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by Badaruddin Badaruddin

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The Study of the Rate of Infiltration and Soil Permeability on Different Land Cover in Watershed Maluka Province of South Kalimantan

Badaruddin[1*], Syarifuddin Kadir[1], Ahmad Yamani[1], Nurlina[2]

[1]University of Lambung Mangkurat, Faculty of Forestry, South Borneo, Indonesia
E-mail: badaruddin.hamdie@ulm.ac.id; odeng1987@yahoo.com;a.yamani@ulm.ac.id
[2] University of Lambung Mangkurat, Faculty of Mathematics and Natural Science, South Borneo, Indonesia E-mail: nurlina_abdullah@ulm.ac.id

Abstract—*Infiltration is part of the hydrologic cycle, namely the process of entering water from the surface into the soil. Infiltration is affected by vegetation, slope and soil type. This study aims to analyze the amount of capacity and volume of infiltration in open land, shrubs and rubber plantations in the watershed Maluka. This research method using the formula Horton with point observation using a purposive sampling by observing the various land closure. The results showed that the highest infiltration capacity value on the secondary forest land cover of 5,945 mm/hour and the lowest is the reeds with a value of 0,687 mm/hour. The value of the highest volume of infiltration in the secondary forest of 3,249 mm³ whereas the lowest on the Palm of 0,153 mm³.*

Keywords— ***Infiltration, Soil Permeability, Watershed of Maluka.***

I. INTRODUCTION

Infiltration is the process or percolating water ingress into the ground through the ground surface which is a thick amount of water can seep into the ground in a unit of time. Infiltration is the main source of the existence of groundwater, in the absence of infiltration of rainwater into the ground th limited water in the ground. Next Indarto suggests that the rate of infiltration is the amount of water that goes into the ground for a certain period[1]. Some of the factors that affect infiltration are: (a) soil texture; (b) the closing of land vegetation and land surface characteristics; (c) levels of permeability land; (d) morphology of the land; (e) the slope of the land, (f) the type and pattern of rainfall; and (g) e intensity of the rain[2,3,4].

Infiltration is a part of the hydrological cycle i.e. the process of water from the surface into the soil. A region if infiltrations is interrupted, it will affect the region in the hydrological cycle, so that the natural balance is not met. Hydrological cycle is the movement of water into the air then fall to the floor the Earth as rain[5].

Patterns of land use is a major factor that affects the soil infiltration. Thus, improving the soil infiltration and reduces runoff-the surface is very important for the conservation of soil and water, it can help farmers choose a rational cropping pattern[6]. Measurement of infiltration on a surface of land or under the closure of land usually consist of Infiltration capacity and infiltration rate, expressed in the thick water per unit of time (inches per hour or centimeters per hour). Rainfall exceeding infiltration capacity can lead to the occurrence of surface flow to lower and ended in rivers, creeks or her shelters in a basin. Some of the factors that affect the rate of infiltration are: (1) the ability of the land lear water on the surface and infiltrated into the soil; (2) water content in the soil profile, (3) the amount of water available in the soil surface; and (4) the characteristics of the land surface[7].

The study of the rate of infiltration is intended to find out how the speed and magnitude of the influx or his pervasive water vertically to the body ground. By observing or testing of this nature is expected to give an overview of the needs of irrigation water that is required for a type of soil for certain kinds of plants at one time. Infiltration rate data can also be used to infer when a run-off will occur when a type of land has received a number of specific water through rainfall or irrigation water of ground level. Infiltration rate measurement results data of this kind can also be used for the purpose of planning the management of irrigation water and soil and water conservation[8].

Sosrodarsono suggests that the vegetation factors affect the variation rate of infiltration, because vegetation in addition to hardening the surface reduces role, it can also improve infiltration[9]. According to Lee *et al*., the capacity

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of infiltration on soil vegetation higher than land does not bervegetasi, and the type of vegetation is largely determining the infiltration capacity[10]. Related to problems relationship this infiltration, vegetation and Widianto *et al*. suggests that deforestation or trees simultaneously and tripe exhausted has been disrupting the function of forest hydrology, because such logging damages the soil surface in the form of a decline in organic matter, the amount of pore space, and rate infiltratio of rain water[11]. Efforts improve the physical properties of the soil and hydrological functions of forest damaged can be charged at the coffee plants, but there needs to be other efforts such as the granting of extra organic matter, closing down plants, making hole sink in, making the terrace and drains.

II. RESEARCH METHODS

The research was implemented on watershed Maluka. Implementation of research, starting from the month of February 2018 until finished. The object examined was infiltration in secondary forest, Scrub, gardens of rubber, palm oil, dry land Farming, open land, Garden blend, and reeds. The equipment used in this research is the Jerry cans to hold water, double ring infiltrometer to measure the rate of infiltration, the stopwatch to measure time, clinometer to measure sloping, a ruler to measure the height of the face of the water, hammer to insert the infiltrometer into the ground, the camera for documentation during the study, the calculator to calculate data, stationery. The materials needed in this study is water.

2.1. Research Procedure

Layout of data retrieval or infiltration rate measurements done on a purposive sampling, double ring infiltrometer tools laying on the area or area that are considered to be representative of the entire area are examined according to the provisions.

Procedures of Data collection and Retrieval Research layout of data retrieval or infiltration rate measurements done on a purposive sampling, double ring infiltrometer tools laying on the area or area that are considered to be representative of the entire area of the examined according to the provisions. Efforts are being made to collect the necessary data in this research in the form of primary data obtained by observing it directly in the field (observation), which consists of the data retrieval rate of infiltration in secondary forest, Shrubs, Rubber, Palm Groves, dry land Farming, open land, Garden blend, reeds. Secondary data retrieval is performed to complete the study, the data collected in the form of data about an overview of the location of the research obtained from the relevant agencies, the rainfall data representing the region of watershed Maluka retrieved from BMKG Station Banjarbaru climatology, as well as a map of the watershed, land cover Maps, sloping maps and maps of soil type.

2.2 Data Analysis

Infiltration Measurement Data analysis conducted in secondary forest, Scrub, gardens of rubber, palm oil, dry land Farming, open land, Garden blend, the reeds so that the retrieved data and volume of infiltration capacity. On the calculation of data research results using the formula Horton infiltration. Model Horton is one of the well-known infiltration m owledged that infiltration ca : to approach the value of be expressed mathematical [12]:

$$f = f_c + (f_0 - f_c)\, e^{-kt}$$

$$V = f_c t + \frac{f_0 - f_c}{K}\,(1 - e^{-kt})$$

Description

f_c : constant Infiltration (mm/h)
f_0 : infiltration of the beginning (mm/h)
f : infiltration Capacity (mm/h)
v : Volume of infiltration (mm ^{3})
t : time
k : Constants
e : 2.718

Follow details the level of classification of the infiltration which can be seen on the Table 1.

Table 1. Classification of soil infiltration

Description	Infiltration (mm/h)
Very slow	< 1
slow	1 – < 5
Being-slow	5 – < 20
Being	20 – < 65
Medium fast	65 – < 125
fast	125 – < 250
Very fast	> 250

Source: Lee, 1988

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III. RESULTS AND DISCUSSION

3.1 Analysis of Infiltration

Analysis of Infiltration Measurement tool using the Double Ring Infiltrometer outer diameter 50 cm and the inside diameter of 30 cm and a height of 30 cm above the ground surface. The outer ring of water function is to maintain the flow of the water ring the inside so that it moves vertically to the bottom so it doesn't spread. Infiltration measurement approaches are conducted every 5 minutes, this is in accordance with the Madrid *et al*. that the infiltration measurement using a circular metal ring with five-minute intervals[13]. Infiltration measurement is done on a variety of land such as the closing of secondary forest, Scrub, gardens of rubber, palm oil, dry land Farming, open land, Garden blend, and reeds.

3.2 Permeability of Soils

Based on the results of laboratory analysis of soil permeability values obtained Agricultural land as in table 2.

Table 2. The Results of the Analysis of Permeability

No.	Land Cover	permeability	Texture Class	Description
1	Secondary forest	2.21	Sandy clay	Medium
2	Scrub	9.02	Days clay	Rather fast
3	Rubber Gardens	4.95	Days clay t	Medium
4	Palm	1.28		Rather slow
5	Dry Land Agriculture	1.49		Rather slow
6	Open Land	8.87		Rather fast
7	Garden Mix	1.59		Rather slow
8	the tares	7.24		Rather fast

Source: Primary Data Field

The data obtained can be seen the highest permeability in bushland 9.02 cm/sec and lowest in plantations of 1.28 cm/sec. This shows that the permeability on the area can be said to be rather slow up rather quickly because affected by factors of soil types sandy clay and clay namely clay according to Rachim that the permeability of the land has the increasingly rough texture then the permeability of the faster, whereas soil texture on the areas of research, namely clay, sandy clay and dusty clay which is smooth, slick and somewhat very closely so that permeabilitas low[14]. Permeability is closely related to the land if the pore size large movements of water and air in the soil will be free so that his infiltration will be high.

Texture soil from the results of research are most clays clay and clays. The soil clays and clay higher in water saving compared to the sandy soil it is in accordance with the opinion of Buckman and Brady; Islami and Utomo that store water for power ground sandy have the binding power against relatively low land permeability, because the surface of contact between the surface of the soil with water on soil texture and soil sandy this dominated by macro-pores, therefore water that falls to the ground sandy will soon be experiencing percolation and capillary water will easily be separated because of evaporating[15,16].

3.3. Average Capacity and Volume of Infiltration

Based on the results of the calculation of the capacity curve of infiltration on the various land closure (Figure 1), the situation analysis conducted further to find out the average capacity and volume of infiltration. The results of the analysis of capacity and volume of infiltration in watershed Maluka presented at table 3. infiltration capacity analysis results and the volume of infiltration in the closure of land and sloping in watershed Maluka.

Table 3. The results of the analysis of capacity and volume of infiltration on the various closures of land and sloping in Watershed Maluka

No.	Land Cover	fo (mm/h)	fc (mm/h)	f (mm/h)	v (mm³)
1	Secondary forest	11	5,0	5,696	3,134
2	Scrub	8	3,0	3,217	1,493
3	Rubber Gardens	5	2,0	2,141	0,734
4	Palm	1	0,6	2,201	0,249
5	Dry Land Agriculture	1,3	0,7	0,750	0,304
6	Open Land	0,3	0,2	0,824	0,160
7	Garden Mix	8	4,0	4,303	3,151

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8	the tares	0,4	0,2	0,234	0,123

Source: Primary Data Field

Description

fo = When the initial infiltration capacity (mm/h)

fc = Infiltasi time constant capacity (mm/h)

f = infiltration capacity or maximum rate of water into the soil (mm/h)

v = volume of infiltration (mm ^{3})

The results of the analysis of infiltration capacity that the highest obtained at the close of the secondary Forest land with a value of 3.134 mm/hour while infiltrating the lowest land on the tares with a value of 0.123 mm/hour. This is due to the magnitude of infiltration in secondary forest affected by the density of the heading. The closure of the heading which more meetings will increase the organic matter of the resulting litter. Palm land vegetation cover soil is dominated by short grass that rooting, so infiltration is low. This is in accordance with the statement of Yanrilla where the rainwater that falls on the soil surface is not direct but halted by the vegetation in the form of the heading and the lower plants so that the resulting infiltration will be high[17]. This is supported by the statement that the existence of trees then the rooting will increase in the absorption of water so it will enlarge infiltration[18].

Based on soil vegetation in addition to rooting activity that helps to form aggregates of soil is also able to protect surfaces from rain resistant so as inhibit the flow of the surface. Vegetation can enhance infiltration because of the rooting that is able to absorb the water goes into the ground. As for the land that is not vegetation have a low infiltration because there is no root that can absorb water so high surface flow and can cause the onset of erosion. Change and conversion of land use and forests usually have an impact on the reduction of the rate of infiltration of rainwater and capacity, as well as an increase in surface runoff and soil erosion[19,20,21,22,23,24,25].

Table 3 shows that the highest volume of infiltration on the closure of secondary forest land of 3.249 mm ^{3}, while the lowest volume of infiltration in the land of Palm 0.153 mm ^{3}. It is influenced by soil conditions, permeability and organic ingredients. Research on soil contains clay obtained a high volume of low flow and infiltration of the surface height. In addition to organic materials and permeability infiltration also affected by the abundance of rain water which fell (rainfall) and the amount of water that is absorbed by the soil (infiltration) and left on the ground and on the surface of the leaves and stem[26,27].

Different soil causes the air permeated with different pace. Every land has different absorption, on the type of sandy soils tend to high infiltration rate and conversely clay tend to rate his infiltration low. Note that the pore on the clay in size small so that the movement of water and air in the soil will not free then his infiltration is low and if rain occurs on the area although with fairly low rainfall will cause a flow of surface. On one of the same soil type with a different density, then the rate of his infiltration is also different, if the more dense the soil the more small rate of his infiltration. Ground with grain that is too coarse (sand) could not resist water and nutrient elements, thus the plants that grow on the soil of this type is prone to drought and nutrient deficiencies[28].

3.4.Land cover against Infiltration

Based on conditions in the field of land cover factors affecting the rate of infiltration. If the more dense the soil then the surface flow is high and low his infiltration. The magnitude of the surface flow will cause the high removal of topsoil and there is no chance of water that goes into the soil (infiltration). Land cover data are based on the rate of infiltration can be seen in table 4

Table 4. Land Cover Data Against The Infiltration Rate

No.	Land Cover	f (mm/jam)	Description field
1	Secondary forest	5,696	medium- slow
2	Scrub	3,217	Slow
3	Rubber Gardens	2,141	Slow
4	Palm	2,201	slow
5	Dry Land Agriculture	0,750	very slow
6	Open Land	0,824	very slow
7	Garden Mix	4,303	Slow
8	the tares	0,234	very slow

Source: Primary Data Field

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Based on data obtained in field on his infiltration rate of secondary forest at the time of observation, the situation that is being slow and more slowly. This can be affected by the State of the soil and the vegetation. On all land cover only the rate of secondary forest his infiltration is slow and more slow, this is because there is the vegetation in the form of the trees roots can absorb water into the ground but also influenced by the circumstances the soil in the form of clay so that the rate of his infiltration slow.

While the rate of land cover on all his infiltration slow is due to the State of the vegetation then the surface flow is high and low his infiltration as well as on the influence by the circumstances of a clay soil. Soil texture is the comparison of the content of the particles in the form of clay faction, dust and sand. Soil particles have different shapes and sizes. Coarse-textured soils have a high infiltration capacity while the fine-textured soil his infiltration capacity is small. Undertook to determine soil texture in ground water that is in the form of infiltration speed and ability of the binding of water by land.

Soils containing high amounts of clay can be suspended by a grain of rain that fell on him and the pores of the surface layer will be clogged by grains, this can lead to the occurrence of surface flow and erosion which is quite height. From a wide range of research on infiltration capacity is indeed a sand fraction greater than the fraction of clay, the clay fraction on induced rich smooth pore but poor will pore large, otherwise the poor will sand smooth and rich pore large.

Based on the above discussion of known capacity and volume of infiltration on watershed of Maluka is influenced by soil type and vegetation. But not only vegetation and soil type that can affect the rate of infiltration but also a high rainfall, which will cause the ground became saturated in the absorption of the water be not optimal, thus causing a high surface flow and triggered erosion and can be concluded that the area of watershed Maluka is going to flood-prone areas.

A very important part of infiltration in the hydrological cycle, with the process of infiltration so can reduce the occurrence of floods, reduce the occurrence of soil erosion as well as meet the needs of crops or vegetation will provide water and river water on When the dry season.

IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of research that has been carried out in watershed Maluka retrieved Data research results obtained as a result of infiltration the highest on secondary forest of 5.696 mm/h and low infiltration on the Tares of 0.234 mm/hour. And the highest Volume of infiltration in the secondary forest of 3.134 mm^3, while the lowest volume of infiltration on the tares of 0.123 mm^3. Research on soil contains clay and sandy clay high so obtained a low infiltration volume and flow of the surface height.

The research of infiltration in watershed Maluka can be said that in the process of his infiltration is low. This is due to the condition of the soil will be less vegetation so that the organic material content a bit. So should the area of watershed Maluka is need for conservation action so that the soil conditions are getting better and the danger of erosion which will cause catastrophic flooding can be resolved.

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