DIVERSITY OF SOIL MACROFAUNA IN RECLAIMED FORMER SAND MINE LAND IN CANGKRINGAN, SLEMAN REGENCY

Nur Rizki Putri Ramadhanti[1*] dan Tien Aminatun[2]

[1]*Master of Environmental Science, Graduate School of Universitas Negeri Yogyakarta, Indonesia*
[2]*Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia*

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Corresponding Email:
nurrizki.2023@student.uny.ac.id

ABSTRACT

Mining activities, particularly sand mining, often cause severe environmental degradation by stripping away topsoil, altering land structure, and reducing soil fertility. Efforts are needed to manage mining land through reclamation, followed by monitoring the success of the reclamed land. This can be assessed by looking at the diversity of soil fauna in the reclaimed land. This study aims to determine the diversity of soil macrofauna in the reclaimed former sand mine land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency. The study sites were differentiated based on the length of time since reclamation. Soil macrofauna samples were collected using pitfall traps and handsorting methods. The soil macrofauna data were analyzed for community structure using an ANOVA test and visualized using Non-Metric Multidimensional Scaling (NMDS). The results showed that the diversity of soil macrofauna in the reclaimed land was varied, with no significant effect found between the length of reclamation time and soil fertility as indicated by macrofauna diversity. Soil macrofauna diversity was not a strong enough bioindicator for soil fertility in the reclaimed former sand mine land of Bulak Salak Hamlet, as the presence of macrofauna was heavily influenced by other environmental factors.

Keywords: *Biodiversity, soil macrofauna, reclaimed land, sand mining*

Introduction

Sleman Regency is one of the regencies located in the Special Region of Yogyakarta. This regency has a total area of 57.482 Ha and is known as Mount Merapi, an active volcano (Pemerintah Kabupaten Sleman, 2007). Mount Merapi in Sleman Regency not only poses a threat of danger when an eruption occurs but also has a positive impact in the form of abundant sand resources obtained from the eruptions. This sand is utilized by the local community for mining which can provide a new source of livelihood.

In addition, from its economic benefits, sand mining activities also have a negative impact on the environment. Herniti and Kiky (2018) explained that sand mining activities in Sleman Regency caused soil damage, decreased soil fertility, decreased and loss of soil organism diversity, and damaged soil permeability. A significant issue related to the environmental impact of sand mining is the damage to the soil layer. This is because the vegetation on the land is lost and the fertility of soil layer which is the habitat of soil organism is being dredged and is made worse by soil erosion (Ainia & Jiarzanah, 2021).

One of the sand mining activities in Sleman Regency can be found in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency. These sand mining is carried out independently by miners directly in their yards. Sand mining in these yards causes significant environmental damage, including loss of vegetation, soil erosion, and decrease the soil fertility. However, most of the mining community in Bulak Salak Hamlet already has knowledge and efforts to improve their sand mining land. Management of the former sand mining area in Bulak Salak Hamlet is carried out through reclamation using revegetation techniques, which convert the land into cropland.

If reclamation has been carried out in former sand mining land, monitoring and maintenance of the land can be implemented so the main objective of reclamation to restore environmental quality can be achieved. One of them by looking at the abundance of biological properties of the soil, namely the

diversity of soil macrofauna as a bioindicators of soil fertility, such as worms and soil Arthropods (Irwanto *et al*., 2022).

This is due to the important role of soil macrofauna, Arthropods and Earthworms, to improving the soil ecosystem quality. Soil Arthropods act as decomposers of organic matter, transport organic matter from the surface of the soil into the soil, also support the process of improving soil quality and structure (Rhengi *et al*., 2022). Earthworms are often associated with animals that act as indicators of the success post-mining land rehabilitation (Pelaez-Sanchez *et al*., 2024). Earthworms are very important in the process of improving soil structure (Sanchez *et al*., 2021). Annelida or worms are also most widely used as indicators of soil quality because they are very sensitive to environmental changes and the presence of foreign material contamination. (Pariyanto & Destriani, 2021). Meanwhile, soil Arthropods also play a role as ecological engineers on degraded land, namely as decomposers and agents for improving the physical and chemical properties of the soil (Auclerc et al., 2022).

Many studies have been conducted on the diversity of soil macrofauna in mining areas, but not many studies have been conducted specifically on sand mining areas independently in community yards, which have an urgent need to continuously monitor the success of reclamation. Therefore, this study was conducted to determine the diversity of soil macrofauna of the Arthropod and Annelida groups in reclaimed land from former community sand mines, where reclamation was carried out based on the ecological knowledge and capabilities of the mining community in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency. This soil macrofauna diversity can also be a bioindicator of soil fertility in the reclaimed land.

Methods

Study area

This study is survey research that analyzed the diversity of soil macrofauna (Arthropod and Annelida) in reclaimed former sand mine land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency. The reclaimed former sand mine land as the research location was selected using the purposive random sampling technique based on specific considerations (Sofiana *et al.*, 2016). The considerations in selecting reclaimed land as a research location were the land had been reclaimed for 10-15 years, >15-20 years, and >20 years. The land area was analyzed to determine the number and sampling plots; each plot consisted of 1 plot measuring 10x10 m^2 and within it there were 5 soil macrofauna sampling points.

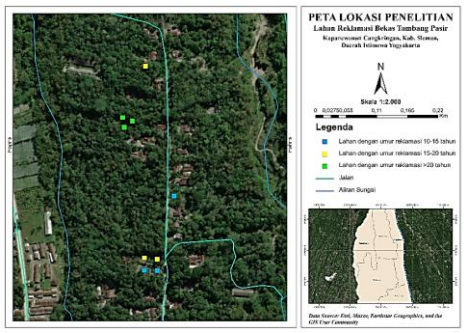

Figure 1. Research Location

The layout of the sampling points in this study is as follows. Each plot consists of five pentagonal sampling points in a 10x10 m^2 plot.

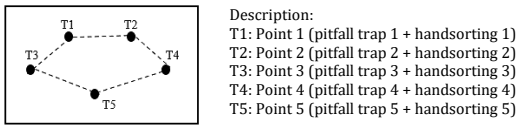

Figure 2. Sampling Points

Tools and materials

The tools and materials used in this study included a soil tester, a soil thermometer, pipettes, trowels, sample bottles, label paper, a measuring tape, and a sieve. The materials used in this study included 70% alcohol, glycerin, tissue, cotton wool, and water.

Procedures

Sampling data collected on plots of 10x10 m^2 with 5 sample points arranged in a pentagon. At each observation and sampling point, there is a pitfall trap point that is not separated from the hand sorting plot of 25x25x25 cm^3. Each point is marked by making a pitfall trap for soil Arthropod samples (Insecta Class) and a 25x25x25 cm^3 hand sorting plot for earthworm samples (Oligochaeta Class).

Pitfall trap is a technique for taking samples of soil insects that are active on the surface of the soil by trapping them in a sample bottle. The soil insects as a samples are macrofauna that active during the day and at night because the pitfall trap is left for 24 hours (Nurmianti *et al*., 2015). The pitfall trap in this study was filled with a trapping fluid, namely a solution of 20 ml of 70% alcohol and 3 drops of glycerin. Furthermore, the hand sorting technique is a technique to involves directly sampling soil organisms using the hands (Afifatur, 2021).

Sampling of soil macrofauna, namely soil Arthropods (Insecta Class) and Annelida (Oligochaeta Class) at each point in the plot, carried out with 1 repetition within a period of 2 weeks. The soil Arthropods (Insecta Class) and Annelida (Oligochaeta Class) obtained, were documented, counted, identified, and analyzed for their diversity index in the Environmental Laboratory, Mathematics and Natural Sciences Faculty of Universitas Negeri Yogyakarta. Each soil macrofauna sampling was followed by measurements of environmental factors in the form of soil edaphic conditions including parameters of temperature, pH, and soil humidity.

Data analysis

Analysis of soil macrofauna diversity was carried out based on the diversity index and structure of the soil macrofauna community in the form of an ecological index. Community structure analysis using the Important Value Index (IVI) results, which include the sum of relative density and relative frequency. Analysis is also carried out on the Shannon-Wienner diversity index, species richness index, species evenness index, and Sorensen species similarity index.

Research data of community structure (species diversity index, species richness index, and species evenness index) were analyzed using descriptive and quantitative. Quantitative analysis based on the results of differences in soil macrofauna community structure at each research location using ANOVA testing on each variable of the index.

The Importance Value Index according to Odum (1996) is as follows.

1. Relative Density
   Density = number of individuals of a species / area (m^2)
   Relative Density = (density of each species / density of all species) x 100%
2. Relative Frequency
   Frequency = number of plots where species found / total plots in research
   Relative Frequency = (frequency of each species / frequency of all species) x 100%
3. Importance Value Index (IVI)
   IVI = relative density + relative frequency

The ecological index according to Odum (1996) is as follows.

1. Shannon-Wienner Diversity Index
   $H' = -\sum pi \ln pi$
   pi : ni/N
   ni : the number of individuals

   N : total number of individuals

The values of the diversity index are as follows.
$H' < 1$: low diversity
$1 \leq H' \leq 3$: moderate diversity
$H' > 3$: high diversity

2. Species Richness Index (Margalef)
   $DMg = S-1 / \ln N$
   S : the number of species
   ln : natural logarithm
   N : total number of individuals
   The values of the species richness index (Margalef) are as follows.
   $DMg < 3,5$: low species richness
   $3,5 < DMg < 5$: moderate species richness
   $DMg > 5$: high species richness
3. Species Evenness Index
   $E = H'/\ln S$
   H' : species diversity index
   S : the number of species
   The values of the evenness index are as follows.
   $E < 0,3$: low species evenness
   $E = 0,3-0,6$: moderate species evenness
   $E > 0,6$: high species evenness
4. Species Similarity Index(Sorensen)
   $IS = (2C / A + B) \times 100\%$
   A : number of species in location A
   B : number of species in location B
   C : number of the same species in location A and B
   The values of the species similarity index are as follows.
   $IS \leq 25\%$: very low (very dissimilar)
   $25\% < IS \leq 50\%$: low (not similar)
   $50\% < IS \leq 75\%$: moderate (similar)
   $IS \geq 75\%$: high (very similar)

Results and Discussion

The Diversity of Soil Macrofauna in The Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

The results of the study showed the presence of soil macrofauna from the Arthropod Phylum in the Insecta Class and the Annelida Phylum in the Oligochaeta Class in the reclaimed former sand mining area in Bulak Salak Hamlet (Table 1). Based on the results of the number of soil macrofauna species, the structure of the soil macrofauna community in the reclaimed land in Bulak Salak Hamlet can be analyzed. The results of the species with the highest number of individuals and IVI found in this study were the Hymenoptera group. The Hymenoptera species with the highest IVI is *Camponotus* sp. and *Solenopsis* sp. The Hyemnoptera order was found in large numbers and abundance on all the reclaimed land studied. This is because Hymenoptera, especially the ant group, can adapt and utilize resources well in their habitat. In line with research by Rahmawati *et al*., (2024), the Hymenoptera order is the most abundant group of soil macrofauna due to the ability to utilize the resources and has an important role in the ecosystem.

The group of ants in the Hymenoptera order plays a role as leaf cutters, seed pickers, termite predators, carrion eaters, mushroom cultivators, and plays a major role as foragers or food seekers (Haneda & Yuniar, 2020). Ants also play a role in the predation process in the food web and act as important predators in their habitat (Bogar *et al*., 2024). Due to its crucial role, Hymenoptera can be

found in abundance in reclaimed land ecosystems. However, its existence still has limiting factors. These include the optimal soil temperature for Hymenoptera life, which is 18-30ºC, with a neutral pH approaching 7 (Riyanto *et al.*, 2020). Such as the research results of Ardianita *et al.*, (2024), who found that the abundance of ant species was significantly correlated with canopy cover in their habitat, litter density, and weather factors such as temperature and soil humidity.

The result of the diversity of soil macrofauna in this research in all reclaimed land showed a moderate category with the highest diversity value in land Q2 (H' = 2,297) and the lowest in land P1 (H' = 1,626). Gumay *et al.*, (2020) said that the diversity of soil macrofauna is greatly influenced by biotic and abiotic factors of the soil. Examples of abiotic factors that influence the survival of soil macrofauna are pH, temperature and soil humidity, while biotic factors are the vegetation of the land. In line with Rahmawati *et al.*, (2024), who stated that biotic factors in the form of plants or vegetation are a food source and habitat for soil macrofauna. The value of diversity is also influenced by the presence of vegetation because high diversity results are usually caused by dense and diverse vegetation. High diversity values tend to be found in the land with wide canopy vegetation (Haneda *et al.*, 2024).

Table 1. Structure of Soil Macrofauna Community in the Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

Reclaimed Land		Amount of Soil Macrofau-na	Soil Macrofauna Community Structure						
			Highest IVI	Diversity Index (H')		Species Richness Index (DMg)		Species Evenness Index (E)	
P	P1	94	0,474 (*Campon otus* sp.)	1,626 (moderate)	1,811 (moderate)	2,201 (low)	2,575 (low)	0,678 (high)	0,791 (high)
	P2	119	0,474 (*Solenops is* sp.)	1,886 (moderate)		3,138 (low)		0,680 (high)	
	P3	66	0,439 (*Campon otus* sp.)	1,922 (moderate)		2,386 (low)		0,801 (high)	
Q	Q1	255	0,474 (*Solenops is* sp.)	1,862 (moderate)	2,020 (moderate)	2,706 (low)	3,346 (low)	0,671 (high)	0,709 (high)
	Q2	106	0,274 (*Campon otus* sp.)	2,297 (moderate)		4,288 (moderate)		0,754 (high)	
	Q3	99	0,490 (*Solenops is* sp.)	1,902 (moderate)		3,046 (low)		0,702 (high)	
R	R1	120	0,375 (*Lasius niger*)	2,144 (moderate)	1,890 (moderate)	3,342 (low)	3,381 (low)	0,756 (high)	0,675 (high)
	R2	86	0,303 (*Campon otus* sp.)	1,850 (moderate)		2,918 (low)		0,701 (high)	
	R3	103	0,625 (*Solenops is* sp.)	1,676 (moderate)		3,883 (low)		0,569 (moderate)	

Description: P (age of reclamation land 10-15 years), Q (age of reclamation land >15-20 years), R (age of reclamation land >20 years)

Table 2. Number of Soil Macrofauna Species in the Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

Order – Species	The Number of Individuals																		Total
	Reclamation Time 10-15 years						Reclamation Time >15-20 years						Reclamation Time >20 years						
	Pitfall Trap			Handsorting			Pitfall Trap			Handsorting			Pitfall Trap			Handsorting			
	Land			Land			Land			Land			Land			Land			
	P1	P2	P3	P1	P2	P3	Q1	Q2	Q3	Q1	Q2	Q3	R1	R2	R3	R1	R2	R3	
Phylum Arthropod – Insecta																			
Araneae																			
Asagena medialis													3						3
Drassodes sp.								1											1
Erigone sp.	3	3						1					3	1	1				12
Euophrys sp.													3						3
Harpactea sp.															1				1
Hygrolycosa sp.	2	3	1						1					5	1				13
Pardosa sp.		5					1	4					3	1	1				15
Trochosa sp.													3	1					4
Blattodea																			
Eurycotis sp.		2											1		1				4
Pseudoglomeris sp.	3														1				4
Reticulitermes sp.		1	2				15	14	5						1				38
Coleoptera																			
Broscus sp.							1												1
Canthon sp.									1										1
Chrysolina sp.														1					1
Cicindela sp.									1										1

Dyscinentus sp.		1								1
Harmonia sp.			1							1
Paederus sp.				1	2					3
Scarabaeinae sp.		3		6						9
Scolytinae xyleborini		4	2		1	1				8
Dermaptera										
Anisolabis maritima	1			1	1	2		2		7
Diplopoda										
Spirostreptus sp.					1					1
Diptera										
Mesembrina sp.					2					2
Plecia sp.									1	1
Hemiptera										
Dysdercus cingulatus								1		1
Melamphaus sp.		1								1
Paraeucosmetus pallicornis								1	1	2
Paraeucosmetus sp.	1									1
Hymenoptera										
Camponotus sp.	36	28	23	27	24	13	30	20	15	216
Dolichoderus sp.	6	12	9	9	3	16	3	2		60
Formica pallidefulva				5	2					7
Lasius niger			3	1	1	3	38		2	48
Solenopsis sp.	33	49	11	105	21	42	14	35	59	369
Tiphia sp.							3			3
Orthoptera										

Atractomorpha sp.	1	1																	2
Califera sp.									1										1
Gryllinae sp.	4	1	1				54	19	7				3		1				90
Gryllus sp.	4	4					16	2	1				3	6	5				41
Mecopoda neponensis								1											1
Polydesmida																			
Oxidus sp.								1					1						2
Thysanoptera																			
Ceratothripoides sp.								1							1				2
Thrips sp.							6	3	4						1				14
Phylum Annelida – Oligochaeta																			
Haplotaxide																			
Eisenia fetida										1									1
Eudrilus eugeniae																	2	1	3
Lumbricus sp.					1	9				6	1	1					8	6	32
Pheretima sp.						4												3	7
Tricladida																			
Platydemus sp.																2			2
TOTAL	**94**	**118**	**53**	**0**	**1**	**13**	**248**	**105**	**98**	**7**	**1**	**1**	**111**	**76**	**93**	**2**	**10**	**10**	**1410**

Description: P (age of reclamation land 10-15 years), Q (age of reclamation land >15-20 years), R (age of reclamation land >20 years)

The results of the species richness show that all of the research location have a low species richness catogory with the highest value in land Q2 (DMg = 4,288) and the lowest in land P1 (DMg = 2,201). The existence and richness of soil macrofauna species are influenced by environmental factors, including biotic and abiotic factors that build the ecosystem. The number of species in the community determines the results of the species richness index (Baderan *et al.*, 2021). The value of species richness is also influenced by biotic and abiotic factors such as temperature, pH, soil humidity, rainfall, altitude, vegetation cover, and the presence of litter as a support for the life of soil macrofauna in ecosystem (Wasis & Sajadad, 2024).

The results of the community structure analysis for the species evenness index obtained the same index value across all reclaimed land in this study. The results of the species evenness index were classified as high category. Based on the calculated values of the species evenness index, the highest value was found in the reclaimed land P3 (E = 0,801) and the lowest in land R3 (E = 0,569). The results of the species evenness are influence by the ability to adapt, competition, and the richness of resources in the ecosystem as a community habitat (Wibowo & Alby, 2020). Species evenness factors also include adaptability, interactions between species, competition, predation, and the ability to utilize habitat conditions (Wasis & Sajadad, 2024).

Table 3. ANOVA Statistical Test

Data	F value	p-value	Sign.
Species Diversity	0,3949	0,6901	0,05
Species Richness	1,1126	0,3882	0,05
Species Evenness	1,4304	0,3105	0,05

Statistical tests show that the length of time the land has been reclaimed does not affect the diversity of soil macrofauna in each area, as shown in Table 3. This may be due to environmental factors that influence the survival and adaptation of the soil macrofauna. Furthermore, this result can be influenced too by environmental changes, including rainfall, vegetation, and land reclamation methods.

According to research by Oktafitria *et al.* (2019) the diversity of soil insects in reclaimed land is influenced by the length of time the reclamation has been carried out and the dominant soil elements. The existence of Annelida and soil Arthropods is also influenced by the dense vegetation cover on soil ecosystem, land reclamation methods, and maintenance of plants on reclaimed land (Zhou *et al.*, 2022). In addition, fertilization in the reclamation process also provides organic material as a source of food and energy for soil macrofauna to support their survival in their ecosystem (Aripfandi *et al.*, 2024).

Table 4. The Similarity Index Value of Soil Macrofauna Species in the Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

Reclaimed Land	P	Q	R
P		15,6% (very low)	17% (very low)
Q	15,6% (very low)		14,7% (very low)
R	17% (very low)	14,7% (very low)	

Description: P (age of reclamation land 10-15 years), Q (age of reclamation land >15-20 years), R (age of reclamation land >20 years)

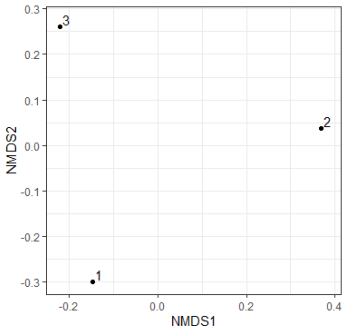

Figure 3. Visualization of Similarity of Soil Macrofauna Species in the Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency Based on Soil Macrofauna Composition (Description: 1 (P: age of reclamation land 10-15 years), 2 (Q: age of reclamation land >15-20 years), 3 (R: age of reclamation land >20 years))

The results of the Sorensen type similarity index between reclaimed lands as shown in Table 4 that the types of similarity between the lands are classified as very low or very dissimilar. These results are strengthened by the visualization of reclaimed land based on the composition of soil macrofauna presented in Figure 3. which does not have similarities in the composition of soil macrofauna species between the reclaimed lands as research areas.

Several factors that influence the similarity index value of soil macrofauna species in the three areas studied are vegetation cover, climate, and measured edaphic conditions. This is because the soil macrofauna, including Annelida and Arthropods, has a range of temperatures, pH, and humidity to survive in this ecosystem. Temperature, pH, and humidity are significantly influence by vegetation cover, soil cultivation, and plant maintenance on reclaimed land (Zhou *et al*., 2022).

Although the results of the similarity of species between reclaimed lands in this study were very low, this indicates that there is no similarity in the composition of soil macrofauna species between reclaimed lands as a research area. These results can actually be an indicator of typical species in reclaimed land based on the age of reclamation. The dissimilarity in the composition of soil macrofauna species between reclaimed lands is in line with the findings that species in the order Araneae or spiders are more commonly found on land R, reclaimed former sand mining land with the longest age of reclamation, namely >20 years. On land R, the most spider species were found, reaching 7 species, compared to land P with only 3 species and land Q with 4 species.

These results indicate that there are species that only exist on the oldest reclaimed land. Meanwhile, in the land less than 20 years old of reclamation, not many spider species were found. However, the presence of these species cannot be considered as a strong bioindicator of soil fertility. This is because based on the total number of individual species and community structure, such as diversity values, it does not show the largest number of individual species with the highest diversity value in land R.

In line with the research of Rahadian *et al*., (2021) which showed that the structure of the microarthropod community was not sensitive enough to detect soil damage due to sand mining, it was less strong as a bioindicator of soil quality. This is because the existence and diversity of soil insects on reclaimed land is greatly influenced by the length of time the reclamation has been implemented, vegetation, and the physical chemistry of the soil (Oktafitria *et al*., 2019).

Environmental Factors of Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

The study of the presence of soil macrofauna in reclaimed land ecosystems can be strengthened by observing the edaphic factors of the soil that can influence the survival ability of soil macrofauna.

Table 5. Average of Temperature, pH, and Soil Humidity of Reclaimed Former Sand Mine Land in Bulak Salak Hamlet, Wukirsari Village, Cangkringan, Sleman Regency

Reclaimed Land		Average Measurement Results					
		Temperature (ºC)		pH		Soil Humidity (%)	
P	P1	24,8	27,1	6,85	6,67	20,2	32,25
	P2	27		6,8		22,2	
	P3	29,5		6,35		54,35	
Q	Q1	25,2	25,7	6,65	6,7	23,2	27,35
	Q2	24,95		6,8		28,35	
	Q3	27		6,65		30,5	
R	R1	28	27,7	6,7	6,67	46,85	42,57
	R2	27,2		6,75		37,85	
	R3	28		6,55		43	

Description: P (age of reclamation land 10-15 years), Q (age of reclamation land >15-20 years), R (age of reclamation land >20 years)

Based on soil temperature parameters, the highest average temperature was found in P3, reaching 29,5ºC, and the lowest average temperature was found in P1, at 24,8ºC. The soil temperature is strongly influenced by environmental conditions. Land with a little vegetation shade tends to have a high temperature fluctuation because the sun's heat directly hits the soil. Meanwhile, in land with dense vegetation shade that covers the soil surface, the soil temperature tends to be maintained. The less shade, the more sunlight and heat will be exposed to the soil surface, resulting an increase in soil temperature (Rosana *et al.*, 2023).

The highest average pH was found in P1 at 6,85, and the lowest average pH was found in P3 at 6,35. Soil pH can be influenced by several factors, including soil material, climate, vegetation, organic matter, and soil cultivation, which includes fertilization and lime application. Soil cultivation is a method of improving and maintaining soil pH to optimally fertilize the soil and plants. This cultivation can include fertilization and lime application (Fatima *et al.*, 2022). In line with the research of Nuraini *et al.*, (2021) that the implementation of dolomite and fertilizer had a significant effect to increasing soil pH.

The highest average soil humidity results were on land P3 at 54,35% and the lowest on land P1 at 20,2%. The primary factor influencing soil humidity is weather. Weather is closely related to the evaporation process of water contained in the soil. When the weather is consistently hot and sunny throughout the day, evaporation will accelerate, reducing the water content in the soil, resulting in low measured humidity. Meanwhile, if the weather is rainy with high intensity, the rainwater will continue to infiltrate and absorb into the soil and resulting the high humidity (Isnanto & Suprayogi, 2023).

However, the average range of temperature, pH, and soil humidity obtained in this research is suitable for the life of soil macrofauna of the Arthropods and Annelida. According to Wulandari & Andriani, (2024), said that the effective of soil temperature of soil macrofauna life is in the range of 15-45ºC. Soil ecosystem that good for habitat of soil macrofauna tends to have a neutral pH, in the range of 7 (Sarah *et al.*, 2024). The suitable soil humidity range of soil macrofauna is in the range of 15-30% (Wasis & Sajadad, 2024).

Conclusion

The diversity of soil macrofauna in the reclaimed former sand mine land in Bulak Salak Hamlet was varied and not strong enough to be a bioindicator of soil fertility. Supported by analysis of the reclamation time in the reclaimed land, which does not significantly affect the diversity of soil macrofauna. This is influenced by the ecosystem condition of the reclaimed land in Bulak Salak Hamlet, such as the edaphic soil, reclamation methods, and vegetation.

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