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Infiltration Rate of Quarternary Sediment at Rumbio Jaya, Kampar, Riau

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Abstract

The study of infiltration rate was conducted at Rumbio Jaya, Kampar, Riau which closed with meandering river of Kampar. Infiltration rate data collected by using double ring infiltrometer with 30 cm and 60 cm diameter of cylinder. To support the data of infiltration test at quarternary sediment, subsurface soil profiling data were taken with hand auger drilling. The result of infiltration rate analysis shown the highest value is located at ST 2 and ST 3 (southwest part of study area) with value 248 mm/hr and 159 mm/hr. infiltration rate gradually decreasing toward northeast of study area with lowest value 2.6 mm/hr at ST 6 which caused location very closed to Kampar River. Core data from hand auger drilling support result of infiltration rate with gravelly sand layer (high porosity and permeability) are dominated at study area and some low infiltration rate location consists of thick layer of silt.
Keywords: Infiltration rate, Quartenary Sediment, Rumbio Jaya

1. Introduction

Infiltration is the process by which water arriving at the soil surface enters the soil. (Richards, 1952) infiltration is defined as the downward entry of water into soil or sediment and infiltration rate (infiltration capacity) as the maximum rate at which a soil will absorb water impounded on the surface at shallow depth when adequate precautions are taken regarding border, or fringe, effects. Infiltration study become important because the effect of capacity of the water that can be enter to the ground. In planning to develop an area, infiltration rate is one of many parameters that have high responsibility to determine which area should and have potential to develop. Many researchers have done water infiltration analysis in many kinds of purpose such as slope stability, air indiltration rate, rainfall runoff and soil erodibilty (Cheng et al., 2017; Cuomo and Sala, 2013; Hou et al., 2017; Wang et al., 2015).

The study area is located in Rumbio Jaya, Kampar, Riau (Fig. 1) bounded by latitude N 00 21' 35.88" - N 00 19' 53.8" and longitude E 1010 07' 35.03" - E 1010 09' 36.4". The study area very closed with meandering river of Kampar. Kampar River originates in the mountainous Bukit Barisan of West Sumatra and empties into the Malacca Strait on the eastern coast of Sumatra Island (Yuskar, 2016; Yuskar and Choanji, 2016a; Yuskar and Choanji, 2017; Yuskar and Choanji, 2016b). Meandering river will change the direction through erosion and depositional proses and produces some of alluvium deposits. Changes or migration of meanders resulting a general fining-upward point bar deposits and in turn silty and muddy floodplain deposits (Allen, 1965; Boggs, 2005).

The aims of this study is to determine the infiltration rate of study area with produce the infiltration rate maps and identify the factor that influence the infiltration rate at sediment quarter.

2. Geology and Geomorphology Regional

Based on geomorphology, Rumbio Jaya, Kampar, Riau divided into two types of geomorphology. The first is plain area that identified as floodplain that very close with meandering river of Kampar. The second is gently hills area with elevation 31 to 106 m above sea level.

Kampar's river is considered as fluvial meandering system because there are erosion of the outer bank and deposition of bedload on the inner bank the channel. Sediment deposit on the inner bank is referred to as a point bar. Here distinction between the meandering and river sinuosity (Yuskar, 2016). Based on geological maps (Clarke et al., 1982), Rumbio jaya included in quaternary deposits. There are three formation at the study area. Young Alluvium (Qh) during Holocene-aged are consist of gravels, sands and clays. Older Alluvium (Qp) during Pleistocene to Holocene aged consist of gravels, sands, clays, vegetation rafts and Peat swamps.

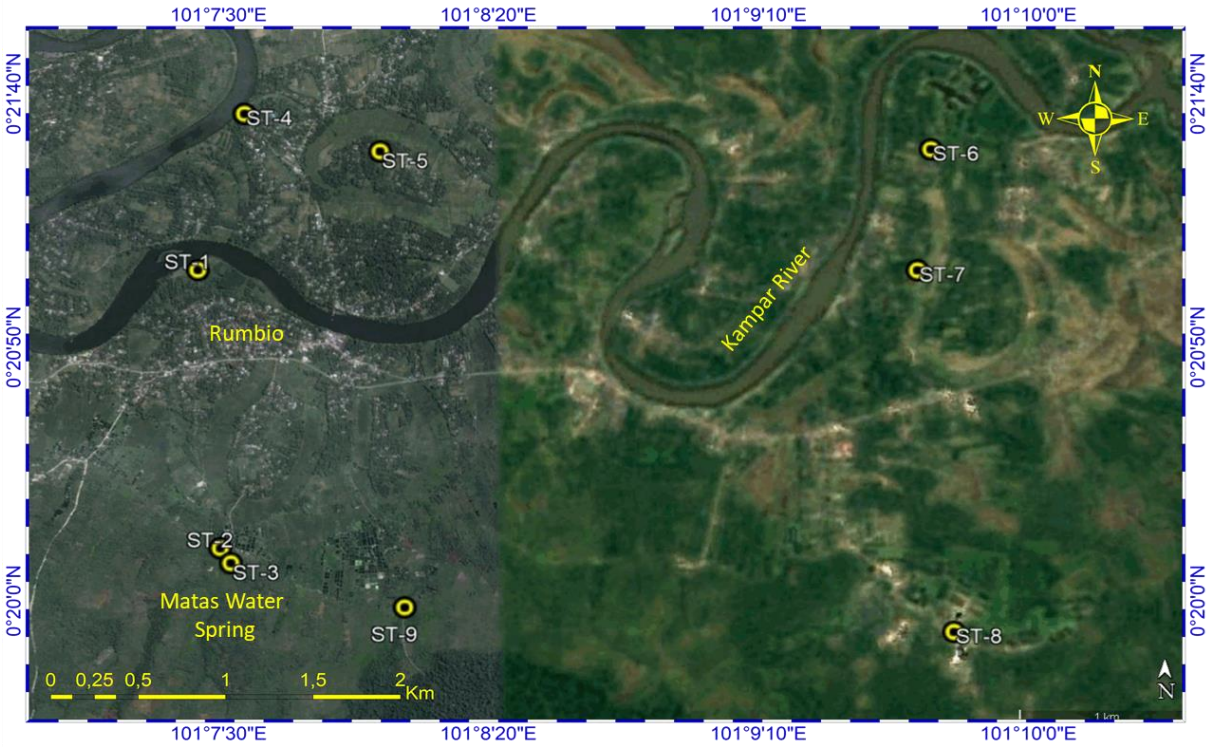

Fig. 1 location of study area

The oldest formation at study area is Minas Formation (Qpmi) that consist of gravels, distribution of pebble, sands and clays. Grain size of sediment such as gravels, sands and clays take the critical value of porosity and permeability (Choanji et al., 2018).

All sediment material produced by sedimentation processes including weathering, erosion, transportation and sedimentation. The highest resistant mineral from all those processes is quartz (Kausarian et al., 2017).

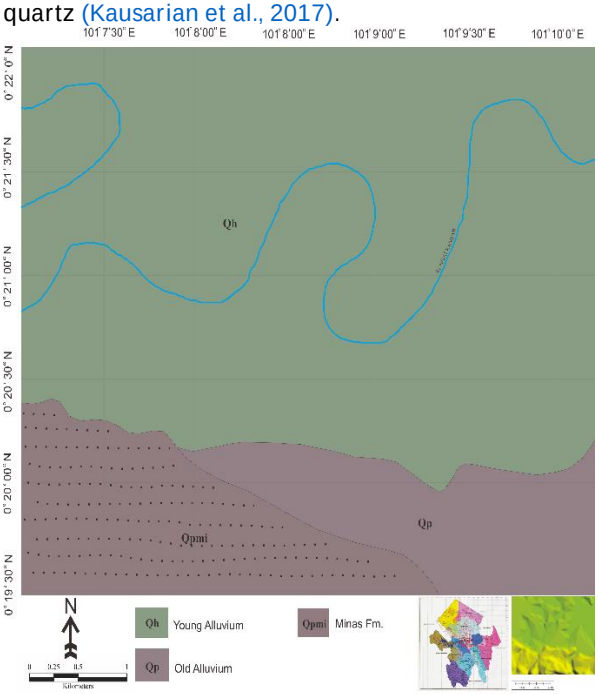

Fig. 2 Geological map of study area.

3. Methodology

3.1 Data collection for water infiltration

Water infiltration carried by using double ring infiltrometer that consist of two metal cylinder (Inner and outer) with 30 cm and 60 cm diameter (Fig.3). Two metal cylinders will minimize the error of lateral spreading of water while infiltrate in the soil because the water level in the outer ring forces vertical infiltration of the water in the inner ring (Gregory et al., 2005). Two metal cylinders penetrated into the ground with depth approximately 15 cm. Water is filled into both cylinders with same level and the water level recorded at a certain time intervals. The data is observed until the recorded value is constant. The infiltration data will be divide by time different to get the infiltration rate.

3.2 Data collection for subsurface sediment profiling

The data for subsurface sediment profiling collected by using hand auger drilling. Penetration of hand auger drilling into the ground depends on subsurface materials. The drilling data will provide the better visualization of subsurface sediment (material and texture). Drilling data were taken every 0.5 m in the metal cylinder and the core sample will be described to determine the soil characteristics. Other than that, geological survey at surface also conducted to determine the relationship with subsurface data (Putra and Yuskar, 2017; Suryadi, 2016). The result of

subsurface soil profiling will support the result of water infiltration analysis.

Fig.3 double ring infiltrometer

4 Result

4.1 Infiltration Rate

Infiltration test was conducted at 9 location within study area. The average of infiltration rate shown at table 1. The range of infiltration rate at study area is 2.6 mm/hr to 248.64 mm/hr. The highest infiltration rate located at ST2 and ST3 with value 248.64 mm/hr and 159 mm/hr. This location is around water source of Sikumbang (MATAS). Meanwhile, ST6 is the lowest infiltration rate with value 2.6 mm/hr. There are several variation of constant value and time of infiltration rate. The curve time versus infiltration rate at Fig. 4 shown their relationship. ST2 and ST3 already has constant infiltration rate from the beginning of test with value around 250 mm/hr and 160 mm/hr. however, mostly of infiltration rate continuously down till come to constant value. ST1, ST3, ST4, ST5, ST6, ST7 and ST8 reach the constant value after approximately 1 hour with constant infiltration value 4 mm/hr, 2mm/hr, 8mm/hr, 2mm/hr, 1.5 mm/hr and 6 mm/hr. meanwhile, ST9 reach the constant infiltration value (100mm/hr) after 30 minutes (Fig. 4).

The isopach map of infiltration rate created by using the average of infiltration rate (Fig. 5). The southwest part of study area is the highest infiltration rate and gradually reduce toward northeast of study area. The study area divided by meandering river (Kampar's river). Northern part of Kampar's river has lower infiltration rate then the southern part.

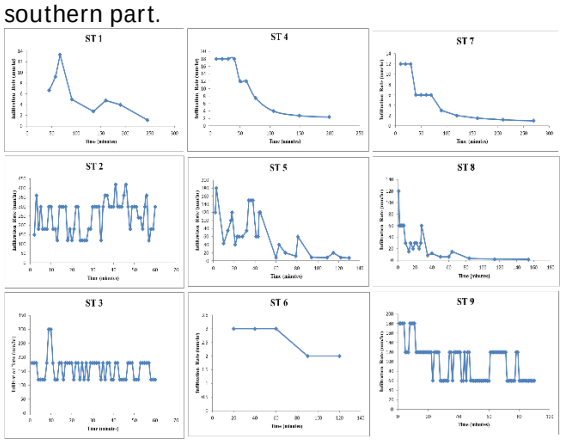

Fig. 4 graph of relationship between infiltration rate and time

Table 1. Result of infiltration rate analysis

Location	Coordinate	Average of Infiltration rate (mm/hr)
ST 1	N 00° 21' 05.08"/ E 101° 07' 26.5"	1.09
ST 2	N 00° 20' 07.3"/ E 101° 07' 32.9"	248.64
ST 3	N 00° 20' 10.2"/ E 101° 07' 30.9"	159
ST 4	N00° 21' 35.88"/ E101° 07' 35.03"	11.27
ST 5	N 00° 21' 28.5"/ E 101° 08' 00.1"	69.15
ST 6	N 00° 21' 29.0"/ E 101° 09' 41.9"	2.6
ST 7	N 00° 21' 05.1"/ E 101° 09' 39.5"	5.72
ST 8	N 00°19'53.8"/ E 101° 09' 46.4"	33.3
ST 9	N 00° 19' 58.6"/ E 101° 08' 05.0"	98

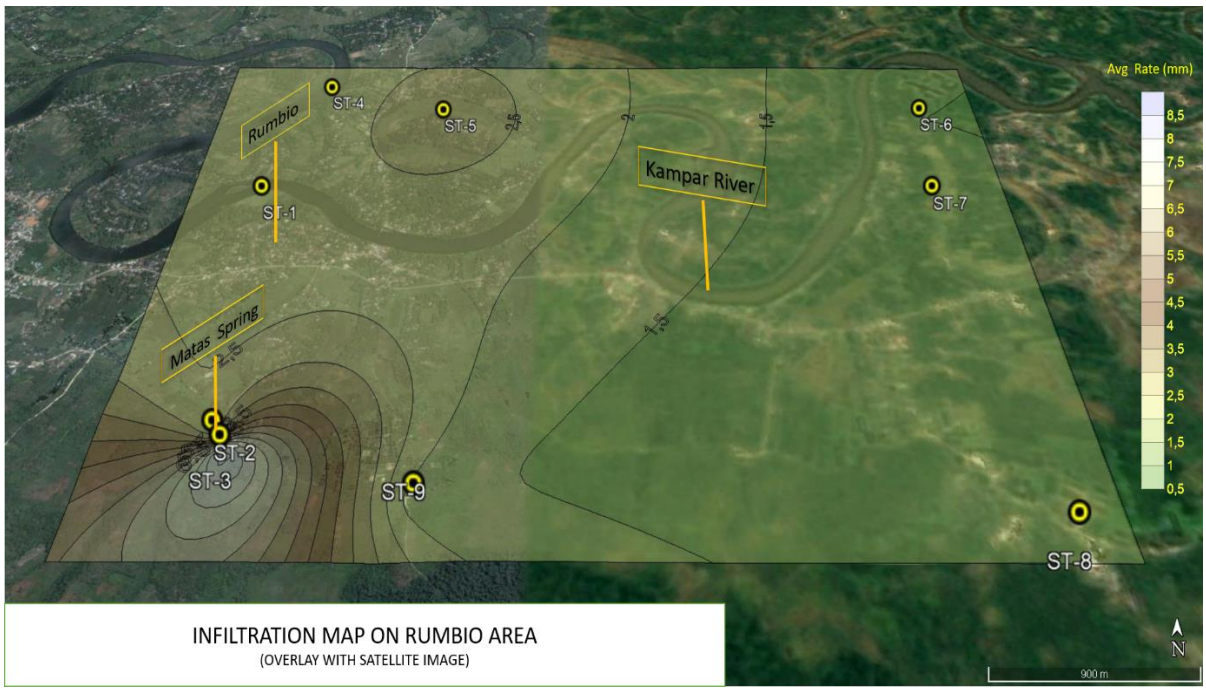

Fig 5. Isopach map of infiltration map overlay with satellite image at Rumbio Jaya, Kampar, Riau.

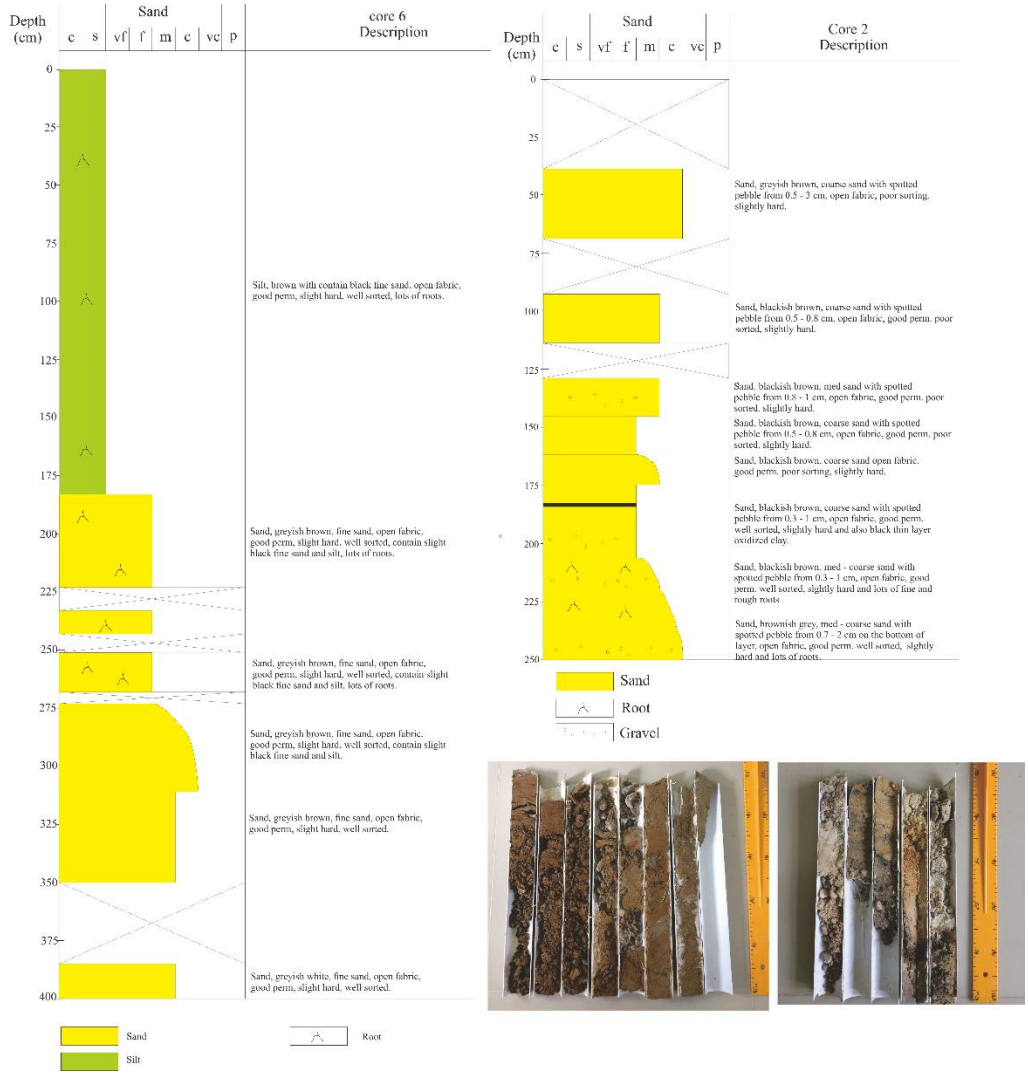

Fig 6. Core sampling and log description of core sampling

4.2 Subsurface profiling of Quaternary deposits

Geologically, study area is a quaternary area that consist of young Alluvium (Qh) during Holocene-aged and old Alluvium (Qp) during Pleistocene-aged. Subsurface sample taken by using hand auger drilling to determine the characteristic of subsurface soil profil. Drilling was conducted at 8 location that nearly from infiltration test have done. The depth of drilling up to 4 meters into the ground. Overall the layer of subsurface at all drilling location are same, they are consist of silty Sand with some gravels layer and Silt with some gravels layer (Fig. 6). At layer that near from surface, some organic materials can be found such as roots, leaves and so on.

Data drilling core 1 to core 5 dominated by material fine sand and medium sand with thin layer of silt. In other sides, at drilling core 6, core 7 and core 8, thick layer of silt was found with 180 cm, 80 cm and 75 cm of thickness. Subsurface material is one of factor that controls infiltration rate where higher porosity and permeability will caused higher infiltration rate. Core 1, core 2, core 3, core 4 and core 5 with sand dominated layer have higher porosity and permeability than core 6, core 7 and core 8 with thick silt layer that lead to faster water infiltration.

5. Discussion

There are many influence factors for infiltration rate. Some of them trying to identify in this study. At ST 2 and ST 3 are the greatest of infiltration rate they are 248.64 mm/hr and 159 mm/hr. the closes drilling data is core 2 which dominant with sand layer and some gravels material up to 2.5 m. sand is the material that has high porosity and permeability that increase infiltration rate. Besides, geomorphology at ST 2 and ST 3 is a gently hills with elevation 31 m – 108 m and about 2 km from main rivers. High elevation and distance from main rivers lead to raising the infiltration rate because groundwater level become more depth and make easy to water to infiltrate into the ground.

On the other hand, ST 1, ST 4, ST 5, ST 6, ST 7 and ST 8 have low infiltration rate. From core data, thick layer of silt only found at ST 6, ST 7 and ST 8 resulting decrease of infiltration rate because of leak of porosity and permeability. For the rest of station, core analysis shown that subsurface layer mostly consist of sand layers but the infiltration rate are slow. Slow rate is triggered by location of station which closed to the main rivers (floodplain area). At floodplain, water infiltration become more slow because the subsurface already saturated by water and capacity to water infiltrate just in small amount.

6. Conclusion

The study of Infiltration rate at sediment Quarter in Rumbio Jaya, Kampar, Riau shown that the highest infiltration rate at study area are ST 2 and ST 3 with value 248.64 mm/hr and 159 mm/hr at southwest of study area nearly with water spring of Sikumbang (MATAS). The distribution of infiltration rate reduce toward northeast of study area. High infiltration rate occur at ST 2 and ST 3 because the subsurface sediment dominated by sand with some gravels. Sand layers lead to high porosity and permeability that caused easily to water to infiltrate into ground. Besides that, geomorphology at ST 2 and ST 3 become main factor to increase the infiltration rate. Gently hills area at ST 2 and ST 3 raising the infiltration rate because of high elevation.

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