ABSTRAK

ANALISIS KORELASI DATA WATER COLUMN HEIGHT DAN GELOMBANG LAUT DENGAN DATA IKLIM MIKRO MENGGUNAKAN METODE KOEFISIEN KORELASI PADA PUMMA SEBESI

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Analisis deret waktu ketinggian kolom air laut diperlukan untuk membedakan gelombang tsunami dengan dinamika alami pasang surut, *swell*, *seiche*, dan bangkitan kapal, serta anomali yang relevan bagi peringatan dini tsunami. Korelasi dengan iklim mikro setempat penting sebagai kontrol operasional untuk membantu menyaring *false alarm* akibat angin/hujan, menilai kualitas sensor, dan membangun fitur prediktif yang realistis. Studi ini menganalisis hubungan antara *water column height* dan ketinggian gelombang hasil pemantauan PUMMA berfrekuensi 1 Hz di Pulau Sebesi dengan variabel iklim mikro (kecepatan/arah angin, curah hujan, intensitas radiasi matahari, kelembapan relatif, dan tekanan udara). Metode mencakup korelasi nonparametrik (Spearman, Kendall–Tau) dan pemodelan *Long Short-Term Memory* (LSTM) untuk prediksi jangka pendek. Alur kerja meliputi akuisisi, prapemrosesan, EDA, uji normalitas, analisis korelasi, dan pemodelan. Hasil menunjukkan tidak terdapat hubungan yang signifikan antara variabel iklim mikro dan *water column height*/ketinggian gelombang pada skala 1 Hz. Temuan ini menyiratkan bahwa variabilitas muka air di Pulau Sebesi lebih didominasi pasang surut, *remote forcing*, dan faktor oseanografis non-meteorologis lokal. Kontribusi iklim setempat terutama memengaruhi *wind-setup*/gelombang pendek dan kurang informatif untuk deteksi anomali level. Model LSTM memprediksi tren tekanan air sensor *submersible gauge* dengan akurasi tinggi (MSE = 0,003; MAE = 0,013; RMSE = 0,016; R^2 = 0,990) serta sensor ultrasonik (MSE = 0,009; MAE = 0,024; RMSE = 0,030; R^2 = 0,973), menegaskan kestabilan sinyal dan kelayakan peramalan *edge*. Studi ini menyimpulkan bahwa korelasi rendah dengan iklim menegaskan perlunya integrasi komponen pasang-surut dan kondisi gelombang/arus regional dalam analitik PUMMA, sementara variabel iklim lebih tepat untuk kontrol kualitas/penjelas sekunder. Selain itu, model LSTM pada 1 Hz layak untuk prediksi jangka pendek dan *gap-filling*. Studi lanjutan diarahkan pada perluasan fitur oseanografi dan validasi lintas-musim untuk meningkatkan sensitivitas deteksi anomali.

Kata Kunci: PUMMA, iklim mikro, koefisien korelasi, Spearman, Kendall-Tau, LSTM, gelombang laut.

ABSTRACT

CORRELATION ANALYSIS OF WATER COLUMN HEIGHT DATA AND OCEAN WAVES WITH MICROCLIMATE DATA USING CORRELATION COEFFICIENT METHOD AT SEBESI PUMMA

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Time-series analysis of sea-level height is essential to distinguish the tsunami wave from routine dynamics such as tides, swell, seiche, vessel wake, and anomalies pertinent to early warning. Correlating sea-level records with local weather provides operational control i.e., filtering wind/rain-induced false alarms, supporting sensor quality checks, and informing realistic predictive features. This study examines relationships between PUMMA 1 Hz sea-level (*water column height*) and wave-height measurements at Sebesi Island and microclimate variables (wind speed/direction, rainfall, solar radiation, relative humidity, and air pressure). Methods include nonparametric correlations (Spearman, Kendall–Tau) and *Long Short-Term Memory* (LSTM) modelling for short-term prediction. The workflow comprises acquisition, preprocessing, EDA, normality testing, correlation analysis, and modelling. Results indicate no significant association between microclimate variables and sea-/wave-height at the 1 Hz scale. This suggests that sea-level variability at Sebesi is primarily governed by tides, remote forcing, and non-local oceanographic drivers, whereas local weather mainly affects wind-setup/short-period waves and is less informative for anomaly detection in level data. The LSTM achieved high predictive skill for the PUMMA pressure channel (MSE = 0.003; MAE = 0.013; RMSE = 0.016; R^2 = 0.990) and the ultrasonic channel (MSE = 0.009; MAE = 0.024; RMSE = 0.030; R^2 = 0.973), confirming signal stability and the feasibility of edge-based short-horizon forecasting. In conclusion, the weak weather correlations underscore the need to integrate tidal constituents and regional wave/current conditions into PUMMA analytics, while treating local weather as secondary explanatory/quality-control inputs. Moreover, the 1 Hz LSTM models are suitable for short-term prediction and gap-filling without compromising real-time operation. Future work will extend oceanographic feature sets and perform cross-season validation to enhance anomaly-detection sensitivity and overall early-warning reliability.

Keywords: PUMMA, microclimate, correlation coefficient, Spearman, Kendall-Tau, LSTM, ocean waves.