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Analysis Of Infiltration Rate In Sub District Of North Tarakan, Tarakan City, Province Of North Kalimantan, Indonesia

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ABSTRACT

Land use changes in an area will affect the infiltration rate for groundwater filling both in quantity and quality. The infiltration rate can describe the water flow, the amount of water entering the soil vertically and the irrigation water requirements needed for certain types of plants. Basides that, the infiltration rate is also able to predict when a runoff will occur if a type of soil has received a certain amount of water either through rainfall or irrigation. Determining the amount of infiltration can be done by field measurements and mathematical calculations. Therefore, needed to research of infiltration rate analysis to support land resources and crop productivity. This study aims to analyze the infiltration rate in Sub District of North Tarakan, Juata Laut Village, Tarakan City, Province of North Kalimantan. This research is divided into several stages, namely determining the sample point, measuring the infiltration rate, and analyzing the data. Measurement of the field infiltration rate was carried out using a double ring infiltrometer at 15 sample points and each sample point was repeated 3 times. The data that has been obtained is then analyzed using the Horton method. The results showed that the lowest field infiltration rate was found at sample point A7, which was 6.93 cm/hour, the highest was at sample point A11, which was 28.53 cm/hour, and an average of 15.69 cm/hour. Based on the value of the field infiltration rate in Sub District of Juata Laut is included in the fast infiltration classification.

Keywords:

crop productivity, groundwater filling, infiltration, land use.

INTRODUCTION

Tarakan City is located in the geographical coordinates between 117°31'45"-117°38'12" East Longitude and 3°14'30"-3°26'37" North Latitude. Tarakan City area has a land area of 250.80 km² and sea area 406.53 km². [1] During the period of 2008-2017 Tarakan City area has a mainstay rainfall value of 3497.68 mm/year, ETp value 499.84 mm/year, runoff value 1630.34 mm/year, and groundwater filling value 1367.54 mm/ year. In general, land use in the Tarakan City area includes forests, settlements, gardens mixture/shrub/field/field, the land is built and the body of the water. In order to guarantee utilization which is sustainable, land must be managed by taking into account the balance between aspects of conservation and its use [2]. Population growth rate is one of the factors which causes land conversion.

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During the period of 2010-2020 the Tarakan City area has increased the population growth rate of 2.23% and total population in 2020 is 242.79 thousand people [3]. This results in the occurrence of physical development of urban and change land use from vegetated land into built land. Changes in land use this tends to turn forest land into agricultural and non-agricultural land. [4] During the period 2005-2020 the use of forest and garden land the mixture of Tarakan City has decreased by 3% and 1% respectively. While the use of residential land and water body has increased each 3% and 1%. Increased changes in forest land use into settlements and land Open resulting in reduced land use for groundwater filling [5,6,7].

Filling groundwater is influenced by changes in land use and land capability returns rainwater and the characteristics of vegetation that shelter it. Vegetated land on generally has a greater ability to absorb water due to the surface of the vegetation Reducing the effect of rainwater collisions. Filling groundwater is very necessary for provide and meet the needs of plant water. This is in accordance with statement [8] that the overall amount of rainfall is very important in determining the results plant. Through its roots every plant tries to absorb enough water from the ground to plant growth and development. The availability of ground water for plants depends on Types of soil and the ability of the plants themselves to use the water in the soil.

The availability of ground water is one of the main factors in the agricultural sector affect plant growth and productivity. Lack of water in good plants In the vegetative and generative phases can interfere with plant growth, decreased rates photosynthesis and interfere with asymilat distribution resulting in a decrease in productivity Plant [9,10]. The plants requires water in the process of growth and development. If the water content in the leaf lost 30%, the photosynthesis process will decrease later when it reaches 60% of water loss then stopped [11].

The availability of water resources is strongly influenced by climatic conditions, topography, soil type, land use and geological structure of an area [12]. Filling water into soil pores are strongly influenced by the amount of rate and infiltration capacity. Infiltration as one factor in the hydrological cycle has an important role in distributing rain. Infiltration greatly affects the amount of runoff water and the ground water content used To support plant growth and productivity. Determine the amount of infiltration can done by field measurements and mathematical calculations using the Horton method.

Therefore it is very necessary research on the analysis of infiltration rates to support resources land and productivity of agricultural crops in the City of Tarakan, North Kalimantan Province.This study aims to analyze the classification of land use and infiltration rates in the region Tarakan City Juata Laut Village. The research is useful for providing references classification of land use and infiltrasin rates as one of the supporting factors of business activities farmers in the Sub District of North Tarakan, Juata Laut Village.

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METHOD

This research will be conducted in April to July 2022 and located in the Sub District of North Tarakan, Juata Laut Village. The materials used in this activity are maps sourced from images satellites and supporting data (land closure and vegetation area of research objects) and water. Besides materials to support observations in the field, also used chemicals for perform land observations or analysis in the laboratory. While the equipment to support this research is a computer device with ArcGis 10.6 and mapsource software programs, GPS (Geographical Positioning System), stopwatch, meter, plastic bags and sample plastic, markers, label paper, and bucket.

Determination of the sample point was carried out in the Sub District of North Tarakan, Juata Laut Village area measuring 84.54 Km^2 by using the survey method and the grid method. Interval interval distance The *x* 2000m axis and *y* 1000m axis. Determination of coordinates and intervals of each point the sample was carried out with the ArcGis and mapsource software programs. The number of sample points will be used in this study as many as 15 points and observations were made 3 times Deuteronomy for each sample point. The research sample point layout can be seen in Figure 1.

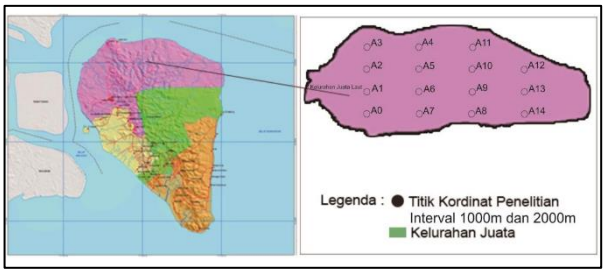

Figure 1. The research sample point layout

Table 1. The sample point coordinates

Sample point	*x* coordinates	y coordinates
A0	560839	375149
A1	560839	376516
A2	560839	377882
A3	560839	379249
A4	564222	379249
A5	564222	377882
A6	564222	376516
A7	564222	375149
A8	567606	375149
A9	567606	376516
A10	567606	377882
A11	567606	379249
A12	570989	377882
A13	570989	376516
A14	570989	375149

Identification of land use conducted a survey with direct observation in the field each sample point. Then classified based on land use in the area research in Sub District of North Tarakan, Juata Laut Village. The soil sample to be analyzed is taken using a ground drill or hoe sample point is 100 grams. Soil analysis to be carried out in this study is soil water content and soil texture (clay, sand, and dust).

The measurement of infiltration rate is done using a double ring infiltrometer device with a diameter of 50 cm and 20 cm. This tool is equipped with a water reserve tank, but in the study of water tanks replaced with buckets and jerry cans. Besides that, still necessary equipped with wooden pads and iron bats to insert a cylinder into the ground. Furthermore, the double ring infiltrometer is put into the ground as deep as 5-10 cm, on the cylinder The scale ruler was installed. Then poured water into the cylinder with height of 10-20 cm from the surface. Decreased water height is recorded at intervals every 5 minutes.

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Observations were stopped after being reached relatively constant infiltration, the infiltration rate was expressed cm/hour. Measurements were made as many as 3 replications at each measurement location.

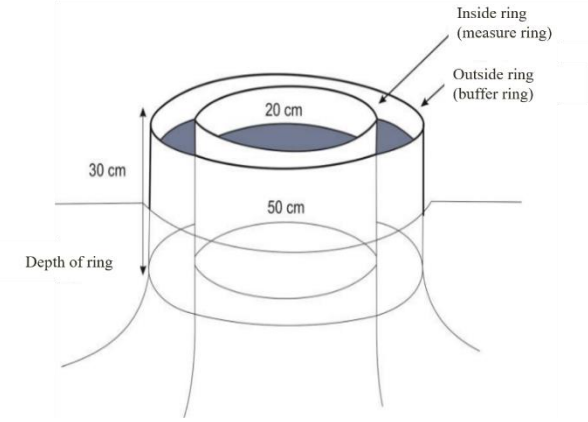

Figure 2. Double ring infiltrometer

Data analysis is done using the microsoft excel program presented descriptively and tabulation of measurement results in the field. The infiltration rate is determined by calculating water levels using equation (1) and infiltration modeling is calculated use equation (2).

$$f = \frac{\Delta H}{t} \times 60 \text{ .....[13]} \quad (1)$$

f : infiltration rate (cm/hour)

ΔH : high water decrease in a certain time interval (cm)

t : time interval (hour)

$$f_t = f_c + (f_o - f_c)^{e^{-kt}} \text{ .....[14]} \quad (2)$$

f_t : infiltration capacity (cm/hour)

f_o : initial infiltration capacity (cm/hour)

f_c : constant infiltration capacity (cm/hour)

k : constants of infiltration capacity

t : time interval (hours)

e : constant numbers

he form of the linear equation of the infiltration variation curve with time is as follows:

$$y = mx + c$$

$$y = t, m$$

$$m = \frac{-1}{k \log e}$$

$$X = \log\ (f_o - f_c)$$

$$C = \left(\frac{1}{k} \log e\right) \log(f_o - f_c)$$

The value of m is a gradient obtained from the plotting of the graph of the relationship between actual infiltration (t or f_o) with log (f-f_o). After all the parameters are known, the calculation of hortonal infiltration done with microsoft excel programs.

RESULT AND DISCUSSION

Identification of land use is one of the factors that determine the value of infiltration. In addition, soil treatment techniques greatly affect the classification of land use especially type of vegetation. Table 2 shows the classification of land use in the Sub District of North Tarakan, Juata Laut Village.

Table 2. The classification of land use

Sample point	Land use classification	Land use
A0	Non-vegetated Area	Settlement area
A1	Non-vegetated Area	Settlement area
A2	Vegetated Area	Corn plant area
A3	Vegetated Area	Grass area
A4	Vegetated Area	Grass area
A5	Vegetated Area	Grass area
A6	Vegetated Area	Papaya plant area
A7	Vegetated Area	Grass area
A8	Vegetated Area	Grass area

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Sample point	Land use classification	Land use
A9	Vegetated Area	Banana plant area
A10	Vegetated Area	Banana plant area
A11	Vegetated Area	Forest area
A12	Vegetated Area	Forest area
A13	Vegetated Area	Papaya plant area
A14	Vegetated Area	Grass area

Table 2 suggests that land use in the Sub District of North Tarakan, Juata Laut Village is mostly grass and agricultural land. This is given that part of large people in the Juata Laut Village work as farmers. Infiltration value will different depending on the condition of the ground surface, soil structure, and vegetation. System the roots of vegetation and litter produced by plants can help raise soil permeability so as to increase the infiltration rate.

Land research sample point was analyzed in the Laboratory of Soil Sciences Faculty of Agriculture Borneo Tarakan University. The parameters analyzed are the physical properties of the soil consists of texture and water content. Soil texture is basically associated with pore state soil. Infiltration capacity will be even greater if the soil has the amount and size of the soil pores the big one. The results of the soil analysis of the research sample point can be seen in Table 3.

Table 3. The analysis of research site soil samples

Sample point	Soil texture (%)			Classification of soil texture	Soil water content (%)
	Sand	Dust	Clay		
A0	73,15	17,85	9,00	sandy loam	21,24
A1	65,05	18,45	16,47	sandy loam	26,67
A2	49,69	11,20	39,11	sandy clay	16,21
A3	77,84	19,78	2,38	loamy sand	21,06
A4	63,76	9,72	26,52	sandy clay loam	30,20
A5	44,62	20,62	34,76	clay loam	18,17
A6	73,29	20,85	5,86	sandy loam	20,01
A7	39,18	29,64	31,18	clay loam	51,07
A8	40,95	25,48	33,57	clay loam	12,35
A9	32,16	38,33	29,51	clay loam	25,03
A10	33,89	34,53	31,58	clay loam	7,53
A11	70,38	9,05	20,57	sandy clay loam	17,48
A12	47,32	24,29	28,39	sandy clay loam	10,95
A13	55,36	7,70	36,94	sandy clay	30,88
A14	51,56	9,62	38,82	sandy clay	8,41

Sand surface that is sandy in general has a high infiltration rate than land whose surface see. Water moves faster in sand textured soils because has a large pore space while clay textured soils have small pore spaces water moves slowly.

Table 3 explains that the sample point of the study location has mostly class clay texture that can increase the value of the infiltration rate. Clay texture has a draw composition between rough fractions and fine fractions and is considered a texture optimal for agriculture. This is because the

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clay texture has the ability absorb nutrients, drainage, aeration, and soil processing that is better than the type of texture other.

Besides that, the value of ground water content also affects the infiltration rate, if the water content In high ground, the water that enters the ground will be small and cause the infiltration rate Small and vice versa.

Measurement of infiltration rate the infiltration rate of a soil is generally higher and tends to decrease achieve constant with increasing time of observation. Infiltration rate at the beginning of observation has a high value because the soil is initially dry and then decreases gradually and reach constant. This decreased infiltration rate is due to reduced suction of soil matrix Along with the deeper the soil profile that is wet due to infiltration and finally Only gravitational pulls that cause water to move down. Table 4 shows the rate Infiltration of the Sub District of North Tarakan, Juata Laut Village area.

Table 4. The infiltration rate of the research location

Sample point	infiltration rate (cm/hour)	
	field infiltration capacity	constant infiltration capacity
A0	7,70	1,60
A1	11,45	2,40
A2	18,03	2,40
A3	19,90	3,60
A4	17,30	4,00
A5	19,61	4,00
A6	7,93	2,40
A7	6,93	2,00
A8	17,17	4,00
A9	12,73	2,40
A10	12,72	2,40
A11	28,53	7,20
A12	25,27	4,80
A13	12,33	2,80
A14	17,75	3,60

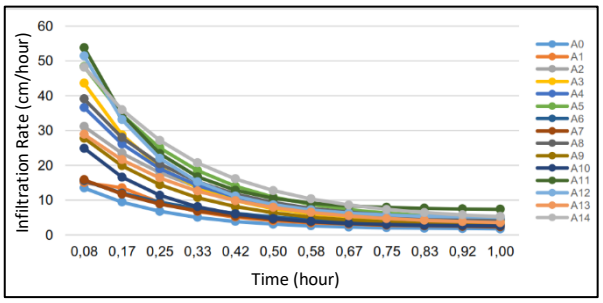

Figure 3. The infiltration rate of Horton models

Table 4 explains that the lowest field infiltration rate value is at the sample point A7 namely 6.93 cm/hour, the highest is at the sample point A11 which is 28.53 cm/hour, and the average amounting to 15.69 cm/hour. Based on the field of infiltration rate of the field that the Sub District of North Tarakan, Juata Laut Village is included in the classification of fast infiltration.

CONCLUSION

The classification of land use in the Sub District of North Tarakan, Juata Laut Village is dominated by use grass land and agricultural land. Most soils the research sample point has a texture class clay that can increase the value of the infiltration rate. The study area has an infiltration classification as fast as 15.69 cm/hour.

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