The analysis of d90 and d50 sediment grain size in Alue Naga estuary, Banda Aceh City

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Abstract. The study of d50 and d90 sediment grain size in the Alue Naga estuary of Banda Aceh City, which was taken in December-March 2017 was completed. The purpose of the study is to determine the size of d50 and d90 sediment diameters and how it was dispersed along the estuarial area. The study used 15 stations sampling which was determined by purposive random sampling. The results of 15 sediment samples were then analyzed at the Marine Science Laboratory using a multilevel sieve method and evaluated using the Wentworth sieve analysis method. The results of the analysis showed that the largest particle size of d50 was 1.44 mm at station 14, and the biggest particle size of d90 of 3.5 mm was also obtained at station 14. The results attained were due to the dynamics of the ocean currents and the flow of the river interacting at station 14. This could happen because during the high tide, the dominant flow is coming from the sea, it causes a large size of d90 grained size sediment while during the low tide the dominant flow is from upstream of river so that the size of 50% sediment is also dominant.

1. Introduction
The coastal areas being intensively exploited areas for human activity by Central Government, residential, industrial, port, farming, agriculture/fisheries, and tourism and so on. The utilization of the area especially the aquatic areas certainly need a good management and planning because this territorial waters is affected either by human activities or natural action such as wind conditions, the flow of sea water, tidal estuary, erosion, abrasion and sedimentation [1, 2]. The dynamic conditions allow some material washed or transported from one location to another location such as sediments.

Sediment is a loose material from the rocks which have varied shapes and sizes by physical and chemical processes. The particles are then transported toward some places because of flow, wind, gravity, and water. The process of sedimentation can be carried out through the study of sediment grain size distribution. Some earlier researchers have done some research related the distribution of grain size of sediment to give an explanation about the changes of spatial and temporal, the process of deposition, sedimentary environment, characteristics of grain size distribution, the process of sorting, and identification of the sediment source [3, 4, 5, 6, 7].
The flow of water and sediment deposition was simultaneous and interactive processes in rivers and coastal areas. Seasonal changes, annual precipitation, temperature, the cycle of erosion and deposition are the cause of the occurrence distribution of sediment in streams that impact a decline in water quality and fisheries [8]. The dynamic of currents, winds and tides that occur in the estuary area cause a change in morphology and have an impact on the sedimentation on the beach and surrounding area. Therefore, this is quite importance factors of sediments variation of its size and shape as well as its distribution that deposited in aquatic zone [1].

Sediment grain size as one of the factors that affect the formation of the river are the parameters used in this study. Measurement and sampling of sediment grains is done in conjunction with the measurement of the characteristics of the river such as depth, width, flow and hydrology of the river. Parameters of the sediment grains are analyzed by using statistical approaches and characteristics evaluating. To study the influence of the material characteristics is employed with the concept of the representative. In general the concept is based on the size of the sediment diameter that is the median (d50) and the diameter of the dominant sediment (d90) so the distribution grain size spatially can be analyzed.

The estuary of Krueng Cut river is linked to the waters of Alue Naga coastal area. On this area, the erosion and sedimentation could come from the sea toward the land and the river mouth or the beach or from the river itself [1]. The occurrence of sediment infiltration and reduction is caused by the influence of land, currents, waves, coastal erosion and tides which will cause negative impacts such as silting of the waters and greatly disrupting community activities [9, 10]. For this reason, research on the Alue Naga waters needs to be done to see how the sediment characteristics of d50 and 90 are through sieve analysis. Therefore, the purpose of this research is to analyze the distribution of d50 and d90 diameter of sediment sizes spatially in Alue Naga waters.

2. Materials and Methods
Sampling for this research was conducted in December 2016 and analyzed in the laboratory of Marine and fisheries Faculty Syiah Kuala University. Sampling locations are in the waters of the Alu Dragon Subdistrict of Syiah Kuala (Figure 1). This study uses two methods, namely field data collection methods and data analysis in the laboratory. Sediment sampling was taken at some points by using tubecore. The tubecore used is PVC pipe of 2.5 inches diameter with a thickness of a layer of a sediment sample about 25 cm. The location of sample taken was along the Alue Naga river (Figure 1) and the area of sample was divided by 15 points that represent the overall area of the river.
The steps of taking the sampling begin with the provision of tools. Then, the samples were taken by inserting the tubecore into the substrate of sediment and the tubecore was closed over the surface. Sample in the tubecore was then cut with a hacksaw. The sampling should be repeated until the last point. The samples that have been obtained were taken to the laboratory to be analyzed; the final measurement of the sediment granules was carried out.

Samples obtained from the study were analyzed at the Marine Biology Laboratory of the Faculty of Marine and Fisheries, Syiah Kuala University to determine the distribution of grains fraction of sand, gravel and mud, so that the characteristics of sediment in the waters of Alue Naga can be determined. Samples were sieved with a stratified filter (sieve analysis) by wet method. The size of the sieve used was 2 mm; 1.00 mm; 0.500 mm; 0.250 mm; 0.125 mm; 0.063 mm; 0.038 mm. The sieve samples were dried and the obtained results were weighed again as dry conditions as part of the dry sample for analysis.

Calculation of the percentage of the weight of sediments to figure out fractions of sediment from each fraction of sediment can be done using the equation:

\[
F_I = \frac{\text{the weight of the sediment to} - i}{\text{the weight of the sediment}} \times 100\% \tag{1}
\]

Where \(F_I\) is the percentage of the weight of sediment fraction and \(i\) is fraction of heavy weight of each fraction of grain size (g).

The calculation of the value of measuring the average grain (Mean Grain Size) is determined using the following equation:

\[
d = \frac{\sum \text{percent weight fraction of sediments} \times \text{grain size fraction}}{100} \tag{2}
\]

To obtain the results of the d50 and d90 could be seen in the table and graphs below.

| Sieve No. | Millimeters | Weight (g) | % |
|-----------|-------------|------------|----|
| 10        | >2 mm       | 500        | 100|
| 18        | 1-2 mm      | 490        | 98 |
| 35        | 0.5-1 mm    | 480        | 96 |
| 60        | 0.25-0.5 mm | 435        | 87 |
| 120       | 0.125-0.25 mm | 390     | 78 |
| 230       | 0.05-0.125 mm | 195     | 39 |
| 400       | <0.05 mm    | 90         | 18 |

![Figure 2](image-url) Sieve analysis charts to determine the effective size and uniformity coefficient
3. Results and Discussion
The results of sediment weight analysis at each sample point can be seen in (Table 2). Samples taken in this study consisted of 15 sample points, 6 points in the Lamnyong side and 9 points on the Krueng Cut River size showing the percentage of the sediment fraction to the 15 sample points that had different mean grain size values.

Table 2. Results of Percent Weight Analysis (%)

| Sample point | gravel (mm) | very coarse (mm) | coarse (mm) | medium (mm) | fine (mm) | very fine (mm) | coarse (mm) | fine (mm) | Total Average (mm) | Size Classified |
|--------------|-------------|------------------|-------------|-------------|-----------|----------------|-------------|-----------|------------------|----------------|
|              | 4-2         | 2-1              | 1-0.5       | 0.5-0.25    | 0.25-0.125 | 0.125-0.063   | 0.063-0.038 | 0.019     |                  |                |
| 1            | 5.65        | 2.83             | 11.48       | 30.17       | 29.83     | 17.26          | 1.39        | 1.39      | 100 0.32         | Medium         |
| 2            | 17.85       | 5.45             | 4.39        | 25.49       | 26.85     | 17.31          | 0.93        | 1.73      | 100 0.54         | Fine sand      |
| 3            | 1.12        | 1.91             | 7.40        | 20.13       | 10.04     | 40.33          | 3.31        | 15.76     | 100 0.17         | Very fine      |
| 4            | 1.49        | 3.09             | 13.92       | 38.84       | 31.79     | 7.46           | 0.94        | 2.47      | 100 0.27         | Medium         |
| 5            | 0.55        | 1.10             | 7.69        | 29.85       | 11.54     | 39.33          | 1.88        | 8.06      | 100 0.18         | Very fine      |
| 6            | 0.79        | 1.30             | 69.26       | 20.40       | 7.37      | 0.79           | 0.10        | 0.00      | 100 0.44         | Coarse sand    |
| 7            | 0.61        | 0.78             | 13.10       | 34.43       | 42.65     | 5.82           | 0.47        | 2.13      | 100 0.23         | Fine sand      |
| 8            | 1.19        | 0.37             | 2.44        | 28.48       | 50.02     | 9.72           | 1.16        | 6.64      | 100 0.18         | Fine sand      |
| 9            | 1.61        | 4.51             | 2.22        | 5.74        | 66.18     | 12.32          | 4.82        | 2.60      | 100 0.20         | Fine sand      |
| 10           | 0.94        | 0.21             | 1.77        | 12.73       | 37.16     | 33.51          | 7.20        | 6.47      | 100 0.13         | Fine sand      |
| 11           | 0.90        | 0.00             | 3.78        | 5.18        | 55.08     | 27.99          | 1.99        | 5.08      | 100 0.14         | Fine sand      |
| 12           | 0.00        | 0.00             | 2.25        | 10.61       | 10.13     | 39.71          | 20.42       | 16.88     | 100 0.09         | Very fine      |
| 13           | 0.07        | 0.07             | 4.83        | 4.83        | 33.26     | 44.66          | 9.38        | 2.89      | 100 0.11         | Very fine      |
| 14           | 37.63       | 21.99            | 29.06       | 8.96        | 1.12      | 0.76           | 0.48        | 0.00      | 100 1.14         | Gravel         |
| 15           | 1.71        | 1.26             | 4.30        | 14.37       | 69.32     | 9.08           | 4.57        | 1.77      | 100 0.19         | Fine sand      |

The sediment size analysis results of d50 and d90 are shown in Table 3. These results are obtained based on the analysis value of cumulative sedimentation of sediment size. These results indicate that the average size of d50 is 0.31 mm and d90 is 0.81 mm while the average d size is 0.28.

The table 3 shows that the average particle size of d is smaller than the particle size of d50 and d90 this is due to the particle size distribution based on the sieve size analyzed. This is different from the particle size distribution of d50 where this size is based on the size of 50% distributed particles. The results also show that the size of 50% sediment particles is smaller than the results of particle size d90. This states that the size of 90% of particles must be greater than the size of 50% of the particles.

It can be seen that the smallest distribution size of 50% sediment found at station 12, while the largest was in station 14. The difference in size occurs because of the location or position of the dynamic of water flow. At station 14, a high turbulence area influences current so that the values found are relatively larger than other stations, while at station 12 the water flow become weaker and almost at rest as the flow energy decrease toward upstream. So the size of the sediment distribution of d50 obtained the smallest value at station 12 with the value of 0.09 mm which is classified as silt (fine mud), while the largest value is in station 14 with the value of 1.44 mm which are classified as very coarse sand.
Table 3. The d50 and d90 analysis

| Station | d50 (mm) | d90 (mm) | d average (mm) |
|---------|----------|----------|----------------|
| 1       | 0.25     | 0.93     | 0.32           |
| 2       | 0.28     | 1.35     | 0.54           |
| 3       | 0.11     | 0.53     | 0.17           |
| 4       | 0.30     | 0.81     | 0.27           |
| 5       | 0.13     | 0.49     | 0.18           |
| 6       | 0.65     | 0.94     | 0.44           |
| 7       | 0.25     | 0.67     | 0.23           |
| 8       | 0.21     | 0.45     | 0.18           |
| 9       | 0.18     | 0.43     | 0.20           |
| 10      | 0.13     | 0.36     | 0.13           |
| 11      | 0.16     | 0.25     | 0.14           |
| 12      | 0.08     | 0.32     | 0.09           |
| 13      | 0.12     | 0.25     | 0.11           |
| 14      | 1.44     | 3.50     | 1.14           |
| 15      | 0.19     | 0.45     | 0.19           |
| Average | 0.31     | 0.81     | 0.28           |

Sediment distribution of d90 that has the smallest results were obtained at stations 13 and 11 with the value of 0.25 mm belonging to the classification of fine sand in where the flow is almost at a rest so that only small size sediment would be deposited in such area. The largest sizes were in stations 14 with the value of 3.5 mm classified as gravel and station 2 with the value of 1.35 mm classified very coarse sand. This result informs that the flow of sediments had undergone a process of high-energy transportation and deposited in these waters, due to the loss of energy to carry the sediment [10].

4. Conclusions

It is concluded that the d50 and d90 sediment distribution analysis in Alue Naga estuary obtained the results of different sizes at each sample point. The size of 50% distribution (d50) shows the smallest sediment fraction and variation which is at station 4 and the largest is at station 2, because the location of the flow position is affected by the current in the turbulence area. Meanwhile at the dominant size (d90) has smallest result at station 3, while the biggest one is at stations 2 and 14.

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