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Analysis of Water Balance Aspect on the Results of Geo-electrical Interpretation with Schlumberger Configuration
(Case Study: Sub-Watershed in Malang Regency)

Esti Wulandari[1], Eko Rony Septoraharjo[2], Laksono Djoko Nugroho[3], Hudyantoro[4], Wateno Oetomo[5,*]
Universitas Tujuh Belas Agustus 1945 Surabaya
profwateno.wiro@gmail.com

Abstract: The background of the problem is that the need for water for various purposes constantly increases in line with the population growth and changes in water use patterns caused by technological advances, industrial growth, and changes in land use. Moreover, from the existing problems, several problem formulations were obtained as the basis for identifying the presumption of groundwater presence, which are, 1). What is the magnitude of the infiltration rate in the study area in relation to the influence of land use conditions, 2). How are the results of geo-electric interpretation using the Schlumberger configuration in estimating aquifer layers based on geo-hydrological aspects, and 3). How is the effect of time and cost efficiency? As the conclusion, the research found that; 1). the average volume of the infiltration rate calculation using the Horton method (q) by considering the land cover / land use conditions (C), is more than 200 cm / year. It indicates that the effective infiltration capacity is enough (the annual average can store water up to> 200 cm / year), 2). In that area, an aquifer layer is at the depth of 30-50 meters at the GL 1 point, and at the depth of 22-55 meters at the GL point. Moreover, the results of the analysis show the ability of the land to carry out the infiltration process properly and validate the results of geo-electric investigations, and 3). the results evaluation analysis abled to streamline the amount of operational costs for groundwater source investigations and the time of implementation.

Keywords: Infiltration, aquifer, geo-electrics, Hydrology

INTRODUCTION
Background

The need for water for various purposes increases from time to time in line with the increase in population and changes in water use patterns as a result of technological advances, industrial growth, and changes in land use. Infiltration rate can be measured by calculating rainfall, surface runoff, and estimating other factors of the water cycle, or calculating the infiltration rate using hydrograph analysis. To determine the condition and position of groundwater, data on its geological structure is needed, this is related to the ability of the soil layer to hold, accommodate, and drain water and its capacity.

Some areas in Malang Regency are areas that experience difficulties in finding water sources based on the position of the aquifer depth. For this reason, it is necessary to conduct a study on "Analysis of Potential Estimation of Groundwater Availability Based on the Aspect of Water Balance (Hydrology) in Supporting the Results of Geo-electrical Interpretation Using the Schlumberger Configuration (Case Study: Sub-watershed in Malang Regency).

Research Objectives

a. Analyze the volume infiltration rate using the Horton method (q) by considering the land cover / land use (C) so that the infiltration capacity of the soil is known.
b. Analyze the results of the geo-electric interpretation in the form of the amount of resistivity at each depth interval of the soil structure, so that it can provide an estimation of the aquifer layer position that can be supported by an analysis of geo-hydrological conditions.
c. Evaluate time and cost efficiency in the process of estimating the aquifer layer by considering the accuracy of the interpretation of the geo-electric investigation results based on the affordability of the study area.

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Research Limitations and Scope of Problems

a) The study area is in the Brantas' watershed in Malang Regency.
b) The study uses Climatological data from the Karangkates climatology station and for hydrological analysis using the results of daily rainfall readings at several hydrological posts over the last 10 years, namely: Turen rain station, Kepanjen rain station and Clumprit Gondanglegi rain station
c) The study uses the Thiessen Polygon calculation to analyze the regional rainfall determination with the consideration that the position density of the rain station in the study area is uneven.
d) The study observes several locations in Malang Regency, which are;
- Krajan Hamlet, Curungrejo Village, Kepanjen District, Malang Regency.
- Balong Hamlet - Margosingo Hamlet, Jatirejoyoso Village, Kepanjen District, Malang Regency.

e) For Geo-electric investigation equipment, the study uses the type of tool "ABEM DC Terrameter-SAZ 2000".
f) The electrode configuration method used is the Schlumberger configuration using 2 (two) predictive points at each study location.
g) The study calculates the infiltration rate volume analysis using the Horton method (q) by considering the land cover conditions or land use.

LITERATURE STUDIES

In order to have a complete overview to the conducted research, understanding and comparing of the previous related research is important. Those will help the research to construct the research's methodology and novelty. In detail, the previous researches used are structured as the table 1.

Table 1. Previous studies related

No	Name and Year of Research	Research Title	Method Used	Research Result
1	Darsono Labs. of Geophysics, Department of Physics, FMIPA, Sebelas Maret University / Indonesian Journal of Applied Physics (2016) Vol. No. Page 40	Identification of Shallow Aquifers and Deep Aquifers with Geoelectrical Methods (Case: In Masaran District)	Schlumberger configuration resistivity geo-electric method	The identification of the aquifer layer has been carried out using the geo-electric resistivity method of the Schlumberger configuration in Masaran District. Data collection was carried out with a stretch of AB/2 from 1.5 m to 350 m using a 2119c series OYO Mc-ohm-el resistivity meter. Data processing using IP2win software. The purpose of this research is to identify the location of shallow aquifer layers and deep aquifers. The results can be concluded that the detected aquifer lithology is clay sand, sand, and gravel sand
2.	Lyn Alby1, Ery Suhartanto, University of Brawijaya, Indonesia (2018)	Comparison of Rain To Discharge Transfer Method With FJ. Mock and NReca in the Kemuning Watershed, Sampang Regency	FJ method. Mock and NRECA calibration produced by watershed characteristics. For the NRECA method is a reduction coefficient of 0.9 with conditions between 0.4-0.9,	The approach to calculating the transfer of rainfall into discharge varies widely. The methods used to estimate the amount of river flow, especially in the Kemuning watershed and Sampang Regency, are based on the assumption that during the rainy season there is excess water available and during the dry season there is a drought. These methods are the FJ Method. Mock and NRECA, where both methods are recommended

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No	Name and Year of Research	Research Title	Method Used	Research Result
			PSUB (percentage of runoff that moves out of the watershed through surface runoff) is 0.4 with conditions between 0.3-0.9, and GWF (percentage of groundwater storage that flows into the river as base flow) is 0.6 with provisions between 0.2-0.8	according to KP-01 in 2010. Compared with FJ. Mock, the NRECA method has better results with calibration results, namely the Nash-Sutcliffe Efficiency Coefficient of 0.858, Mean Absolute Error (MAE) of 2.928, Correlation Coefficient of 0.977, and Relative Error (Kr) an average of 27.924%. The resulting calibration parameter value (watershed characteristics) for the NRECA method is a reduction coefficient of 0.9 with conditions between 0.4-0.9, PSUB (percentage of runoff that moves out of the watershed through surface runoff) which is 0.4 with conditions between 0.3-0.9, and GWF (percentage of groundwater storage that flows into the river as base flow) is 0.6 with provisions between 0.2-

For the literature purposes, there are some related subjects need to be discussed, which are watershed, infiltrations, hydrology and designed flood analysis. Firstly, Kodoatie and Sugiyanto (2002) define a watershed as a unitary area/region of water management that is formed naturally where water is caught (derived from rainfall), and will flow from the area/region towards the rivers and its connected rivers.

Secondly, the definition of infiltration according Bambang Triatmodjo (2008) is the water movement underground through soil pores which influenced by gravity and capillaries force. Moreover, refer to Yair dan Leave (1991), the factors influence to the pace of infiltration are coverage area, slope, and differences in soil density. One of the common tools to measure infiltration pace is inflitometer, yet the measurements show by the tool is not precise. Usually it shows higher than the actual values. Moreover, the maximum pace of precipitating that can be absorbed by the soil in certain conditions is called infiltrations capacity (Ersin Seyhan, 1977). On the other hands, according Horton, the infiltration capacity will decrease until becoming constant over times.

Thirdly, Asdak (2006) defines that in the hydrology cycle, input in the form of rainfall will be distributed in several ways, namely water escapes, stem flow, and rainwater that directly reaches the ground surface and is then divided into runoff, evaporation, and infiltration water. Moreover, for hydrology analysis, there are steps or methods need to be considered, which are regional rainfall analysis and designed rainfall. Lastly, designed flood analysis is needed for bringing better research results. Within this discussion, rainfall distribution hours, flows coefficient, flood hydrographs, evapotranspiration and mainstay debit are the importance element of the analysis.

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METODOLOGY

In brief, the research uses methodology as illustrated in figure 1.

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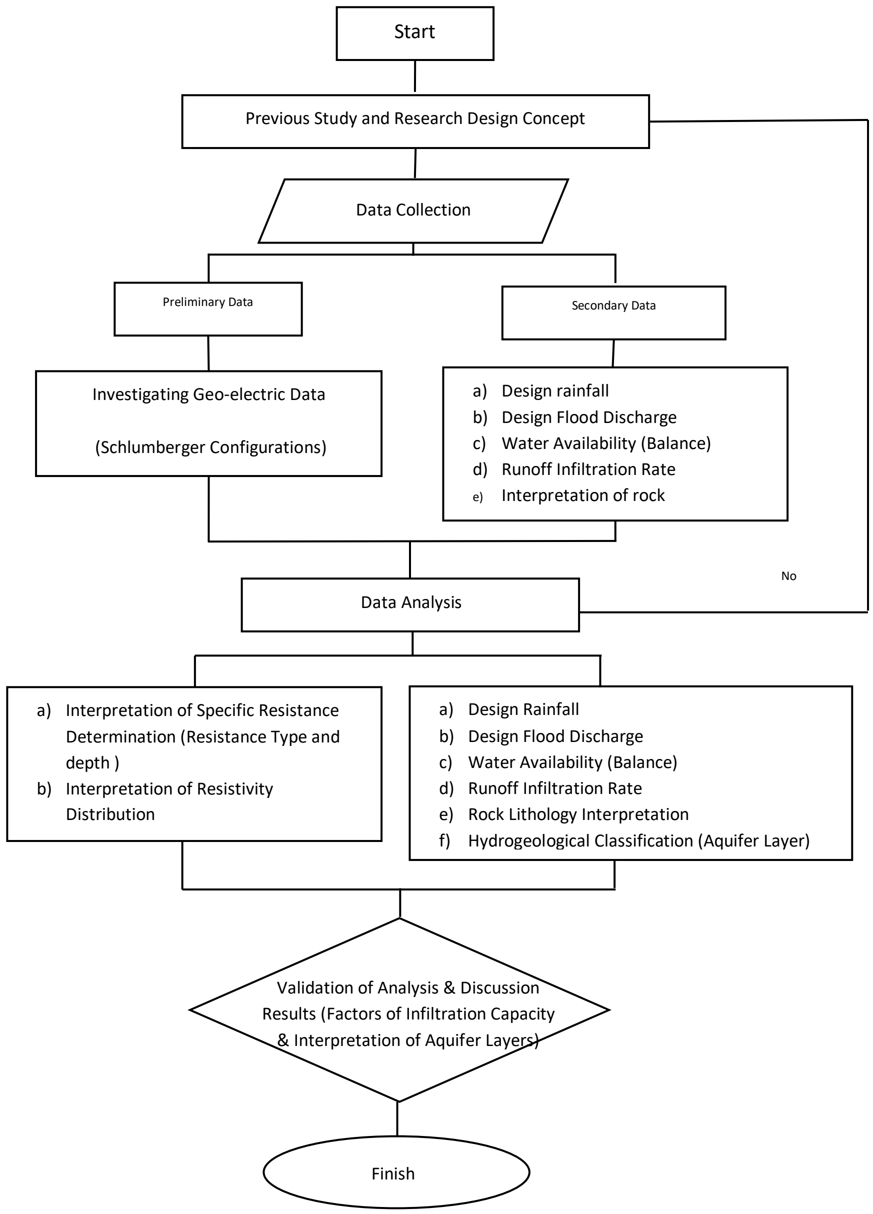

Figure 1. Flowchart of the Research

ANALYSIS AND DISCUSSION

Area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency

Geo-electrical Estimation

Geo-electrical estimation at this location (as pictured in figure 2) was carried out on November 11, 2019 resulting in 2 (two) geo-electrical estimation points at the area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency.

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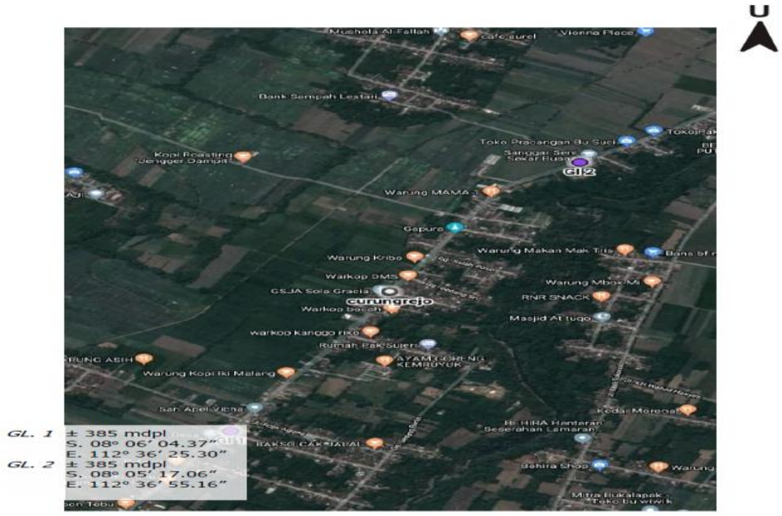

Figure 2. Sketch of Geoelectrical Estimation Locations in area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency

Surface Geology

Vertically and laterally, the rock units that make up this area are alluvium of plain deposits, coarse to medium grained (gravel and sand) with clay inserts, with high to medium graduation.

Hydrogeology

Based on the Hydrogeological map (figure 3), groundwater and aquifers in the study area penetrate the aquifer system in flow through the inter-grain spaces with productive aquifer conditions and widely distributed (moderate continuity aquifers; groundwater table or groundwater level piemetry near or above ground level; well discharge is generally 5 to 10 l/d, and in some places more than 20 l/d).

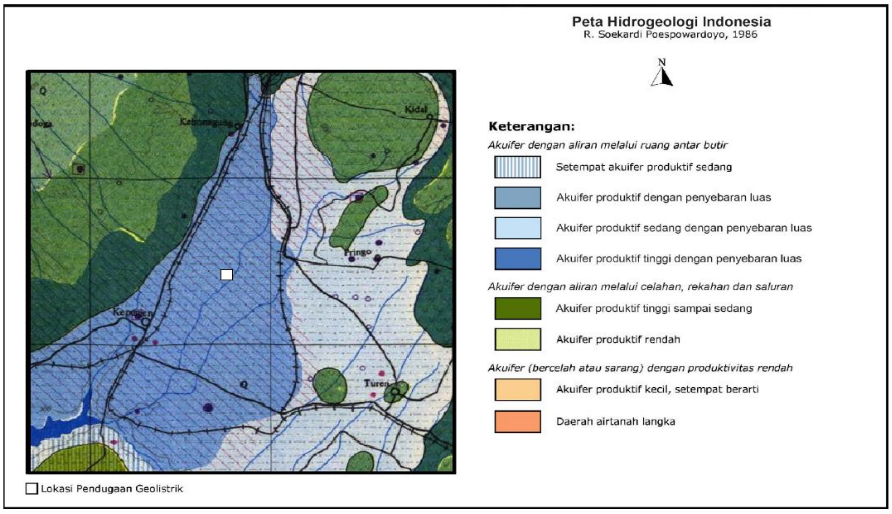

Figure 3. Hydrogeological Map of the Investigation Area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency

Soil Grounded Resistance Prediction Results

Some predictions were made based on soil type and structure and as can be seen in table 2, whilst table 3 illustrates the correlation of soil grounded resistance. From the interpretation results of geo-electrical estimation and has been correlated with local geological and hydrogeological data, in the investigation area of this geo-electrical estimation the soil grounded resistance is between 10 - 250 Ohm-meters.

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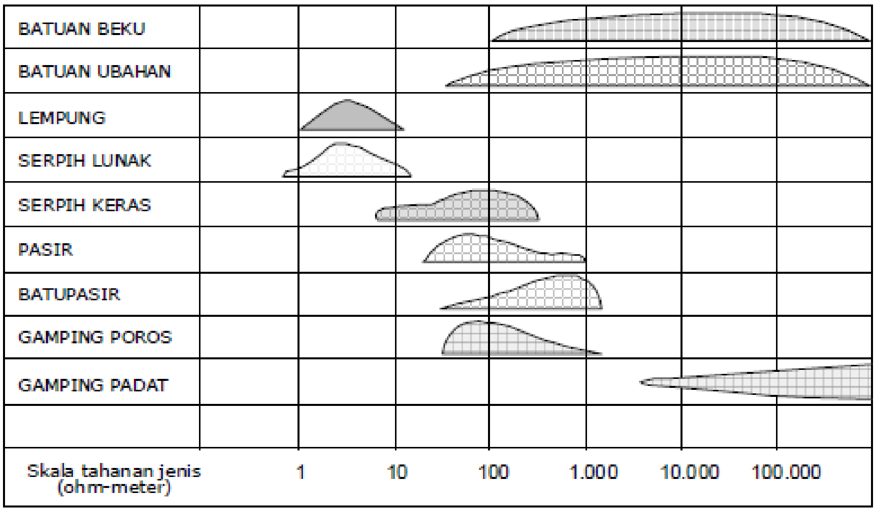
Table 2. Soil Grounded Resistance Prediction

Soil Resistance	Lithology Estimation	Hydrology Estimation
< 10	Lempung	Akuifer
60 – 70	Tufa Pasir	
100 – 110	Tufa Bolder	
250 <	Batuan Breksi	

Table 3. The Correlation of Soil Grounded Resistance



As result of the research investigation, the figure 4 shows the vertical configuration views of soil grounded resistance, whilst figure 5 illustrates the spread of soil grounded resistance in the subjected research location. Moreover, the complete results of soil grounded resistance is shown in table 4.

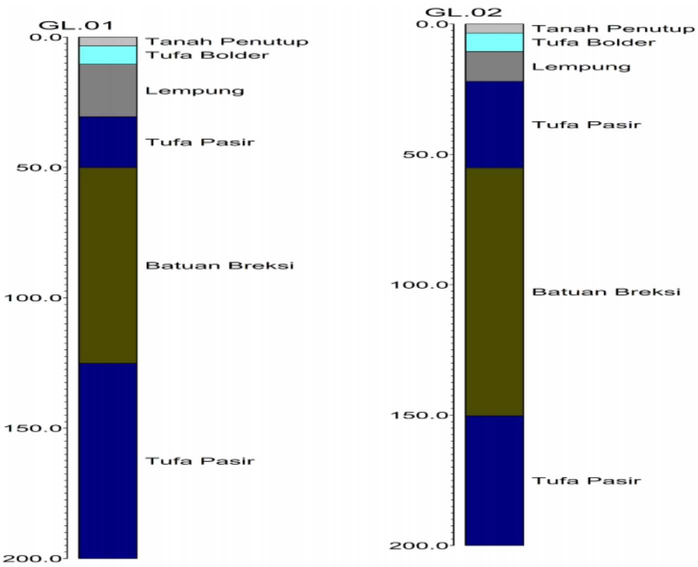


Figure 4. Vertical Section Configuration of Soil Grounded Resistance in the Area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency

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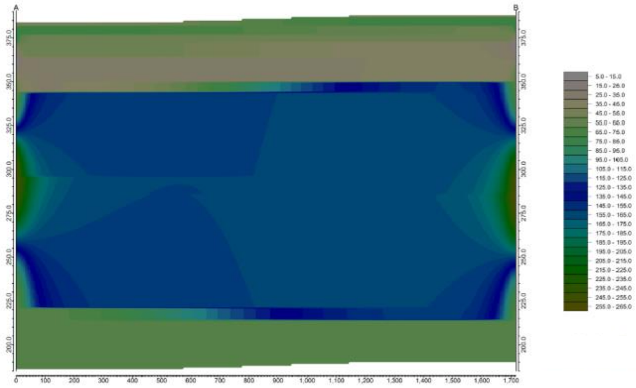

Figure 5. The Spreed configuration of soil grounded resistance in area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency

Table 4. Results of soil grounded resistance in area of Krajan, Curung Rejo Village, Kepanjen District, Malang Regency.

Titik Duga	*Lapisan*	*Hasil Penafsiran*				*Perkiraan Litologi*	*Perkiraan Hidrogeologi*
		Kedalaman			*Tahanan Jenis*		
GL.1	1	0.00	–	3.33	42.66	Tanah Penutup	
	2	3.33	–	10.43	101.44	Tufa Bolder	
	3	10.43	–	30.53	6.04	Lempung	
	4	30.53	–	50.03	61.14	Tufa Pasir	Akuifer
	5	50.03	–	125.13	255.24	Batuan Breksi	
	6	125.13	–	200.00	62.34	Tufa Pasir	Akuifer
GL.2	1	0.00	–	3.44	44.77	Tanah Penutup	
	2	3.44	–	10.54	102.11	Tufa Bolder	
	3	10.54	–	22.04	7.21	Lempung	
	4	22.04	–	55.14	63.31	Tufa Pasir	Akuifer
	5	55.14	–	150.24	260.41	Batuan Breksi	
	6	150.24	–	200.00	64.01	Tufa Pasir	Akuifer

Area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency

Geo-electrical Estimation

Geo-electrical estimation at this location (as pictured in figure 6) was carried out on November 11, 2019 resulting in 2 (two) geo-electrical estimation points at the area of Balong and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency.

Figure 6. Sketch of Geoelectrical Estimation Locations in the area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency

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Surface Geology

Vertically and laterally, the rock units that make up this area are alluvium of plain deposits, coarse to medium grained (gravel and sand) with clay inserts, with high to medium graduation.

Hydrogeology

Based on the Hydrogeological map (figure 7), groundwater and aquifers in the study area penetrate the aquifer system in flow through the inter-grain spaces with productive aquifer conditions and widely distributed (moderate continuity aquifers; groundwater table or groundwater level piemetry near or above ground level; well discharge is generally 5 to 10 l/d, and in some places more than 20 l/d).

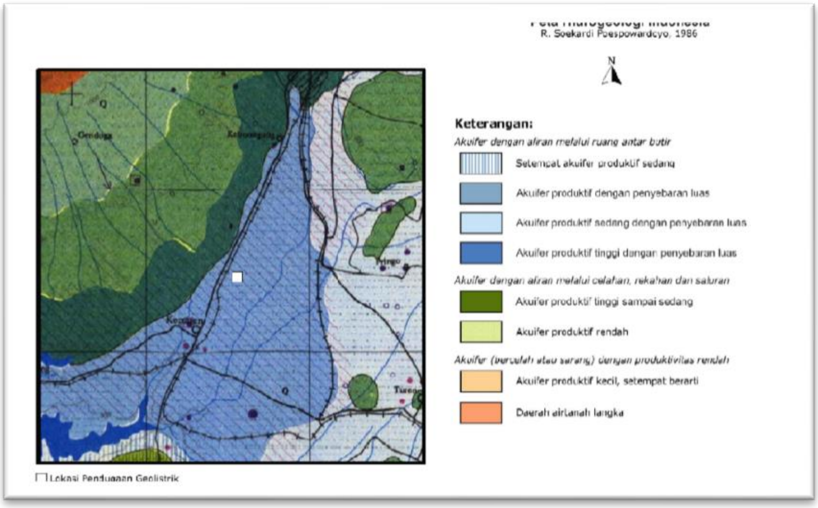

Figure 7. Hydrogeological Map of the Investigation Area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency

Soil Grounded Resistance Prediction Results

Some predictions were made based on soil type and structure and as can be seen in table 4, whilst table 5 illustrates the correlation of soil grounded resistance. From the interpretation results of geo-electrical estimation and has been correlated with local geological and hydrogeological data, in the investigation area of this geo-electrical estimation the soil grounded resistance is between 10 - 250 Ohm-meters.

Table 4. Soil Grounded Resistance Prediction

Soil Resistance	Lithology Estimation	Hydrology Estimation
< 10	Lempung	
60 – 70	Tufa Pasir	
100 – 110	Tufa Bolder	Akuifer
250 <	Batuan Breksi	

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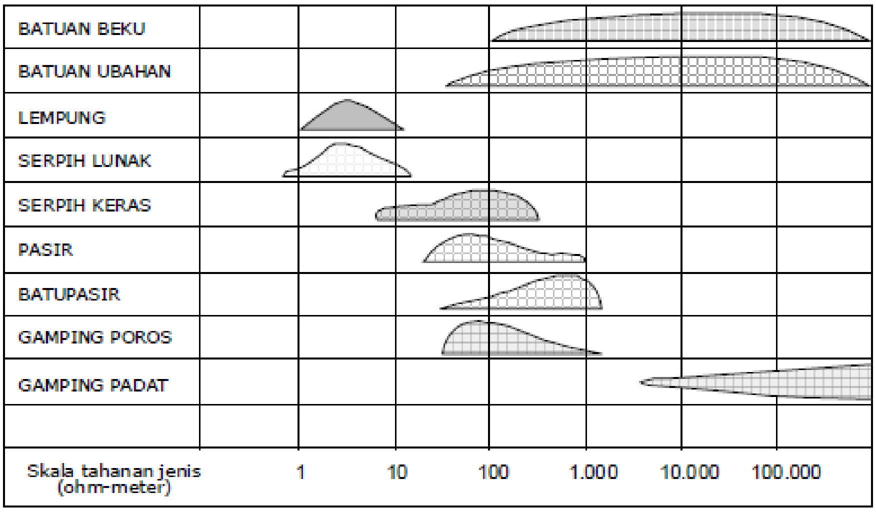
Table 5. The Correlation of Soil Grounded Resistance



As result of the research investigation, the figure 8 shows the vertical configuration views of soil grounded resistance, whilst figure 9 illustrates the spread of soil grounded resistance in the subjected research location. Moreover, the complete results of soil grounded resistance is shown in table 6.

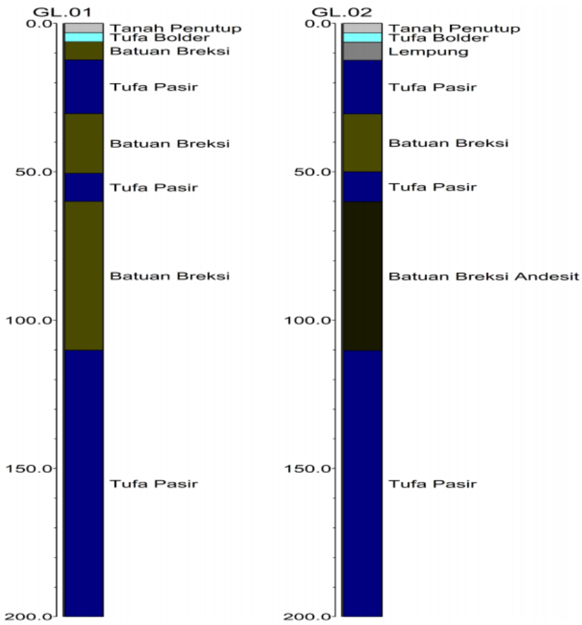


Figure 8. Vertical Section Configuration of Soil Grounded Resistance in the Area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency

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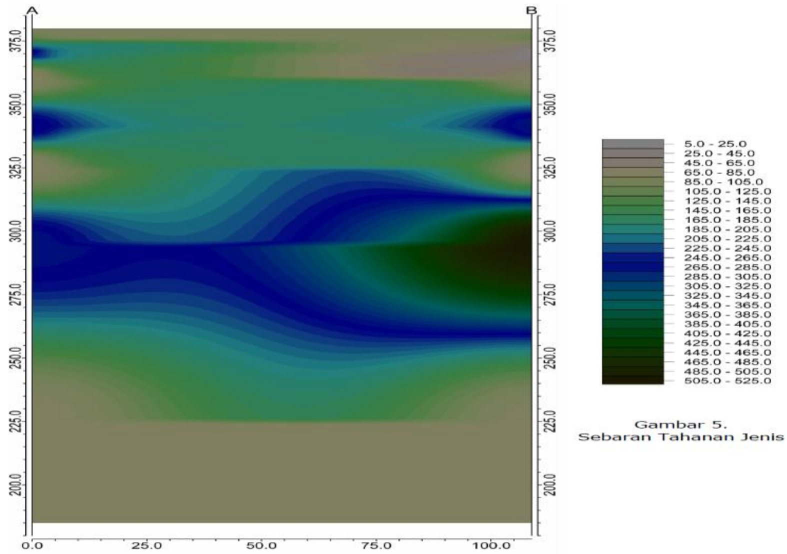

Figure 9. The Spreed configuration of soil grounded resistance in area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency

Table 6. Results of soil grounded resistance in area of Bolang and Margosingo, Jatirejoyoso Village, Kepanjen District, Malang Regency.

Titik Duga	*Lapisan*	*Hasil Penafsiran*		*Perkiraan Litologi*	*Perkiraan Hidrogeologi*
		Kedalaman	*Tahanan Jenis*		
GL.1	1	0.00 – 3.11	49.66	Tanah Penutup	
	2	3.11 – 6.21	101.22	Tufa Bolder	
	3	6.21 – 12.31	255.32	Batuan Breksi	
	4	12.31 – 30.41	61.42	Tufa Pasir	AP
	5	30.41 – 50.51	260.02	Batuan Breksi	
	6	50.51 – 60.01	62.12	Tufa Pasir	Akuifer
	7	60.01 – 110.13	265.24	Batuan Breksi	
	8	110.13 – 200.00	63.34	Tufa Pasir	Akuifer
GL.2	1	0.00 – 3.22	47.77	Tanah Penutup	
	2	3.22 – 6.32	103.33	Tufa Bolder	
	3	6.32 – 12.42	6.43	Lempung	
	4	12.42 – 30.52	64.03	Tufa Pasir	AP
	5	30.52 – 50.02	270.13	Batuan Breksi	
	6	50.02 – 60.12	65.23	Tufa Pasir	Akuifer
	7	60.12 – 110.24	505.31	Batuan Breksi Andesit	
	8	110.24 – 200.00	66.41	Tufa Pasir	Akuifer

Hydrology Analysis

Climate

The climate in the study area as well as other areas in Indonesia is generally influenced by a tropical climate with two seasons, namely the rainy season and the dry season.

Meteorology

Meteorological data used in this study was taken from the nearest Climatology Station, namely Karangkates Climatology Station. Rain Station Post, area of Krajan, Curungrejo Village, Kepanjen District

The rain station posts used for monthly rain analysis at the area of Krajan, Curungrejo Village, Kepanjen District are the Turen, Clumprit Gondanglegi and Kepanjen rain stations. Monthly average rainfall is presented by calculating the rain for 10 days.

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Calculation of Design Rainfall

Completing Missing Rainfall Data

The missing data was collected from 3 Rain Station Posts recorded from 2010 to 2019.

Rainfall Consistency Test

Research conducted in recent years shows that about 15% of the available data show such symptoms, so analyze carefully.

Rescale Adjusted Partial Sums Method (RAPS)

Based on the RAPS method, the table 7 shows the results of the rainfall data test.

Table 7. RAPS test result

No	Years	Rain mm/day	Sk*	Dy²	Sk**	[Sk**]
1	2010	118	-125.01	1562.80	-1.37	0.39
2	2011	125.69	-117.32	1376.45	-1.29	1.16
3	2012	161	-82.01	672.60	-0.90	0.95
4	2013	235.33	-7.68	5.90	-0.08	1.59
5	2014	237.5	-5.51	3.04	-0.06	0.43
6	2015	238	-5.01	2.51	-0.06	1.62
7	2016	280.6	37.59	141.29	0.41	0.42
8	2017	292.17	49.16	241.65	0.54	0.20
9	2018	300	56.99	324.76	0.63	1.02
10	2019	441.83	198.82	3952.86	2.18	1.01
Sums		2430.12		8283.85		
Average		243.012				
n		=	10			
Dy		=	91.01567522			
Sk**max		=	2.18			
Sk**min		=	-1.37			
Q		=	1.62			
R		=	3.56			
Q / ($n^{0,5}$) cal		=	0.512288981			
R / ($n^{0,5}$) cal		=	1.13			
Based on Table (90%) :						
Q / ($n^{0,5}$) tabel		=	1.05	then :	Q / ($n^{0,5}$)	**Accept**
R / ($n^{0,5}$) tabel		=	1.21	then :	R / ($n^{0,5}$)	**Accept**
Based on Table (95%) :						
Q / ($n^{0,5}$) tabel		=	1.14	then :	Q / ($n^{0,5}$)	**Accept**
R / ($n^{0,5}$) tabel		=	1.28	then :	R / ($n^{0,5}$)	**Accept**
Source: research calculation, 2020						

Rainfall Data Frequency Distribution Analysis

1. Gumble Type I Method

   From the existing rainfall data, frequency analysis of the maximum daily average rainfall data at the location can be seen in the table 8.

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Table 8. Gumble Type I Method

No.	year	rainfall (mm)	(X-X avg)	(X-Xavg)²
1	2010	118	-125.012	15,628.00
2	2011	125.69	-117.322	13,764.45
3	2012	161	-82.012	6,725.97
4	2013	235.33	-7.682	59.01
5	2014	237.5	-5.512	30.38
6	2015	238	-5.012	25.12
7	2016	280.6	37.588	1,412.86
8	2017	292.17	49.158	2,416.51
9	2018	300	56.988	3,247.63
10	2019	441.83	198.818	39,528.60
	Sum	**2430.12**		**82,838.53**
	Average	**243.012**		**8,283.85**
Standart Deviasi (S)			95.94	
Kepencengan (Cs)			1.14	
Number of Data (n)			10	
with (n) = 10, then value of Sn and Yn				
taken from appendix :				
Yn	=	0.0507		
Sn	=	0.09971		
Sumber : Research Calculation, 2020				

2. Log Pearson Type III Method
   The Calculation of the Type III Log Person Test Method is set out in the table 9.

Table 9. Log Pearson Type III Method

No.	Year	Rain (X)/mm	Log X	(Log X - Log	(Log X - Log	(Log X - Log Xrerata)³
1	2010	118	2.072	-0.282	0.079	-0.022
2	2011	125.69	2.099	-0.255	0.065	-0.016
3	2012	161	2.207	-0.147	0.022	-0.003
4	2013	235.33	2.372	0.018	0.000	0.000
5	2014	237.5	2.376	0.022	0.000	0.000
6	2015	238	2.377	0.023	0.001	0.000
7	2016	280.6	2.448	0.094	0.009	0.001
8	2017	292.17	2.466	0.112	0.013	0.001
9	2018	300	2.477	0.123	0.015	0.002
10	2019	441.83	2.645	0.291	0.085	0.025
Sums			23.538	0.000	0.289	-0.013
Average			2.354	0.000	0.029	-0.001
Standart Deviasi			0.179			
S Log X			0.179			
Kepencengan (Cs)			-0.032			
Number of Data			10.000			
Source : Research Calculation, 2020						

<u>Frequency Distribution Conformity Test</u>

1. Chi Square Test
   All data from the rainfall distribution analysis was confirmed using Chi Square Test. Table 10 and 11 show the Gumble Type I and Log Pearson Type III was tested using Chi Square Test, respectively.

Table 10. Chi Square Test for Gumble Type I

No	Batas Kelas			Ei	Oi	Oi - Ei	$(Oi - Ei)^2/Ei$	Pengujian nilai X^2 hitung 5%		Pengujian nilai X^2 hitung 1%	
								dk	= K - (P+1)	dk	= K - (P+1)
1	0,00	-	72,71	2,5	3	1	0,10	dk	1	dk	1
2	72,71	-	88,40	2,5	1	-2	0,90	X^2 kritis	3,841	X^2 kritis	6,635
3	88,40	-	108,31	2,5	2	-1	0,10	X^2 hitung	1,20	X^2 hitung	1,20
4	108,31	-	~	2,5	3	1	0,10				
Jumlah				10	9	-1	1,20	maka hipotesis yang ada		maka hipotesis yang ada	
Sumber : Hasil Analisa dan Perhitungan, 2020								**DITERIMA**		**DITERIMA**	

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Table 11. Chi Square Test for Log Pearson Type III

No	Batas Kelas			Ei	Oi	Oi - Ei	$(Oi - Ei)^2/Ei$
1	0,00	-	167,01	2,5	4	2	0,9
2	167,01	-	216,14	2,5	0	-3	2,5
3	216,14	-	294,69	2,5	2	-1	0,1
4	294,69	-	~	2,5	3	1	0,1
Jumlah				10	9	-1	3,6
Sumber : Hasil Analisa dan Perhitungan, 2020							

Pengujian nilai X^2 hitung 5%		Pengujian nilai X^2 hitung 1%	
dk	= K - (P+1)	dk	= K - (P+1)
dk	1	dk	1
X^2 kritis	3,841	X^2 kritis	6,635
X^2 hitung	3,600	X^2 hitung	3,600
maka hipotesis yang ada		maka hipotesis yang ada	
DITERIMA		DITERIMA	

2. Smirnov Kolmogorov Test
   Table 12 shows the result of the rainfall design calculation (critical D value). Then, table 13 and table 14 shows the Smirnov Kolmogorov test for Gumble Type I method and Log Pearson Type III method, respectively.

Table 12. Critical D values for Smirnov Kolmogorov

n \ a	0,200	0,100	0,050	0,010
5	0,450	0,510	0,560	0,670
10	0,320	0,370	0,410	0,490
15	0,270	0,370	0,340	0,400
20	0,230	0,260	0,290	0,360
25	0,210	0,240	0,270	0,320
30	0,190	0,220	0,240	0,290
35	0,180	0,200	0,230	0,270
40	0,170	0,190	0,210	0,250
45	0,160	0,180	0,200	0,240
50	0,150	0,170	0,190	0,230
n > 50	$\frac{1,07}{n^{0,5}}$	$\frac{1,22}{n^{0,5}}$	$\frac{1,36}{n^{0,5}}$	$\frac{1,63}{n^{0,5}}$

Table 13. Smirnov Kolmogorov for Gumble Type I Method

No	Data Hujan Terurut (mm)	Log R	G	Pr (%)	Pr	Pt (x)	Pe(x)	Δ
1	118,00	2,072	-1,574	94,212	0,942	0,058	0,091	0,033
2	125,69	2,099	-1,421	92,162	0,922	0,078	0,182	0,103
3	161,00	2,207	-0,821	80,053	0,801	0,199	0,273	0,073
4	235,33	2,372	0,100	48,638	0,486	0,514	0,364	-0,150
5	237,50	2,376	0,122	47,653	0,477	0,523	0,455	-0,069
6	238,00	2,377	0,127	47,461	0,475	0,525	0,545	0,020
7	280,60	2,448	0,526	32,381	0,324	0,676	0,636	-0,040
8	292,17	2,466	0,624	28,682	0,287	0,713	0,727	0,014
9	300,00	2,477	0,689	24,338	0,243	0,757	0,818	0,062
10	441,83	2,645	1,627	2,356	0,024	0,976	0,909	-0,067
Maksimum Δ								0,103
Sumber : Hasil Analisa dan Perhitungan, 2020								

Pengujian nilai Δ hitung 5%		Pengujian nilai Δ hitung 1%	
n	10	n	10
Δ kritis	0,409	Δ kritis	0,486
Δ hitung	-0,091	Δ hitung	-0,091
maka hipotesis yang ada		maka hipotesis yang ada	
DITERIMA		DITERIMA	

Sumber : Hasil Analisa dan Perhitungan, 2020

Table 14. Smirnov Kolmogorov for Log Pearson Type III Method

No	Data Hujan Terurut (mm)	K	Yt	Tr	P(x)	Pt (x)	Pe(x)	Δ
1	118,00	1,241	1,674	5,848	0,171	0,829	0,091	-0,738
2	125,69	1,599	2,013	8,000	0,125	0,875	0,182	-0,693
3	161,00	3,241	3,573	36,131	0,028	0,972	0,273	-0,700
4	235,33	6,699	6,856	950,512	0,001	0,999	0,364	-0,635
5	237,50	6,800	6,952	1045,923	0,001	0,999	0,455	-0,544
6	238,00	6,823	6,974	1069,269	0,001	0,999	0,545	-0,454
7	280,60	8,804	8,856	7016,312	0,000	1,000	0,636	-0,363
8	292,17	9,342	9,367	11694,440	0,000	1,000	0,727	-0,273
9	300,00	9,707	9,713	16528,770	0,000	1,000	0,818	-0,182
10	441,83	16,304	15,978	8689826,341	0,000	1,000	0,909	-0,091
Maksimum Δ kritis								-0,091
Sumber : Hasil Analisa dan Perhitungan, 2020								

Pengujian nilai Δ hitung 5%		Pengujian nilai Δ hitung 1%	
n	10	n	10
Δ kritis	0,409	Δ kritis	0,486
Δ hitung	0,103	Δ hitung	0,103
maka hipotesis yang ada		maka hipotesis yang ada	
DITERIMA		DITERIMA	

Sumber : Hasil Analisa dan Perhitungan, 2020

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The Smirnov and Kolmogorov calculation proves that Gumble Type I and Log Pearson Type III method used for the rainfall design are valid (accepted). Furthermore, table 15 shows the calculation recapitulation of Smirnov and Kolmogorov, whilst table 16 displays the recapitulation of infiltration calculation per year.

Table 15. Calculation Recapitulation of Smirnov and Kolmogorov

Periode	Rainfall Design(mm)	
	Gumble Distribution	Log Pearson Dist.
2	900.79	216.14
5	1009.79	313.54
10	1081.95	390.89
25	1173.13	505.02
50	1240.77	602.72
100	1307.91	712.36
200	1374.81	835.53
1000	1529.77	1187.22

Source : Research Calculation, 2020

Table 16. Recapitulation of Infiltration Calculation per Year

Years	I	
	(mm/year)	(cm/year)
2010	2,264.32	226.43
2011	5,639.82	563.98
2012	2,195.64	219.56
2013	2,258.60	225.86
2014	2,819.26	281.93
2015	745.68	74.57
2016	1,432.18	143.22
2017	2,115.52	211.55
2018	1,716.54	171.65
2019	1,353.96	135.40
Rerata	**2,254.15**	**225.42**

Source : Research Calculation, 2020

Hourly Rain Distribution and Flow Coefficient

From the results of this analysis, hourly rainfall was determined at the planning location, namely for this study a 6 hour distribution was chosen which was distributed by Mononobe method. The ratio of the distribution of rain can be seen in the Table of Calculation Patterns for the Distribution of Rainfall with the Mononobe Method.

1. Flow Coefficient
   Flow Coefficient According to Dr. Mononobe (Sosrodarsono, 1978: 145) can be seen in the Flow Coefficient Table According to Dr. Mononobe
2. Hourly Net Rainfall
   Assuming that the process of transforming rain into runoff directly follows a linear process and does not change in time (linear and time invariant process).

Calculation of Evapotranspiration

The amount of evapotranspiration was calculated using the Modified Penman method (FAO).

Infiltration Calculation

In this study, the infiltration model was calculated with the Horton method. Based on the results of the analysis of the mainstay discharge calculation of the F.sJ Mock method, for the infiltration volume uses a coefficient or constant of 0.7 based on the land cover use pattern in the study location which is based on the Mononobe flow coefficient.

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Mainstay Debit Calculation

In this study, the mainstay discharge calculation uses the Water Balance Method. The stations used in the calculation of the mainstay discharge are climatological data from the Karangkates Climatology Station, with the F.J. Mock Method for rivers that will be used as water sources, the results of the mainstay discharge calculation are presented.

CONCLUSSION

1. The volume of the infiltration rate was calculated using the Horton method (q) by considering the condition of land cover / land use (C) so that it is known that the average infiltration capacity of the soil in several study locations per year is more than 200 cm/year with the conclusion of the study area has the ability to infiltrate quite effectively so that on average it can store water up to > 200 cm/year.
2. The results of the geo-electrical interpretation provide the results of estimating the position of the aquifer layer which can be supported by an analysis of geo-hydrological conditions, an aquifer layer is found at a depth of 30-50 meters at GL 1 point, and at GL 2 an aquifer layer is found at a depth of 22-55 meters. So from the analysis of the land's ability to carry out the infiltration process properly, it can be validated with the results of geo-electrical investigations.
3. The accuracy of interpretation of the results of geo-electrical investigations and soil infiltration capabilities and based on the affordability of the study area can streamline the operational costs of groundwater source investigation activities and implementation time.

SUGGESTION

Based on the conclusions obtained, the author can provide several recommendations related to groundwater investigation activities, especially geo-electric investigations, including:

1. Mapping the planned area of the geo-electrical investigation point.
2. Analyzing the geo-hydrological conditions of the area that will be used as the study location, by analyzing inflow-outflow data, analyzing rain data, and analyzing soil infiltration capabilities

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