Various impacts of Sinabung eruption volcanic ash thickness with different vegetation on the microorganism population in andisols

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Abstract. The aim of this research is to observe the impact of various thicknesses of volcanic ash and different vegetation on microorganism populations in Andisol affected by the eruption of Mt. Sinabung in NamanTeran Sub-district, Karo district, which was affected by the eruption of Mt. Sinabung after 5 years of eruption which is distinguished by several ash thicknesses, namely: A0: 0cm (already processed), A1: <2 cm (thin), A2:> 2-5 cm (moderate), A3:> 5 cm (thick) with annual plant vegetation and grass vegetation. Soil sampling was using the survey method. Calculation of total soil microorganisms was done by the Total Plate Count method. The results indicated that the higher the pH, C-organic, humidity and temperature, the more microorganism population, also different thickness of ash and vegetation affected the number of microorganism population.

1. Introduction
Mount Sinabung experienced an eruption in September 2013. Sinabung emitted volcanic ash and smoke which will decay into soil parent material and subsequently will affect the nature and characteristics of the soil that will be formed. The soil properties that are affected are physical, chemical and biological soil [1]. Andisol is a soil formed from volcanic ash that is rich in minerals Al and Fe [10].

Volcanic ash contains harmful micro-substances and heavy metals that are precipitous. According to the research results of [11;13] that the soil pH affected by the eruption of Mount Sinabung is classified as very acidic with a value of 4.29, while the soil pH ranges from 4.4 to 5.6. Low soil pH and volcanic ash deposits will disrupt the activity of soil organisms [2;3;16].

Volcanic ash that covers the soil surface for a long time will settle and harden depending on the thickness level. This can result in the disruption of soil aeration which affects the life of microorganisms in the soil. The thicker the volcanic ash covering the soil, the fewer microorganisms that are in the soil [7].

One of the factors that influence the development of soil microorganisms is soil pH. As is the case with fungi, fungi can live and tolerate soil pH ranges between pH 4 - 6.5 while for bacteria prefer soil conditions with a pH range of 6-7. Besides, vegetation also greatly affects the activity and population of microorganisms in the rhizosphere [4]. Plants determine the abundance and activity of soil microorganisms, and soil microorganisms determine the productivity of the vegetation above it [8].
The number and activity of microorganisms in the soil are also influenced by the type of plant growth (species composition, soil cover, litter and others), the treatment applied to the soil, planting, macro and microclimate in each location [4].

2. Material and method

This research was conducted at the Soil Biology Laboratory of the Faculty of Agriculture, University of Sumatera Utara, Medan in May-July 2018. The soil used in this research was soil exposed to Sinabung volcanic ash at several thicknesses with different vegetation, Jelly Nutrient media for composition per litre of distilled water: (10 g beef extract, 10 g peptone, 5 g NaCl, 1,000 ml distillate water and 15 g jelly / L).

The making of NA media was by weighing the following ingredients: 10 g beef extract, 10 g peptone, 5 g NaCl, 1,000 ml distillate water and 15 g jelly / L. Then, jelly was sterilized by autoclaving it at 121°C for 15 minutes.

Sampling was taken after making the media using the survey method, the point of soil sampling is distinguished by several thicknesses of ash, namely: A0: soil that has been processed (0cm), A1: Thin (<2cm), A2: Medium (> 2-5 cm), A3: Thick (> 5 cm) [19] with annual plant vegetation and grass, hence the number of sampling points was 8 points. Sampling was carried out at a depth of 0-20 cm.

Calculating the total microbial population used NA media, carried out by the Total Plate Count method or dilution, then a soil suspension of 3 dilutions used as anticipation if the dilution not produced any fungus or bacteria. After 7 days incubated, the total number of microorganisms was calculated using the formula, the total number of microorganisms = number of colonies per cup x dilution factor.

The parameters observed were soil pH, Humidity (%), C-Organic (%), soil temperature (0°C) and total microorganism population (CFU / ml).

3. Results and discussion

Based on the analysis conducted on the soil conditions on some ash thicknesses in soil pH parameters, Humidity, C-Organic, soil temperature and the total population of microorganisms can be seen in Table 1. Based on Table 1, it can be seen that the highest soil pH was found in the soil at ash thickness of 0cm (already processed) with annual plant vegetation of 5.42, while the lowest pH was found in soil at ash thickness >5cm (thick) with grass vegetation at 4.26. This was due to the Mount Sinabung volcanic ash dominated by high sulphur content causing a decrease in pH. This was in accordance with the literature of [20] which stated that the high content of Mn, Fe and S in Sinabung volcanic ash are 67.80 ppm, 2500.65 ppm, and 130.20 ppm, respectively, resulting in the pH of Mount Sinabung volcanic ash classified as very low. In fact, one of the volcanic ash samples was 3.6. This was also in accordance with the analysis results of [6;17-18;14-15] that the soil pH affected by the eruption of Mount Sinabung is very acidic with a value of 4.29. The results of [16] on the A0 ash thickness (without ash) pH value is 4.50 but the pH decreases at A3 (ash thickness >8cm) to 3.74, this indicated that the thicker the ash the lower the soil pH.

Based on Table 1, it can be seen that the highest C-organic in the soil at 0 cm ash thickness (already processed) with annual plant vegetation with 7.55% value and the lowest C-organic in the soil at ash thickness >5 cm (thick) with grass vegetation 0.75% value. This is in accordance with the literature of Sarah et al (2015) which stated that the activity of microorganisms in soils not exposed to volcanic ash is higher than that of soils exposed to volcanic ash, this is due to the higher pH and C-organic when compared to pH and C-organic in soil samples exposed to volcanic ash. The research results of [13] stated that the C-organic content of andisol soils affected by Sinabung eruption was 4.7% and from the research of [7] obtained levels of C-organic soils affected by Sinabung eruptions ranged from 4.41 – 7.34%. The lowest C-organic in soils with ash thickness >8cm. This indicated that the thicker the soil is covered with volcanic ash, the lower the levels of C-organic, and vice versa, this was in accordance with the literature of [16] stated that volcanic ash which has covered the soil for a long time will settle and harden depending on the level of thickness. This will affect soil aeration, respiration, availability of oxygen and organic matter in the soil which affects the life of organisms in the soil.
Table 1. Soil pH, humidity, C-Organic, soil temperature, total population of microorganisms

| Ash Thickness (cm) | Vegetation | Soil pH | Humidity (%) | C-Organic (%) | Soil Temperature | Total Population of Microorganisms (CFU/ml) |
|-------------------|------------|---------|--------------|---------------|-----------------|-------------------------------------------|
| 0 cm              | Annual Plants | 5.42    | 78           | 7.55          | 19              | 35 x 10^7                                  |
| 0 cm              | Grass Plants      | 5.13    | 75           | 6.03          | 20              | 150 x 10^7                                |
| <2 cm             | Annual Plants | 5.14    | 73           | 5.22          | 19              | 10 x 10^7                                  |
| <2 cm             | Grass Plants      | 5.37    | 70           | 4.80          | 19              | 23 x 10^7                                  |
| 2-5 cm            | Annual Plants | 5.10    | 73           | 2.02          | 20              | 77 x 10^7                                  |
| 2-5 cm            | Grass Plants      | 5.33    | 60           | 0.64          | 20              | 60 x 10^7                                  |
| >5 cm             | Annual Plants | 4.26    | 55           | 2.14          | 21              | 6 x 10^7                                   |
| >5 cm             | Grass Plants      | 4.38    | 40           | 0.75          | 20              | 63 x 10^7                                  |

The highest total microbial population was found in soils with ash thickness of 0 cm (processed) with grass vegetation with a total population of 150 x 10^7 CFU/ml and the lowest total microbial population was found in soils with ash thickness >5cm (thick) with annual plant vegetation population 6 x 10^7 CFU/ml. It can be concluded that the thicker the volcanic ash, the microbial population is fewer. This was in accordance with the research results of [9] which stated that the activity of microorganisms in soils not exposed to volcanic ash is higher when compared to soils that are exposed to volcanic ash, this is caused by pH and C-Organic in soils not exposed to volcanic ash is higher than the pH and C-Organic in soils exposed to volcanic ash.

The highest total number of microorganism populations was found in soil with ash thickness of 0 cm (processed) with grass vegetation of 150 x 10^7 CFU / ml, while the total population of microorganisms in ash thickness >5cm (thickness) with annual plant vegetation of 6 x 10^7 CFU / ml. This indicated that the thickness of volcanic ash and different vegetation affect the population of microorganisms. This was in accordance with the result of the research of [7] which stated that the thicker the volcanic ash covering the soil, the less microorganisms in the soil, in addition to the number and activity of microorganisms in the soil are also influenced by the type of plant growth (species composition, soil cover, litter and others), the treatment applied to the soil, planting, macro and microclimate at each location [4].

4. Conclusion
The difference in ash thickness affects soil conditions, the higher the pH, C-organic, humidity and temperature, the more microorganism population. Different thickness of ash and vegetation affect microorganism population.

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