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Spatial Variation of Sediment Grain Size and Its Environmental Implications in the Anoi Itam Coastal Waters, Pulau Weh, Indonesia

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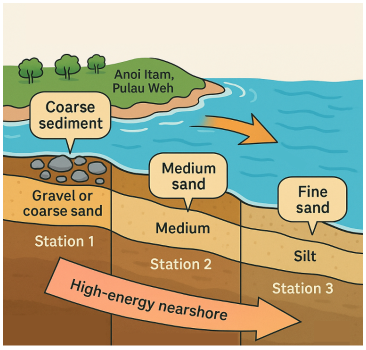

Abstract: This study investigates the grain-size distribution and sediment characteristics of the Anoi Itam coastal waters, Sabang City, Aceh Province, Indonesia. The objective was to determine spatial variations in sediment texture and their relationship with hydrodynamic energy conditions and depositional environments. Sediment samples were collected from three stations representing distinct energy zones along the Anoi Itam coastal transect using a Van Veen grab sampler. Laboratory analysis employed the dry-sieving method, and grain-size fractions were classified following the Wentworth and Folk & Ward scales. The results revealed significant spatial variability among stations, reflecting a clear gradient of hydrodynamic energy. Station 1 was dominated by coarse and very coarse sands, indicating a high-energy nearshore environment. Station 2 exhibited a mixture of coarse and medium sands, representing moderate-energy transitional conditions, while Station 3 consisted mainly of medium to fine sands, typical of low-energy depositional zones. The overall trend shows progressive fining from Station 1 to Station 3, consistent with decreasing flow energy and increasing depositional stability. These findings demonstrate that sediment distribution in the Anoi Itam coastal system is primarily influenced by hydrodynamic sorting, geomorphological features, and sediment transport direction, providing essential baseline data for coastal management and environmental assessment.

Keywords: Sediment composition, Grain size distribution, Hydrodynamic energy, Anoi Itam Waters, Pulau Weh, Coastal processes

1. Introduction

Aquatic Coastal environments, such as those found on Pulau Weh, Indonesia, are essential for understanding sediment dynamics due to the distinctive characteristics of their coastal sediments, particularly the volcanic sands prevalent in zones like Anoi Itam. The sedimentary processes operating in these regions are closely linked to local hydrodynamic conditions, which strongly influence geomorphological development and benthic ecosystems. Sediment characteristics, especially grain size, provide crucial insights into the hydrodynamics and sediment transport mechanisms shaping these dynamic intertidal zones [1,2]. Grain-size analysis serves as a fundamental tool for determining depositional environments and sediment transport pathways. Coarse sediments typically occur in high-energy environments, where vigorous wave action and tidal currents prevent the deposition of fine materials. Conversely, finer sediments accumulate in low-energy settings, promoting deposition and sediment stability. Hence, examining the spatial variability of sediment textures in Anoi Itam can elucidate local hydrodynamic processes and geomorphological controls that govern sedimentation patterns and influence coastal ecosystem health [5]. The unique volcanic origin of Pulau Weh, coupled with the complex hydrodynamic interactions generated by tidal currents and monsoonal winds, creates dynamic sedimentary conditions at Anoi Itam. Changes in wind direction, wave energy, and current strength can significantly modify sediment transport and deposition along the coastline [6,7]. In addition, anthropogenic activities such as coastal infrastructure development and land reclamation can amplify natural processes, accelerating coastal erosion and altering sediment balance [6,7]. Despite the ecological and geomorphological importance of the Anoi Itam coastline, comprehensive sedimentological studies of this region remain limited. Research focusing on grain-size distribution is vital for generating baseline data that support coastal management, erosion monitoring, and habitat assessment [8,9]. By investigating spatial variations in sediment composition, researchers can better understand the interaction between hydrodynamics and geomorphic settings that regulate sedimentation in the Anoi Itam coastal system. Such insights are essential for environmental monitoring and sustainable coastal management, as sediment texture and composition directly influence nutrient cycling, pollutant retention, and ecosystem stability [10,11].

Accordingly, this study aims to analyze the sediment grain-size distribution across three sampling stations in the Anoi Itam coastal waters. The objectives of this research are (a) to determine the percentage composition of different sediment size fractions (gravel, sand, and mud) at each sampling station, (b) to identify spatial variations in grain size and relate them to the hydrodynamic energy conditions of the environment and (c) to interpret the depositional characteristics and sedimentary processes governing the sediment distribution in the study area. The outcomes of this study are expected to contribute to a better understanding of sediment dynamics and coastal processes in volcanic island systems like Pulau Weh, and to provide a scientific basis for future coastal management and environmental conservation efforts in the region.

2. Results

2.1. Sediment Analysis

The sediment grain-size distribution in the Anoi Itam coastal waters showed clear spatial variations among the three sampling stations, reflecting differences in hydrodynamic energy and depositional conditions. The analysis was conducted across seven grain-size classes of 2 mm, 1 mm, 500 µm, 250 µm, 125 µm, 63 µm, and 38 µm and expressed as the percentage of total sediment weight for each station. At Station 1, the sediments were dominated by coarse materials. The 500 µm (coarse sand) and 1 mm (very coarse sand) fractions accounted for the majority of the sediment, representing approximately 74–81% of the total weight across all plots. The 2 mm (gravel) fraction contributed about 10–11%, while the 250 µm (medium sand) fraction represented between 10% and 22%. Finer fractions, including particles smaller than 125 µm, were negligible and together made up less than 1% of the total sediment composition. This dominance of coarse material indicates that Station 1 is characterized by a high-energy nearshore environment, where strong wave and current activity continuously rework and transport sediments, preventing the accumulation of finer particles.

Table 1. Percentage of Sediment Weight in Station 1

Plot	2 mm	1 mm	500 µm	250 µm	125 µm	63 µm	38 µm
1	10.38766	20.51256	45.63882	22.60101	0.798526	0.0546	0.006825
2	11.32458	28.85758	47.46149	10.39599	1.896325	0.056925	0.007116
3	9.426642	32.91477	53.46502	4.08399	0.097731	0	0

In contrast, Station 2 displayed a shift toward finer sediment textures compared with Station 1. The 500 µm (coarse sand) fraction remained the most abundant, ranging from 65% to 79%, followed by the 1 mm (very coarse sand) fraction, which contributed approximately 16–27%. The 2 mm (gravel) fraction decreased substantially, ranging only from 1% to 4%. Finer fractions, including 250 µm (medium sand), 125 µm (fine sand), and smaller particles, each contributed less than 3% to the total composition. This pattern suggests that Station 2 represents a moderate-energy depositional environment, where the flow velocity is reduced compared to Station 1, allowing partial deposition of medium sands but still dominated by coarser materials due to persistent, though weaker, hydrodynamic activity.

Table 2. Percentage of Sediment Weight in Station 2

Plot	2 mm	1 mm	500 µm	250 µm	125 µm	63 µm	38 µm
1	3.699313	20.447474	0.024695	73.09725	2.563343	0.158048	0.009878
2	3.366956	27.262395	64.75825	3.684235	0.767154	0.146801	0.014207

3	1.331646	16.284044	79.25102	1.352736	1.750422	0.030128	0

At Station 3, sediments showed a further increase in finer materials, though coarse sand still predominated. The 500 µm (coarse sand) fraction accounted for 55–68% of the total, while the 250 µm (medium sand) fraction ranged from 24% to 40%. The 1 mm (very coarse sand) and 2 mm (gravel) fractions decreased markedly, with proportions between 0.6% and 4.8%. Finer fractions below 125 µm remained very low, contributing less than 3% in total. This composition indicates that Station 3 is a low-energy or sheltered depositional environment, where wave and current intensity are considerably reduced, allowing finer sediments to settle and accumulate.

Table 3. Percentage of Sediment Weight in Station 3

Plot	2 mm	1 mm	500 µm	250 µm	125 µm	63 µm	38 µm
1	0.643636	1.454545	55.39636	39.63636	2.585455	0.283636	0
2	1.305006	3.328543	59.00105	35.27401	1.068086	0.023304	0
3	1.828397	4.795002	68.41111	24.00649	0.871818	0.087182	0

Furthermore, when comparing the average sediment composition across all stations, a clear fining trend was observed from Station 1 toward Station 3. The proportion of gravel and very coarse sand decreased consistently, while coarse and medium sands became increasingly dominant offshore. On average, gravel accounted for 10.38% at Station 1 but declined to 2.80% at Station 2 and 1.26% at Station 3. Similarly, the very coarse sand fraction decreased from 27.43% at Station 1 to 21.33% at Station 2 and only 3.19% at Station 3. Conversely, the coarse sand fraction increased progressively from 31.04% at Station 1 to 48.01% at Station 2 and 60.94% at Station 3. Medium sand followed a similar pattern, with values of 28.82%, 26.05%, and 32.97% for Stations 1, 2, and 3, respectively. The finer fractions, including fine sand, very fine sand, and mud, remained consistently low (below 2%) at all stations. These results collectively demonstrate that the sediments of the Anoi Itam coastal area are dominated by sand-sized particles, with minimal silt and clay content. The overall trend, from coarse, gravel-rich sediments nearshore to finer sands offshore, suggests a progressive decrease in hydrodynamic energy along the transect. Station 1, being closest to the shore, experiences strong wave and current activity that transports and retains only coarse materials. Station 2 represents a transitional zone of moderate energy, where partial deposition of medium sands occurs. Station 3, located further from direct wave influence, represents a relatively calm depositional area dominated by finer sands.

3. Discussion

The sediment size distributions observed across the three sampling stations at Pulau Weh exhibit a clear spatial gradient, transitioning from coarse to fine textures, which indicates systematic variations in hydrodynamic energy and depositional conditions across the study area. At Station 1, the predominance of coarse sand (500 µm) and very coarse sand (1–2 mm) fractions, along with notable gravel content, suggests a high-energy environment where dynamic conditions transport coarse particles while winnowing finer materials; such conditions are typical of nearshore zones or channel margins where strong currents and wave action prevail [12]. In contrast, Station 2 presents a more balanced grain-size distribution, with coarse and medium sands (500–250 µm) dominating the sediment composition. The reduction in gravel content and increased presence of medium sand indicate a moderate-energy environment in which current velocities remain sufficient to transport coarser grains yet low enough to permit some deposition of finer material; this setting likely represents a transitional depositional zone (e.g., inner shelf or tidal flat) where sediment sorting occurs under fluctuating hydrodynamic forces [13].

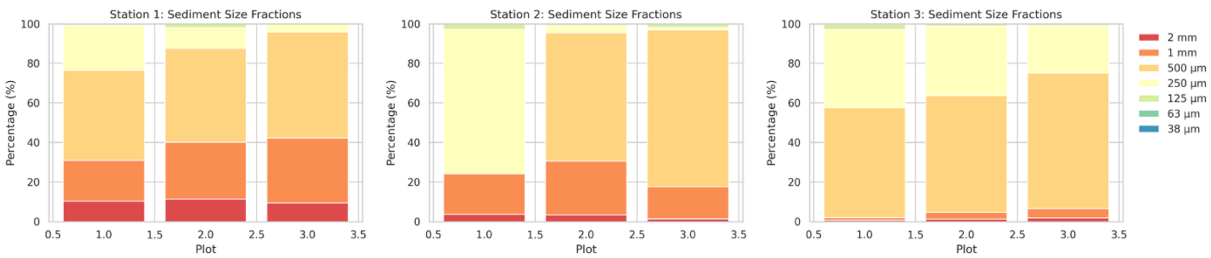

Figure 1. Sediment size fraction on Station 1-3

The characteristics of Station 3 differ markedly from those of Stations 1 and 2. Here, sediments are primarily composed of fine to medium sands (250–125 μm), with minimal contributions from coarser fractions, indicating a low-energy depositional setting in a more sheltered area where flow energy dissipates substantially and reworking is limited, favoring the accumulation of fine particles and organic matter [14,15]. Across all stations, the consistently low proportion of the fine fraction (silt and clay) implies that bedload and saltation dominate sediment transport, with minimal suspended-load deposition and frequent reworking by waves and currents. The observed transition from coarse to fine sediments is attributable to hydraulic sorting, whereby the capacity of the flow to transport sediment decreases along the transport path, leading to preferential deposition of smaller grains as energy dissipates [16,17].

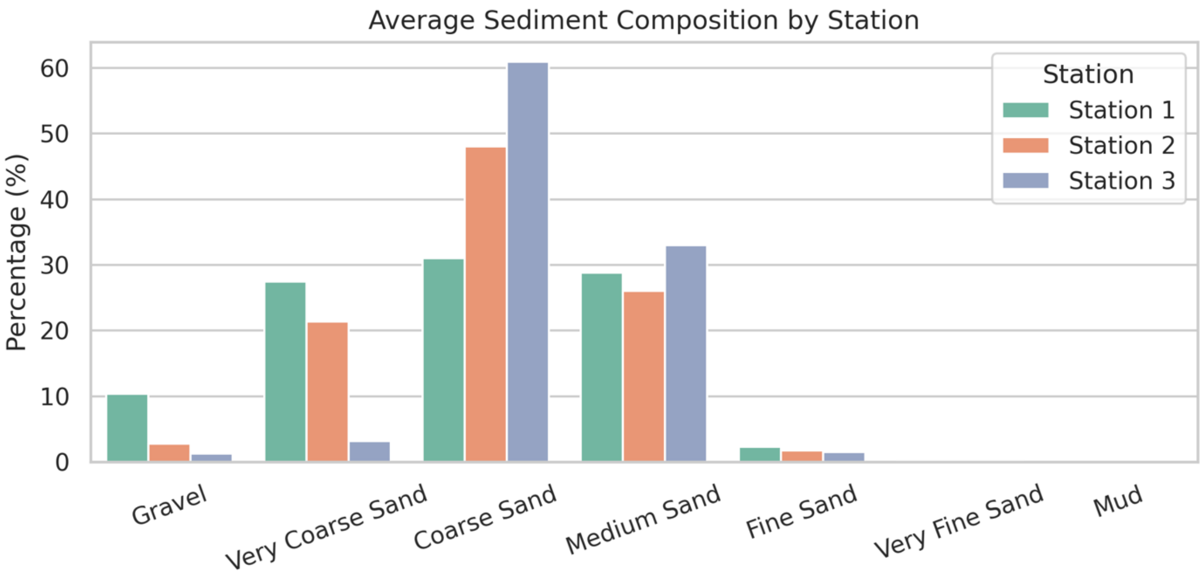

Figure 2. Average sediment composition

Moreover, based on sedimentological perspective, these textures can be grouped into distinct facies linked to energy regimes: Station 1 corresponds to a coarse-grained, poorly sorted facies typical of high-energy settings; Station 2 corresponds to a moderately sorted sand facies formed under transitional conditions; and Station 3 represents a well-sorted, fine-grained facies indicative of calmer waters. This gradation provides strong evidence for a hydrodynamic energy gradient along the sampling profile [18,19]. Patterns of sediment provenance suggest transport pathways governed by a single dominant source of detrital material. Coarser sediments near Station 1 imply proximity to a sediment source (e.g., riverine input or coastal erosion). With increasing distance from the source, finer particles are progressively deposited in more distal, sheltered zones, consistent with the documented fining trend [20]. The dominance of sand-sized fractions across stations further indicates that grain-size sorting, rather than mineralogy, primarily controls the spatial sediment variability [21].

Averaged sediment composition reinforces these interpretations: coarse sand is the dominant fraction across all stations (≈30–>60%), gravel and very coarse sand are concentrated at Station 1, and medium–fine sands increase toward Station 3. This pattern reflects a classic grading sequence tied to decreasing transport energy and progressive deposition along the flow path [22]. From an ecological standpoint, coarse, well-oxygenated substrates at Station 1 likely favor epifaunal assemblages adapted to turbulent conditions, whereas the finer, more stable sediments at Station 3 are conducive to infaunal communities; the fining trend also implies a net transport direction from Station 1 toward Station 3 under prevailing hydrodynamic regimes [23].

4. Materials and Methods

4.1. Study Area and Materials & Methods

This study was conducted in the Anoi Itam Waters, located in Sabang City, Aceh Province, Indonesia. The collection took place on April 14, 2018, between 08:00 and 18:00 Western Indonesian Time. The study area lies along the eastern coast of Pulau Weh, which forms part of the northernmost tip of Indonesia. The region is characterized by volcanic-origin black-sand beaches, a feature unique to the Anoi Itam coastline, and represents a dynamic nearshore environment influenced by both marine and terrestrial processes. Geographically, the Anoi Itam waters are positioned within a tropical maritime climate zone, with hydrodynamic conditions strongly affected by the northeast and southwest monsoon systems. The area experiences semi-diurnal tidal cycles, with alternating high and low tides that drive periodic sediment resuspension and redistribution. The coastal morphology consists of gently sloping sandy substrates interspersed with rocky outcrops, providing an ideal setting for studying sediment composition and grain-size variability along an energy gradient. Following field sampling, sediment identification and laboratory analyses were performed on May 10, 2018, at the Marine Chemistry Laboratory, Faculty of Marine and Fisheries, Syiah Kuala University, located in Darussalam, Banda Aceh. All collected samples were processed and analyzed under controlled conditions to ensure accuracy and reproducibility of results.

4.2. Field Sampling Procedures

Sediment samples were collected from three sampling stations (Station 1, Station 2, and Station 3) distributed along the Anoi Itam coastal zone to capture spatial variations in hydrodynamic energy and sediment deposition. Each station represented a distinct environmental setting: Station 1 (nearshore, high-energy zone), Station 2 (mid-energy transitional area), and Station 3 (offshore or sheltered low-energy zone). At each station, three replicate samples (Plot 1, Plot 2, and Plot 3) were taken using a Van Veen grab sampler covering a surface area of approximately 0.05 m^2. The upper 2 cm of the surface sediment was subsampled to represent the actively reworked sediment layer. Samples were placed in pre-labeled polyethylene bags, stored in an ice chest, and transported to the laboratory. Upon arrival, all samples were air-dried at room temperature, gently disaggregated using a porcelain mortar and pestle, and cleaned of visible organic debris and shell fragments before further analysis.

4.3. Grain Size Analysis

Grain-size distribution was determined through the dry-sieving technique, following the standard procedure described by Folk and Ward (1957) and Wentworth (1922). Approximately 100 g of each dried sediment sample was placed in a nest of stainless-steel sieves arranged in decreasing mesh size order: 2 mm, 1 mm, 500 µm, 250 µm, 125 µm, 63 µm, and 38 µm. The sieve stack was subjected to mechanical agitation for 15 minutes using a Retsch mechanical shaker to ensure complete separation of particle sizes. Each retained fraction was weighed with a precision digital balance (±0.01 g), and the mass of each fraction was converted into percentage composition relative to the total dry weight of the sample.

4.4. Sediment Classification

The grain-size fractions were classified according to Wentworth's (1922) scale into the following categories as (a) Gravel: >2 mm, (b) Very Coarse Sand: 1–2 mm, (c) Coarse Sand: 500–1000 µm, (d) Medium Sand: 250–500 µm, (e) Fine Sand: 125–250 µm, (f) Very Fine Sand: 63–125 µm and (g) Mud (Silt + Clay): <63 µm. For each sample, the percentage weight of each fraction was calculated. Subsequently, sediment textural parameters, including mean grain size (Mz), sorting (σ_1), skewness (Sk_1), and kurtosis (K_1), were computed using the Folk and Ward (1957) graphical moment method.

4.5. Data Analysis and Visualization

The results from the three plots at each station were averaged to obtain representative mean percentage compositions and standard deviations. Data visualization was performed using Python (Matplotlib and Seaborn libraries) to generate stacked bar charts and comparative grouped plots, which illustrate the relative abundance of sediment size fractions across stations. Statistical summaries were computed in Microsoft Excel and R (version 4.3). Descriptive statistical analyses were used to evaluate spatial differences in grain-size distribution among stations, providing the basis for interpreting hydrodynamic energy gradients and depositional trends within the Anoi Itam coastal system.

4.5. Quality Assurance and Control

To ensure data reliability, all sieves were thoroughly cleaned after each run, and each sample was sieved twice. Differences between repeated measurements were maintained below 2%, ensuring analytical precision. The weighing balance was calibrated daily using certified standard weights. Randomly selected subsamples were reanalyzed to confirm reproducibility. All laboratory work adhered to standardized sedimentological procedures, ensuring consistent and comparable results across stations.

4.6. Data Interpretation Framework

The interpretation of grain-size data followed classical sedimentological principles, where coarser fractions indicate higher hydrodynamic energy, and finer fractions correspond to low-energy depositional environments. The spatial variation in sediment texture among the three stations was thus used to infer differences in sediment transport dynamics, depositional processes, and energy regimes along the Anoi Itam coastline. The resulting data formed the basis for identifying sedimentary facies, assessing energy gradients, and establishing the environmental implications of sediment distribution patterns in the study area.

5. Conclusions

The analysis of sediment grain-size distributions across the three sampling stations in the Anoi Itam coastal waters of Pulau Weh reveals a distinct spatial gradient that reflects variations in hydrodynamic energy and depositional processes. The results demonstrate a clear fining trend from coarse, gravel-rich sediments at Station 1 to finer, sand-dominated deposits at Station 3, indicating a gradual decline in energy from the nearshore zone toward more sheltered offshore areas. At Station 1, the dominance of coarse and very coarse sands signifies a high-energy nearshore environment characterized by strong wave action and active sediment reworking. Station 2 represents an intermediate energy regime, where both coarse and medium sands coexist, suggesting transitional depositional conditions influenced by fluctuating hydrodynamic forces. In contrast, Station 3 is typified by fine to medium sands with minimal gravel content, indicative of a low-energy depositional environment where finer particles settle and accumulate under calmer conditions.

The overall sedimentary pattern points to hydraulic sorting as the principal mechanism governing sediment distribution, with transport primarily occurring through bedload and saltation, and minimal contribution from suspended-load deposition. The consistent dominance of sand-sized particles across all stations suggests that sediment sorting, rather than compositional variation, is the key driver of textural differences in the Anoi Itam system. Based on an environmental perspective, these textural variations have direct implications for benthic habitat diversity and sediment stability. Coarse, well-oxygenated substrates at the high-energy stations provide suitable habitats for epifaunal species adapted to turbulent conditions, whereas finer, stable sediments in low-energy zones favor infaunal communities and organic matter accumulation.

In conclusion, the study confirms that the Anoi Itam coastal system operates under a well-defined hydrodynamic gradient, where decreasing current strength and wave energy with distance from the shore produce predictable patterns of sediment fining and sorting. These findings contribute valuable baseline information for future coastal monitoring, sediment management, and ecological assessment in the volcanic coastal environments of Pulau Weh and similar high-energy tropical shorelines.

Author Contributions: J.N. contributed to the conceptualization, supervision, and overall coordination of the study. A.N. was responsible for data collection, formal analysis, and methodological design, while M.A.R. contributed to data processing, visualization, and software development. All authors participated in the interpretation of results, manuscript preparation, and critical revision of the final paper. Each author has read and approved the final version of the manuscript.

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Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Hoch, C.; Weaver, R.; Webb, B.; Resio, D.; Ward, N.; Lodge, C.; Kachouie, N. Predicting near-bed sediment transport through particle image velocimetry. *Coast. Eng. Proc*. **2023**, 37, 9.
2. Huang, L.; Zhao, C.; Jiao, C.; Zheng, G.; Zhu, J. Quantitative analysis of rapid siltation and erosion causing coastline evolution in the coastal mudflat areas of Jiangsu. *Water* **2023**, 15(9), 1679.
3. Pagán, J.; Tenza-Abril, A.; Aragonés, L.; Villacampa, Y.; López, I. Classification of sediment quality according to its behavior in the accelerated particle wear test (APW). *Sustainability* **2021**, 13(5), 2633.
4. Vieira, B.; Pinho, J.; Barros, J.; Carmo, J. Hydrodynamics and morphodynamics performance assessment of three coastal protection structures. J. *Mar. Sci. Eng*. **2020**, 8(3), 175.
5. Sauvé, P.; Bernatchez, P.; Glaus, M. Identification of coastal defence measures best adapted to mitigate hazards in specific coastal systems: Development of a dynamic literature meta-analysis methodology. *J. Mar. Sci. Eng*. **2022**, 10(3), 394.
6. Papasarafianou, S.; Siarkos, I.; Gkaifyllia, A.; Sahtouris, S.; Varra, G.; Chatzipavlis, A.; Tzoraki, O. A holistic approach for coastal–watershed management on tourist islands: A case study from Petra–Molyvos Coast, Lesvos Island (Greece). *Geosci*. **2024**, 14(12), 326.

7. Asiah, A.; Hisyam, E.; Hambali, R. Planning of coastal protection structures in the area of Arung Dalam Beach, Central Bangka. *IOP Conf. Ser. Earth Environ. Sci*. **2022**, 1108(1), 012043.
8. Dimyati, M.; Trihatmoko, E.; Marfai, M. Ten years erosion–sedimentation monitoring: System-based automatic interpretation in coastal area of Brebes Regency, Central Java Province, Indonesia. *Geogr. Tech*. **2020**, 16(1), 25–38.
9. Tenuta, M.; Dominici, R.; Donato, P.; Imbrogno, G.; Lirer, S.; Rosa, R. Approaches for the sustainable management of the Apulian coastal areas: The potential of a geoportal. *Rend. Online Soc. Geol. Ital*. **2023**, 60, 37–50.
10. Lima, M.; Ferreira, A.; Coelho, C. A cost–benefit approach to assess the physical and economic feasibility of sand bypassing systems. *J. Mar. Sci. Eng*. **2023**, 11(9), 1829.
11. Zhang, L.; Yan, J.; Zhao, B.; Xia, L.; Wang, P.; Zhang, C.; Zhang, P. The rapidly evolving Fudu Estuary sandbar lagoon landform on the east coast of the Bohai Sea: Recent changes and mechanism. *J. Mar. Sci. Eng*. **2021**, 9(12), 1350.
12. Rafati, Y.; Hsu, T.; Calantoni, J.; Puleo, J. Entrainment and transport of well-sorted and mixed sediment under wave motion. *J. Geophys. Res. Oceans* **2022**, 127(8), e2022JC018686.
13. Schenone, S.; Hewitt, J.; Hillman, J.; Gladstone-Gallagher, R.; Gammal, J.; Pilditch, C.; Thrush, S. Seafloor sediment microtopography as a surrogate for biodiversity and ecosystem functioning. *Ecol. Appl*. **2024**, 35(1), e3069.
14. Wang, H.; Titschack, J.; Wienberg, C.; Korpanty, C.; Hebbeln, D. The importance of ecological accommodation space and sediment supply for cold-water coral mound formation: A case study from the western Mediterranean Sea. *Front. Mar. Sci.* **2021**, 8, 760909.
15. Bi, S.; Lai, H.; Guo, D.; Liu, X.; Wang, G.; Chen, X.; Li, G. The characteristics of intestinal bacterial community in three omnivorous fishes and their interaction with microbiota from habitats. *Microorganisms* **2021**, 9(10), 2125.
16. Vandenberghe, J.; Yang, X.; Wang, X.; Wang, S.; Lu, H. Diverse floodplain deposits of reworked loess in a monsoon climate (Hanzhong Basin, Central China). *Quat. Res*. **2021**, 103, 4–20.
17. Zayed, A.; El-Tapey, H.; Al-Toukhy, A. Sedimentation pattern of soils south El-Amiria, Alexandria Governorate, Egypt. *Menoufia J. Soil Sci*. **2021**, 6(6), 183–196.
18. Kotlia, B.; Kukreti, M.; Bisht, H.; Palar, B.; Seiler, M.; Nadeauc, M.; Mehra, A. Palaeoenvironmental and palaeoclimatic conditions in the Bhimtal Valley, Kumaun Lesser Himalaya, between 40 and 24 ka using granulometric analysis. *J. Climate Change* **2023**, 9(4), 1–11.
19. Chen, J.; Zhang, W.; Porz, L.; Arlinghaus, P.; Hanz, U.; Holtappels, M.; Schrum, C. Physical mechanisms of sediment trapping and deposition on spatially confined mud depocenters in high-energy shelf seas. *J. Geophys. Res. Oceans* **2025**, 130(7), in press.
20. Dietze, M.; Schulte, P.; Dietze, E. Application of end-member modelling to grain-size data: Constraints and limitations. *Sedimentology* **2021**, 69(2), 845–863.
21. Feil, S.; von Eynatten, H.; Dunkl, I.; Schönig, J.; Lünsdorf, N. Inherited grain-size distributions: Effect on heavy-mineral assemblages in modern and ancient sediments. *J. Geophys. Res. Earth Surf*. **2024**, 129(2), e2023JF007356.
22. Zhang, Z.; Sun, Y.; Sun, M.; Zeng, Y.; Chongyi, E. Investigating the Late Pleistocene to present-day deposition processes of paleofloods in the Yellow River–Huangshui River Valley through end-member modeling. *Adv. Eng. Technol. Res.* **2023**, 4(1), 62.
23. Sun, X.; Filgueira, R.; Wang, N.; Han, M.; Guyondet, T.; Zhang, X. Vacuum effect: A redistribution process of organic carbon mediated by bivalve farming. *ACS ES&T Water* **2023**, 3(10), 3215–3222.