River Discharge Analysis Using Soil and Water Assessment Tools Method in Bonto Saile Wathershed, Selayar Island Regency

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***Abstract*— Basically the need for water will increase along with the increase in population. The problems experienced in the North Benteng area which is included in the Bonto Saile watershed are experiencing flooding due to overflowing of river water in the Bonto Saile watershed and some places are submerged due to the lack of functioning of the drainage network, so a study on the Bonto Saile watershed is needed to determine the quantity of water. The purpose of this study is to analyze the discharge in the Bonto Saile watershed in 2015 and 2020. The method used to analyze the discharge is to collect climate data, data on soil properties, land cover, and slope. The data were analyzed using the SWAT model. The results showed that the highest discharge value in 2015 was 0.71 m^3/s and in 2020 it was 1.02 m^3/s. The minimum value in 2015 is 0.00 m^3/s in months 9 and 10 in all Sub-watersheds and in 2020 by 0.01 m3/s in months 8, 9, and 10 in Sub-watershed 2. This is due to differences in rainfall that occurred in 2015 and 2020 as well as several changes in land cover in the Bonto Saile watershed area. The 2015 KRA value in the Bonto Saile sub-watershed has two categories, namely medium and very high, while the 2020 KRA value in the Bonto Saile sub-watershed has very low criteria.**

Key words: River Discharge, SWAT, Bonto Saile Watershed

I. INTRODUCTION

Watershed (DAS) as a rainwater catchment area that has a major influence on the availability of water in an area. Basically, the need for water will increase as the population increases. Man will exploit natural resources in this case the land and water to the maximum to meet his needs. The increase was due to the increasing needs of various sectors, both domestic, industrial, agricultural, energy, and others. However, this does not go hand in hand with the availability of water that cannot be ensured to meet these needs in a sustainable manner. Not only is the availability of water reduced, water quality is also sometimes not good [3].

The characteristics of water discharge in a watershed are strongly influenced by two important factors, namely the physical condition of a watershed and rainfall in the catchment area. Soil and land cover factors are physical conditions that play an important role in the characteristics of the watershed area, so that the discharge characteristics in the watershed will change when these two factors also change. Thus the characteristics of a water discharge can mean the physical condition of a watershed in question. In addition, information about the characteristics of water discharge is very important to know the potential of water resources in the area so that the water management plan can take place effectively [1]. Changes in land cover that occur in a watershed affect the condition of the area or catchment area and can cause changes in surface flow. This affects the condition of river discharge at the sub-watershed outlet and the watershed [3].

The Bonto Saile Watershed (DAS) flows from East to West which flows through Bontoharu District and part of Benteng City. In December 2020, the North Fort area (included in the Bonto Saile watershed) experienced flooding caused by overflowing river water in the Bonto Saile watershed and several places were submerged due to the malfunctioning of the drainage network. The rate of population growth, which continues to increase every year and the need for more land, is expected to increase land use that is not in accordance with its function, especially in watersheds.

Based on this description, a study is needed in the Bonto Saile watershed to determine the quantity of water, in this case water discharge through an analysis that refers to several important factors in determining the magnitude of the flow discharge at the river outlet. Important factors in determining the magnitude of water discharge are rainfall,

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infiltration, runoff, evapotranspiration, surface retention, and groundwater with the analysis stage using the Soil and Water Assessment Tool (SWAT) model. Furthermore, the slope factor of the land, the type of soil and vegetation on it plays a very important role in determining the amount of runoff that occurs and the water that can be stored into the soil through the infiltration process. If the runoff that occurs during small rains and water infiltration into the soil is large, then the water is first stored in the soil so that it will increase the availability of groundwater [3].

II. Material and Method

A. Research Location

This research was for 10 months, from February 2021 to November 2021 in the Bonto Saile Watershed and the Silviculture and Tree Physiology Laboratory, Faculty of Forestry, Hasanuddin University. The Bonto Saile watershed is administratively located in Bontoharu District and the Fort of the Selayar Islands Regency, South Sulawesi Province.

The tools used in this study, namely GPS (Geographic Position System) receivers, mapping software such as ArcGIS, hardware such as Microsoft Excel and Microsoft office word, sample rings, label paper, hoes, plastic samples, cameras, and writing stationery. The tools used in the laboratory are drip pipettes, burettes, measuring cups, pH meters, roll film bottles, digital scales, and paralon pipes.

The materials used in this study were in the form of a watershed boundary map, a Digital Elevation Model (DEM) map of 8x8 meters resolution, a 1:50.000 RBI map, a land cover map and a map of the Bonto Saile watershed soil type as well as non-spatial data, namely climate data including daily rainfall data, air temperature, relative air humidity, wind speed, and sunlight radiation for the last 10 years and soil physical and chemical properties data. As for the materials used in the laboratory, namely soil samples, water, aquades, conductors, sulfuric acid, and indicator solutions.

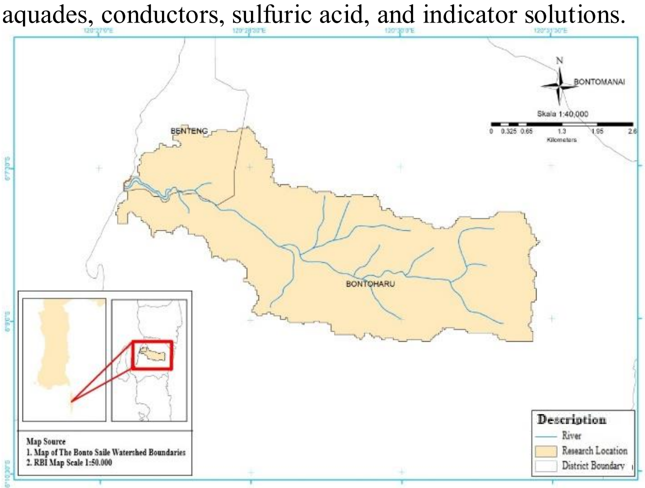

Figure 1. Research location in Bonto Saile Watershed, Selayar Islands, South Sulawesi.

B. Research Procedures

Input Data Setup

1. The prepared climate data consists of daily rain, daily maximum-minimum temperature, humidity, minimum and maximum daily temperatures, length of solar irradiation, average daily wind speed for 2006-2020. Climate data obtained from https://power.larc.nasa.gov/data-access-viewer/
2. Data on the type of soil used was obtained from data from the land system data Regional Physical for Transmigration (RePPProt) National Survey and Mapping Coordinating Board in 1987.
a) Soil Crack volume (SOL_CRK)
b) Available Water Capacity (SOL_AWC)
c) Saturated Hydraulic Conductivity (SOL_K)
d) Soil hydrological group (HYDGRP)
e) Soil Albedo (SOL_ALB)
3. Soil physical properties data are obtained from the results of laboratory tests on soil samples taken in the field to detail information related to soil characteristics.
a) Number of soil layers (NLAYERS)
b) Plant root depth (SOL_ZMX)
c) Porosity of the soil (ANION_EXCL)

$$Porosity = 1 - \frac{Bulk\ Density}{Partikel\ Density} \text{ x } 100\%$$

where,

Particle density = 2,56 g/cm^3

d) Texture (TEXTURE)

The results of the analysis of soil samples obtained the percentage of silt, clay and sand. The determination of the soil texture class using texture triangles from the United State Department of Agriculture (USDA) is presented in Figure 2.

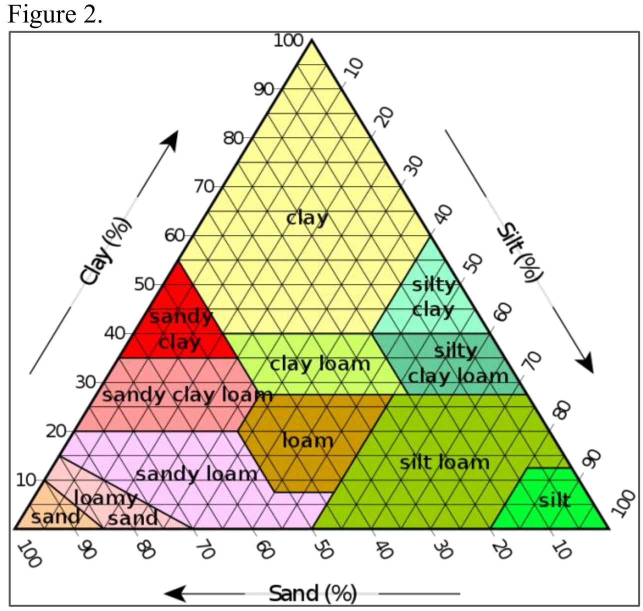

Figure 2. Soil Texture Triangle (USDA)

$$\%\ clay = \text{Sand weight } BDL + \text{ Sand weight} \times 100\ (\%)$$
$$\%\ silt = \text{Silt weight } BDL + \text{ Sand weight} \times 100\ (\%)$$
$$\%\ sand = \text{Clay weight } BDL + \text{ Sand weight} \times 100\ (\%)$$

with,

$$BDL = H1 + 0{,}3 \times (T1 - 19{,}8)2 - 0{,}5$$
$$BL = H2 + 0{,}3 \times (T2 - 19{,}8)2 - 0{,}5$$
$$\text{Silt weight} = BDL - BL$$

Information :

BDL = Weight of Sand Clay Silt
BL = Clay Weight

H1 and H2 = Measurement of suspension with hydrometer
T1 and T2 = Suspension measurement with thermometer

e) Soil Depth (SOL_Z)
The depth of the soil is measured after digging using a meter tape.
f) Bulk Density (SOL_BD)
Bulk density (BD) values were analyzed by taking non-disturbed soil samples. The soil sample was dried in the oven for 24 hours at 105°C, then weighed and obtained the dry weight of the soil or the weight of the soil volume.

$$Soil\ Volume\ Weight = \frac{Dry\ Soil\ Weight\ (g))}{Soil\ Volume\ (cc)}$$

where,

Ground Volume = Ring volume ($\pi r^2 t$)

g) Permeability
Disturbed soil samples are soaked overnight on the container. After soaking the sample is then fed with water. The amount of volume that escapes through the ring is the total volume of water that can be passed by the ground.

$$\text{Permeability} = \frac{x}{\frac{1}{4}\pi d^2}; x\ \frac{Vol.\ of\ Each\ Layer}{0{,}25}$$

h) Organic Matter (SOL_CBN)
Organic matter levels are analyzed using the titration method. The titration results are processed and then obtained organic matter levels in soil samples.

$$C\% = \frac{(B-T)\times 0{,}2\times 3\times 1{,}33}{Soil\ Sample\ Weight}\ \text{x}\ 100\%$$

where,

Organic Matter = C% x 1,724

i) Clay Percentage (CLAY)

$$\%Clay = \frac{Sand\ Weight}{BDL + Sand\ Weight}\ \text{x}\ 100\%$$

where,

$$\text{Sand Clay Silt Weight (BDL)} = \frac{H1+0{,}3\times(T1-19{,}8)}{2} - 0{,}5$$

j) Silt Percentage (SILT)

$$\%\ Silt = \frac{Silt\ Weight}{BDL + Silt\ Weight} \times 100\%$$

where,

Silt Weigh t = BDL – BL

k) Sand Percentage (SAND)

$$\%Pasir = \frac{Clay\ Weight}{BDL - Sand\ Weight}\ \text{x}\ 100\%$$

where,

$$Clay\ Weight = \frac{H + 0{,}3 \times (T2 - 19{,}8)}{2}\ \text{x}\ 100\%$$

l) Soil Erodibility (USLE_K)
m) pH (SOL_pH)

4. Marble maps can be created by processing DEM (Digital Elevation Model) data based on the 2010 DEMNAS which can be downloaded on the INAGEOPORTAL website (tanahair.indonesia.go.id). The classification of the slope class consists of 5 classes namely 0-8% (flat), 8-15% (gently sloping), 15-25% (moderately steep), 25-40% (steep), >40% (very steep).

Analysis of Land Cover Change in 2015 and 2020

Assessment of the accuracy of the classification is useful for gaining the degree of trust of remote sensing. A common way to describe the level or magnitude of classification accuracy is to use an error matrix or commonly referred to as a confusion matrix or contingency table and kappa accuracy. An example of a confusion matrix table can be seen in Table 1.

TABLE 1. CONFUSION MATRIX CALCULATION

		Reference Data (Field Checking)			Total
		A	B	C	
Image classification result data	A'	Xn			∑Xn
	B'				
	C'				
		∑Xn			N

Kappa's accuracy in its calculations uses all column elements in the error matrix [8].

$$\text{Kappa} = \frac{N\sum_{i-1}^{r} xii - \sum_{i-1}^{r} xi+x+1}{N^2 \sum xi+x+1}$$

Information:
X_{ii} : Diagonal value of the contingency matrix of the i-th row and the i-th column
X_{+i}: Number of pixels in the i-th column
X_{i+}: Number of pixels of the i-th line
N : the multiplicity of pixels in the example

The result of the acceptable classification process is a classification process that has a kappa accuracy value of more or equal to 85% or a coefficient of 0.85 [8].

Analysis of Land Cover Change against Water Discharge with SWAT Model

1. Watershed delineation, this process forms boundaries or defines the watershed being modeled. The process includes set up DEM, stream and watershed definition.
2. HRU analysis, a process that compiles land use maps, soil and marbles to form or define Hydrologic Response Units (HRUs) in the modeled watershed area.
3. The climate database (Weather Generator Data) of the SWAT model is operated through the weather data definition sub menu. At this stage, climate data input (Weather Generator Data), rainfall, temperature, humidity, solar radiation, and wind speed are carried out.
4. Build SWAT model input data based on inputs in stages 1 to 3 which will be formed automatically by selecting the Write All sub menu.
5. SWAT Simulation is performed by selecting the time to be simulated in Run SWAT mode. The storage of output data from the simulation results is carried out by selecting Read SWAT Output.

C. Data Analysis

The calculation of discharge data is carried out using the SWAT model. SWAT will automatically simulate the amount of discharge value according to the data that has been entered. The principle of SWAT calculation in determining the value of discharge using the Manning equation is [6]:

$$q_{ch} = \frac{A_{ch} \cdot R_{ch}^{\frac{2}{3}} \cdot slp_{ch}^{\frac{2}{3}}}{n}$$

Information:

q_{ch} : Channel discharge (m^3/s)
A_{ch} : Channel cross-sectional area (m^2)
R_{ch} : Hydraulic radius of the channel (m)
slp_{ch} : Slope along the channel (m/m)
n : Manning's roughness coefficient

The calculation of the propophysient flow regime (KRA) is carried out after the maximum and minimum discharge values are known. Kra calculations are formulated with [2].

$$KRA = \frac{Q\ maks}{Q\ min}$$

Information:

KRA : Flow regime coefficient
Q max : Maximum discharge
Q min : Debit minimum

The results of the flow regime's coefficient calculations are then classified into several classes which can be seen in Table 2.

TABLE 2. COEFFICIENT CLASSIFICATION OF FLOW REGIMES [2]

Value	Class
KRA ≤ 20	Very low
5 < CRA ≤ 10	Low
10 < CRA ≤ 15	Keep
15 < CRA ≤ 20	Tall
KRA > 20	Very high

III. Result and Discussion

A. General State of Location

The Bonto saile watershed is one of the watersheds located in the Selayar Islands Regency with an area of 1.621,88 ha. The Bonto Saile watershed is administratively located in two sub-districts, namely in Bontoharu District and Benteng District.

B. Climatic Conditions

Climatic conditions are one of the factors affecting the hydrological conditions of the watershed. High rainfall intensity will increase the value of river discharge and vice versa. Based on schmidt Ferguson's climate classification, the Bonto Saile watershed region belongs to the C (moderately wet) climate type. Schmidt Ferguson classified the climate by calculating the ratio between the average number of dry months and the average wet months. This study used rainfall data for 15 years by dividing it into 2 periods, namely 2006-2015 and 2011-2020.

C. Slope Class

The Bonto Saile watershed area has varying slope classes. The percentage of area in each slope class in the Bonto Saile watershed can be known by analyzing data digital elevation model (DEM). A map of the slope class of the Bonto Saile watershed can be seen on Figure 3.

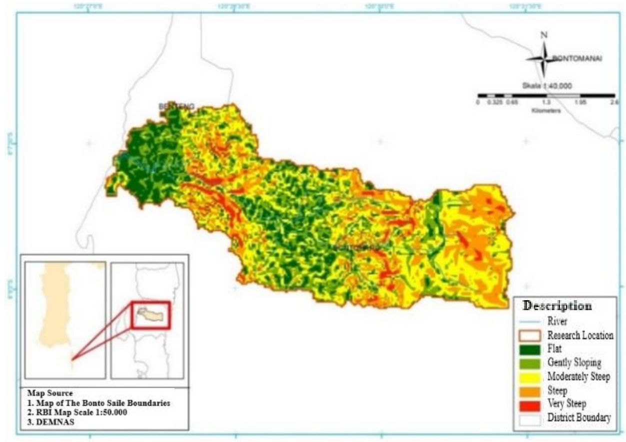

Figure 3. Bonto Saile Watershed Slope Class Map

The Bonto Saile watershed area is in a low to high area. Most of its territory has a slope class of 15-25% and is categorized as rather steep. The percentage of area categorized as rather steep is 31,79% of the total area. The slope class that has the next largest percentage of area is 8-15% which is categorized as sloping with an area of 25% which is generally located in the middle and downstream. Areas with steep slope classes are generally upstream and have the smallest percentage of area, which is only 4,63% of the total area of the Bonto Saile watershed.

D. Soil

The soil map is made based on the overlay results of the RePPProt soil map, slope class map, and land cover map to be used as a reference in soil sampling which aims to detail soil characteristics. A map of the soil type in the Bonto Saile watershed can be seen in Figure 4.

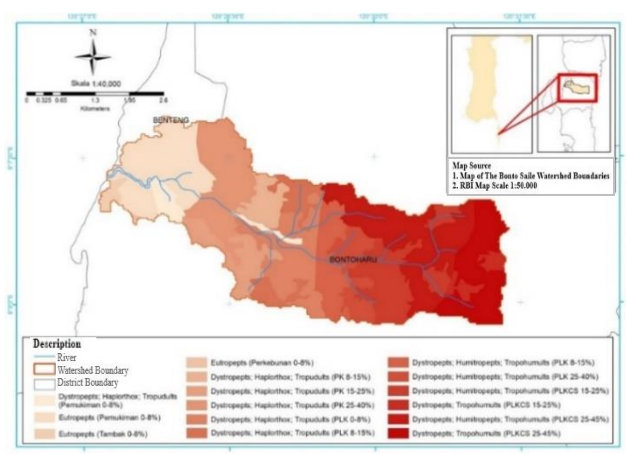

Figure 4. Bonto Saile Sub-Watershed Soil Type Map

The soil characteristics tested include porosity, c-organic, texture, structure, permeability, and pH needed as input data for SWAT analysis. Analysis of soil characteristics in the Bonto Saile watershed produced 15 types of soil, in which each soil has its own characteristics. Differences in soil type characteristics are influenced by the class of the slope as well as the shape of the land cover. Dystropepts soil types with dryland farmland cover mixed with shrubs and steep slopes will have less infiltration capacity when compared to Dystropepts soil types that are in sloping marbles with dryland farmland cover.

E. Land Cover Change in 2015 and 2020

Land cover in the Bonto Saile watershed varies widely. The Bonto Saile watershed area is dominated by dryland agriculture, mixed bush dryland agriculture, and plantations. There are also other land closures in the form of settlements, water bodies, and ponds. The body of water is the narrowest land cover among other land cover. The land cover data used is the result of the interpretation of Landsat 8 imagery in 2015 and 2020. The interpretation results can be used because accuracy tests have been carried out and the values obtained are 93,95% in 2015 images and 94.78% in 2020 images. Land cover data from the interpretation of Landsat 8 imagery in 2015 and 2020 can be seen in Table 3.

TABLE 3. LAND COVER AREA IN 2015 AND 2020 OF THE BONTO SAILE WATERSHED (Source: Interpretation of Landsat 8 imagery in 2015 and 2020).

Land Cover	**Broad**			
	Year 2015		**Year 2020**	
	Ha	**%**	**Ha**	**%**
Mixed Bush Dryland Agriculture	513,43	31,67	526,92	32,49
Dryland Agriculture	464,76	28,66	452,31	27,89
Pond	15,70	0,96	15,70	0,96
Plantation	444,85	27,43	405,56	25,01
Settlements	180,37	11,12	218,64	13,48
Water Body	2,75	0,17	2,76	0,17
Total	1.621,86	100,00	1.621,89	100,00

F. SWAT Analysis Results

1. Boundary Delineation Watershed

The delineation of the watershed boundary carried out as one of the stages of swat simulation resulted in 4 sub-watersheds. A map of the Bonto Saile Sub-Watershed can be seen in Figure 5.

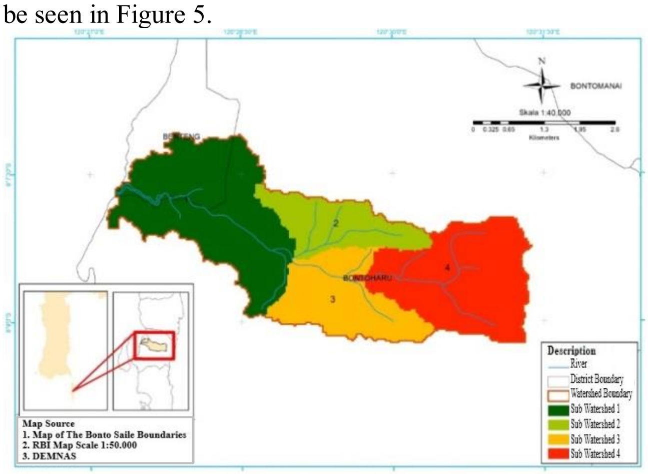

Figure 5. Sub-watershed Boundaries

TABLE 4. AREA OF SUB-WATERSHED IN BONTO SAILE WATERSHED

Sub Watershed	**Large**	
	Ha	**%**
1	602,68	37,16
2	225,48	13,90
3	308,21	19,01
4	485,50	29,93
Total	1621,87	100,00

Based on the results of the delineation, the Sub-watershed which has the largest area is Sub-Watershed 1 with an area of 602.68 ha and the smallest Sub-Watershed is Sub-Watershed 2 with an area of 225.48 ha.

2. HRU Analysis

The definition of HRU based on overlay maps of land cover, marbles, and soil types produced as many as 164 HRU from 4 Sub-watersheds in 2015. In 2020, the results of the hru formed amounted to 165 HRU from 4 Sub-watersheds. This difference is due to changes in land cover. Changes in land cover that occur result in the closure of new land formed in the watershed area, thus making land cover conditions in 2020 produce more HRU. The results of the formation of the HRU contain information on land use, slope, land, area and percentage of HRU area in the Bonto Saile watershed.

3. SWAT Simulation

Swat simulation produces output in the form of several HRU. the HRU code is used to find out the amount of HRU and RCH and see the discharge value based on the sub-watershed formed. SWAT is also able to provide an overview of the hydrological conditions in the watershed. The results of the simulation of hydrological conditions are displayed in the form of an image on the Read SWAT Output menu.

This study was conducted with 2 model simulations, for land cover in 2015 and 2020. The hydrological processes that occurred in the Bonto Saile watershed for climatic conditions and land cover in 2015 were; 1) Total rainfall of 1.375,7 mm, 2) 8,64% into surface flow, 3) 14,89% infiltrated, 4) 54,61% of total rainwater evaporates through the evapotranspiration process, and 5) 21,22% into lateral flow. The hydrological cycle in the Bonto Saile watershed from the SWAT simulation results can be seen in Figure 6.

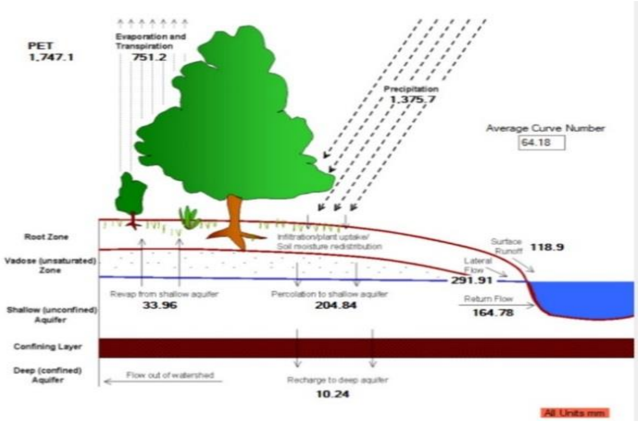

Figure 6. Hydrological Cycles in the Bonto Saile Watershed in 2015

The water cycle in 2015 showed that the largest amount of water coming out of the Bonto Saile watershed was caused by an evapotranspiration process of 751,2 mm. Evapotranspiration is the incorporation of a process of evaporation on the surface of the land called evaporation and a process of evaporation that occurs in vegetation called transpiration. The evapotranspiration process is mainly influenced by temperature and vegetation type. The area of land cover in the form of agriculture in 2015 that dominated the area in the Bonto Saile watershed is the reason why the evapotranspiration process that occurred was quite high. [9] states that areas covered by vegetation will have a greater evapotranspiration value than those without vegetation.

The state of the Bonto Saile watershed area, which is dominated by non-forest vegetation, causes the infiltration process to occur quite low. Infiltration is the process of water ingress into the soil. The low infiltration value that occurs in the Bonto Saile watershed is because non-forest vegetation is unable to absorb more water into the soil with its root system. Based on research conducted by [5] also showed that vegetation roots affect the infiltration rate and are able to increase the volume of infiltrated water.

The surface flow that occurs is quite high because non-forest vegetation makes rainwater directly all fall to the ground surface. Non-forest vegetation is unable to intercept rainwater. In addition, more water that falls to the surface turns into surface flow so that the value of the peak discharge in the river becomes larger.

The hydrological processes that occurred in the Bonto Saile watershed in 2020 were; 1) Total rainfall of 1.800,7 mm, 2) 6,8% into surface flow, 3) 12,1% infiltrated, 4) 57,23% of total rainwater evaporated through the evapotranspiration process, and 5) 21,21% into lateral flow. The results of the SWAT simulation can be seen in Figure 7.

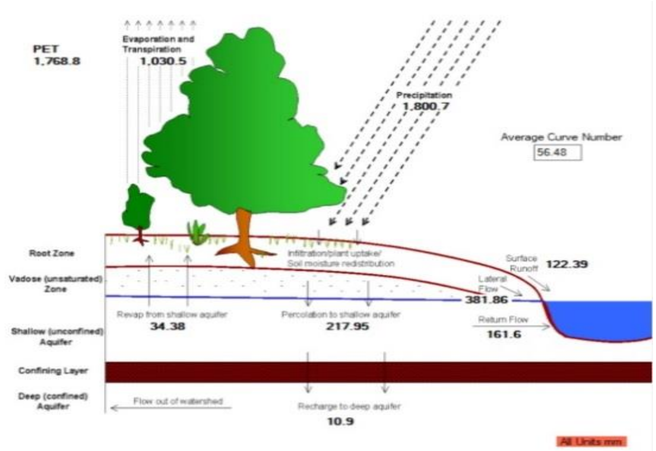

Figure 7. Hydrological Cycles in the Bonto Saile Watershed in 2020

The amount of rainfall in 2020 was greater than in 2015. Just like in 2015, most of the water in the Bonto Saile watershed comes out through the evapotranspiration process. The difference between the water cycle in 2015 and 2020 lies in the amount of water that is able to be revalused. Based on figures 6 and 7, evapotranspiration in 2020 was a smaller percentage than in 2015, due to large differences in rainfall in 2015 and 2020.

G. **Factors Affecting Discharge**

1. Rainfall

Rainfall in 2015 tends to be very low in the dry season. Peak precipitation was obtained in January with values reaching 351,42 mm. During the dry season rainfall becomes very low. The lowest rainfall occurs in August with a rainfall of 0,72 mm. The uneven distribution of rainfall in 2015 will have an impact on river discharge conditions.

2. Slope Class

The Bonto Saile watershed area has varying slope classes, namely flat (0-8%), gently sloping (8-15%), moderately steep (15-25%), steep (25-40%), and very steep (>40%). Slope class data can be seen in Table 5.

TABLE 5. AREA DISTRIBUTION OF SUB-WATERSHEDS (HA) BY SLOPE CLASS

Sub Watershed	Slope Grade Area (ha)					Total
	0-8% Flat	8-15% Gently Sloping	15-25% Moderately Steep	25-40% Steep	>40% Very Steep	(ha)
1	152	162	151	98	38	601
2	42	67	67	43	7	226
3	61	97	98	44	8	308
4	23	79	200	160	23	485
Total	278	405	516	345	76	1620

3. Land Closure Changes

Land cover in an area is one of the factors that can affect the hydrological conditions of the area, including water discharge. Land cover data for 2015 Sub-watersheds can be seen in Table 6.

TABLE 6. 2015 LAND COVER DATA IN EACH SUB-WATERSHED

Sub	Land Cover (ha)

Watershed	Mixed Bush Dryland Agriculture	Dryland Agriculture	Plantation	Settlements	Pond	Water Body		Mixed Bush Dryland Agriculture	Dryland Agriculture	Plantation	Settlements	Pond	Water Body
1	-	29,37	384,20	170,65	15,70	2,75	1	-	30,45	344,91	208,86	15,70	2,75
2	76,44	88,31	58,28	2,46	-	-	2	89,97	74,77	58,28	2,46	-	-
3	26,33	276,93	2,37	2,58	-	-	3	26,29	276,93	2,37	2,62	-	-
4	410,66	70,16	-	4,68	-	-	4	410,66	70,16	-	4,69	-	-
Total	513,43	463,33	444,85	180,37	15,70	2,75	Total	526,92	452,31	405,56	218,63	15,70	2,75

Land cover changes are known by analyzing the form of land cover in 2020. Data on 2020 land cover in each Sub-Watershed are listed in Table 7.

4. Discharge Characteristics

The SWAT simulation carried out resulted in 4 Sub-watersheds in the Bonto Saile watershed area. The value of river discharge in 2015 and 2020 can be seen in Tables 8 and 9.

TABLE 7. 2020 LAND COVER DATA ON SUB-WATERSHEDS

Sub Watershed	Land Cover (ha)

TABLE 8. 2015 DISCHARGE VALUE IN BNTO SAILE SUB-WATERSHED

Sub Watershed	Monthly Debit (m^3/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0,71	0,64	0,54	0,59	0,23	0,16	0,02	0,01	0,00	0,00	0,02	0,61
2	0,07	0,08	0,08	0,08	0,04	0,02	0,00	0,00	0,00	0,00	0,00	0,06
3	0,33	0,30	0,26	0,29	0,12	0,08	0,01	0,00	0,00	0,00	0,01	0,30
4	0,23	0,19	0,15	0,18	0,06	0,04	0,01	0,00	0,00	0,00	0,01	0,21

Based on Table 8, the discharge value of each Sub-Watershed is different every month. The highest discharge value is in January in Sub-Watershed 1 with a discharge value of 0,71 m3/s and the lowest in months 9 and 10 with a value of 0,00 mm^3/s in all existing Sub-Watersheds.

TABLE 9. 2020 DISCHARGE VALUE IN EACH BONTO SAILE SUB-WATERSHED

Sub Watershed	Monthly Debit (m^3/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0,45	0,52	0,66	0,34	0,46	0,21	0,10	0,14	0,04	0,06	0,21	1,02
2	0,04	0,06	0,09	0,06	0,06	0,04	0,02	0,01	0,01	0,01	0,02	0,11
3	0,21	0,24	0,31	0,17	0,23	0,11	0,05	0,07	0,03	0,04	0,12	0,53
4	0,14	0,16	0,19	0,09	0,15	0,06	0,03	0,05	0,02	0,03	0,08	0,36

Based on Table 10, the sub-watershed discharge values are different every month. The highest discharge value was Sub DAS 1 in December with a discharge value of 1,02 m^3/s and the lowest in Sub-Watershed 2 months 8, 9, and 10 with a discharge value of 0,01 m^3/s. Maximum and minimum discharges obtained in 2020 were greater in value than the maximum discharge value in 2015. The difference in maximum and minimum discharge values in the Bonto Saile Sub-Watershed in 2015 and 2020 was due to differences in rainfall values. The minimum discharge value in 2020 is still better than the debit value in 2015 because not all months experience drought, there is a discharge value in all months even with a small value.

5. The Philopynics of the Flow Regime

The soofyn of river regim in a watershed is one of the things that is an indakator in monitoring the hydrological conditions of the watershed. The value of KRS is important to know in maintaining water systems in watershed areas so that the continuity of water resources is always maintained.

The maximum and minimum discharge values of each Sub-Watershed can be seen in Tables 10 and 11.

TABLE 10. 2015 KRA VALUE IN BONTO SAILE SUB-WATERSHED

Sub Watershed	River Flow Discharge (m^3/s)		KRA	Criterion
	Q max	Q min		
1	0,710	0,001	710,00	very high
2	0,080	0,001	80,00	Keep
3	0,330	0,001	330,00	very high
4	0,230	0,001	230,00	very high

The 2015 KRA value in the Bonto Saile Sub-Watershed has two categories, namely medium and very high. The value is categorized based on the KRA value classification published by the Regulation of the Minister of Forestry of the Republic of Indonesia No: 61 of 2014. Based on the Ministry of Forestry (2014), the high value of KRA means that the range of runoff water in the rainy season that occurs is large and during the dry season the flow that occurs is very small (drought). The main cause of the high value of KRA in the Bonto Saile Sub-Watershed in 2015 was extreme weather with a long dry season. Rainfall in September 2015 even only reached 0,72 mm with a minimum discharge value of only 0,001 m^3/s which resulted in the maximum and minimum discharge being very large. Unevenly distributed rainfall is the reason why the calculation of the KRS value in 2015 is very high.

TABLE 11. 2020 KRA VALUE IN BONTO SAILE SUB-WATERSHED

Sub Watershed	River Flow Discharge (m^3/s)		KRA	Criterion
	Q max	Q min		
1	0,660	0,040	16,50	very low
2	0,110	0,010	11,00	very low
3	0,530	0,030	17,67	very low
4	0,360	0,020	18,00	very low

The 2020 KRA value in the Bonto Saile Sub-Watershed has the same category, which is very low. The low value of KRA in 2020 indicates that the amount of discharge value that occurs in the rainy season is not too much difference from the discharge during the dry season or briefly that the gap in the maximum discharge value is not too large with the minimum discharge value. The main factor causing the low value of KRA in the Bonto Saile watershed in 2020 was the almost even distribution of rainfall throughout the year.

From the results of KRA in 2015 and 2020, it shows that discharge fluctuations are not only influenced by the area of vegetation cover, but also influenced by several factors. According to [4], factors that affect the magnitude of river discharge are (1) rain, rain intensity and the duration of rain greatly affect the magnitude of infiltration, groundwater flow and soil surface flow. The length of time of rain is very important in relation to the length of time the flow of rainwater into the river. (2) the topography, especially the shape and slope of the slope affects the length of time the rainwater flows through the ground surface into the river and the intensity of its flooding. (3) the type and structure of the soil greatly affect the shape and density of the drainage. (4) the state of the vegetation will affect the magnitude of interception, transpiration, infiltration, and percolation. (5) humans with the manufacture of buildings, the opening of agricultural land, urbanization can change the state of the nature of the watershed.

IV. CONCLUSSION

Based on the research that has been carried out, it can be concluded that the highest discharge value in 2015 was 0,71 and in 2020 it was 1,02. This is due to the high rainfall that occurred in 2020 and some changes in land cover that occurred.

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