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Prediction of Erosion and Sedimentation in Micro Catchment Area of Air Lanang Using Soil and Water Assessment Tool (SWAT) Model

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ABSTRACT

This research aims to obtain erosion and sedimentation rate data in the micro catchment area of Air Lanang using soil and water assessment tool (SWAT) modelling within existing and scenario land uses. Geographically, the study area is located between latitude 3°26`23.48” - 3°31`46.09” S and longitude 102°24`11.74” - 102°28`26.35” E with a total area of 2987.06 ha. Soil analysis was conducted in the Soil Science Laboratory, Faculty of Agriculture, University of Bengkulu. The research data was analysed using SWAT model. Recorded data in this study were including soil analysis data, soil type map from land unit and soil map book Bengkulu sheet (0912) Sumatra, data of status area from KLHK, Digital Elevation Model National data from BIG, a set of climate data from BMKG, data of administrative border from RBI map Bengkulu Province and data of land use from the interpretation of satellite image and ground checking, as well as the scenario land use which was prepared following the community forest program from the government in the protected forest by converting the coffee plantation located within the protected forest area to woody plants with economic, social and conservative values. The results showed total erosion in the micro catchment area of Air Lanang with the existing land use in 2020 was 820731.87 ton year^{-1}, while in the scenario land use was 288212.45 ton/year which were classified to very light, light, moderate, heavy and very heavy in class erosion. Based on the existing land use data, there was a decrease of erosion in the moderate to very heavy class of erosion for 7.27 % resulting in the very light and light class of erosion become 15.55 % after the simulation of the scenario land use model. The use of scenario land use model is effective to decrease erosion and sedimentation rate. The total sedimentation in the micro catchment area of Air Lanang in existing land use in 2020 was 354949.98 ton year^{-1} with the highest sedimentation in sub-basin 2 while the lowest sedimentation was found in sub-basin 12. On the other hand, the total sedimentation in the scenario land use model was 137365.04 ton year^{-1}. The reduction of total sedimentation in existing land use in 2020 to the scenario land use model was 36.76 %.

Keywords : watershed, erosion, sedimentation, SWAT, Air Lanang

INTRODUCTION

A micro catchment area is an area bounded by topographic separators that receive rain, accommodate, store and drain into rivers and so on to lakes or seas (Asdak, 2010). A micro catchment area is a management unit of a natural resource that serves as a producer of goods or services that are beneficial to life (Rahmad *et al*., 2017). Such as agricultural areas, plantations, fisheries, settlements, hydropower construction, utilization of timber forest products, and others (Gunawan *et al*., 2014). Thus micro catchment area can be viewed as a natural system that is the place where hydrological biophysical processes take place as well as complex socio-economic and cultural activities of the society. The increase in demands for natural resources (water, land, and forests) is due to increased population growth which results in changes in the condition of the micro catchment area water system. Human intervention in the natural system of micro catchment areas occurs in the form of land development of cultivated areas that directly affect biophysical processes of micro-catchment area hydrological as a natural process of a cycle known as the water cycle (KLHK, 2017).

The micro water system catchment area is the individual unity relationship of hydrological elements that include rain, surface flow, river flow, suction, groundwater flow, evapotranspiration, and other elements that affect the water balance of a Micro catchment area. Because almost all development sectors have an interest in the micro catchment area, the management of micro catchment areas must be considered. That is, in addition to the importance of the preservation of the ecohydrological function of the micro catchment area, economic and social benefits. The micro catchment area is also important to accommodate (Lestari, 2010). Based on this, the spatial planning of micro catchment areas must pay attention to all aspects of development with the main goal is to protect the micro catchment area to remain sustainable its main function as a regulator of water management in addition to the biodiversity function of forest areas that are the main controllers. One of the important elements of the micro catchment area hydrological system in Indonesia on average, experiencing surface erosion and sedimentation problems, one of which is Micro Catchment Area Air Lanang.

Erosion is a natural phenomenon eroded by the upper soil surface by the movement of water and wind (Sayanti *et al*., 2017). Erosion occurs due to the kinetic energy of rain that breaks down soil grains and is carried away by runoff water from rain (Satriawan & Fuady, 2014). Some causes of erosion are classified into three, namely energy factors (erosivity, surface flow, wind, relief, angle and length of slopes, and porch distance), resilience factors (erodibility, infiltration, and tillage), and protective factors (population density, cover crops, land use value, and land processing) (Banuwa, 2013).

Eroded soil transported by surface streams will be deposited on slowed water flows such as rivers, irrigation canals, reservoirs, lakes, or river estuaries. This has an impact on the shallowing of the river resulting in frequent flooding in the rainy season and drought in the dry season (Arsyad, 2010). The impact of the erosion process will produce sediment. Sedimentation is the process of displacement and deposition of soil erosion, especially the result of surface erosion and trench erosion. Sedimentation describes a suspended load that is transported by the movement of water and or accumulated as a micro catchment area (bedload) material. From the sedimentation process, only a portion of sediment flow material in the river is transported out of the micro catchment area, while others settle in certain locations in the river during the journey (KLHK, 2015).

Micro Catchment Area Air Lanang Area becomes important to be managed so that it can be predicted and identified the rate of erosion and sedimentation donated to the catchment area of the PLTA Musi. Based on the report of PT. PLN PERSERO (2019) reservoir management at the PLTA Musi has challenges in its management, namely sedimentation problems. The sediment buildup affects the change in the typology of the puddle area around the reservoir and the buildup of sediment is caused by erosion that occurs on critical lands contained in the reservoir catchment area.

One way to manage micro catchment areas is to apply a model to find out how much erosion, sedimentation, and flow potential. Various management models are developing in predicting the impact of land processing on hydrological conditions by utilizing GIS (Geographic Information System) technologies such as USLE, MUSLE, RUSLE, WEPP, CREAMS, and SWAT (Arsyad, 2010).

The USLE (Universal Soil Loss Equation) model is a model built to analyze the impact of erosion on each land. As science developed, this model evolved into M (Modified)-USLE and R(Revised)-USLE. The change of USLE to MUSLE lies in the erosion value of rain which is transformed by the area of the ratio of surface flow to the magnitude of rainfall at the event (Kinnell, 1998). Then MUSLE was developed again into RUSLE by Renard *et al*. (1997) with the erosive factor of rain as the result of multiplication of total rain energy with a maximum rain intensity of 30 minutes. The SWAT (Soil and Water Assessment Tool) is a model used to predict the effect of land use on discharges, sediments, and agricultural chemicals entering rivers or bodies of water in a micro catchment area. This model is a development of the previous models' creams and USLE (Neitsch *et al*., 2011). This semi-distribution model can simulate with the smallest scale (Hydrolical Response Unit) for a long period in a short time (Arsyad, 2010). The hydrological cycle simulated in SWAT uses the water balance equation:

$$SW_t = SW_0 + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw})$$

SWt is the water content in the soil (mm), SW0 is the initial water deposit (mm) on the 1st day, t is the time on the daily scale, Rday is the amount of precipitation on the first day (mm), Qsurf is the Flow/surface runoff/run off on the 1st day (mm), Ea is evapotranspiration on the ith day, Wseep is the amount of water entering the soil aquifer zone on the first day (mm), Qgw is a subsurface flow (mm) (Neitsch *et al*., 2011).

Erosion and sedimentation estimates in the SWAT model are predicted at the HRU (Hydrolical Response Unit) level using the MUSLE approach.

The SWAT concept describes rainwater that flows into the ground and if the amount exceeds the rate of infiltration, then there will be surface water runoff that can lead to erosion and sedimentation (Swami & Kulkarni, 2016). Micro catchment areas that have soil conditions with high permeability greatly affect lateral flow. The water collected above the impermeable layer will be a source of water. SWAT calculates the percolation at each layer of the soil profile and this process only occurs when the groundwater content is more than the airy capacity (Neitsch *et al*., 2011).

Several studies in various countries conducted by Zettam *et al*. (2017) in Africa, Nguyen & Nguyen (2014) in Vietnam, Rahmad *et al*.(2017), and Christanto *et al*. (2018) in Indonesia showed that the SWAT method can simulate hydrological processes with Nash-Sutcliffe Efficiency (NSE) values > 0.5. The model is expected to be one of the considerations in planning the management of micro catchment areas with erosion and sedimentation indicators in the Air Lanang Area Micro Catchment.

This study aims to obtain data on erosion and sedimentation rates in the Air Lanang Area Micro Catchment through simulated SWAT (Soil and Water Assessment Tool) models with existing land use and scenarios.

MATERIALS AND METHODS

This study was conducted from August to October 2020 in Micro Catchment Area of Air Lanang and analysis of soil samples at Soil Science Laboratory Faculty of Agriculture, University of Bengkulu. Geographically Micro Catchment Area Air Lanang is located at 102°24'11.74" - 102° 28'26.35" East Longitude and at 3°26'23.48" - 3° 31'46.09" South Latitude with an overall area of about 2987.06 ha.

The main ingredient used in this study is, the Provincial Land Type map Bengkulu Scale 1:250,000 sourced from Bengkulu Sheet Land and Land Unit Map 0912 Sumatra, DEMNAS (National Digital Elevation Model) data from BIG (Badan Geospatial information), climate data (Daily rainfall, Maximum temperature and minimum daily, and Daily wind speed) Micro Catchment area Lanang Water Area The last 5 years are sourced from the Bureau of Meteorology, Climatology, and Geophysics (BMKG), RBI map (Rupa Bumi Indonesia) North Bengkulu Regency, Kepahiang, Rejang Lebong and Bengkulu Tengah scale 1:50,000 sourced from BIG (Geospatial Information Agency) and satellite imagery in 2020 are sourced from SAS Planet.

The tools used in this study are a set of laptops, software ArcGIS Map 10.3, SAS Planet software, ArcSWAT software, SWAT output software viewer, GPS (Global Positioning System), microsoft office 2010, notepad, gadget, ring samples, meters, field knives and stationery.

This research is carried out with the initial stage in the form of preparation, data collection. secondary and primary (field surveys) as well as the extraction of spatial data sourced from secondary and primary data to be inputted the depth of the SWAT model as a component which used the model in the simulation which further outputs from the results of the model simulation processed into a map of erosion hazard levels and sedimentation rates in the Micro Catchment Area Air Lanang is in accordance with the purpose of research.

The data used in this study is data on Indonesia's earth map. (RBI), climate data, soil type data, satellite imagery data, land cover data and status regions, Digital Elevation Model (DEM) data and community trend data for conservation measures.

Laboratory analysis includes soil texture, C-organic, conductivity soil hydraulics, bulk density, pH and soil electrical conductivity from soil samples which has been taken at predetermined points. The data that has been collected is then analyzed, the results of the analysis become the basis for drawing conclusions and drafting recommendations. Analysis The data was carried out by modeling the Soil and Water Assessment Tool (SWAT). The data analysis stage using the SWAT model is divided into several stages. Watershed Delination, Create HRU, SWAT Run and Setup).

Output data from the results of SWAT analysis obtained is processed use Microsoft office excel and ArcGIS to determine the number erosion and sedimentation in the Micro Catchment Area of Air Lanang so that it can presented spatially. For the determination of the grade of erosion hazard level for Table 1.

Land use scenarios are structured based on existing land use that covered with protected forest areas so that protected forest areas are known which has turned into another designation. Protected forest areas that have been transformed into plant areas woody that has not only conservation value but also social and economic value for the public with guidelines for research journals around the research area and community forest program from the government.

Table 1. Soil Erosion Risk Class Based on The Depth of Solum

The Depth of Solum (cm)	Rate of Erosion				
	I	II	III	IV	V
	Erosion (ton/ha/year)				
	<15	15-60	60-180	180-480	>480
High (>90)	VL 0	L I	M II	H III	VH IV
Medium (60-90)	L I	M II	H III	VH IV	VH IV
Low (30-60)	M III	H IV	VH IV	VH IV	VH IV
Very Low (<30)	H III	VH IV	VH IV	VH IV	VH IV

Source: Permenhut(2009)

Remarks: 0-VL = Very Low; I-L = Low; II-M = Medium; III-H = High; IV-VH = Very High

RESULTS AND DISCUSSION

Overview of Research Sites

Administratively, the Air Lanang Micro Catchment Area is mostly located in Rejang Lebong Regency, especially in South Curup District and Bermani Ulu District. However, there is a small, insignificant area into the districts of Central Bengkulu, North Bengkulu, and Kepahiang Province Bengkulu. The following is the area of the Air Lanang Micro Catchment Area (Table 2).

Table 2. The Administrative District/City Area in Micro Catchment Area Air Lanang

District	Area (ha)
Bengkulu Tengah	25.07
Bengkulu Utara	8.57
Kepahiang	58,77
Rejang Lebong	2894,65
Total	2953.42

Ecologically the research area is part of the hydropower catchment area Musi, which has the main problem of forest areas in the upstream area, which many functions have been converted to other uses such as community plantations, settlements and others. The average area of community arable land in Air Lanang Village approximately 2.5 ha, with 1.6 ha located within protected forest areas with commodities mainly coffee (Senoaji, 2011). Air Lanang's Micro Catchment Area is an area directly adjacent to the Bukit Daun Protection Forest. Of the 2987.06 ha of Air Lanang's Micro Catchment Area of 1492.36 ha, it is the Bukit Daun Protected Forest area with the remaining 1494.70 being other use areas. The Bukit Daun Protection Forest has an important role in regulating groundwater and environmental protection, namely as a source of springs and water catchment areas for several large rivers such as the Musi River, Ketahun River, and Seblat River.

The classification of soil types from soil combinations for adjusted to the input data in the SWAT model Table 3). Hapludults soil combination, Haplohumults, and Humitropepts are classified into SOIL 1 and so on with each soil classification having attribute data in it in the form of soil parameters that are input into the SWAT model such as soil depth and Soil erodibility values, SOIL 1 – SOIL 7 has a soil depth of > 150 cm unless for SOIL 2 with a depth of 60 cm, while for the erodibility value of SOIL 1 – SOIL 7 is 0.13, 0.19, 0.13, 0.15, 0.10, 0.14 and 0.15. In general, the distribution of soil types in the Micro Catchment Area Air Lanang has the order ultisols and inceptisols. Ultisols when viewed from the stability of soil aggregates, it is a stable soil because of soil aggregation clay textured with Fe and Al oxide compounds that are abundant in the soil but with the presence of an argillic layer that can inhibit the infiltration of water into the soil, It is estimated that this soil has a relatively high soil erodibility. However, based on the results of research data Dariah *et al.* (2004) stated that there are still. The erodibility variation is quite high for ultisols, which range from very low to slightly high. Organic matter shows a great role in determining the level of soil erodibility. Ultisols that contain organic matter (including sub-order Humult) generally have very low soil erodibility.

zation of the image (Campbell, 2002). Classification results can be seen in Table 5.

The results of the interpretation of land use in Table 5 were field-tested by surveying the research area. The survey was conducted using the purposive sampling a random sampling technique but accompanied by certain criteria (Arikunto, 2006). It can be seen from the table of interpretations of land use, plantation coffee has the largest land-use area of 2322.59 ha. Rice farming culture is not the main culture of people's work, their main culture is coffee gardening on their land (Air Lanang Village Government, 2007). If the percentage of coffee plantations in the Bukit Daun Protection Forest area has reached 62.29%. Hindarto *et al.* (2009) stated that the area that is no longer forested in the forest area in the Bukit Daun Protection Forest reached 66.64%. Villagers' forest with farmer type of work tends to increase the value coefficient of population pressure in the forest area (Senoaji & Ridwan, 2006).

Table 3. Classification of Soil Types in Micro Chatchment Area Air Lanang

No.	Soil Types			SWAT`s Code	Area (ha)	Percentage (%)
1	(1) Hapludults	(2) Haplohumults	(3) Humitropepts	SOIL 1	134.86	4.51
2	(1) Dystropepts	(2) Dystrandepts	(3) Humitropepts	SOIL 2	5.58	0.19
3	(1) Dystropepts	(2) Humitropepts	(3) Eutropepts	SOIL 3	0.05	0
4	(1) Hapludults	(2) Haplohumults	(3) Humitropepts	SOIL 4	59.14	1.98
5	(1) Dystropepts	(2) Humitropepts	(3) Eutropepts	SOIL 5	18.14	0.61
6	(1) Hapludults	(2) Haplohumults	(3) Humitropepts	SOIL 6	2506.77	83.92
7	(1) Dystropepts	(2) Dystrandepts	(3) Humitropepts	SOIL 7	262.53	8.79
Total					2987.06	100

Slope conditions in the Air Lanang Micro Catchment Area classified into 5 classes, namely flat, sloping, slightly steep, steep, and very steep. can be seen in Table 4.

The Air Lanang Micro Catchment Area is mostly in the form of hills with a slope above 25-40% with an area of 1360.44 ha. Reyes (2006) states that one of the things that play a role in determining the ability of land namely the slope of the land. Land with a slope of 25 – 65% requires action conservation such as making terraces, making drainage channels, or crop rotation in its use as agricultural land. Factors affecting class Land capability is the slope associated with erosion, climate, and soil.

Land Use in 2020

Based on the results of the interpretation of Google Satellite imagery for 2020 for closing Micro Catchment Area Air Lanang area based on elements such as hue, patterns, sizes, shapes, shadows, and land use sites is classified into 7 class. Image classification is carried out to determine land use classes and information types of land use by assigning objects, features, or areas to one class based on the characteri-

Land use from the interpretation results which are reclassified adjust to the SWAT model classification so that there are areas that must be unified in one class, namely primary forest and secondary forest to become Forest Evergreen with SWAT code FRSE.

Scenario Land Use

Scenario land use is a structured land use based on the existing land use as a result of the interpretation of Google Satellite imagery Year 2020 and reclassified protected forest areas taking into account the conditions socio-economic community around the Air Lanang Micro Catchment Area which sourced from related journals, as well as community forestry programs from the government which was rolled out starting in 1999 in the form of assistance for planting seeds of various types of trees such as candlenut, durian, petai, mango, rambutan and onion trees (Senoaji, 2011). The community forest program in Air Lanang Village has the ultimate goal of replacing coffee plants with forestry plants but forestry plants that are considered to interfere with the growth of coffee are cut down by the community. Through the program the government hope that forestry plants can provide results and protect growing coffee, farmers will reduce their activities on coffee and switch to cultivation forestry plants, so that forest gardens are no longer dominated by coffee plants but filled with hardwood plants that do more for environmental protection than coffee.

When viewed from the pattern of land use of the Bukit Daun Protection Forest in the Forest Area society. Based on Aritonang *et al*. (2018), there are 6 land-use patterns in Indonesia the community forest area of Air Lanang village, namely : Coffee Land Use Patterns and Areca nut; Candlenut land-use patterns; Coffee, areca nut, and land-use patterns Johar; Land Use Patterns for Coffee, Areca Nut, Johar, Avocado; Utilization Patterns Coffee, Areca, Nutmeg and Durian Fields, and Land Use Patterns for Coffee, Areca, Johar, Durian, and Jengkol. Based on the things above, the land use is arranged a scenario consisting of 6 classes with adjustments to the classes contained in The SWAT model, can be seen in Table 6.

Table 4. Classification Slope of Land in Micro Catchment Area Air Lanang

No	Tilt (%)	Class	Large (ha)	Percentage(%)
1	0-8	Flat	134.85	4.51
2	8-15	Sloping	326.73	10.94
3	15-25	Rather Steep	720.54	24.12
4	25-40	Steep	1360.44	45.54
5	>45	Very Steep	444.5	14.88
	Total		2987.06	99.99

Source : Decision Letter (SK) Minister of Agriculture No. 837/KPTS/Um/11/1980 (Kementan, 1980) and Regulation of The Minister (Permen) Public Works No. 41/PRT/M/2007 (PU, 2007).

Table 5. The Result of Existing Land Use Interpretation in 2020

No.	Classification of Land Use	Classification of SWAT	SWAT`s Code	Area (ha)	Percentage (%)
			Agricultural		
1	Field	Land-Row Crops	AGRR	4.13	0.14
2	Barren Land	Barren	BARR	59.61	2
3	Coffee Plantation	Coffee	COFF	2322.59	77.75
4	Primary/Secondary Forest	Forest-Evergreen	FRSE	509.38	17.05
5	Rice Field	Rice	RICE	9.44	0.32
6	Bush	Range-Brush	RNGB	69.44	2.32
7	Settlement	Residential-Med/Low Density	URML	12.48	0.42
		Total		2987.06	100

Source: Data Analysis. 2021

Table 6. Land Use Scenario

No	Scenario of Land Use	Classification of Land use	Classification of SWAT	SWAT`s Code	Area (ha)	Percentage (%)
1	Primary/Secondary Forest	Primary Forest	Forest-Evergreen	FRSE	509.38	17.05
2	Coffee Plantation	Coffee Plantation	Coffee	COFF	1393.06	46.64
3	Settlement	Settlement	Residential-Med/Low Density	URML	12.48	0.42
4	Rice Field	Rice Field	Rice	RICE	9.44	0.32
5	Field	Field	Agricultural Land-Row Crops	AGRR	4.13	0.14
6	Conservation Forest. Protected Forest. Production Forest. Limited Production Forest. and Community Forest	Forest-Mixed (High/Low Density Forest)	Forest-Mixed	FRST	1058.57	35.44
		Total			2987.06	100

Source: Data Analysis. 2021

The area of land use for coffee plantations from the previous one (use existing land) is 2322.59 ha to 1393.06 ha if the percentage is 31.11%. Reduction of land use for coffee plantations in the scenario land use is carried out by converting coffee plantations scattered in protected forest areas into the mixed forest followed by bare soil and shrubland. The mixed forest that replaces coffee plantations are expected to be used for conservation forests, protected forests, production forest, limited production forest, or community forest with woody plants that not only have conservation value but also have value social and economic benefits for the surrounding community so that the expansion of coffee plantations in protected forest area does not happen again. Some woody plants that can considered as nutmeg, candlenut, areca nut, and palm trees even though at this time according to Suhartoyo *et al*. (2015), these plants are only made in the community Air Lanang Village as a hedge plant.

Hydrologic Response Unit (HRU) Analysis

The results of the overlay were carried out from the data of land, land use, and slope slopes automatically with a SWAT model to form HRU. Modeling on Micro The Air Lanang Catchment Area produced 724 HRU units which are presented in Figure 1.

HRU data analysis of existing land use has the largest area, namely 115.94 ha and the smallest area is 0.01 ha, while the land-use scenario produced 579 units of HRU. Differences in the units formed in the HRU Micro Catchment Air Lanang area due to differences in overlayed land use input data. The SWAT model is by the statement by Definnas *et al.* (2020) that changes in the use of the land that occurs cause changes in the spatial pattern of HRU. Changing spatial pattern this also causes changes in the dominant and extensive HRU. HRU changes that most dominant in the existing land use to the scenario occurs for class coffee plantation.

The number of HRU units formed is influenced by overlay and subbasin data contained in the Air Lanang Micro Catchment Area so that each HRU has information on subbasin, land use, soil type, and slope. HRU formed simulated with the last input data, namely climate data stored in the table according to the SWAT format. In this research, the climate data that becomes the input is the data daily rainfall at 7 rainfall post points, maximum air temperature data and daily minimum and daily wind speed data on one climate station.

Erosion Hazard Level 2020 (Existing)

The amount of erosion resulting from the results of the SWAT analysis on the Micro Catchment Air Lanang area is 465781.89 tons/year which is further classified into 5 classes which can be seen in Table 7.

Table 7 shows that areas with a high level of erosion hazard dominate in Air Lanang Micro Catchment Area with existing land use in 2020, which is the medium class with a percentage of 68.99% of the total Micro Catchment Area Air Lanang which is spread dominantly on various slope conditions especially slopes (15-40%) with dominant land use of coffee, forest, and shrubs followed by heavy and very heavy classes, the percentage of heavy erosion area was 20.37% and very heavy 2,36% spread on slopes

(25-40%) with land use dominant in the heavy class, namely coffee, forest, and shrubs and the very heavy class, namely soil bare, bushes and fields/fields. As for the light and very light classes which spread on slopes (0-15%) dominated by land use, namely for the very low-class light forest and light class namely forest, coffee, and shrubs.

This is similar to that stated by Lanyala *et al*. (2016) the level of dangerous erosion in the Kawatuna watershed which is included in the category of low to moderate level occurs in lowland rice fields and forests, mixed garden lands, bushes, and fields. Land use factors have a big role in the prevention of erosion, especially on lands that have steep slopes, rather steep to very steep because the ground cover can reduce the runoff rate by preventing raindrops from falling to the ground.

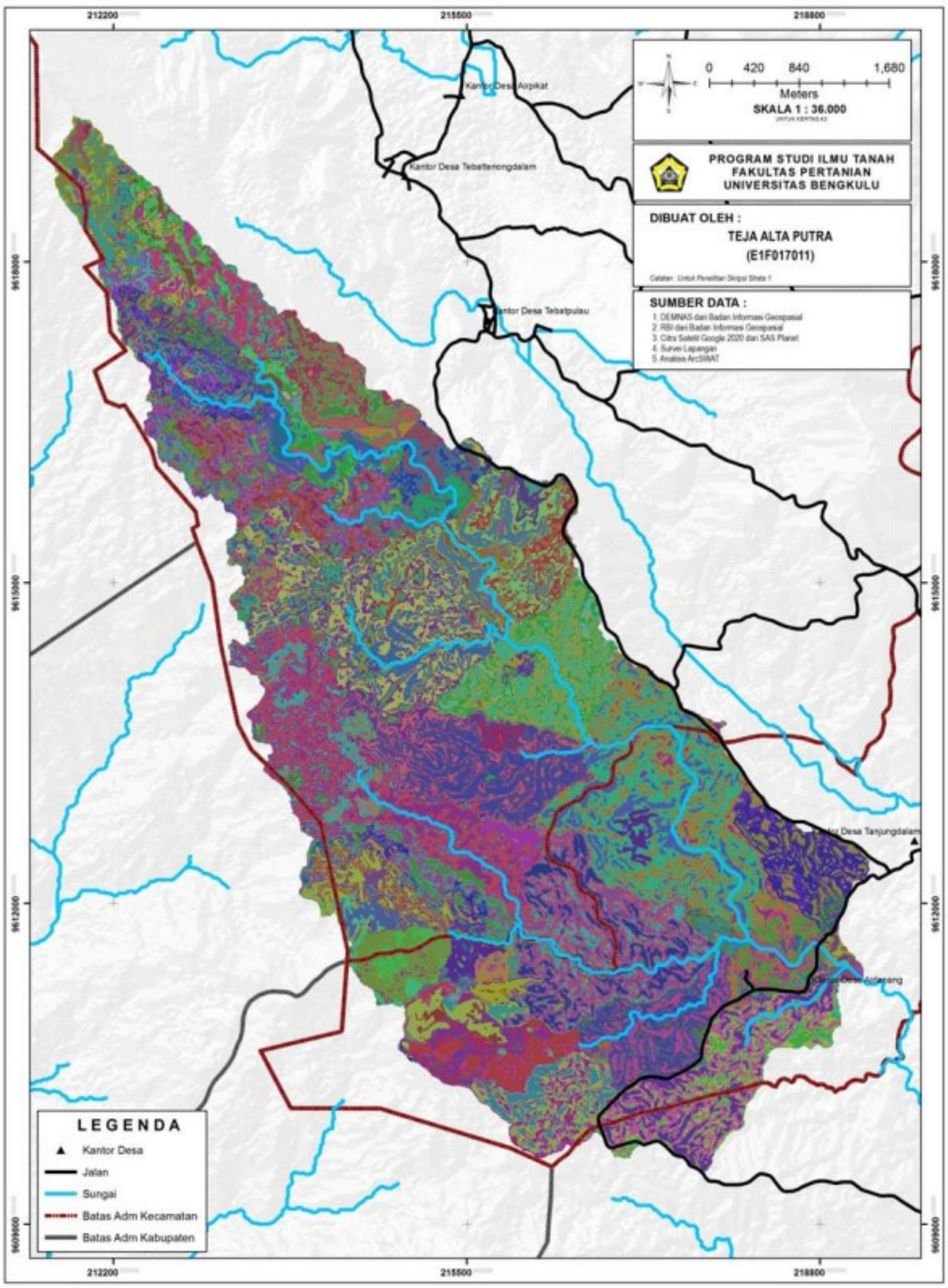

Figure 1. HRU Mikro Catchment Area Air Lanang Existing

Table 7. Erosion Risk Classification Area in 2020

No.	Erosion Class	Erosion (ton/ha/year)	Existing Area (ha)	Existing Percentage (%)
1	Very Low	<15	1.91	0.06
2	Low	15-60	245.56	8.22
3	Medium	60-180	2060.64	68.99
4	High	180-480	608.49	20.37
5	Very High	>480	70.46	2.36
	Total		2987.06	100

Source: Data Analysis, 2021

Existing Erosion Hazard Level and Scenarios

Erosion results based on scenario land use data on micro Catchment Air Lanang area is 67230.05 tons year^{-1}. Classification results based on usage of 2020 existing land and scenarios are compared to see differences in erosion results what happened as shown in Table 8.

Differences in the area of erosion can be seen based on land use data existing in 2020 and the scenarios in Table 5. The results of the comparison of the classifications shows that the very heavy erosion class decreased up to 14.28% or approx. 426.48 ha of the Air Lanang Micro Catchment Area. The erosion distribution map based on the Classification of erosion class land-use scenarios. This is appropriate to that proposed by Hasani *et al*. (2019) the level of erosion in forest areas that has a value lower than the allowable erosion value, while the erosion rate in agricultural areas, shrubs, and settlements is greater than the allowable erosion determination.

Changes in the area both increase and decrease from each erosion class are influenced by changes in land use. The use of land is protected forest areas programmed by the government for the cultivation of timber plants is simulated through land-use scenarios.

The decrease in erosion area is very heavy, heavy, and moderate which are 2.24%, 4.72%, and 0.31% respectively so the increase in very light and light classes is 0.09% and 7.18%, respectively, indicating that programs that have been carried out by the government if it can run properly then erosion can be reduced according to changes in land use. When viewed from the percentage of the total change in the level of erosion hazard, it is not very significant, which is only 7.72% from the medium, heavy, and very heavy classes to the very light and light classes. .89 tons year^{-1} to 67230.05 tons year^{-1} a decrease of around 398551.84 tons.

However, after approximately nine years of planting and growing trees in good conditions, farmers still prioritize their coffee plants and even slowly cut down their forest plants (Senoaji, 2011). Based on this, it is necessary to provide counseling to farmers in the Air Lanang Micro Catchment Area so that they can change land-use patterns that only focus on plants. Coffee to other plants, especially in community forests in the protected forest area of Bukit Daun by providing information on woody plants that do not only have conservation value but also high socio-economic value such as nutmeg, areca nut, sugar palm, and candlenut which so far have only been used as hedges, this is not in line with the enormous potential of these plants. himself in Air Lanang Village. Based on Humam *et al*. (2019), the land suitability class for nutmeg in Air Lanang Village is dominated by the S3eh sub-class covering an area of 1198.79 ha or 85.01% of the total area of Air Lanang Village, so based on this, community empowerment in the community forest scheme in the Bukit Daun protected forest area is indispensable.

Existing Sediments and Scenarios

The results of the analysis of the existing SWAT output data obtained that the total sediment rate in the Air Lanang Micro Catchment Area reached 354949.98 tons/year for the existing land use data in 2020. Sedimentation is influenced by the size of the fine particles carried by surface runoff, river flow velocity, and the physical condition of lake waters (Bahari, 2017). The decrease in sediment yield in the land-use scenario is in line with the decrease in erosion yield obtained. Air Lanang Area Micro Sediment Results with using scenario land use data which is 220982.40 tons year^{-1}, this shows that the sediment produced is reduced by around 133967.58.6 tons from the results of existing land use sediments in 2020. The decrease in the amount of sediment in Scenario land use is affected by decreasing erosion yield of Scenario land use.

Table 8. The Rate of Erosion in Existing and Land Use Scenario

Erosion Rate Value	Class	Existing		Scenario		Variance (%)
		Land Use	Area (ha)	Land Use	Area (ha)	
<15	Very Low	FRSE	1.91	FRSE	1.09	
				FRST	2.68	
				COFF	0.81	
Total			1.91		4.58	0.09
15-60	Low	BERM	3.54	BERM	10.68	
		COFF	122.56	COFF	62.83	
		FRSE	115.84	FRSE	130.99	
		RNGB	3.62	FRST	255.02	
				RICE	0.41	
Total			245.56		459.93	7.18
60-180	Medium	AGRR	0.02	AGRR	40.91	
		BERM	8.93	BERM	55.68	
		COFF	1715.12	COFF	832.35	
		FRSE	312.93	FRSE	348.5	
		RICE	2.31	FRST	653.79	
		RNGB	21.33	RICE	120.15	
Total			2060.64		2051.37	0.31
180-480	High	AGRR	1.18	AGRR	3.29	
		BARR	0.05	BERM	0.01	
		BERM	0.08	COFF	304.3	
		COFF	483.35	FRSE	88.86	
		FRSE	78.48	FRST	66.55	
		RICE	6.63	RICE	4.61	
		RNGB	38.71			
Total			608.49		467.63	4.72
>480	Very High	AGRR	2.94	AGRR	3.07	
		BARR	60.74	FRST	0.29	
		RICE	0.61	RICE	0.19	
		RNGB	6.17			
Total			70.46		3.55	2.24

CONCLUSION

Based on the results of the SWAT model simulation output analysis in the form of daily erosion rate each HRU and sediment rate in each sub basin in the Micro Catchment Area Water Lanang with 2020 existing land use and land use scenario the data obtained are:

Total erosion in Air Lanang Micro Catchment Area with land use the existing year 2020 is 465781.89 tons/year, while the amount of erosion that occurs with the land use scenario, which is 67230.05 tons year^{-1} which divided into very light, light, moderate, heavy and very erosion classes heavy. Based on the existing land use data, the erosion class is moderate to very heavily decreased by 7.27% so that the erosion class was very low light and light to 15.55% after a simulation using land-use scenario.

Land use scenarios that are defined can reduce erosion and rate sedimentation. Total sediment yield of Air Lanang Micro Catchment Area the existing land use in 2020 is 354949.98 tons year^{-1} with the highest sediment yield in subbasin 2 followed by the lowest sediment yield in sub-basin 12, while the total sediment yield by land-use scenario, namely 220982.40 tons year^{-1} with the highest sediment yield in sub-basin 23 followed by the lowest sediment yield in sub basin 12. Decrease total sediment yield from 2020 existing land use to use scenario area of 14.91%.

The land use scenario carried out can reduce the rate of erosion and sedimentation in the Air Lanang Micro Catchment Area by 398551.84 tons year^{-1} for erosion and 133967.58 tons year^{-1} for sediment

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