

Sedimentation Model Area of Lau Kawar Lake from Volcanic Eruption of Sinabung Mountain in Karo District, North Sumatra Province

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Abstract— *Lau Kawar Lake is a Volcanic Lake has wide around 200 hectares which below hillside of Sinabung mountain located in Kutagugung Village, District Naman Teran, Karo District, North Sumatera Province. Impact eruption of mount Sinabung is Volcanic material in the form of important from clastic sediment to be done research. Purpose of this research is HIBAH Dikti 2016 year, item to know type of sediment that is election mean, sorting, skewness and curtosis is. and deposition public area of sediment volcanic post eruption of Sinabung.*

Primary data collection activities sediment core with PVC core method. generates data in the form of characters sediment grain size, sedimentary structures, sediment composition and sedimentary depositional environment interpretation presented in the stratigraphic column Lake Lau Kawar.

Calculation method applied that is, Method of Moments (Mathematic) and Folk & Ward (Graphic). Result of sediment material analysis in 15 points, value mean either graphically mathematical and also shows flattening - plane of grain size coarse sand - very fine sand, Value sort as moderately sorted - poorly sorted, Value skewness smooth and rugged normal same relative distribution like at sample LK 11 LK 12 LK 13 LK 34 and LK 53, Curtosis value from overall of sample included in classification of finite mesokurtic of leptokurtic ($Kc = 0,90 - 1,1$ and $Kc = 1,11 - 1,50$). Crossplot between values $Y1$ and $Y2$ indicates that deposition area to stay at [shallow/superficial] deposition area at $Y2$ and $y3$ stays at fluvial area of marine, at $Y3$ and $Y4$ still residing in at fluvial deposition area of marine Data analysis result of screening of sediment sample is done to apply GRADISTAT, a program proposed by Blott and Pye (2011) and developed by Kenneth Pye Associates Ltd. Software GRADISTAT implemented in program Microsoft Excel.

Keyword— *Sedimentation, Lau Kawar, Volcanic Eruption, Sinabung mountain, PVC core method.*

I. INTRODUCTION

The study discusses about the lake through sedimentology studies in Indonesia is still a bit todo, especially for a lake formed by volcanic or volcanic activity. Lake as a water body shaped

hollows on the surface of the Earth can serve as indicators of natural ecosystems and the stability of the surrounding environment. In the case of lakes associated with volcanic activity, the lake also can be used as an indicator to determine the activities that took place surrounding volcanoes.

Lake Lau Kawar example is one example of the lake forming associated with volcanic activity, on Mount Sinabung (Figure 1.1 and Figure 1.2) located in Karo, North Sumatra. Geographically, the presence of Lau Kawar lake which is right at the foot of Mount Sinabung put this lake as one of the areas affected directly against volcanism especially sediments materials happened. It makes Lake Lau Kawar are the areas most appropriate to be used as a research location.

Geological aspect which addresses specifically about sedimentology will be assessed properly by studying the condition of sedimentation that took place in the Lake Lau Kawar which has an area of approximately 200 hectares located in the village of Kutagugung, District Naman Teran, under the foot of the volcano Sinabung, Karo, North Sumatra Province.

Increased volcanic activity of Mount Sinabung in the last 5 years as well as ongoing eruption since 2013 and is currently producing a variety of types and sediment material contained in the waters of Lake Lau Kawar become the main background research, especially granulometry. Granulometry is material grain size analysis method so that it can be seen how the transport properties, shape and grain size as well as the deposition environment.

Based on the background of the above, then there is some problem formulation needed to know the history of the depositional environment of the lake Lau Kawar located at the foot of Mount Sinabung among other things, how to determine the distribution of the deposition of sediment material volcanic activity the eruption, how to know the texture of the material granulometry the eruption, and environmental factors are influential model of sediment deposition after the eruption of Mount Sinabung. The purpose of research, is to know what and how to model and characteristics of Sedimentary environments that exist in the region present Lau Kawar lake. The village is located Kutagugung, District Naman Teran North Sumatra after the eruption Sinabung volcano. The contribution of this study

support the construction and acquisition of baseline data for the development of science-related volcanic sediment.

Sedimentation process also affects the characters recent sediments deposited in a basin. Media and transport mechanisms will affect sediment grain size, the variation form sedimentary structures. There was also a time factor affecting the length of the process of sedimentation sediment grain size. Sedimentary basin as a place to settle also have different properties related to environmental conditions. General conditions deposited sedimentary basins place called the depositional environment. Bentl (2001), describes the particle sediment is the result of the weathering of rocks, the biological material, chemical deposition, dust, material remains of plants and leaves.

The research objective was to determine the characteristics of sedimentary material recent that granulometri nature, environment sedimentation of the lake, and the history of the deposition from the eruption of volcanoes Sinabung. The contribution of this study support the construction and acquisition of baseline data for the development of science.



Fig.1: Google Earth's image location Lau Kawar Lake and Volcano Sinabung

II. METHODOLOGY

1. Location

The research was conducted on Lau Kawar lake area in the village Kutagugung, Sub-District Naman Teran (first Sub-District Simpang Empat), under the foot of the volcano Sinabung, Karo District, North Sumatra Province. The lake extends 2.127,25 km² with a depth of 22 meters is located the foot of Mount Sinabung, Karo and is part of the Hutan Wisata Deleng areas.

2. Type Methods

The method used is research and descriptive. Furthermore, the data were analyzed using four (4) models approaches namely: descriptive approach, historical approach sediment, conceptual approach, and comparative grain size approach. In the implementation of sampling recent sediment cores the field with PVC Coring obtained 15 samples of sediment core recent with varying depths. Megascopics methods and laboratory analysis (granulometri) to determine the physical properties of the sediments. Megascopic sediment analysis using the

parameters of texture and sedimentary structures. Texture analyzed were grain size, grain shape and sorting sediments. Analyzed sedimentary structures analyzed were conditions layering on a sediment core. It also made observations of sediment content such as the existence of a carbonaceous content or calcareous content in the sediment core. Based on the analysis performed on a sediment core obtained physical condition of sediment which is then presented in the statistical data, especially the texture parameters of the sediment, where the results are then analyzed by a laboratory test. Analysis of data from the sifting of sediment samples was performed using GRADISTAT, a program proposed by Blottan and Pye (2011) and developed by Kenneth Pye Associates Ltd. Software GRADISTAT run in Microsoft Excel program Calculation method used, namely, Method of Moments (Mathematical) and Folk & Ward (Graphic) in Sedimen to logical Laboratory of Universtas Gadjah Mada (UGM) in Yogyakarta.

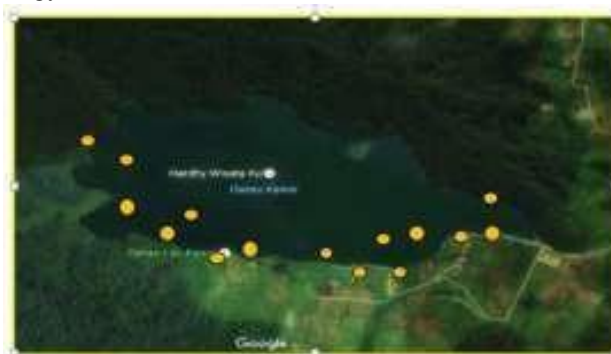


Fig.2: Map of Data Retrieval PVC Core Sediment Samples Lake Lau Kawar

III. RESULT

Has conducted sampling method coring against Lau Kawar lake sediments recent as much as 15 sample points. Based on the data tabulation description of the sorting of the overall analysis of the sample can be in sorting or level of uniformity of grain sediments are generally a group again sorting poor to moderate because of the layers of sediment are generally prepared by grain - fine grain size of mud to sand as shown in the results analysis of statistical calculations which each sample is dominated by fine sand-sized minerals to mud.

Based on the analysis performed on a sediment core obtained physical condition of sediment which is then presented in the statistical data, especially in sediment texture parameter descriptions PVC Core profile (Figure 3).

Sediment grain size indicates that the hydrodynamic flow conditions that work on Lake Lau Kawar environment and surroundings have the power measuring sediment transporting sand to the weak currents which can only move the silt sized sediment.

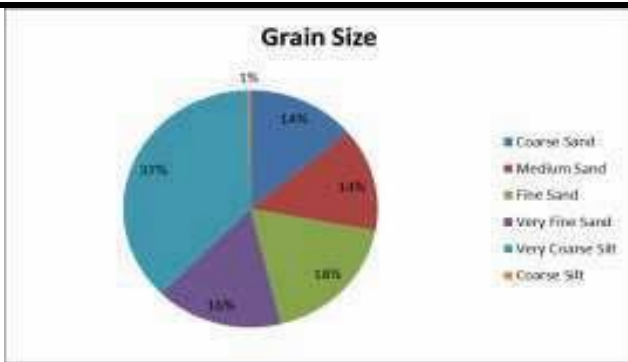


Fig.3: Diagram of Particle Size Distribution of Sediment From PVC Coring

Grain shapes are represented by the type of grain roundness showed sediment from a sediment core obtained from the implementation of the PVC Coring is dominated by rounded shapes and rounded being. It is clear that sediment has been obtained from sources of sediment that have been transported long distances to middle of sedimentary environments that exist in the region Lau Kawar lake and its surroundings. Can be interpreted also that these sediments are generally derived from the rivers that enter to lake system that also serves as a source of sediment in Lake Lau Kawar.

Sorting obtained from the analysis of sediment cores show a trend of poorly sorted, where sorting sediment grains are not uniform due to the instability of currents that carry sediment and during the deposition of sediments. Sorting both the results of the analysis explained that the current instability does not occur in all depositional environments that exist in the lake Lau Kawar. Further data analysis results using GRADISTAT sieving sediment samples, method of Moments (Mathematical) and Folk & Ward (Graphic) in Sedimentological Laboratory of Universitas Gadjah Mada (UGM, 2016) Yogyakarta, Indonesia is as follows:

Table.1. Results of the analysis on 15 samples of sediments Granulometric

Sampel	Mean	Sortasi	Skewness	Kurtosis
LK 1.1	1.449	1.297	0.218	0.928
LK 1.2	1.361	1.380	0.337	0.797
LK 1.3	1.456	0.959	-0.036	0.875
LK 1.4	4.447	0.495	-0.305	1.421
LK 2.1	4.589	0.278	-0.070	0.857
LK 3.1	3.644	1.171	-0.408	0.790
LK 3.2	2.864	1.042	-0.170	0.886
LK 3.3	3.842	1.092	-0.528	1.264
LK 3.4	3.298	0.942	-0.055	0.801
LK 3.5	3.421	0.733	-0.097	1.039
LK 4.1	2.785	1.400	-0.392	0.697
LK 4.2	4.555	0.351	-0.181	1.158
LK 5.1	1.658	1.296	0.067	0.938
LK 5.2	1.284	0.929	0.062	0.895
LK 5.3	1.778	1.516	0.112	0.854

Based on the Granulometric analysis performed, and by analogy that the samples taken on LK at 1 STA has a relationship with LK others. If the sampling is not random but linear then:

- At LK 1.1 to 1.4 relative occurs reduction of energy deposition shown from LK mean values of 1.1 - 1.4 is decreased, except in LK 1.2 that increased energy deposition, which then decreased energy deposition. Based on analysis of sorting impaired sorting (more well sorted), except in LK 1.2 which has increased the value sorting.
- At LK 2.1 sediments deposited in low energy deposition, on a relatively quiet environment so that the grain size of silt can be deposited, it is also shown by the sorting value that indicates well sorted. When viewed based on an analysis of grain size can about that LK 1.4, 2.1 LK, LK 4.2 deposited on environmental conditions are relatively similar; an environment of the quiet stream, for example in the flood plain on the river morphology.
- At LK 3.1 - 3.5 LK 1,2,3,4,5 when sorted by grain size (mean) do not reflect a meaningful relationship in which the mean value of random. But when grouped into 2 groups: group 1 consists of LK 3.1 & LK 3.3 and Group 2 consists of LK 3.2, LK 3.4, and LK 3.5, then both groups showed a decrease in the value of the grain size (energy deposition) and impairment sorting (increasingly well sorted).
- LK 4.1 and 4.2 on a decline in energy deposition shown to increase the fine from the existing sediment grain size (mean). Sorting at 4.1 and 4.2 LK relatively impaired sorting (more well sorted).
- At LK LK 5.1 and 5.3 relative decline seen energy deposition of increasingly fine grain size (mean) of the value of the previous LK sorting unlike an increasing rate of sorting (increasingly poorly sorted). LK 5.2 has an energy deposition is relatively the largest among LK 5.1 and 5.3. sorting value most sorting relatively low (more well sorted) of the LK 5.1 and LK 5.3.

In the following picture, is one of the tabulated data showing that quartecic whole of data analysis, statistical calculations and data phi cumulative histogram curve showed two types of diagrams histogram is unimodal and bimodal. In this case the whole sample showed cumulative histogram curve phi dominated by a diagram showing the cusp or unimodal also that it can be interpreted sediments. Deposition area than those that are in the area of coastal sediment / river that has the characteristics.

Here is one example of the data analysis results sieving sediment samples was performed using GRADISTAT, a program proposed by Blott and Pye (2011) and developed by Kenneth Pye Associates Ltd. Software GRADISTAT run in Microsoft Excel program. Calculation method used, namely, Method of Moments (Mathematical) and Folk & Ward (Graphic)

Further analysis of the data using GRADISTAT produce sorting varied group description. Group sorting of each test sample can be seen in Table 2 below.

Tabel.2: Granulo metric cummulative table

Mesh	Phi unit	Diameter (mm)	Grain Size	Fraction (gr)	Frequency (% Fraction)	Cumulative (%)
18	<0	1	Very Coarse Sand	11,4	11,85	11,85
35	0 - 1	0,5	Coarse Sand	26	27,03	38,88
60	1 - 2	0,25	Medium Sand	29,4	30,56	69,44
120	2 - 3	0,125	Fine Sand	16,9	17,57	87,01
230	3 - 4	0,0625	Very Fine Sand	4,8	4,99	92,00
270	4 - 4,25	0,053	Silt	4,8	4,99	96,99
>270	>4,25	<0,053	Clay	2,9	3,01	100,0
T				96,2	100	100

Table.3: Description Tabulation Sorting

No	Poorly Sorted	Moderately Sorted	Well Sorted	Very Well Sorted
1	LK 1.1 (Bimodal)	LK 1.3 (Unimodal)	LK 1.4 (Unimodal)	LK 2.1 (Unimodal)
2	LK 1.2 (Bimodal)	LK 3.4 (Bimodal)	LK 4.2 (Unimodal)	
3	LK 3.1 (Bimodal)	LK 3.5 (Unimodal)		
4	LK 3.2 (Unimodal)	LK 5.2 (Unimodal)		
5	LK 3.3 (Unimodal)			
6	LK 4.1 (Unimodal)			
7	LK 5.1 (Bimodal)			
8	LK 5.3 (Bimodal)			

Overviews of the depositional environment of the test sample can be obtained from the statistical parameters using the analysis function of discrimination raised by Sahu(1964).

The use of bivariate scatter plots proposed by Moiola and Weiser(1968) and Friedman (1961) also used to get a general overview of the depositional environment of the test sample.

Values of mean, sorting, skewness, and curtosis for each test sample can be seen in Table 2 and Table 3.

Here is presented a sample graphic of grain characteristics (mean, sorting, skewness, and curtosis) for each sample (figure 4 and 8 for sample). Overview depositional environment of the test sample can be seen on the plot charts by making crossplot between Y1, Y2, Y3 and Y4 as presented figure 9.

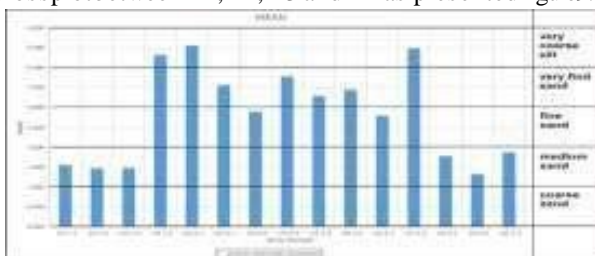


Fig.4: Grain characteristics (mean, sorting, skewness, and curtosis) from sample LK-1

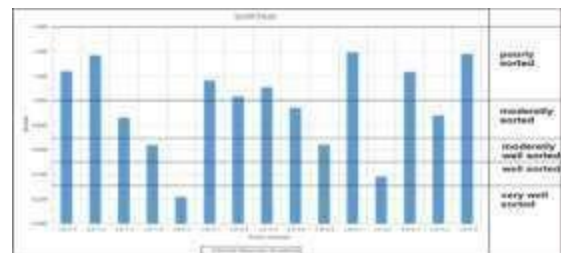


Fig.5: Grain characteristics (mean, sorting, skewness, and curtosis) from sample LK-2

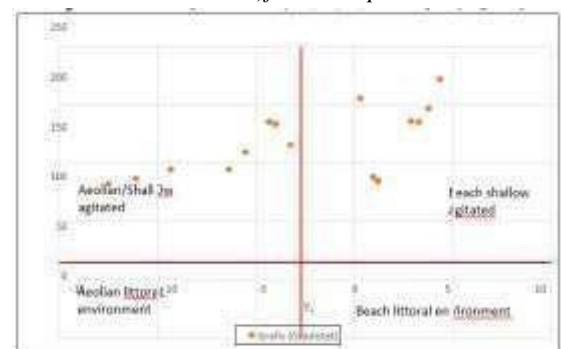


Fig.9: Depositional Environment from LK-1

Table.4: Tabulation Characteristics Sample Test Granulas (Mathematical Methods GRADISTAT)

Sample	Mean	Sorting	Skewnes	Curtosis
LK 1.1	1,552	1,243	0,769	2,816
LK 1.2	1,475	1,372	0,809	2,630
LK 1.3	1,479	0,864	0,092	2,319
LK 1.4	4,325	0,641	-2,987	13,530
LK 2.1	4,563	0,220	-3,830	17,310
LK 3.1	3,564	1,166	-0,810	2,700
LK 3.2	2,900	1,036	-0,587	2,911
LK 3.3	3,783	1,112	-1,509	4,476
LK 3.4	3,295	0,944	-0,448	3,070
LK 3.5	3,447	0,645	-0,030	2,379
LK 4.1	2,796	1,395	-0,522	1,940
LK 4.2	4,488	0,385	-3,451	15,700
LK 5.1	1,786	1,238	0,439	2,414
LK 5.2	1,328	0,882	0,678	3,423
LK 5.3	1,875	1,381	0,375	2,199

Overview depositional environment obtained from bivariate plot as noted by Moiola and Weiser (1968) and Friedman (1961) presented in the graphs below.

Table.5: Characteristics of Grain Sample Tabulation Test (Graphic Methoda GRADISTAT)

Sample	Mean	Sorting	Skewnes	Curtosis
LK 1.1	1,449	1,297	0,218	0,928
LK 1.2	1,361	1,380	0,337	0,797
LK 1.3	1,456	0,959	-0,036	0,875
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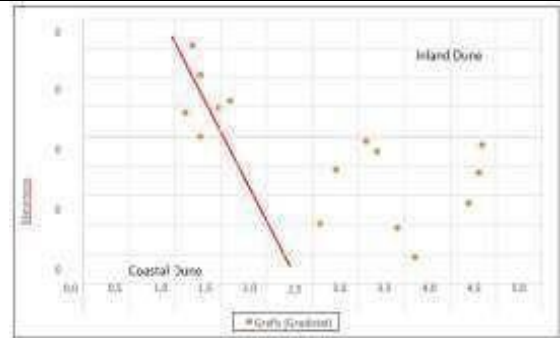


Fig.6: Depositional Environment Crossplot from LK-1

IV. CONCLUSIONS

1. The mechanism of transport of sediment in the sample indicates that the transport mechanism is very influential in sediments are suspended load and deposition processes on the river.
2. In the mechanism that is where the suspended load sediment materials transported by river, by floating above the bottom of the river by the flow of water turbulence. So that the transported material will generally produce the grain size of silt to clay as shown in the statistical calculation data on how many samples between 1.4 sample LK LK LK 2.1 3.1 9 In the deposition process streams according to Thornbury 1964; where the river can no longer transport the material - material he was carrying. It is influenced by factors decrease the flow rate of the river, the addition of material that is transported on the river, its flow is reduced due to climate change, as well as their results by the wind deposition of thick and extensive consisting of grain size of clay, silt, and sand. This can be seen by the data analysis on the curve grain size distribution in the sample, which showed an increase and cumulative particle diameter phi drastic thus producing two peak on cumulative histogram phi diagram. As well as a greater percentage relative presence of granules composed of sand-sized grains like that are shown in the data sample statistical analysis results.
3. Characteristics of Pellets and results tabulation Discrimination function test samples in Table 3, it produced some of the data are then displayed in the chart overview depositional environment of the test sample that can be seen in the graph plot by making cross plot between Y_1 , Y_2 , Y_3 and Y_4 as presented. Where on cross plot between the Y_1 and Y_2 indicate that the sedimentary depositional environment than it is on the shallow depositional environment that is influenced by the relative flow speed is quieter, the Y_2 and y_3 is in an environment where there are marine fluvial influence of flow rate water is fairly quiet. In Y_3 and Y_4 is still in the marine fluvial depositional environment but in this environment has affected the water flow in the turbid sediments. Each of

sediment deposition will be influenced by the rate of water flow, conditions of lithology area depositional environments, physical processes during transport, climate conditions, the density of granules of sediment conditions of weathering and the distance of transportation thana grain of sediment from the initial site / host rock to the accumulation of granules - granules so deposited back (tersedimentasi) the farther the distance as well as the water flow rate fluctuations will result in a material with a grain shapes more rounded.

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