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The Effect of Land Use Changes on Water Availability as Water Resources Conservation Effort in Brantas Hulu Watershed

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Abstract:- The research focuses on the effect of land use changes on water availability as an effort to conserve water resources in the Upper Brantas watershed. The purpose to be achieved by the author include analyzing the condition of land use changes to the forest area, analyzing the availability (discharge) of water, and how to conserve land in the Upper Branras watershed with a social and community approach, so as to added the economic value. While the limitations in this study are limited to the scope of the upstream Brantas watershed up to the Sengguruh Dam, which has a sub-watershed system including the Sumber Brantas Sub-watershed, Bango Sub-watershed, Amprong Sub-watershed, and Upper Brantas Sub-watershed. The analytical method is the mainstay discharge calculation using the Mock method while land use changes are processed with the help of ArcGIS software. From the results of this study it was found that there was a change in land use from 2017 to 2019 where secondary dry land forest decreased by 1,357.27 ha, while industrial plantation forests decreased by 465.79 ha, a significant addition occurred in the use of paddy fields, namely area of 4,319.19 ha. From the results of the hydrological analysis, it was found that the availability of water (effective discharge) had a downward trend where in 2017 it was 9.92 m3/s while in 2019 it was 6.70 m3/s. From this it can be concluded that changes in land use in 2017-2019 have an impact on the response of the upstream Brantas watershed which can be seen in the decrease in effective discharge in the same year. Therefore, this needs to be a special concern for the government and stakeholders in the Upper Brantas watershed area to take conservation actions so that they can maintain and even improve the quality of the area. In carrying out the conservation of the Brantas watershed area, it is necessary to increase the awareness of the surrounding community to participate in maintaining the quality of the environment in this area, where by implementing the concept of environmental conservation programs that can improve the community's economy either through the agricultural or plantation sectors as well as from other sectors. Where the program with the concept of the community for the Upper Brantas watershed is expected to be able to create good and sustainable environmental conservation.

Keywords:- *Land Use; Water Availability; Community Conservation; Das Brantas Hulu.*

I. INTRODUCTION

An area that is surrounded and limited by a range of hills or mountains is a watershed, the rainwater that falls on the watershed then flows through the river and into a lake, reservoir, or sea as its estuary. All types of activities in a watershed can affect the flow of water in the river in that watershed (Asdak C, 2002). Therefore, in utilizing land in the watershed, it must be in accordance with the principles of environmental sustainability and in accordance with the directions contained in regional regulations or other regulations, so as not to cause negative impacts that can harm us all. Human activities are growing rapidly is the main factor causing land conversion. Changes in land use in a watershed are very influential in terms of hydrology, erosion and sedimentation. The study of the role of forest hydrology in integrated watershed management focuses more on global aspects of the components that affect the hydrological cycle.

The Brantas watershed is one of the strategic watersheds in Indonesia, where the water in the Brantas watershed is used for various benefits for the community such as a source of power for power generation, PDAM, irrigation, industry and so on. The Brantas watershed is the largest watershed in East Java, with a length of 320 km and an area of 12,000 km2. This means that the area of the Brantas watershed is about 25% of the total area of East Java Province. Meanwhile, the Upper Brantas sub-watershed is a small part of the rain catchment area of the Brantas watershed which is located in Batu City, Malang City, and Malang Regency. This area has an area of 99,722.63 Ha. The aim of this research as follows

- To analyze the condition of land use change on the forest area in the Upper Brantas watershed.
- To analyze the availability (discharge) of water in the Upper Brantas watershed.
- As an effort to conserve land in the Upper Brantas watershed with a social and community approach, so as to get added economic value.

This research is limited to the scope of the upstream Brantas watershed which is located in Batu City, Malang City, and Malang Regency. The upstream part of the Brantas watershed is calculated from the source of the Brantas river to the Sengguruh Dam, which has a sub-watershed system including the Sumber Brantas sub-watershed, the Bango sub-watershed, the Amprong sub-watershed, and the upstream Brantas sub-watershed. This research does not take into account the level of erosion on the slopes in the Upper

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Brantas watershed, analyzes the availability of water using the Mock method, and does not analyze how much water is needed in the downstream area.

II. LITERATURE REVIEW

A. River Catchment Area

According to the Government Regulation of the Republic of Indonesia Number 37 of 2012 concerning Management of Watersheds, it is stated that a watershed is a land area which is an integral part of a river and its tributaries, which functions to accommodate, store and drain water from rainfall to lakes. or to the sea naturally, where the land boundary is a topographical separator and the sea boundary to the water area which is still affected by land activities.

B. Brantas River

The Brantas River Basin Development Project or better known as the Brantas Project was born on June 6, 1961 in connection with the Japanese War Reparation Fund for Indonesia (Sukistijono, et. al. 2021)

Furthermore, the development of water resources in the Kali Brantas River Basin is based on the principle of "one river, one plan, one management" as outlined in a Master Plan which is prepared in stages and consistently receives support from all stakeholders. The master plan is reviewed every 10 to 15 years to be adapted to the development of community needs and government programs.

C. Land Use

Land cover includes the condition of the biophysical appearance of the earth's surface in certain areas, while land use is a condition of the earth's appearance and has been associated with human activities in utilizing land (Phiri and Morgenroth, 2017).

D. Water Availability

Availability of surface water in this river area is calculated based on data on river flow discharge at water estimates measured in the field. The data used for river flow is only data that has been officially published in the Publication Book of Water Resources Research and Development Center, Public Works Research and Development Agency, Ministry of Public Works. Public Works. For each river area in Indonesia, the value of surface water availability is calculated, which is expressed as the average monthly flow height, and the mainstay of Q80%, so that by multiplying the flow height by the area of the catchment area, at any point in Indonesia, it can be estimated the amount of availability water (Hatmoko W. et, al., 2021).

E. Previous Research

Mahzum Muchilsin (2015) states that the projected water discharge in the Upper Brantas sub-watershed tends to experience a significant decrease from the potential available water discharge of 75,199,046.43 m^3 per year in 2015 which decreased to 72,435,678.58 m^3. This decline continues until 2020, 2025, and 2030 where in the results of the analysis each year it decreases by 72,256,070.42 m^3, 72,030,078.4 m^3, and 68,157,452.03 m^3.

Nurrizqi, E., & Suyono. (2012) stated that the rainfall that occurred in 2003 to 2007 did not have a significant difference, but the peak flood discharge that occurred in that year had a significant difference, where the peak flood discharge in 2003 had an average of 96.79 m3/ sec while in 2007 it was 189.19 m3/sec. Nurrizqi, E., & Suyono. (2012) stated that the rainfall that occurred in 2003 to 2007 did not have a significant difference, but the peak flood discharge that occurred in that year had a significant difference, where the peak flood discharge in 2003 had an average of 96.79 m3/ sec while in 2007 it was 189.19 m3/s.

Hakim Luthul (2004) revealed that during the six years between 1997 and 2003 there had been a conversion of land from forest to non-forest by 15% of the forest area of 42,273 ha in 1997 to 36,075 ha in 2003. The impact of land conversion from forest to non-forest is very influential on the decrease in water supply to the Sutami Reservoir by 36%, which is marked by an increase in surface runoff by 79% and a decrease in base flow discharge by 90%, and has an impact on the occurrence of floods in Malang Regency.

III. RESEARCH METHODS

A. Research Sites

The study location is in the Upper Brantas Watershed which is geographically located at coordinates 7°44'55.36" South Latitude - 8°03'40.56" South Latitude and 112°28' 25.63" East Longitude - 112°56' 37.51 BT. The Brantas Hulu watershed is administratively located in the Batu City area, part of Malang Regency and Malang City. The Upper Brantas watershed has several sub-watersheds including the Sumber Brantas sub-watershed, the Bango sub-watershed, the Amprong sub-watershed, and the Upper Brantas sub-watershed. The research location can be seen in Figure 1, while the area of the sub-watershed can be seen in Table 1 below.

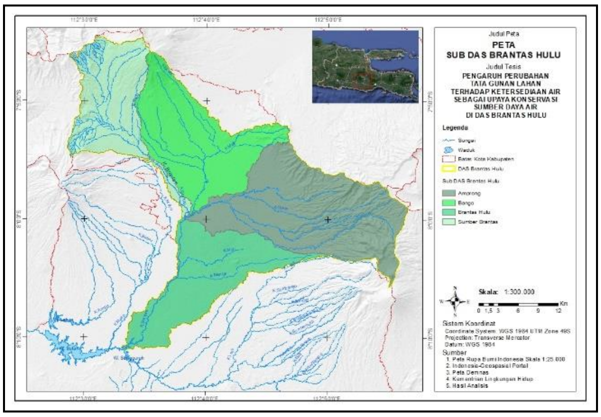

Fig. 1: Upper Brantas Sub-watershed Map

No	Sub Das	Large (ha)	Percentage (%)
1	Sumber Brantas	18.635,32	18,69
2	Bango	24.970,36	25,04
3	Brantas Hulu	21.370,37	21,43
4	Amprong	34.746,58	34,84
Total		**99.722,63**	**100,00**

Table 1: Area of each Upper Brantas Sub-watershed

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B. Data Types and Sources

The following are the types of data and data sources used in this study:

- Land use map obtained from the Ministry of Environment and Forestry
- Climatological data obtained from BMKG Karangploso
- Rain data obtained from the East Java Provincial Irrigation Service
- RBI map obtained from Ina-Geoportal, https://tanahair.indonesia.go.id/
- DEM map obtained from Ina-Geoportal, https://tanahair.indonesia.go.id/

C. Data Analysis Method

The data analysis carried out included the following:

a) Rainfall analysis

The method used in this research is the Thiessen polygon method, the Thiessen polygon method is also known as the Weighted Mean Method. The equations are used as follows:

$$P = \frac{P_1A_1 + P_2A_2 + \dots + P_nA_n}{A_1 + A_2 + \dots + A_n} = \frac{\sum_{i=1}^{n} PiAi}{\sum_{i=1}^{n} Ai} \quad (1)$$

Where P is the average rainfall height of the area; P_1, P_2, ..., Pn are the rainfall recorded at the rain gauge post; A_1, A_2, ..., An is the area of influence of the rain gauge post; and n is the number of rain gauge posts.

b) Land use analysis

Land use maps were obtained from the Ministry of Environment and Forestry, data processing was carried out using ArcGIS software. Land cover changes were analyzed in 2017, 2018 and 2019.

c) Water Availability Analysis (Metode F J. Mock)

The basic approach of this method, considers the factors of rainfall, evapotranspiration, water balance at the soil surface and soil water content. The stages carried out in the analysis using the method of Dr. F.J. The mocks are as follows:

- Hydrological and meteorological data
- Evapotranspiration
- Water balance at ground level
- Run off and ground water storage
- Amount of water available from the source

d) The relationship of land use change to the quantity of the Upper Brantas river

Data analysis was carried out descriptively, consisting of analysis of land use changes from 2017 to 2019, analysis of the relationship between rainfall and climatology to obtain data on water availability, as well as analysis of the relationship between changes in land use and changes in water availability.

D. Research Flowchart

Here is the flow chart Figure 2.

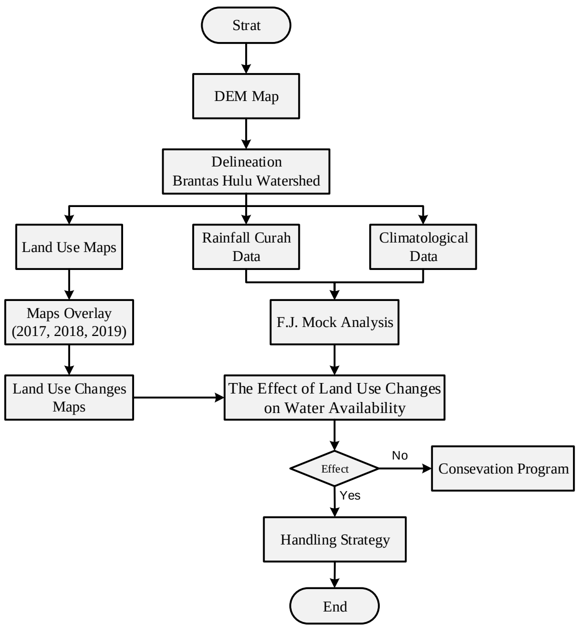

Fig. 2: Research Flowchart

IV. RESULTS OF ANALYSIS AND DISCUSSION

A. Land Use Change Analysis

The following is the result of the analysis of land use change from 2017 to 2019 in the Upper Brantas watershed.

a) Land use 2017

In 2017 land use was dominated by rice fields covering an area of 41,798.45 ha with a percentage of 41.91% of the area of the Upper Brantas watershed. In detail, it can be seen in Table 2 and for Figure 3 the 2017 land use map.

No	Land Use Classification	Large (ha)	Percentage (%)
1	Reservoir	12,62	0,01
2	Secondary Dryland Forest	18.254,02	18,31
3	Industrial Plantation Forest	10.528,71	10,56
4	Settlement	16.304,61	16,35
5	Plantation	185,11	0,19
6	Dryland farming	9.321,59	9,35
7	Savanna/Grassland	394,67	0,40
8	Ricefield	41.798,45	41,92
9	Shrubs	2.897,64	2,91
10	Open field	25,22	0,03
Total		**99.722,63**	**100,00**

Table 2: Land Use 2017

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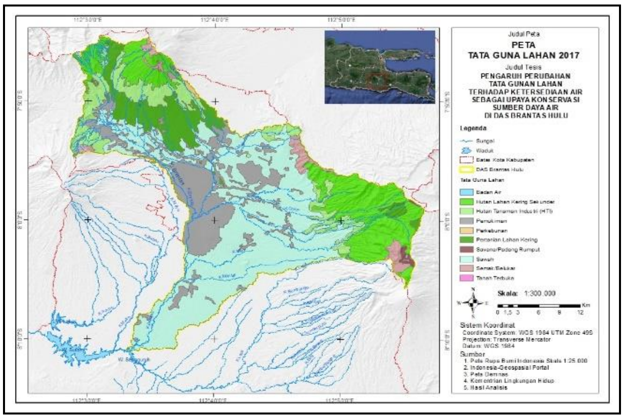

Fig. 3: Land Use 2017

b) Land use 2018

In 2018 land use was dominated by rice fields covering an area of 46,300.13 ha with a percentage of 46.43% of the area of the Upper Brantas watershed. In detail, it can be seen in Table 3 and for Figure 4 the 2018 land use map.

No	Land Use Classification	Large (ha)	Percentage (%)
1	Reservoir	14,28	0,01
2	Secondary Dryland Forest	16.766,24	16,81
3	Industrial Plantation Forest	9.787,10	9,81
4	Settlement	14.983,36	15,03
5	Plantation	172,69	0,17
6	Dryland farming	8.630,26	8,65
7	Savanna/Grassland	368,58	0,37
8	Ricefield	46.300,13	46,43
9	Shrubs	2.674,75	2,68
10	Open field	25,25	0,03
Total		**99.722,63**	**100,00**

Table 3: Land Use 2018

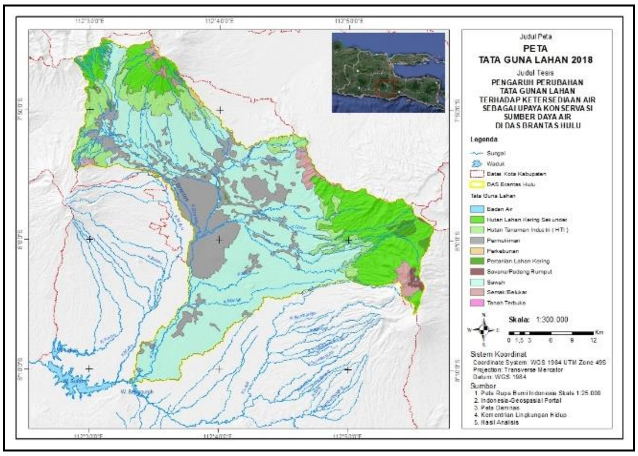

Fig. 4: Land Use 2018

c) Land Use 2019

In 2019, land use was dominated by rice fields covering an area of 46,300.13 ha with a percentage of 46.43% of the area of the Upper Brantas watershed. In detail, it can be seen in Table 4 and Figure 5 for the 2019 land use map.

No	Land Use Classification	Large (ha)	Percentage (%)
1	Reservoir	13,91	0,01
2	Secondary Dryland Forest	16.896,75	16,94
3	Industrial Plantation Forest	10.062,95	10,09
4	Settlement	14.929,11	14,97
5	Plantation	172,08	0,17
6	Dryland farming	8.556,06	8,58
7	Savanna/Grassland	368,73	0,37
8	Ricefield	46.117,64	46,25
9	Shrubs	2.264,82	2,27
10	Open field	340,59	0,34
Total		**99.722,63**	**100,00**

Table 4: Land Use 2019

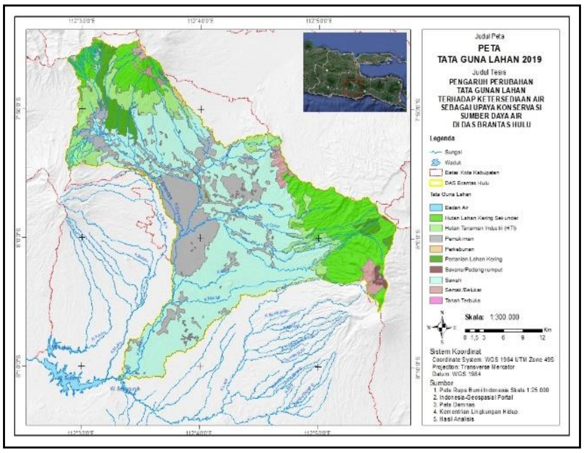

Fig. 5: Land Use 2019

d) Land Use Change 2017 to 2019

From 2017 to 2019 the most significant decrease in area occurred in the land cover classification. Secondary forest land, which can be seen in Figure 6, the trend of decreasing area, while the increase occurred in the classification of paddy land cover.

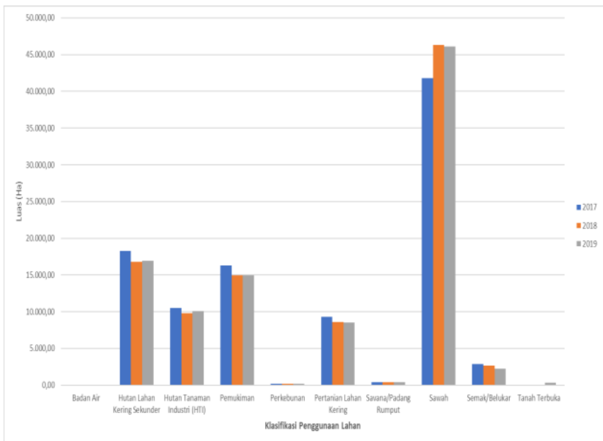

Fig. 6: Graph of Land Changes in the Upper Brantas Watershed in 2017-2019

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B. Hydrological Analysis

The following is the result of hydrological analysis in the Upper Brantas watershed.

a) Poligon thiessen

From the results of data collection and analysis of rain stations there are 7 (seven) rain stations that have an effect. The area and percentage of influence of each rain post station can be seen in Table 5, while Figure 7 is a map of the results of the analysis.

No	Rain Post	Large (ha)	Percentage (%)
1	Bululawang	4.942,99	4,96
2	Jabung	17.585,31	17,63
3	Karangploso	35.649,27	35,75
4	Karangsuko	4.983,21	5,00
5	Tajinan	8.930,11	8,95
6	Tangkilsari	3.966,94	3,98
7	Tumpang	23.664,81	23,73
Total		99.722,63	100,00

Table 5: Area of Rain Station Post with Polygon Thiessen

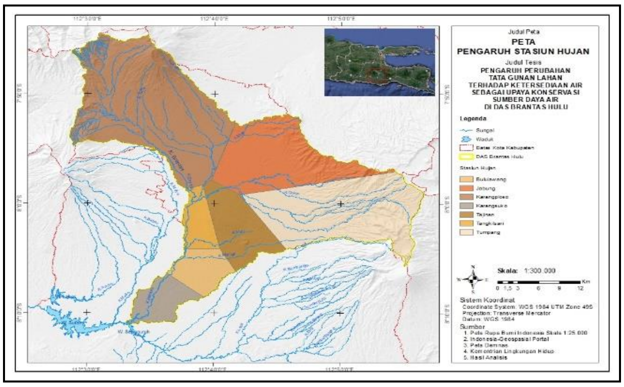

Fig. 7: Effect of Rain Station Post Result of Thiessen Polygon Analysis

b) Calculation of regional average rainfall

In the upstream Brantas watershed there are 7 (seven) measuring stations or rainfall recording, therefore to get the rainfall value for the area, the average rainfall value from each rain gauge station has been accumulated and multiplied by the percentage of the total area of the rain gauge station. . From the calculation results, the average rainfall value is shown in Table 6 below.

	2017	2018	2019	Max	Average	Min
Jan	264,78	300,97	353,76	353,76	306,5	264,78
Feb	367,33	205,74	284,44	367,33	285,84	205,74
Mar	282,51	212,29	304,98	304,98	266,59	212,29
Apr	229,03	238,59	183,52	238,59	217,05	183,52
May	182,3	127,16	95,51	182,3	134,99	95,51
Jun	121,66	24,3	16,38	121,66	54,11	16,38
Jul	59,16	5,69	3,13	59,16	22,66	3,13
Aug	19,69	0,05	0	19,69	6,58	0
Sep	66,3	15,82	10,06	66,3	30,72	10,06
Oct	143,59	33,9	13,96	143,59	63,82	13,96
Nov	383,14	352,18	118,18	383,14	284,5	118,18
Dec	260,46	322,85	223,72	322,85	269,01	223,72

Table 6: Average Rainfall of the Upper Brantas Watershed in 2017-2019

After knowing the area's average rainfall (area rainfall), the next step is to determine the average number of rainy days in the area based on data from each rain station. This needs to be done because the number of rainy days in an area is very influential on the mainstay discharge of a watershed area. To find out the average number of rainy days in an area, the calculation step is to accumulate the number of rainy days from each rain station which has been multiplied by the percentage of the area. From the calculation results, the average rainy day value is shown in Table 7 below.

	2017	2018	2019	Max	Average	Min
Jan	17	20	20	20	19	17
Feb	18	14	19	19	17	14
Mar	17	15	17	17	16	15
Apr	15	12	13	15	13	12
May	7	8	8	8	8	7
Jun	7	2	2	7	4	2
Jul	3	1	1	3	2	1
Aug	2	0	0	2	1	0
Sep	3	1	1	3	2	1
Oct	8	3	1	8	4	1
Nov	21	17	8	21	15	8
Dec	17	16	17	17	17	16

Table 7: Average Number of Rainy Days in the Upper Brantas Watershed in 2017-2019 (days)

c) Meteorological data

From the results of data collection sourced from BMKG Karangploso, climatological data was obtained in 2019, with the parameters of average temperature, sun brightness, relative humidity, and wind speed.

d) Mock method discharge analysis

In this study, the discharge of the Brantas River in the upstream was calculated using the Mock Method. This is because the researchers did not get data from the Water Level Record (AWLR) in the river flow. The influencing factors in determining river discharge using the Mock Method are:

- Area of sub-watershed
- Rainfall (P)
- rainy days (h)
- Potential evapotranspiration (ETo)
- open field (m)
- Infiltration coefficient (i)
- Groundwater flow recession factors (k)
- Initial Storage, IS

The following is the conclusion of the analysis of the effective discharge for 2017-2019 with the Mock method which is fully described in Table 8 below.

Month	Year					
	2016	**2017**	**2018**	**Max**	**Ave**	**Min**
Jan	13,24	15,05	17,69	17,69	15,33	13,24
Feb	18,37	10,29	14,22	18,37	14,29	10,29
Mar	14,13	10,61	15,25	15,25	13,33	10,61
Apr	11,45	11,93	9,18	11,93	10,85	9,18
May	9,11	6,36	4,78	9,11	6,75	4,78
Jun	6,08	1,21	0,82	6,08	2,71	0,82
Jul	2,96	0,28	0,16	2,96	1,13	0,16
Aug	0,98	0,00	0,00	0,98	0,33	0,00
Sep	3,31	0,79	0,50	3,31	1,54	0,50
Oct	7,18	1,69	0,70	7,18	3,19	0,70
Nov	19,16	17,61	5,91	19,16	14,22	5,91
Dec	13,02	16,14	11,19	16,14	13,45	11,19
Ave	**9,92**	**7,66**	**6,70**			

Table 8: Effective Debit a Year (m^3/dtk)

In order to get an analysis of the effective discharge that is close to the real thing in the field, it is necessary to calibrate, namely the comparison between the measured river discharge and the results of the calculation of the discharge in the river in the Upper Brantas watershed using the Mock method. However, in this case, the researchers lacked data on the results of AWLR measurements or manual measurements in the study area. Therefore, the analysis of effective discharge does not use calibration.

In sufficient water needs, it is necessary to make a reference in the use of water, namely by referring to a Mainstay Debit. The mainstay discharge is the minimum discharge that is used as a review point for a river which is a combination of direct runoff and base flow for the purpose of sufficient community water needs.

Before determining the amount of the mainstay discharge, first, sort the annual discharge from the analysis of the annual effective discharge (Table 8) from the largest to the smallest. The following are the results of the calculation of the mainstay discharge of Q50, Q70, Q80, and Q90 which can be seen in Table 9.

Month	Q50	Q70	Q80	Q90
Jan	15,12	15,84	13,60	13,24
Feb	13,89	15,47	11,07	10,29
Mar	13,06	14,46	11,32	10,61
Apr	10,68	11,59	9,63	9,18
May	6,55	7,19	5,09	4,78
Jun	2,52	2,68	0,90	0,82
Jul	1,04	1,09	0,18	0,16
Aug	0,30	0,30	0,00	0,00
Sep	1,43	1,55	0,56	0,50
Oct	2,94	3,34	0,90	0,70
Nov	13,39	18,07	8,25	5,91
Dec	13,22	13,96	11,55	11,19

Table 9: Mainstay Debit (m^3/dtk)

C. Effect of Land Use Change on Water Availability

From the results of the analysis of land use changes from 2017 to 2019 it was found that there was a conversion of land functions, especially in forest areas, both secondary dry land forests and industrial plantation forests. Where secondary dryland forest decreased by 1,357.27 ha, while industrial plantation forest decreased by 465.79 ha. A significant addition occurred in the use of paddy fields, which was 4,319.19 ha.

The decrease in water availability (effective discharge) from the analysis results has a downward trend where in 2017 it was 9.92 m3/s while in 2019 it was 6.70 m3/s. From the results of the analysis of the two variables between land use and water availability, it can be concluded that when there is a land change in the watershed it will affect the availability of water in the river flow. From this it can be concluded that changes in land use in 2017-2019 have an impact on the response of the upstream Brantas watershed which can be seen in the decrease in effective discharge in the same year.

Therefore, land use in the Upper Brantas watershed needs to be handled both preventively and correctively, so that damage to the Upper Brantas watershed can be addressed early on.

D. Strategies for Handling the Management of Upper Brantas Watershed

The complexity of the watershed ecosystem requires a management approach that is multi-sectoral, cross-regional, including institutions with their respective interests and takes into account the principles of interdependence. Important things to consider in watershed management:

- There is a link between various activities in the management of natural resources and the development of human activities in the utilization of natural resources;
- Involves various disciplines and includes various activities that do not always support each other;
- Covers upstream, middle and downstream areas that have biophysical linkages in the form of a hydrological cycle.

Therefore, the strategy formulation in this study was carried out using two approaches, where the first approach was to use the vegetative method as an effort to overcome the short term, while for the long term to form a community group that cares about the watershed, so that apart from increasing the sustainability of the Upper Brantas watershed area, it can also improve the sustainability of the watershed area. the economy of the community residing in the Upper Brantas watershed.

a) Vegetative method

One of the efforts to minimize the water deficit that occurs during the dry season is by restoring the land use function to its original function, where the role of vegetation conservation is an alternative.

The Brantas Hulu watershed area is included in the administrative area of Malang Regency, Malang City and Batu City, where this area is an area that has potential in agriculture and plantations, therefore researchers have alternative types of plants that can be planted as conservation measures in the Brantas watershed. Upstream, where these plants have economic, hydrological and conservation values and are in accordance with the local topography and climate, these types of plants are divided into 2 (two) namely plantation crops and trees that can be used for their fruit, while examples of these plants include:

- Examples of Plantation Plants
  - Cocoa (*Theobroma cacao*)
  - Patchouli (*Pogostemon cablin*)
  - Clove (*Syzigium aromaticum*)
  - Coffee (*Coffea canephora*)
- Examples of Fruit Plants
  - Avocado (*Persea americana*)
  - Duku (*Lansium domesticum*)
  - Mangosteen (*Garcinia mangostana*)
  - Durian (*Durio zibethinus*)

If the use of land use in some areas of the Upper Brantas watershed uses some of the above plants, then the water deficit in the dry months of each year can be minimized. In addition, the above plants are plants that are very suitable to be planted in critical areas in the Upper Brantas watershed area.

However, this needs to be studied further in terms of the area, the number of trees planted and the location of the plantings so that the effectiveness of existing water storage can be determined and recalculates related to water availability and land cover. So that this strategy can be measured with a good level of success.

b) Fostering human activities

Watershed is an ecosystem unit area where humans, including humans, have a dual function, namely as part of the watershed ecosystem component and function in the use of natural resources. The targets of fostering human activities in the use of natural resources include:

- Counseling and coaching to improve perception and ability to manage the environment;
- Reducing the rate of growth and population density;
- Increase people's income;
- Creating job opportunities outside the agricultural sector improve public health through improved nutrition, improved health infrastructure;
- Develop non-government organizations.

In this study, the authors create a concept of community empowerment around the Upper Brantas watershed with the aim of environmental sustainability and economic improvement for the surrounding community, both from the agricultural/plantation sector and creating new sources of income from other sectors such as ecotourism-based tourism. The brief can be seen in Figure 8 below.

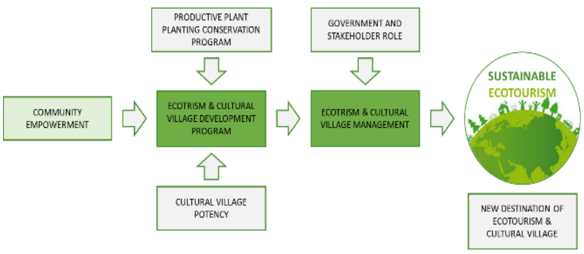

Fig. 8: Community Participation Development Scheme

There are several stages and aspects in realizing the program concept in the picture above, including:

- Conservation activities for planting productive plants
- Community participation as an element of development is a process of community adaptation to ongoing changes. Therefore, this activity was pioneered by the community around the Upper Brantas watershed as implementers and managers.
- Cultural tourism potential

  There is a lot of cultural potential in the Upper Brantas watershed area in the sense of the greater Malang area that needs to be exposed and can be shown to the outside community so that it is interesting to show, based on ecotourism, this can support the potential of tourists who come.
- Government and stakeholder support

  Government support cannot be separated from this strategy where the role of the government can increase the level of success, the government can assist in marketing, funding and through the making of laws and regulations to support activities carried out by the community.
- The realization of a new tourist destination

  From the 3 (three) points above, new tourist destinations with the concept of ecotourism and culture can run well. However, this needs to be studied, and further approaches because in this study it is still limited to execution in the field.

V. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

The conclusions that have been reached in research on the Effect of Land Use Changes on Water Availability as Water Resources Conservation Efforts in the Upper Brantas Watershed include:

a) There was a change in land use where secondary dryland forest decreased by 1,357.27 ha, while industrial plantation forest decreased by 465.79 ha. A significant addition occurred in the use of paddy fields, which was 4,319.19 ha. With this, the conversion of land functions from forests to rice fields, or other land uses to rice fields. With the decline in forest areas, this will have an impact on the rivers in the Brantas watershed area, one of which is a decrease in discharge during the dry season.

b) There is a decrease in water availability (effective discharge), from the results of the analysis it has a downward trend where in 2017 it was 9.92 m3/s while in 2019 it was 6.70 m3/s. This needs to be a special concern for the government and stakeholders in the Upper Brantas watershed area to take conservation actions so that they can maintain and even improve the quality of the Upper Brantas watershed area.

c) In carrying out the conservation of the Brantas watershed area, it is necessary for the role of the surrounding community to participate in maintaining the quality of the environment in this area, where with the concept of environmental conservation and can improve the community's economy through agricultural and plantation products as well as from other sectors, it is expected to increase the enthusiasm of the community in participating in protecting the Brantas watershed area. upstream.

d) In carrying out the conservation of the Brantas watershed area, it is necessary to increase the awareness of the surrounding community to participate in maintaining the quality of the environment in this area, where by implementing the concept of environmental conservation programs that can improve the community's economy either through the agricultural or plantation sectors as well as from other sectors. Where the program with the concept of the community for the Upper Brantas watershed is expected to be able to create good and sustainable environmental conservation.

B. Suggestions

In this research, there are still many shortcomings in terms of further analysis related to the level of success in the developed strategy, which is due to the limitations of the authors based on the time and length of the study. Therefore, the authors hope that there will be further research in this regard.

The author also hopes to be able to carry out this strategy as an effort to participate in preserving the Brantas watershed area with the support of relevant stakeholders.

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