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THE RELATIONSHIP BETWEEN PHYSICAL PROPERTIES OF SOIL WITH INFILTRATION RATE OF LAND PRACTICE OF VOCATIONAL SCHOOL OF PP N BANJARBARU

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ABSTRACT

The practice area for the Banjarbaru State Agricultural Development Vocational School (SMK PP N Banjarbaru) is located in Kemuning Village, South Banjarbaru District, Banjarbaru City, South Kalimantan Province. Regarding the land use in the research location, the majority is used for plantation land, which is one of the lands suitable for water catchment areas in Banjarbaru City. The Practice Land of PP N Banjarbaru Vocational School, is one of the models of good catchment area land from good land use and irrigation systems. This research was conducted to analyze the infiltration rate and its influence on the physical properties of the soil. From the results of the infiltration test using a double ring infiltometer which was then analyzed using the Horton method, the largest infiltration rate was in open land, namely 33.83 cm/hour, rubber plantations of 22.57 cm/hour, then on palawija land it is 15.57 cm/hour and on mahogany land it is 14.47 cm/hour. From the results of the analysis using the linear regression approach, the physical properties of the soil that can affect the infiltration rate include 16.7% bulk density, 75% permeability and 90% moisture content. Meanwhile, particle density and porosity only affect 0.7% and 3.5%.

Keywords: Infiltration, Infiltration Rate, Soil Physical Properties

1. INTRODUCTION

Water is a very vital natural resource, very necessary and determines the sustainability of life on earth. The availability of groundwater is one of the roles of infiltration capacity. The infiltration process is one of the processes in the hydrologic cycle, infiltration determines the amount of rainwater that seeps and enters the soil directly. An understanding of the infiltration process and the magnitude of the rate of infiltration that occurs and the factors that influence it are needed as a reference for implementing more effective water management and land use(Aidatul, 2015). Measurement of this infiltration parameter was carried out in the area of the Banjarbaru State Development Agriculture Vocational High School, South Banjarbaru District, Banjar Baru City, South Kalimantan Province. The purpose of this study was to analyze the relationship between the infiltration rate and the physical properties of the soil with

the parameters of the physical properties of the soil, namely bulk density, particle density, porosity, permeability, moisture content and grain distribution.(Indarwati & Harisuseno, 2016).

2. THEORETICAL BASIS

Infiltration

Infiltration is the flow of water into the soil through the soil surface. In the country, water flows in a lateral direction, as interflow to springs, lakes, rivers, or vertically, known as percolation to groundwater. The movement of water in the soil through the pores of the soil is influenced by gravitational forces and capillary forces(Triatmodjo, 2010). Infiltration Rate according(Arsyad, 2010)Infiltration rate is the amount of water that enters the soil during rainfall, which is expressed in units of mm/hour, or cm/hour. When the soil is dry, the infiltration rate is fast. If the soil is saturated with water, the infiltration rate will decrease and become constant. Data from measurements of the infiltration rate can be calculated by equation 2.1, which is as follows(A. Salsabila & IL Nugraheni, 2020)

$$f = \frac{\triangle H}{t} \quad (1)$$

Where:

f = infiltration rate (cm/hour)

ΔH = Height of water drop in a certain time interval (cm)

t = time needed by water at ΔH to enter the ground (minutes)

Horton's method

One of the soil infiltration tests can be done with the Horton Method. According to Horton, the infiltration capacity will decrease over time until it reaches a constant value. Horton stated that the decrease in infiltration capacity is controlled more by factors at the soil surface than by the flow process in the soil. Factors that play a role in reducing infiltration rates include land cover, closing of soil cracks by soil colloids and the formation of soil crusts, destruction of the land surface structure and transport of fine particles to the soil surface by raindrops. The infiltration capacity based on the Horton model can be expressed mathematically according to the following equation(RE Horton, 2012).

$$f = f_c + (f_0 - f_c) \cdot e^{-k.t} \quad (2)$$

Where:

f =Infiltration capacity or maximum infiltration rate (cm/hour)

f0 =Infiltration capacity at the beginning of the infiltration process (cm/hour)

fc =Infiltration capacity constant (as t approaches infinity) (cm/hour)

e =Naperian base logarithm

t = that timecalculated from the start of the rain (hours)

k =constant for soil type

Relationship between Soil Physical Properties and Infiltration Rate

The rate of infiltration on some land varies depending on land use and several factors that influence the physical properties of the soil, among others, organic matter, bulk density, porosity, stability/aggregate stability and water content.(C. Yunagardasari et al., 2017)

3. METHOD

Research sites

This research was conducted at the Banjarbaru State Agricultural Development Vocational School of Practice located in the Kemuning Village, South Banjarbaru District, Banjarbaru City, South Kalimantan Province. Data on the area of each research area, namely rubber land 0.79 ha, mahogany land 0.29 ha, palawija land 0.12 ha, open land 0.14 ha. The research was conducted on December 10, 2022.

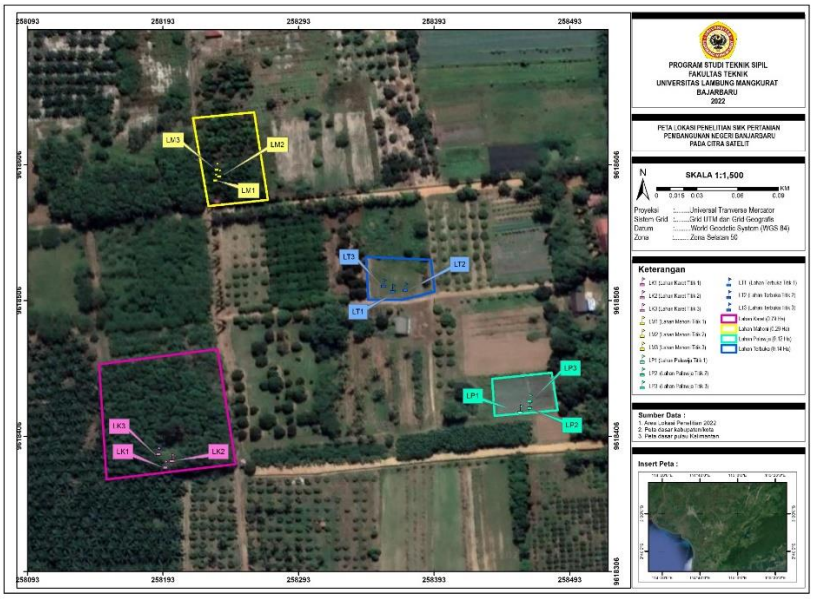


Figure 1. Research Locations that display each point of land

Research procedure

1. Preparation for this study was to carry out survey activities at the research location and prepare the research tools to be used.

2. Determination of points for each research area
3. Data retrieval. Primary data is in the form of infiltration rate in the field and secondary data is in the form of literature, books, journals, ArcGIS and Google Earth.

Data Processing and Analysis Techniques

1. Measurement of the infiltration rate in the field is carried out to determine the value of the infiltration rate, then from the value of the infiltration rate, infiltration parameters are obtained. Measurement of infiltration parameters using an infiltrometer, namely a double ring infiltrometer. The location for data collection or measurement of infiltration rate was carried out by purposive sampling, meaning infiltration data collection and placement of the infiltrometer in an area that is considered representative of the entire area studied. The procedure for measuring infiltration parameters is as follows.(Andara et al., 2018).
   a. Installing a double ring infiltrometer at the observation point.
   b. Insert the double ring infiltrometer into the soil slowly.
   c. Fill water into the ring, first enter the outer ring and then continue in the inner ring. Filling water is done slowly so as not to damage the surface structure of the soil.
   d. Turn on the stopwatch when the inner ring is filled with water
   e. Record the initial water level by looking at the scale and record the decrease in water at certain time intervals, the time interval depends on the speed of the water decline. In this study, the water reduction interval was used every 5 minutes.
   f. Add water after 5 minutes and record the initial water level, repeat until three times there is a constant decrease in water.
2. Sampling of disturbed soil (disturb sample), disturbed soil is used for analysis purposes. Parameters observed from the soil sample are grain distribution, bulk density, water content particle density, soil porosity and permeability. Soil samples will be taken at several test points, the soil samples taken are representative soil samples at the sampling location, while the procedure for taking disturbed soil is as follows:
   a. Level and clean the ground surface.
   b. Dig the soil to a depth of about 5cm around the test point.

c. Take a soil sample with a hoe as much as 1-2 kg.

d. Place the soil sample in a plastic bag.

4. RESULTS AND DISCUSSION

Soil Physical Properties at Research Sites

Differences in soil physical properties at each location will affect the amount of infiltration rate to be measured. This happens because the physical properties of the soil such as grain distribution, bulk density, water content, particle density, porosity, and soil permeability will affect how quickly water enters the soil and reaches the saturation point. The physical properties of the soil that have been analyzed will be presented in the tables below.

Table 1. Grain Analysis, which displays the distribution of grains at each location

No	Land	Land Classification %					
		Gravel	Rough sands	Medium Sand	Fine Sand	Silt & Clay	Clay
1	Rubber	26,63	5,62	9.00	12.25	25,72	20.78
2	Palawija	0.60	7,27	32,38	27,23	17,22	15.30
3	Mahogany	19,13	6.97	12.93	16.52	20.95	23.50
4	Open	5.97	3,23	10.75	26,48	29,34	24,23

Table 2. Permeability Analysis

No	Land	Permeability cm/hour
1	Rubber	1,13
2	Mahogany	1.03
3	Palawija	2.50
4	L. Open	3.84

Table 3. Water content per land

No	Land	Soil Water Content %
1	Rubber	17.79
2	Palawija	27,10
3	Mahogany	30,73
4	Open	11.03

Table 4. The results of the analysis of bulk density, particle density and porosity values

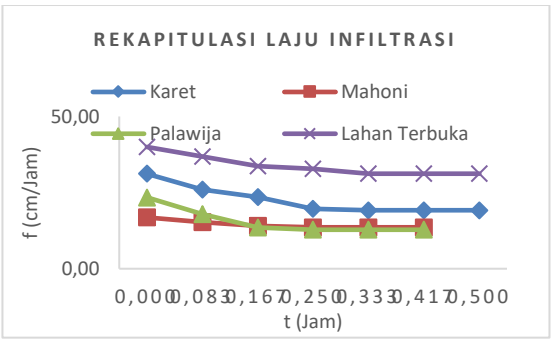
No	Land	BD (gr/cm3)	PD (gr/cm3)	Porosity (%)
1	Rubber	1,483	1,912	22,437
2	Palawija	1.413	2,475	42,909
3	Mahogany	1,744	2,400	27,333
4	Open	1,469	2,425	39,423

Results of Average Infiltration Rate Analysis

Table 5. The results of the analysis of the average infiltration rate

No	t	t	Laju Infiltrasi (cm/jam)															
	(Menit)	(Jam)	LK1[a]	LK2[b]	LK3[c]	Rata-rata	LM1[d]	LM2[e]	LM3[f]	Rata-rata	LP1[g]	LP2[h]	LP3[i]	Rata-rata	LT1[j]	LT2[k]	LT3[l]	Rata-rata
1	0	0,000	2,72	2,72	2,72	2,72	5,10	25,50	19,92	16,84	30,96	22,50	16,80	23,42	35,88	39,36	44,70	39,98
2	5	0,083	2,72	2,72	2,72	2,72	3,60	24,00	18,00	15,20	25,20	18,00	10,80	18,00	30,00	37,20	43,20	36,80
3	10	0,167	2,72	2,72	2,72	2,72	2,40	22,80	16,80	14,00	20,40	14,40	6,00	13,60	24,00	34,80	42,00	33,60
4	15	0,250	2,72	2,72	2,72	2,72	2,40	22,80	15,60	13,60	18,00	14,40	6,00	12,80	21,60	34,80	42,00	32,80
5	20	0,333	2,72	2,72	2,72	2,72	2,40	22,80	15,60	13,60	18,00	14,40	6,00	12,80	19,20	32,40	42,00	31,20
6	25	0,417	0,00	0,00	2,72	0,91	2,40	22,80	15,60	13,60	18,00	14,40	6,00	12,80	19,20	32,40	42,00	31,20
7	30	0,500	13,20	40,80	0,00	18,00									19,20	32,40	42,00	31,20
						4,64				14,47				15,57				33,83

[a]Point one rubber land
[b]Rubber ground point two
[c]Triple point rubber
[d]Mahogany land point two
[e]Point one mahogany land
[f]Three point mahogany land
[g]Point one rubber land
[h]Rubber ground point two
[i]Triple point rubber
[j]Mahogany land point two
[k]Point one mahogany land
[l]Three point mahogany land



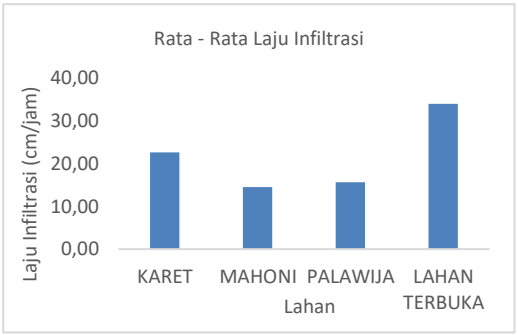
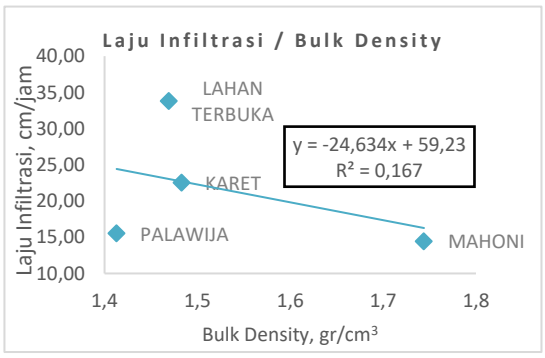


Figure 1. The average infiltration rate value Figure 2. Infiltration rate recapitulation graph

Based on the results obtained, it is known that from the three observation locations the highest average infiltration rate is in the open with 39.383 cm/hour, then in rubber land with 22.57 cm/hour the third is palawija with 15.57 cm/hour and the third is palawija with 15.57 cm/hour and last 33.83cm/hour.

Relationship between Soil Physical Properties and Infiltration Rate



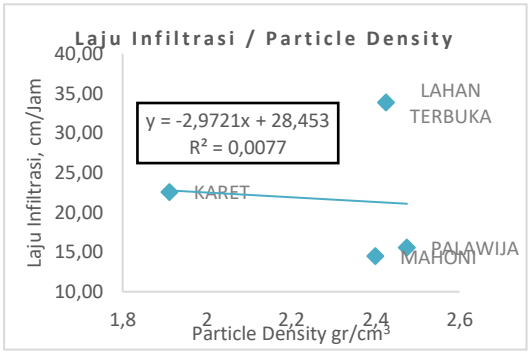
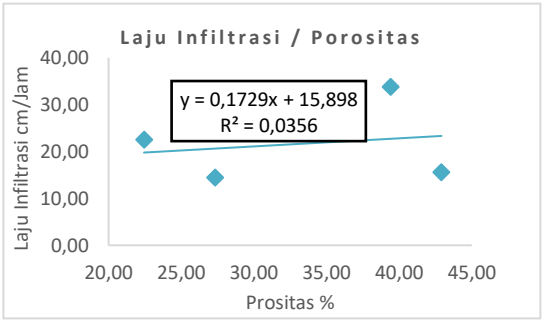


Figure 3. Infiltration and Bulk Density Figure 4. Infiltration and Particle Density



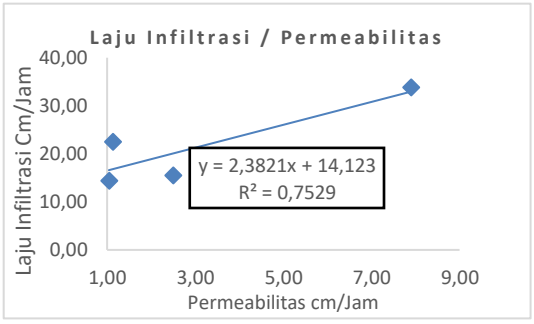


Figure 5. Infiltration and Porosity **Figure 6.**Infiltration and Permeability

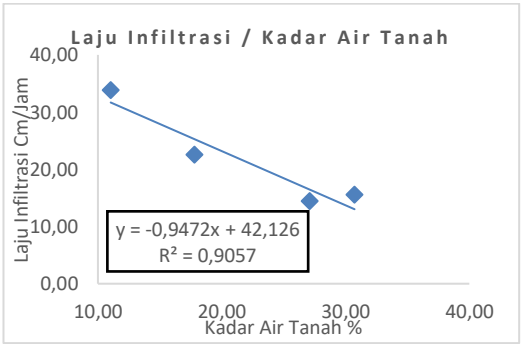


Figure 7. Soil Infiltration and Water Content

The effect of the physical properties of the soil on the infiltration rate is known that the results of the analysis using a simple linear regression approach obtained the value of R2, each soil physical property has an influence value on the infiltration rate which is explained on the graph, namely the straight line on the graph is the perfect value line from the comparison between infiltration rate with soil physical properties. The closer the straight line point is between infiltration rate and bulk density, the higher the attachment value between the two variables or close to 100% and vice versa, the farther the point is from the straight line on the graph, the lower the attachment value between the two

variables used. From the statement above, it can be assumed that some of the physical properties of the soil can affect the rate of infiltration, namely, bulk density 16.7%, permeability 75% and water content 90%. Meanwhile, particle density and porosity only affect 0.7% and 3.5%. The following recapitulates the effect of the physical properties of the soil on the infiltration rate in table 6.

Table 6. Recapitulation of the relationship between soil physical properties and infiltration rate

Soil Physical Properties	Bulk Density (gr/cm3)	Particle Density (gr/cm3)	Porosity (%)	Soil Water Content	Permeability cm/hour
R2	0.167	0.007	0.035	0.91	0.752
Influence %	16,7	0.7	3,5	90	75

Comparison With Other Research

On research(Wake & Helda, 2022)in the Banjarbaru ULM Area which also examined the infiltration rate and capacity on open and closed land in the South Banjarbaru District, a clear difference was at the time of infiltration rate data collection,(Wake & Helda, 2022)take infiltration rate data for a long period of time at each point of approximately one month and do not describe the weather before the day of infiltration rate data collection. Whereas in this study, data were collected from all points in one day and with clear weather conditions one day before the day of infiltration rate data collection. The average value of the infiltration rate found in several lands in the ULM Banjarbaru area is sequential from the highest, namely in forest land with a size of 24 cm/hour, open land of 16 cm/hour, and the lowest is in garden land which is equal to 10 .4cm/hour.

Comparison with the results of the analysis in this study with(Wake & Helda, 2022)namely in the open land of the Banjarbaru ULM Area, the infiltration rate value obtained is 16 cm/hour which indicates that the infiltration rate is fast as shown in Table 2.1. Whereas in the open land of SMK PP N Banjarbaru, an average infiltration rate of 33.83 cm/hour is obtained, it can be said that the infiltration rate in this area is very fast. The average of the other fields tested on open and closed land also produced a fast infiltration rate. So that it can be concluded that open and closed land areas in the South Banjarbaru sub-district are one of the right choices as water catchment areas.

Then on to research(Herviana et al., 2021)in the Forest area with a Special Purpose (KHDTK) Education and training at Lambung Mangkurat University, Karang Intan

District, Banjar Regency, South Kalimantan Province. The highest infiltration rate value is in Mahogany stands, which is 146.33 mm/hour, the second highest infiltration rate value is in mixed forest with a value of 123 mm/hour, the lowest infiltration rate value is in Alang-alang plains with a value of 19.66 mm/hour. O'clock.

This is in contrast to Mahogany land in the SMK PP N Banjarbaru area which is the land with the lowest infiltration rate value of 16.84 cm/hour. This is due to the Mahogany land in KHDTK ULM, showing that the physical properties of the soil on mahogany land really support the infiltration process. Soil texture determines the density contained in the soil where the number of large pores means that the infiltration capacity is greater because the infiltrated water enters the soil to fill the empty pores. Soil texture with a high sand fraction makes the soil have a high infiltration rate.

It can be concluded that from the results the average infiltration rate in the ULM KHDTK area, Karang Intan District, Banjar Regency, is higher than in the PP N Banjarbaru Vocational School Practice Area, Kemuning District, Banjarbaru City

5. CONCLUSION

Conclusion

From the results of the analysis using the linear regression approach, the physical properties of the soil that can affect the rate and capacity of infiltration include 16.7% bulk density, 75% permeability and 90% moisture content. Meanwhile, particle density and porosity only affect 0.7% and 3.5%. The distribution of soil grains at the study sites varied, one of which was the distribution of granules on rubber land which was dominated by gravel, namely 26.63%, on palawija land there was a lot of medium sand by 32.38% and on mahogany land, 23.50% was dominated by clay. Whereas in open land the grain distribution is dominated by silt clay as much as 29.34%.

Suggestion

1. For further research, it is recommended to study on different lands, as well as with distant infiltration points so that they can represent the land under study.
2. Calculation of infiltration rate and capacity using another method.
3. Infiltration rate data collection in the field can be done several times within a specified range.

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