Identification of macrofauna on various volcanic ash thickness and different vegetation in andisol affected by Sinabung eruption

H Munawaroh, M Sembiring* and A S Hanafiah

Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *mariani.sembiring29@yahoo.com

Abstract. Mount Sinabung eruption caused the soil covered by volcanic ash with various thickness. Changes in soil conditions will affect population and diversities in the soil. The research aims to identify soil macro-fauna on andisol in Karo County with various thickness of volcanic ash of Mount Sinabung with different vegetation after 5 years of eruption. The Plots were placed onto eight locations, I = processed land (0 cm) grass vegetation, II = uncovered by ash land (0 cm) coffee vegetation, III = covered by thin layer of ash land (≤2 cm) grass vegetation, IV = covered by thin layer of ash land (≤2 cm) coffee vegetation, V = covered by medium layer of ash land (2-5 cm) grass vegetation, VI = covered by medium layer of ash land (2-5 cm) coffee vegetation, VII = exposed by thick ash land (≥5 cm) grass vegetation, VIII = exposed by thick ash land (≥5 cm) coffee vegetation. Sampling was done by method Pitfall Trap, Square Monolith, and Hand Sorting. The result shows that the change of soil will affect soil macro-fauna - based on macro-fauna identification results, found 3 phylum(s), 7 class(es), 12 ordo(s), 18 family(ies), and 20 species.

1. Introduction

Mount Sinabung erupted in September 2013, spouting volcanic ash that would transform into a landholding material and would further affect the nature and characteristics of the soil to be formed. The affected properties of the soil are physical, chemical as well as biological (Assessment Institute for Agricultural Technology, North Sumatera, 2013). High metal and sulfur content in volcanic ash causes pH to drop and the pH value indicates how much concentration of hydrogen ions in the soil. The higher H+ content in the soil, the sourer the soil. pH value can affect the life of microorganisms in soil. Volcanic ash of Mount Sinabung eruption has a very sour pH, just as in accordance to the results of the research of [1; 2; 3; 4]. pH of andisol affected by volcanic ash of Mount Sinabung eruption ranges from 4.4 to 5.6. Low soil pH and volcanic ash deposits will interfere with the activity of soil organisms [5; 6]. Ecosystem provides a variety of resources for the survival of organisms which is commonly known also as biodiversity (biological diversity). Biodiversity is the concept of variability of living creatures from a variety of sources (terrestrial ecosystem, sea, lake, river, and so on) ranging from genes, species, to ecosystems. Practically, biodiversity is usually reserved for a variety of species - this concept is also known as species wealth [7].

Based on research results [8], the level of volcanic ash thickness covering the soil also affects the properties of soil such as the value of humidity, C-organic, water content, and soil pH resulting in thick
volcanic ash covering the soil experience decreasing. Soil moisture and water content affect several groups of soil macro-fauna and so does groundwater content as it is associated with cations in the soil, the decomposition of organic matter, and the life of soil organisms. If volcanic ash covering the soil becomes thicker, the content of organic matter will be decreased due to soil organism will have difficulty to survive, hence the decomposition process is stunted so it affects the content of organic material in the soil. Identification of macro-fauna soil is necessary to find out the diversity of soil macro-fauna that exists on the land affected by Mount Sinabung eruption. [9] states that macro-fauna is called an ecosystem regulator owing to the fact that they strongly affect the soil structure and impurities that produce organic materials or mineral-organic mixtures.

The research aims to identify macro-fauna on andisol in Karo district which is covered with volcanic ash of Mount Sinabung eruption with various thickness and various vegetation. This research is also linked to the alteration of physical properties of chemical and biological soil related to the life of soil macro-fauna after 5 years affected by eruption.

2. Materials and methods
This research was conducted in Karo Regency North Sumatera precisely in the village of Kuta Rakyat and Sigarang-garang NamanTeran Subdistrict. The research starts from May 2019 until complete in Soil Biology Laboratory, Agroecotechnology Department, Faculty of Agriculture, University of North Sumatera. The soil type belongs to the land of andisol. Naman Teran Subdistrict is located at an altitude of 1300 m to 1600 m above sea level with average temperature ranging from 16°C-17°C. The materials used in this research were soil samples that were not exposed to the volcanic ash of Mount Sinabung eruption and the affected land ash above the annual plant vegetation and the grass with a depth of 0-30 cm. This research was conducted using several survey methods. The observation was done by observing the existing soil macro-fauna, which includes the identification of macro-fauna by Pitfall Trap Method as well as Quadratic Method and Hand Sorting.

3. Results and Discussion
Andisol has high organic matter content hence it is suitable for soil macro-fauna. C-Organic on coffee vegetation is better compared to grass vegetation due to the plenty amount of litter from the coffee plants so that the soil temperature is lower and the humidity is higher, as can be seen in the location VII and VIII with same level of thickness and different vegetation meanwhile on grass vegetation, the value of macro-fauna is relatively low - it is in accordance with the literature [8] stating that the physical properties of chemical and biological soil related to the life of soil macro-fauna and the literature of [10] the plant serves the supply of organic matter into the soil either through production of litter and exudate roots. Soil organism activity is also highly dependent on vegetation conditions.

Based on the results of the research that has been done, in table shows soil macro-fauna found at various study sites. Location I = Uncovered Land (0 cm) Annual Vegetation, Location II = Uncovered Land (0 cm) Grass Vegetation, Location III = Land Covered with Thin Ash (≤2 cm) Annual Vegetation, Location IV = Land Covered with Thin Ash (≤2 cm) Grass Vegetation, Location V = Land Covered with Medium Ash (2-8 cm) Annual Vegetation, Location VI = Land Covered with Medium Ash (2-8 cm) Grass Vegetation, Location VII = Land Affected by Thick Ash (≥8 cm) Annual Vegetation, Location VIII = Land Affected by Thick Ash (≥8 cm) Grass Vegetation. The result of research that has been done on some of the thickness of volcanic ash covering the surface of the soil found a variety of soil macro-fauna that can be seen in table below:
### Table 1. Classification and description of soil Macro-fauna species found at research site

| Picture | Classification | Description |
|---------|----------------|-------------|
| ![K: Animalia, P: Annelida, C: Chaetopoda, O: Oligochaeta, F: Megascolecidae, G: Megascoleox, Sp: Megascolex sp.](image1) | K : Animalia  
P : Annelida  
C : Chaetopoda  
O : Oligochaeta  
F : Megascolecidae  
G : Megascoleox  
Sp : Megascolex sp. | Dorsal colour is purplish red, pale ventral or whitish brown, can be found on locations I-V |
| ![K: Animalia, P: Annelida, C: Chaetopoda, O: Oligochaeta, F: Megascolecidae, G: Pheretima, Sp: Pheretima sp.](image2) | K : Animalia  
P : Annelida  
C : Chaetopoda  
O : Oligochaeta  
F : Megascolecidae  
G : Pheretima  
Sp : Pheretima sp. | The segment is clear, the body colour is dorsal brown purplish, ventral pale, anterior tip brown to pale / yellow, can be found on locations I, II, III, IV, V, VII. |
| ![K: Animalia, P: Arthropoda, C: Arachnida, O: Araneae, F: Lycoside, G: Trochosa, Sp: Trochosacanapii](image3) | K : Animalia  
P : Arthropoda  
C : Arachnida  
O : Araneae  
F : Lycoside  
G : Trochosa  
Sp : Trochosacanapii | Body colour is brown, has 8 pairs of eyes, has 4 pairs of legs with an average length of 0.8 cm. Cephalothorax has a unique pattern in most genera of the Lycosidae family, can be found on locations III, IV, VI. |
| ![K: Animalia, P: Arthropoda, C: Arachnida, O: Araneae, F: Lycoside, G: Trochosa, Sp: Cheiracanthium spp.](image4) | K : Animalia  
P : Arthropoda  
C : Arachnida  
O : Araneae  
F : Lycoside  
G : Trochosa  
Sp : Cheiracanthium spp. | Has 8 pairs of eyes, has 4 pairs of legs with an average length of 0.8 cm, brownish-yellow in colour. Can be found on locations I, II, V. |
| ![K: Animalia, P: Arthropoda, C: Chilopoda, O: Lithobiomorpha, F: Lithobiidae, G: Lithobius, Sp: Lithobius spp.](image5) | K : Animalia  
P : Arthropoda  
C : Chilopoda  
O : Lithobiomorpha  
F : Lithobiidae  
G : Lithobius  
Sp : Lithobius spp. | The head is round and short and there is a pair of eyes and a long antenna. segments have 2 shapes, width and narrow, each segment is found a pair of legs, the body is completely reddish brown. Can be found on locations I and III |
| ![K: Animalia, P: Arthropoda, C: Insecta, O: Coleoptera, F: Carabidae, G: Calosoma, Sp: Calosoma sp.](image6) | K : Animalia  
P : Arthropoda  
C : Insecta  
O : Coleoptera  
F : Carabidae  
G : Calosoma  
Sp : Calosoma sp | clear eyes, has 3 pairs of legs and consist of, koksa, trochanter, femur, tibia, tarsal (3 pairs) and metatarsal, and the body colour is black metallic. Can be found on locations I, III, IV, VII, VIII. |
K : Animalia  
P : Arthropoda  
C : Insecta  
O : Coleoptera  
F : Melolonthidae  
G : Phyllophaga  
Sp : Phyllophaga sp.

The body is sturdy, oval and thick. The head is round and flat. Body Colour is dark yellow, reddish yellow until black and sometime the colour is metallic, can be found on locations I-IV.

K : Animalia  
P : Arthropoda  
C : Insecta  
O : Dermaptera  
F : Carcinophoridae  
G : Euborelia  
Sp : Euborelia sp.

The head is triangle and black. there is a pair of white eyes. The type of mouth is biter and chewer. Overall body colour is brown, can be found on locations I-V.

K : Animalia  
P : Arthropoda  
C : Insecta  
O : Hymenoptera  
F : Formicidae  
G : Odontoponera  
Sp : Odontoponera sp.

The head is sturdy, round, and short jaw. There is 12 segment of. Clear eyes. Overall body colour is black with some pinstripe, can be found on all locations.

K : Animalia  
P : Arthropoda  
C : Insecta  
O : Orthoptera  
F : Gryllotapidae  
G : Gryllotalpa  
Sp : Gryllotalpa sp.

round eyes with shortmouth has a pair of claws resembles a saw, Has 2 pairs of wing, Body colour is brown and little dark at this head, can be found on locations I-VI.

K : Animalia  
P : Arthropoda  
C : Insecta  
O : Orthoptera  
F : Gryllidae  
G : Gryllus  
Sp : Gryllus sp.

Head is round, there are a pair of eyes and an antenna whose length is ± 1 cm. In the thorax there are 3 pairs of legs, short wings. Black body colour except for the legs and wings which are brown, can be found on locations I, II, III, IV, VI, VII, VIII.

K : Animalia  
P : Arthropoda  
C : Malacostraca  
O : Isopoda  
F : Philosciidae  
G : Philoscia  
Sp : Philoscia sp.

There are a pair of eyes and a long antenna, the dorsal body colour is dark, the ventral body colour is brownish yellow, can be found on locations I-VII.
K: Animalia
P: Mollusca
C: Gastropoda
O: Stylommatophora
F: Arionidae
G: Hemphillia
Sp: *Hemphillia* sp

Has a little shell in the middle that looks through the gap behind the mantle. The back of the shell is more tapered. Pneumostome is located under the visceral hump. Overall body colour is brown. can be found on locations I, II, III, IV, VI, VII.

K: Animalia
P: Mollusca
C: Gastropoda
O: Stylommatophora
F: Bradybaenidae
G: Bradybaena
Sp: *Bradybaena* sp

Thin shell and smooth texture. There is a spiral line that surrounds the shell. Shell walls are fragile, the lines of growth are not clearly visible. Yellowish-brown shell colour, can be found on locations I and III

K: Animalia
P: Mollusca
C: Gastropoda
O: Stylommatophora
F: Hygromiidae
G: Monacha
Sp: *Monacha* sp

Thin shell and rough texture. The shell walls are fragile and have growth lines that are wrinkled and clear. The top of the shell is slightly whitish and brown to the base, can be found on locations I-VII

K: Animalia
P: Arthropoda
C: Insecta
O: Coleoptera
F: Carabidae
G: Stenolophus
Sp: *Stenolophus* sp

Body rather flat. Caput oval with clear eyes. Has a pair of eyes that protrude on the head, on the edge of the pronotum and the legs are yellow. can be found on locations I, II, III, IV, VI, VII, VIII.

K: Animalia
P: Arthropoda
C: Diplopoda
O: Polydesmidae
F: Polydesmida
G: Polydesmus
Sp: *Polydesmus* sp

Elongated round body shape and has a pale brown head. Brownish white body color shaped like the letter c, thick scaly, can be found on locations I-IV.

K: Animalia
P: Arthropoda
C: Insecta
O: Coleoptera
F: Scarabaeidae
G: Lepidiota
Sp: *Lepidiota stigma*

Blackish brown body colour, white feet, protect itself by rolling her body if it feels threatened. can be found on locations I, II, III, VI, VII.
From the result on table 2, soil macrofauna found at various research sites. Location I (land not covered by grass vegetation ash), consisting of 3 phylum(s), 6 class(es), 11 order(s), 17 family(ies), and 16 species location II (land not covered by coffee vegetation ash) consisting of 3 phylum(s), 6 class(es), 11 order(s), 17 family(ies), and 19 species. Location III (land covered with thin ash of grass vegetation) consists of 3 phylum(s), 6 class(es), 10 order(s), 17 family(ies), and 16 species. Location IV (land covered by thin ash of coffee vegetation) consists of 3 phylum(s), 6 class(es), 12 order(s), 18 family(ies), and 19 species. Location V (land covered with medium ash of grass vegetation) consists of 3 phylum(s), 5 class(es), 10 order(s), 11 family, and 11 species, location VI (land covered with medium ash coffee vegetation) consists of 3 phylum(s), 6 class(es), 10 order(s), 9 family(ies), and 11 species, location VII (land exposed to thick ash (≥8 cm) grass vegetation) consists from 3 phylum(s), 1 class(es), 3 order(s), 3 family(ies), and 4 species of location VIII (land exposed to thick ash of coffee vegetation) consisting of 3 phylum(s), 4 class(es), 4 order(s), 7 family(ies), and 7 species. The predominantly arthropod phylum was found because it was the largest phylum with the largest of members of kingdom animalia [8].

4. Conclusion
Increasing the thickness of Sinabung mountain volcanic ash and different vegetation will affect soil conditions and properties. Macro-fauna identification results obtained from several research sites were found 3 phyla, 7 classes, 12 orders, 18 families, and 20 species.

Reference
[1] Masdariah, Sembiring M, Mukhlis and Rosneli 2019 The increasing of phosphorus availability and corn growth (Zea mays L.) With the application of phosphate solubilizing Microbes and some sources of organic materials on andisol IOP Conf Ser: Earth Environ Sci 260012166  
[2] Silitonga N, Sembiring M, Marbun P and Rosneli 2019 Application of phosphate solubilizing fungi and various sources of P-Fertilizers toward P-Available and P Nutrient content of Soybean (Glycine max L. Merrill) in andisol soil IOP Conf Ser: Earth Environ Sci 260 012159  
[3] Siswana S R, Sembiring M, Hanum H and Rosneli 2019 The effect of phosphate solubilizing microbes and chicken Manure in increasing the P availability and growth of Green Beans (Phaseolus radiatus L.) On Andisol IOP Conf Ser: Earth Environ Sci 260012160  
[4] Sembiring M, Elfiati D, Sutarta E S and Sabrina T 2017 Phosphate solubilization agents in increasing potatoes production on andisol sinabung area Asian journal of plant sciences 16 3 141-8
[5] Sinaga B I L J, Sembiring M and Lubis A 2015 Dampak Ketebalan Abu Vulkanik Erupsi Gunung Sinabung Terhadap Sifat Biologi Tanah di Kecamatan Naman Teran Kabupaten Karo [Impact of volcanic ash thickness of Mt. Sinabung eruption on soil biology in Naman Teran sub-district, Karo district] Jurnal Online Agroteknologi 3 3 1159-63

[6] Fatmala V, Sembiring M and Jamilah 2015 Eksplorasi dan Potensi Jamur Pelarut Fosfat pada Andisol Terdampak Erupsi Gunung Sinabung dengan Beberapa Ketebalan Abu di Kecamatan Naman Teran Kabupaten Karo [Exploration and Potential of Phosphate Solvent Fungi in Andisols Affected by Mount Sinabung Eruption with Some Thickness of Ash in Naman Teran District, Karo Regency] Jurnal Online Agroteknologi

[7] Sumarto S and Koneri R 2016 Ekologi Hewan [Animal Ecology] (Bandung: CV Patra Media Grafindo)

[8] Simbolon A S, Sembiring M and Sabrina T 2018 Deskripsi Makrofauna pada Tanah Andisol di Kabupaten Karo dengan Berbagai Ketebalan Abu Vulkanik Gunung Sinabung [Description of Macrofauna on Andisol Land in Karo District with Various Thickness of Mount Sinabung Volcanic Ash] Jurnal Pertanian Tropik 5 1 2356-4725

[9] Hanafiah A S, Sabrina T and Guchi H 2009 Biologi dan Ekologi Tanah [Soil Biology and Ecology] (Medan: USU Press)

[10] Widyawati E 2013 Dinamika Komunitas Mikroba Di Rizosfir Dan Kontribusinya Terhadap Pertumbuhan Tanaman Hutan, Pusat Penelitian dan Pengembangan Peningkatan Produktivitas Hutan Kampus [The Dynamics of Microbial Community in Rizosfir and Its Contribution to Growth of Forest Plants, Research and Development Center for Campus Forest Productivity Improvement] (Bogor: Balitbang Kehutanan)

[11] Sembiring M, Elfiati D, Sutarta E S and Sabrina T 2016 Effect of Burkholderia cepacia and SP36 on available phosphate and potato production on Andisol impacted by Mount Sinabung Eruption, North Sumatera, Indonesia Journal of Applied Horticulture 18 3 233-5

Acknowledgement
The authors gratitude conveys to the Directorate General of Higher Education, Ministry of Research, Technology, Higher Education of Indonesia. Through the University of Sumatera Utara's Research Institute which has provided funding for TALENTA Basic research No. 345/UN5.2.3.1//PPM/KP-TALENTA/2019. The authors also convey their gratitude to the Faculty of Agriculture for giving permission and facilities to conduct research.