux in regions subjected to tidal currents, wind-driven flows, and bathymetric gradients. Particular attention is given to mechanisms such as wave refraction, Doppler shifting, wave blocking, and current-induced wave steepening, which significantly alter the spatial distribution of wave energy. The results indicate that opposing currents enhance wave energy concentration and promote localized dissipation, while following currents facilitate energy spreading and reduced wave breaking intensity.

The study further demonstrates that variations in current strength and direction can lead to substantial temporal fluctuations in near-shore energy budgets, affecting coastal erosion patterns and the performance of marine energy systems. By quantifying the influence of wave-current interactions on coastal energy pathways, this research provides an improved understanding of coastal hazard assessment, shoreline management, and sustainable utilization of marine resources. The findings highlight the necessity of incorporating coupled wave-current dynamics into coastal modelling frameworks for more accurate prediction of energy transport in complex near-shore environments.

KEYWORDS: *Ocean, Ocean Surface Waves, Coastal*

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