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Coastal Dynamics of Thua Thien Huế, Vietnam: Insights from 35 Years of Earth Observation Data

Felix Bachofer¹, Ronja Lappe¹, Hoang Khanh Linh Nguyen², Dang Giang Chau Nguyen³, Patrick Sogno¹, Tobias Ullmann⁴, and Claudia Kuenzer^{1,4}

¹German Aerospace Center (DLR), Earth Observation Center (EOC), Wessling, Germany (felix.bachofer@dlr.de)

²International School, Hue University, Hue, Vietnam

³Department of Chemistry, Hue University, Hue, Vietnam

⁴Institute for Geography and Geology, Julius-Maximilians-University of Würzburg, Würzburg, Germany

For the entire shoreline of Vietnam, a comprehensive analysis spanning from 1984 to 2021 was conducted. The study employed a cloud-based processing strategy on Google Earth Engine, utilizing Landsat-derived annual composites based on the Modified Normalized Difference Water Index (MNDWI). Coastline change rates were quantified using linear regressions along shore-normal transects, and hotspots were identified based on erosion and accretion rates. Notable erosion hotspots were observed in the Mekong Delta and Nam Dinh province, while accretion was prominent near Hai Phong city.

The coastal region of Vietnam, including Thua Thien Hue province, is exceptionally susceptible to sea level rise, storm surges and changing sedimentation patterns due to urbanization, agriculture, aquaculture, tourism, and industrial activities competing for limited and attractive coastal zones. Thua Thien Hue, home to the largest lagoon in Southeast Asia, the Tam Giang-Cau Hai lagoon, emerged as a unique case emphasizing the significance of understanding and monitoring coastline dynamics. An extensive dune, stretching across approximately 70 km, acts as a natural barrier, separating the lagoon from the sea. This region encompasses a distinctive ecosystem, agricultural expanses, aquaculture ventures, and the culturally rich City of Hue, once the imperial capital boasting numerous heritage sites. The hinterland, sheltering this amalgamation of natural and cultural treasures, faces the recurrent challenge of compound flooding events. These events are intensified by the interplay of storm surges from the sea and associated backwater effects. Given this, comprehending the historical dynamics becomes imperative, serving as a cornerstone for informed decisions on future adaptation strategies in the realms of coastal and flood protection.

More than half of Thua Thien Hue's coast was classified as predominantly stable, but localized erosion and accretion patterns revealed varying dynamics. The central finding was the identification of five local hotspots with strong coastline change rates. These hotspots exhibited dynamic patterns of erosion and accretion, notably at the Thuan An inlet and in Tu Hien in the south of Hue province.

The Thuan An inlet showcased an erosion hotspot with an average erosion rate of -4 m/yr over 900 meters. This erosion intensified in the 2000s, stabilizing after 2014, illustrating the temporal variability of coastal dynamics. Conversely, on the opposite side of the lagoon inlet, a headland was identified as an accretion hotspot with an average rate of +3 m/yr and alternating phases of erosion and accretion. Severe erosion hotspots were also noted north and south of the lagoon inlet in Tu Hien.

Thua Thien Hue's coastline changes are multifaceted but understudied. They are probably influenced by sediment redistribution, reduced coastal sediment availability, and direct human interventions. Despite the overall stability of most parts of the coastline, the localized changes underscore the intricate interplay of natural and anthropogenic factors shaping the coastal dynamics of Thua Thien Hue over the past three and a half decades.