Grain size distribution analysis of Lhong Beach, Aceh Province

N Syarif1, R S Isman1, S Agustina1, I Setiawan1, S Purnawan1*

1Department of Marine Sciences, Faculty of Marine and Fishery Sciences, Syiah Kuala University, Banda Aceh 23111, Indonesia

*Email: syahrulpurnawan@unsyiah.ac.id

Abstract. This paper discusses the horizontal and vertical distribution of sediments on the coast of Lhong Beach, Aceh Province. A total of 3 stations located along the coast were chosen to represent the research location. At each station, data collection was carried out twice, each in the lower swash zone (LSZ) and upper swash zone (USZ). Sediment sampling was carried out in November 2018. The coring method was applied vertically to a depth of 15 cm to obtain three sediment layers with each layer of 5 cm thickness. The wet sieve technique was applied to separate each sediment sample based on the size of the grain. Sediment statistical analysis was carried out based on the Folk and Ward formula. The sediment conditions obtained for the USZ are sand medium; moderately well sorted; fine skewed to symmetrical; mesokurtic to leptokurtic. While for the LSZ, the condition of the sand medium is obtained; moderately to moderately well sorted; coarse skewed; mesokurtic to leptokurtic.

1. Introduction

The beach is a very dynamic area, which combines interaction from the ocean and land [1], [2]. Sediment conditions on the coast are generally affected by various oceanographic parameters, including wave action, longshore and cross-shore current, and tides [3]–[5]. Furthermore, it is also influenced by weather conditions, which results in erosion conditions by the energetic wave during the storm [6], [7].

In particular, the behavior of sediments in the swash zone area is still very difficult to understand, related to the complexity and dynamics formed in the swash zone area [8]. The swash process is highly correlated with waves [9]. However, the dynamics that occur in the swash zone are not only formed by one wave energy, but also by the energy contained in the wave group [10]. The swash zone itself is on the beach which is marked by a run-up/run-down area of water formed by the remaining waves.

The re-shaping process produced by ocean dynamics can be observed in the sedimentary conditions that exist on the surface of the coast. Statistical parameters of grain size are quite reliable tools that are used to predict the environment of sedimentation in waters [11], [12]. In addition, uniformity in the size of the sediment granules is an indicator of sediment deposition behavior by transport agents. Dynamics formed in coastal areas are important to study related to the use of tourist zones and erosion potential, where sediment studies are one of the excellent tools in understanding the behavior of natural changes in coastal conditions [13].
Lhong is a village located in the Aceh-Besar District, where the beach is adjacent to the Indian Ocean to the west. This research was conducted to assess the sandy sediment conditions on Lhong beach. This study was to infer the sediment characteristics of Lhong Beach from quaternary sediment analysis. Furthermore, this paper is the initial stage of the study of the behavior of temporal sediments on the beaches of Lhong and Leupung.

2. Methods

The field survey was arranged during November 2018 along the Lhong coast (Fig. 1). Three stations were determined to represent the Lhong beach area, where precision coordinates were taken using GPS. Sediment collection was carried out twice at each station representing the LSZ and USZ regions.

![Figure 1](image-url)

**Figure 1.** The sediment sampling station at Lhong village of Aceh Besar district (A); situation during sampling (B)

Data retrieval was carried out using vertical coring using a 3-inch diameter PVC pipe into the coastal sediment with a thickness of 15 cm. The thickness of the layer is intended to obtain a sediment profile that is formed vertically with the thickness of each layer is 5 cm, i.e. 0-5cm; 5-10cm; and 10-15cm, which was measured from the surface layer of the sediment.

A total of 18 collected samples are available and processing of sediment samples have been carried out in the laboratory. Each sediment samples were separated according to grain size. The wet sieve method was applied using a seven-grade sieve, with a mesh size of 2 mm; 1mm; 0.5mm; 0.25mm; 0.125mm; 0.063mm; and 0.038mm. The sediments were sun dried and weighed the remaining sediment in each size.
Sediment statistical analysis was carried out based on sediment size distribution, namely: mean, sorting, skewness, and kurtosis. This process has been done using Gradistat software [14]. The results of the calculations used are the original Folk and Ward [15] method, based on the value of phi for each of the statistical parameters.

3. Result and Discussion

A total of 18 samples have been analyzed for weight distribution (Table 1). The results of the weight percent distribution of the samples analyzed showed that many modes were found in the medium sand fraction (0.25mm). The sand fraction sediment is dominant in all samples analyzed. Gravel fraction (>2mm) was found in several samples with a small amount, while no mud fraction was found in all samples of Lhong Beach. The composition of the mud-sand-gravel in each sample produced various types of sediments in Lhong beach samples. Slightly Gravelly Sand is the most commonly found where the type shows the presence of small amounts of gravel fraction (<5%) of the total sample weight.

| Type          | USZ          | LSZ          |
|---------------|--------------|--------------|
| 0-5           | 0.03%        | 0.01%        |
| 5-10          | 0.00%        | 0.03%        |
| 10-15         | 0.00%        | 0.00%        |
| 0-5           | 0.11%        | 0.00%        |
| 5-10          | 0.07%        | 0.03%        |
| 10-15         | 0.17%        | 0.11%        |
| 0-5           | 0.00%        | 0.00%        |
| 5-10          | 0.04%        | 0.07%        |
| 10-15         | 0.00%        | 0.00%        |
| 0-5           | 0.00%        | 0.00%        |
| 5-10          | 0.00%        | 0.00%        |
| 10-15         | 0.00%        | 0.00%        |
| 0-5           | 0.00%        | 0.00%        |
| 5-10          | 0.00%        | 0.00%        |
| 10-15         | 0.00%        | 0.00%        |

Table 1. Sediment weight distribution (%) per fraction at USZ and LSZ

Statistical analysis of grain size has been done using Gradistat software to extract values: mean, sorting, skewness, and kurtosis, where the value of each parameter displayed is the average yield per depth layer (Figure 3). Based on the average for all stations of Lhong Beach, the mean size parameter (phi) values are in the range of moderate sand for both USZ and LSZ. Sediment sorting parameters at USZ (having an average value of 0.58) are in the moderately well sorted range, while LSZ (having an average value of 0.77) is moderately sorted. Skewness parameter values for USZ and LSZ shows different forms, where LSZ has a negative skewness value (-0.1884) and is classified as coarse skewed, while USZ has a positive mean value (0.0964) which is classified as symmetrical. There was no significant difference in the value of kurtosis between USZ and LSZ, but both were classified in different categories, USZ was classified as leptokurtic while LSZ was mesokurtic.

There is no vertical trend as a function of the value shift from each parameter to the depth of the sediment layer. In addition, the high standard error rate of each sediment statistical parameter produced by large variations between each station, makes the trend between the values of each parameter and depth not significantly formed, as it rather difficult to present conclusions through trends that are not available precisely.
4. Conclusion

The high standard error value in the LSZ indicates that the area has a fairly varied sediment size distribution. By average, both USZ and LSZ moderately well sorted and grain sizes in the range of fine sand. Furthermore, the skewness value indicates LSZ is coarse skewed and USZ has symmetrical in average. There is no tendency obtained by grain size parameter values differ as depth layer increase.
Acknowledgements
Authors would like to thank RISTEKDIKTI and LPPM Unsyah for financial assistance under ‘Penelitian Dasar’, with contract number: 63/UN11.2/PP/SP3/2019. We also thank to Muchlis and Muntazir, which helped a lot along the data preparation and analysis.

References
[1] Alsina J M, I Cáceres, M Brocchini, T E Baldock 2012 Coast. Eng. 68 31–43
[2] Obu J et al. Geomorphology 2017 293 331–346
[3] Montreuil A L, F Levoy, P Bretel, E J Anthony 2014 Geomorphology 219 114–125
[4] Vakarelov B K, R B Ainsworth, J A MacEachern 2012 Sediment. Geol. 279 23–41
[5] Jackson N L, M D Harley, C Armaroli, K F Nordstrom 2015 Geomorphology 239 48–57
[6] Grasso F, H Michallet, E Barthélemy Coast. Eng. 58(2) 184–193
[7] Brooks S M, T Spencer, E K Christie 2017 Geomorphology 283 48–60
[8] Shanehsazzadeh A, P Holmes 2013 Coast. Eng. 71 60–67
[9] Hughes M G, I L Turner 1999 The beachface in Handbook of Beach and Shoreface Morphodynamics A D Short, Ed. John Wiley & Sons 119–144
[10] Baldock T, D. Huntley, P A D Bird, T O’Hare, G Bullock 2000 Coast. Eng. 39 213–242
[11] Purnawan S, I Setiawan, H A Haridhi, M Irham 2018 Granulometric analysis at Lampulo Fishing Port (LFP) substrate, Banda Aceh, Indonesia IOP Conference Series: Earth and Environmental Science 106 2018 p. 012070
[12] Purnawan S, R Adidarma, Z Jalil, C Akmal, Y Ilhamsyah 2018 Aceh Int. J. Sci. Technol. 7(1) 63–68
[13] Armaroli C, E Grottoli, M D Harley, P Ciavola 2013 Geomorphology 199 22–35
[14] Blott S J, K Pye 2001 Earth Surf. Process. Landforms 26(11) 1237–1248
[15] Folk R L, W C Ward 1957 J. Sediment. Petrol. 27 3–26