

ABSTRAK

Perubahan garis pantai di wilayah pesisir sangat dipengaruhi oleh parameter hidro-oseanografi seperti arus sejajar pantai (*longshore current*). Penelitian ini bertujuan untuk menganalisis dinamika garis pantai, mengidentifikasi karakteristik *longshore current*, serta menguji pengaruhnya terhadap pergeseran garis pantai di Pantai Kondang Iwak, Kabupaten Malang, selama periode 2015–2025. Metode ekstraksi garis pantai menggunakan *Modified Normalized Difference Water Index* (MNDWI) pada citra Sentinel-2 melalui *platform* Google Earth Engine, dengan penyamaan resolusi spasial *band* secara *bilinear interpolation* ke skala 10 meter. Karakteristik arus dihitung secara matematis, sedangkan hubungan antar variabel diuji dengan regresi linear sederhana. Hasil penelitian menunjukkan dinamika garis pantai sangat fluktuatif, stasiun I (Barat) didominasi abrasi tertinggi mencapai -3,78 m/tahun (2023–2025), Stasiun II (Tengah) mengalami akresi tertinggi 4,37 m/tahun (2019–2021), dan Stasiun III (Timur) mengalami lonjakan akresi ekstrem hingga 10,11 m/tahun (2023–2025) akibat suplai sedimen muara sungai. Aktivitas *longshore current* bergerak konstan ke arah Barat dengan magnitudo yang dikontrol oleh batimetri lepas pantai yang curam hingga kedalaman -280 meter. Arus terkuat berada di Stasiun I (1,29–1,71 m/s) dengan sudut pecah gelombang tertajam (2,98°–7,83°), sedangkan arus terlemah berada di Stasiun II (0,17–0,64 m/s) akibat topografi landai. Uji regresi linear menghasilkan koefisien determinasi (R^2) sebesar 0,4553, membuktikan bahwa *longshore current* memengaruhi perubahan garis pantai sebesar 45,53%. Secara mekanis, pelemahan arus di zona tengah memicu pengendapan sedimen (akresi), sehingga terjadi kelangkaan pasokan sedimen (*sediment deficit*) di sisi hilir (Stasiun I). Arus hilir yang kembali menguat ekstrem terus menguras material pantai tanpa adanya suplai pengganti, sehingga menyebabkan abrasi kronis di sisi Barat. Sisa pengaruh sebesar 54,47% dikontrol oleh faktor lain seperti fluktuasi sedimen muara sungai, gelombang ekstrem monsun, pasang surut, dan resistensi tebing batuan pantai.

Kata Kunci: Batimetri, Longshore Current, MNDWI, Pantai Kondang Iwak, Perubahan Garis Pantai.

ABSTRACT

Shoreline changes in coastal areas are heavily influenced by hydro-oceanographic parameters such as longshore currents. This study aims to analyze shoreline dynamics, identify longshore current characteristics, and examine their influence on shoreline shifts at Kondang Iwak Beach, Malang Regency, during the 2015–2025 period. The shoreline extraction method used the Modified Normalized Difference Water Index (MNDWI) on Sentinel-2 imagery via Google Earth Engine, with band spatial resolution aligned using bilinear interpolation to a 10 meter scale. Current characteristics were calculated mathematically, while the relationship between variables was evaluated using simple linear regression. The results showed highly fluctuated shoreline dynamics, station I (West) was dominated by erosion reaching -3.78 m/year (2023–2025), station II (Center) experienced the highest accretion of 4.37 m/year (2019–2021), and station III (East) faced extreme accretion spikes up to 10.11 m/year (2023–2025) due to river mouth sediment supply. Longshore currents moved constantly westward with a magnitude controlled by steep offshore bathymetry plunging deeper than -280 meters. The strongest current was at Station I (1.29–1.71 m/s) with the sharpest breaking angle (2,98°–7,83°), while the weakest was at Station II (0,17–0,64 m/s) due to shallow topography. The regression test yielded a coefficient of determination (R^2) of 0.4553, proving that longshore currents contribute a 45.53% influence on shoreline changes. Mechanically, the current deceleration in the central zone triggered sediment deposition (accretion), leading to a supply shortage (sediment deficit) downstream at station I. The restrengthened downstream current continuously eroded beach materials without sufficient replacement supply, resulting in chronic erosion on the western side. The remaining 54.47% of the influence is controlled by other factors, such as river mouth sediment fluctuations, extreme monsoon waves, tidal ranges, and the resistance of coastal rocky cliffs.

Keywords: Bathymetry, Shoreline Changes, Longshore Current, MNDWI, Kondang Iwak Beach.