Analysis of Oceanographic Physical Parameters at Sako Bungus Beach

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Abstract

This study was conducted at Sako Beach, Bungus Teluk Kabung District, Padang City, West Sumatra, to analyze the physical parameters of the water and examine changes in the shoreline occurring in the area. Data collection was conducted in November 2024 at five observation stations located using GPS. The measured parameters included water temperature, salinity, current velocity, and beach slope. The results showed that water temperatures ranged from 34 to 35°C, which is relatively high for tropical coastal waters. Salinity values ranged from 15 to 22 ppt, indicating brackish water characteristics and the influence of freshwater runoff from the land. Current velocity ranged from 0.1 to 0.25 m/s, falling into the category of weak to moderate currents, while the beach slope ranged from 0.744° to 2.919°, indicating a gently sloping beach. These physical conditions are interrelated and play a role in coastal dynamics, particularly in sediment distribution. Analysis of shoreline changes indicates that Sako Beach is undergoing accretion, or land gain, driven by sedimentation. The gentle slope influences this process, as does relatively low wave energy and the potential contribution of terrestrial runoff. The results of this study show that the dynamics of physical water parameters play a significant role in shaping changes in coastal morphology; therefore, periodic monitoring is necessary to support sustainable coastal zone management

1. Introduction

Sako Beach is located in the Bungus Teluk Kabung District, which is part of the city of Padang, West Sumatra. The geographic coordinates of Sako Beach are 1°02'47" S (South Latitude) and 100°24' E (East Longitude). Sako Beach is also a marine tourism destination with the longest shoreline among other tourist attractions in the city of Padang's other tourist attractions. It features a relatively gentle beach topography, moderate waves, and white sand (Raesa et al., 2019).

Marine dynamics are inextricably linked to the physical parameters of the water. Physical parameters such as temperature, salinity, current velocity, and pH significantly influence the aquatic life inhabiting these waters, affecting their foraging, spawning, shelter-seeking, and habitat expansion (Umasugi et al., 2021). Changes in these physical components not only lead to a decline in water quality but can also cause erosion of the seabed and shoreline, thereby affecting marine life (Patty et al., 2021).

Coastline monitoring is a crucial element for predicting future shoreline changes as part of appropriate management strategies (Jonah et al., 2016). Coastlines are dynamically changing due to the interaction between the sea and the land during tidal movements. Changes in the shoreline exhibit varying characteristics

depending on regional conditions. Regional characteristics that cause shoreline changes include hydro-oceanographic factors, sediment types, and human activities in coastal areas (Fuad et al., 2021), as well as other factors such as wind, waves, currents, and beach types and materials that influence sedimentation processes, water movement, and beach morphology, as well as variations in land subsidence rates, land clearing, high runoff volumes, and sediment transport from rivers to the sea (Aniendra et al., 2020). Therefore, this study was conducted to analyze the physical parameters and changes in the shoreline in the coastal waters of Sako, Bungus District, West Sumatra.

2. Methodology

2.1. Time, Place, and Materials

This study was conducted in the Sako coastal area, Bungus Subdistrict, Padang City, West Sumatra, in November 2024.

2.2. Method

The physical parameters analyzed included temperature, salinity, and current velocity. Additionally, primary data on slope gradient were collected for this study.

2.3. Procedures

The positions of the 5 observation station were determined using GPS. Station 1 was located at coordinates 1°1′53.40″ S (South Latitude) 100°24′2.97″ E (East Longitude), and Station 2 was located at 1°1′54.33″ S (South Latitude) 100°24′3.84″ E (East Longitude) for Station 2, 1°1′55.46″ S (South Latitude) 100°24′4.86″ E (East Longitude) for Station 3, 1°1′59.21″ S (South Latitude) 100°24′6.20″ E (East Longitude) for station point 4, and 1°2′2.40″ S (South Latitude) 100°24′6.98″ E.

3. Result and Discussion

Temperature

Sea surface temperature is an environmental parameter that plays a key role in regulating the distribution and behavior of marine life. Sea surface temperature influences the biological activity and distribution of marine organisms (Ningrum et al., 2022). Sea surface temperature variability is crucial in climate dynamics, affecting marine ecosystems and linked to extreme events such as the Indian Ocean Dipole (IOD) oscillation and marine heatwaves (Azuga et al., 2020; Ning et al., 2024). The importance of sea surface temperature is studied because it is a key variable in oceanography (Sukresno et al., 2021; Liu et al., 2021), serves as an indicator for assessing seawater quality (Audroulidakis & Krestenitis, 2022), and is a critical factor in determining the distribution of ecosystems and biodiversity for marine organisms. Water temperature can influence the metabolic rates of aquatic organisms and the rates of photosynthesis in aquatic plants, and it plays a crucial role in shaping ocean circulation patterns and the distribution of nutrients in the ocean (Krivouguz et al., 2021). The temperature values recorded at several monitoring stations along Sako Beach, Bungus, West Sumatra, are presented in Table 1.

Table 1. Temperature readings at all monitoring stations

No	Station	Value
1.	1	35° C
2.	2	34° C
3.	3	35° C
4.	4	34° C
5.	5	35° C

Based on temperature data from five stations along Sako Beach, which range from 34–35°C, these values are considered quite high for tropical coastal waters. According to the Ministry of Environment and Forestry of the Republic of Indonesia, in stated in Minister of Environment Decree No. 51 of 2004, temperature changes in marine waters designated for marine life must not exceed ±2°C from natural conditions, as significant increases can disrupt the stability of coastal ecosystems.

Salinity

Salinity is a parameter that cannot be overlooked in nearly every marine study. Pratama et al. (2018) explain that salinity is a key factor in the distribution of marine organisms. Water masses exhibit characteristics specific to their region of origin, as the physical properties of a water body are influenced by the climate of its region. Salinity is a physical parameter that significantly affects water quality. According to Suhana (2018), salinity is the total concentration of ions present in the water. Factors that significantly influence salinity as one of the primary parameters for characterizing water bodies include circulation patterns, tides, freshwater inflow via river

discharge, and solar irradiance, all of which play a role in the physicochemical processes occurring within the water column (Sari et al., 2017). Furthermore, seasonal changes can lead to shifts in the distribution patterns of both temperature and salinity (Suhana, 2018). The salinity values measured at several monitoring stations along Sako Beach, Bungus Subdistrict, West Sumatra, are presented in Table 2.

Table 2. Salinity values

No	Station	Value
1.	1	22 ppt
2.	2	22 ppt
3.	3	15 ppt
4.	4	15 ppt
5.	5	15 ppt

Salinity values of 15–22 ppt at Sako Beach indicate brackish water conditions strongly influenced by land runoff or river flow. Generally, the seawater quality standards for biota, as defined by the Ministry of Environment and Forestry of the Republic of Indonesia, refer to a natural range of approximately 33–34 ppt; therefore, this value is considered lower than that of open-ocean conditions.

Current Velocity

A current is the movement of a water mass both horizontally and vertically from one place to another. Currents play a crucial role in water quality by distributing nutrients from one location to another. Currents also regulate the fertility of sites in seaweed cultivation areas and similar environments. Open waters generally have fairly high current intensities, meaning that the direction and distribution of nutrients, suspended materials, and various physicochemical and biological water parameters will be significantly influenced by current direction, velocity, and patterns (Pratiwi et al., 2018). Longshore current velocity can transport sediment displaced by waves; waves approaching the shore can generate longshore currents that play a role in sedimentation or coastal erosion. The current velocity values measured at several stations along Sako Beach, Bungus District, West Sumatra (Table 3).

Current speeds of 0.1–0.25 m/d at Sako Beach are classified as weak-to-moderate currents, which are still common in semi-enclosed waters. Regulatory standards do not specify numerical quality standards for current speed; however, current remains an important physical parameter as it controls mixing processes, nutrient distribution, and sediment transport. Putra et al. (2019), in their study, explained that variations in coastal currents in Indonesia directly influence sedimentation patterns and beach stability. Furthermore, another study conducted by Ramadhan et al. (2021) also confirmed that current dynamics can significantly affect water mass distribution and coastal water quality.

Table 3. Current velocity

No	Station	Value
1.	1	0.196 m/s
2.	2	0.25 m/s
3.	3	0.147 m/s
4.	4	0.165 m/s
5.	5	0.1 m/s

Slope Gradient

Surfaces are not always flat; elevation differences cause them to slope at various points. This topographic condition, known as slope gradient, is commonly encountered in various civil engineering projects. Coastal slope is the inclination of land relative to a horizontal plane, expressed in degrees or degrees. The shape of the shoreline profile is greatly influenced by waves, sediment properties, particle size and shape, currents, and coastal depth (Hamuna et al., 2018). According to Kershaw et al. (2019), beach slope affects debris accumulation; gentle or flat shorelines are expected to facilitate debris buildup. The slope values obtained at several monitoring stations on Sako Beach, Bungus District, West Sumatra, are shown in Table 4.

Table 4. Slope values

No	Station	Value
1.	1	2.576°
2.	2	2.919°
3.	3	2.805°
4.	4	2.233°
5.	5	0.744°

Slope gradients ranging from 0.744° to 2.919° at Sako Beach indicate a gently sloping beach typology, where wave energy is generally dissipated gradually before reaching the shore. Beach slope gradients influence wave run-up intensity and erosion potential (Kurniawan et al., 2018). Furthermore, beaches with gentle slopes tend to experience predominantly sedimentation processes, whereas steeper slopes increase the risk of local erosion (Hidayat et al., 2021).

Coastal Line Changes

Signs of shoreline changes need to be identified early on because they have a significant impact on the environment and on the effectiveness of environmental management, so that the area can be optimally utilized. Ocean wave energy traveling toward the shore breaks due to differences in water depth, resulting in nearshore currents. Coasts are dynamic areas, so the shoreline is subject to change (Melisa et al., 2020), including changes driven by sediment transport, which can result in abrasion or accretion/sedimentation. The shoreline changes occurring at Sako Beach, Bungus Subdistrict, West Sumatra, are shown in Figure 1.

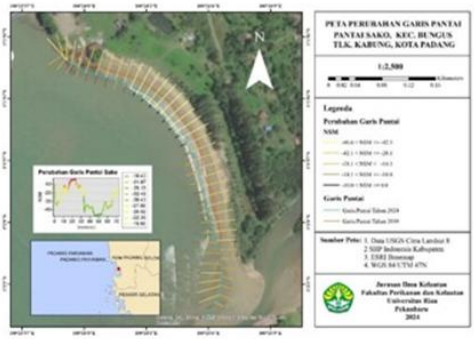

Figure 1. Map of shoreline changes at Sako Beach

Based on the research conducted and the results of shoreline change mapping at 5-year intervals (2019–2024), it is evident that the dominant dynamic driving shoreline changes at Sako Beach is sedimentation or accretion. Accretion is the process by which the shoreline advances, triggering sedimentation that leads to shallowing, which can disrupt ship navigation (Pane, 22). This process frequently occurs in areas with river mouths and low wave energy, and can result in shallowing that forms new land, such as deltas. Factors influencing accretion include stormwater runoff and land clearing. On the positive side, accretion can increase land area, create new land for agriculture or settlements, and expand habitats for ecosystems such as mangroves and seagrass beds. However, on the negative side, accretion can cause siltation, disrupting navigation and altering habitats, potentially damaging coral reef ecosystems due to increased turbidity.

4. Conclusion

Based on research conducted at Sako Beach, Bungus Subdistrict, West Sumatra, it can be concluded that the water's physical parameters indicate coastal water characteristics that are still influenced by terrestrial factors and local ocean dynamics. Relatively high water temperatures, brackish salinity levels, and weak to moderate current speeds indicate the influence of freshwater runoff and semi-enclosed water conditions. The gentle slope of the shoreline also supports sedimentation processes in the coastal area. This is consistent with the results of shoreline change analysis, which show accretion or land gain due to sediment deposition. In general, the dynamics of the physical parameters at Sako Beach are interrelated and play a crucial role in shaping coastal environmental conditions; therefore, regular monitoring is essential to support sustainable coastal zone management.

References

[KLH] Kementrian Lingkungan Hidup Republik Indonesia. (2004). *Keputusan Menteri Negara Lingkungan Hidup Nomor 51 Tahun 2004 tentang Baku Mutu Air Laut.* KHL. Jakarta.

Androulidakis, Y. S., & Krestenitis, Y.N. (2022). Sea Surface Temperature Variability and Marine Heat Waves over the Aegean, Lonian, and Cretan Seas from 2008-2021. *Mar. Sci. Eng*, 10 (42), 1-28.

Aniendra, A.A., Sasmito, B., & Sukmono, A. (2020). Analisis Perubahan Garis Pantai dan Hubungannya dengan Land Subsidence Menggunakan Aplikasi Digital Shoreline Analysis System (DSAS) (Studi Kasus: Wilayah Pesisir Kota Semarang). *Jurnal Geodesi Undip*, 9(1): 12-19.

Azuga, N.A., Galib, M., & Elizal, E. (2020). Analyzing the Effect of the Indian Ocean Dipole Phenomenon on the Distribution of Sea Surface Temperature Anomalies in West Sumatra. *Asian Journal of Aquatic Sciences*, 3(3): 260–270.

Fuad, A.K., Fajaria, F., & Hidayati, N. (2021). Pemodelan dan Analisis Perubahan Garis Pantai di Kabupaten Situbondo, Jawa Timur. *Journal of Fisheries and Marine Research*, 5(2): 335-349.

Hamuna, B., Sari, A.N., & Alianto, A. (2018). Kajian Kerentanan Wilayah Pesisir ditinjau dari Geomorfologi dan Elevasi Pesisir Kota dan Kabupaten Jayapura, Provinsi Papua. *Jurnal Wilayah dan Lingkungan*, 6(1), 1-14.

Hidayat, R., Rochaddi, B., & Widada, S. (2021). Analisis Morfologi Pantai dan Kemiringan Lereng terhadap Dinamika Abrasi di pesisir indonesia. *Jurnal Ilmu dan Teknologi Kelautan Tropis,* 13(2): 215-226.

Kershaw, P.J., Turra, A., & Galgani, F. (2019). Guidelines for the Monitoring and Assessment of Plastic Litter and microplastics in the ocean. https://www.gesamp.org/publications/guidelines-for-the-monitoring-and-assessment-of-plastic-litter-in-the-ocean

Krivoguz, D., Semenova, A., & Mal'Ko, S. (2021). Spatial Analysis of Seasonal Patterns in Sea Surface Temperature and Salinity Distribution in the Black Sea (1992-2017). *IOP Conference Series: Earth and Environmental Science,* 937 (032013), 1-6.

Kurniawan, F., Setiyono, H., & Yulianto, B. (2018). Pengaruh Karakteristik Morfologi Pantai terhadap Kerentanan Abrasi di Wilayah Pesisir Indonesia. *Jurnal Segara*, 14(1): 33-44.

Liu, J., Jin, B., Yang, J., & Xu, L. (2021). Sea Surface temperature prediction using a Cubic B-Spline Interpolation and Spatiotemporal Attention Mechanism. *Remote Sensing Letters*, *12*(5): 478-487.

Melisa, W., Hariyadi., Widada, S., Indrayanti, E., Sugianto D.N., Ismunarti, D.H., & Yusuf, M. 2020. Studi Pengaruh Longshore Current terhadap Abrasi di Pantai Moro, Kabupaten Kendal, Jawa Tengah. *Indonesian Journal of Oceanography*, 2(4): 324-333.

Ning, D., Vetrova, V., Bryan, K.R., & Koh, Y.S. (2024). Harnessing the Power of Graph Representation in Climate Forecasting: Predicting Global Monthly Mean Sea Surface Temperatures and Anomalies. *Earth and Space Science*, *11*(3), 1-44.

Ningrum, D., Zainuri, M., & Widiaratih, R. 2022. Variabilitas Bulanan Klorofil-A dan Suhu Permukaan Laut pada Perairan Teluk Rembang dengan Menggunakan Citra Sentinel-3. *Indonesioan Journal of Oceanogaphy*, 4(2): 88-96.

Pane, N.A. (2022). *Analisis Perubahan Garis Pantai Menggunakan Digital Shoreline Analysis System (DSAS).* Universitas Lampung. Lampung.

Patty, S.I., Yalindua, F.Y., & Ibrahim, P.S. (2021). Analisis Kualitas Perairan Bolaang Mongondow, Sulawesi Utara Berdasarkan Parameter Fisika-Kimia Air Laut. *Jurnal Kelautan Tropis, 24*(1): 113-122.

Pratama, L., Surnbakt, H., & Agustriani, F. (2018). Pola Sebaran Salinitas Menggunakan Model Numerik Pattern of Salinity Distribution Using Numerical Models in Bungin River Estuary Banyuasin Regency, South Sumatera, *Maspari Journal*, *10*(1): 9-16.

Pratiwi, A.N.W., Luthfi, O.M., Ibrahim, F., & Putri, G.A. (2018). Studi Pola Arus Perairan Selatan Daerah Istimewa Yogyakarta dengan Menggunakan Metode Penginderaan Jauh. *Journal Ilmiah Rinjani*, *6*(1): 32-38.

Putra, A., Siregar, V.P., & Setiawan, A. (2019). Karakteristik Arus dan Kaitannya dengan Distribusi Sedimen di Perairan Pesisir Indonesia. *Jurnal Ilmu dan Teknologi Kelautan Tropis, 11*(2): 321-334.

Raesa, T. (2019). *Perancangan Resort di Pantai Sako, Bungus, Teluk Kabung, Padang, Sumatera Barat.* Teknik Sipil dan Perencanaan, Universitas Bung Hatta.

Ramadhan, A., Atmadipoera, A.S., & Kuswardani, R.T.D. (2021). Variabilitas Arus Permukaan dan Implikasinya terhadap Kualitas Perairan Pesisir. *Jurnal Segara*, *17*(1): 45-56.

Sari, S.H.J., Kirana, J.F.A., & Guntur, G. (2017). Analisis Kandungan Logam Berat Hg dan Cu Terlarut di Perairan Pesisir Wonorejo, Pantai Timur Surabaya. *Jurnal Pendidikan Geografi*, *22*(1): 1-9.

Suhana, M.P. (2018). Karakteristik Sebaran Menegak dan Melintang Suhu dan Salinitas Perairan Selatan Jawa. *Dinamika Maritim*, *6*(2), 9-11.

Sukresno, B., Jatisowo, D., & Hanintyo, R. 2021. Validation of Sea Surface Temprature from DCOM-C Satellite Using iQuam Datasets and MUR-SST in Indonesian Waters. *Indonesian Journal of Geography*, *53*(1): 136-143.

Umasugi, S., Ismail, I., & Irsan. (2021). Kualitas Perairan Laut Desa Jikumerasa Kabupaten Buru berdasarkan Parameter Fisik, Kimia dan Biologi. *Biopendix*, 8(1): 29-35