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Commentary

Variability in Coastal Erosion Caused By Enso

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ABOUT THE STUDY

In the Pacific Basin, El Nino / Southern Oscillation (ENSO) is the dominant mode of climate change year after year, with significant changes in oceanographic coercion and the potential for significant impacts on the Pacific coast. However, how sandy beaches respond to these changes in basin scale has so far been limited to some long-term beach monitoring sites on the predominantly developed beaches. Here, we use 35-year Landsat images to map coastline variability around the Pacific Rim (72,000 beaches transects) and identify consistent patterns of beach erosion and sedimentation controlled by ENSO. Approximately one-third of all beaches experience significant erosion during the El Nino period, indicating that the East Pacific is particularly vulnerable to widespread erosion (especially during major events in 1997/1998). In contrast, the La Nina phenomenon is consistent with a significant increase in about a quarter of all beaches, although it causes severe erosion in southeastern Australia and elsewhere. Significant regional variability's in the coastal response to ENSO need to be considered in the light of future foreseeable enhancements and changes in ENSO amplitude.

Sandy beaches occupy 31% of the world's coastal areas, most of which are classified as wave-dominated. These beaches are particularly vulnerable to ocean wave energy and sea level fluctuations, which facilitate erosion and adhesion cycles on a temporary, yearly, and decade's timescale, and adjacent infrastructure and beachside habitat. The yearly timescale is particularly interesting because it is closely related to the Earth's climate and the internal modes of climate change. In climate change, the strengthening of these major climate patterns, coupled with the projected changes in storms and sea level rise, can exacerbate coastal erosion and threaten the future resilience of many coastal communities around the world.

To study the effect of ENSO on coastline variability from year to year, we evaluated anomalies in seasonal averaged coastline positions during the El Nino and La Nina periods in each transect. Considered one of the most complete indexes to describe ENSO, the Multivariate ENSO Index (MEI) has been used to identify El Nino and La Nina periods over the last 35 years. A test was performed to assess whether coastline anomalies were significantly different from the long-term averages for each phase. In addition, anomalous analysis for the northern winter coastline and all four, due to the strong seasonal coastline fluctuations, especially in the Northern Hemisphere, where energy wave conditions occur primarily during the Northern Winter (DJF).

Since sandy beaches are generally eroded in response to high energy waves and rising water levels and grow during milder periods, the spatial distribution of these two major ocean variables was analyzed at the same coastal location as satellite coastline analysis. ECMWF global products, ERA 5 wave reanalysis, and daily sea level anomalies with satellite altimeters were used. It shows regional differences in wave energy flux during positive and negative ENSO periods and describes both boreal winters and all seasons. In Peru and Chile, wave energy fluxes show a mixed response to El Nino, suggesting that rising sea levels may control the erosion responses observed in these areas during the El Nino period. This may explain the less widespread coastal erosion observed in Peru and Chile compared to the United States and Mexico.

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