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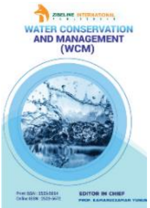

RESEARCH ARTICLE

APPLICATION OF THE SWAT MODEL FOR SPATIAL ANALYSIS OF SEDIMENTATION RATES IN THE TANRALILI SUB-WATERSHED, MAROS WATERSHED

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ABSTRACT

Tanralili Sub-Watershed is the upstream of the Maros watershed which experiences land problems in the form of erosion and sedimentation. The Tanralili Sub-Watershed is a water catchment area that serve as a source of clean water for the Eastern and Northern regions of Makassar. This Sub-Watershed continously experience land use changes in sedimentation rate and as a result decrease the water discharge of the Lekopancing Dam (downstream of the Tanralili Sub-Watershed) from 1000 liters/second to 200 liters/second. Therefore, research related to sedimentation rates in the Tanralili Sub-Watershed is needed to obtain information on the sedimentation rate that occurs. This study used SWAT (Soil and Water Assessment Tools), a hydrological modeling that calculates sedimentation rates. SWAT procedures are divided into 4 processes, namely delineation, generation of Hydrological Response Unit (HRU), data processing and model simulation. For the procedures, the data input are slope condition, soil type, land cover, and rainfall intensity. The results showed that the accumulation of sediment for 10 years in the Tanralili Sub-Watershed reach 7,618.85 tons/ha/year from 41 Sub-Sub-Watersheds. The highest sediment rate occurs in Sub-Sub-Watersheds number 26, 27, and 38 which are dominated by dryland agricultural land cover and rice fields located on slopes of 25-45%. Meanwhile, the smallest sediment rate occurs in Sub-Sub-Watershed 9 which is dominated by forest land cover which is on a slope of 15-25%.

KEYWORDS

Sedimentation Rate; Tanralili Sub-Watershed; Soil and Water Assessment Tools (SWAT), Hydrological Response Unit (HRU)

1. INTRODUCTION

Over the past few decades, watersheds worldwide have been increasingly impacted by intense anthropogenic activities, resulting in changes to water discharge and elevated sediment loads in river systems (Rezagama et al., 2018; Wahaba et al., 2019; Sok et al., 2020). The analysis reveal a growing number of critical watersheds in Indonesia, primarily driven by population growth and the expansion of supporting infrastructure (Fadhil et al., 2021;Utami, 2020). The large-scale conversion of land for agricultural purposes, particularly in areas highly prone to soil erosion, has further exacerbated environmental degradation (Sujarwo et al., 2020). Water erosion damages agricultural land and water resources, leading to water scarcity, soil fertility problems, and reservoir sedimentation due to improper agricultural practices (Kuti and Ewemoje, 2021).

Changes in land use and land cover significantly impact the hydrological characteristics and dynamics of a watershed often evidenced by the expansion of flood-prone areas, increased soil erosion on agricultural lands, and heightened sedimentation in rivers (Yusrina et al., 2018; Fadhil et al., 2021; Sadhwani et al., 2022). Understanding the processes that cause soil erosion at the sub-watershed level and implementing appropriate sub-watershed management strategies and measures are some of the potential solutions to prevent and/or control soil erosion problems (Zewde et al., 2024). River sedimentation is a complex process driven by the deposition of materials transported by water, where the rate of sediment transport is influenced by flow velocity and sediment particle size (Mananoma et al., 2022). The continuous increase in sediment volume within rivers, primarily caused by erosion and sedimentation, significantly affects riverbed stability. This reduction in river capacity results, which heightens the risk of flooding during heavy rainfall events (Arsyad, 2010; Isma et al., 2019; Kusdian and Primawardhana, 2021; Mananoma et al., 2022).

One of the sub-watersheds in South Sulawesi experiencing significant land degradation issues is the Tanralili Sub-watershed, which serves as the upstream area of the Maros Watershed (Suhairin, 2020). The Research condition and quality of the Tanralili Sub-watershed declined over a 10-year period (1996–2005) due to land use changes that led to forest degradation at a rate of 1.58 hectares per day, amounting to a total loss of 5,795 hectares (Asir, 2007; Surahman, 2017). Further studies indicate that by 2013, the Tanralili Sub-watershed had lost 6,219 hectares of vegetative cover density, equivalent to 24.21% of its total area (Hasnawir et al., 2017).

This study forested areas in the Tanralili Sub-watershed experienced a

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significant decline between 2009 and 2019, shrinking by 1,455.749 hectares or 27.83% of the total watershed area Sukmawati, 2019). In contrast, other land-use types saw notable increases, including rice fields by 754.872 hectares (14.43%), plantations by 76.28 hectares (1.46%), and dryland farming by 280.736 hectares (5.37%). These changes in land use have amplified erosion and sedimentation issues. The degradation of upstream areas due to land-use changes has contributed to an annual erosion rate of 74.72 million tons. In 2005, sedimentation from erosion was recorded at 74.99 tons/ha/year, attributed to various land-use types in the Tanralili Sub-watershed (Asir, 2007, cited in Suhairin, 2020). By 2019, the total erosion increased dramatically, rising from 338,68 tons/ha in 2009 to 34.746,38 tons/ha, marking an additional 3,407.70 tons/ha over the decade (Sukmawati, 2019).

Erosion and sedimentation issues have persisted for a long time in the Tanralili Sub-watershed and have shown an annual increase (Suhairin, 2020). This is evident from the extreme variations between maximum and minimum water discharge and the erosion-induced sedimentation, which has led to the silting of the Lekopancing PDAM Dam, located downstream of the Tanralili Sub-watershed (Surahman, 2017). According to information cited from, under normal conditions during the rainy season, the water discharge of the Lekopancing Dam can reach 1,500 liters per second. However, there has been a drastic reduction, with discharge dropping to 418 liters per second (Makassar Antara News, 2019).

Estimating sediment values within a watershed provides important information about the influence of topography, land use, river flow, and surface materials (Ramadhan, 2020). Accurate method for estimating streamflow and sediment production is essential for the effective management of water resources. Hydrological models are key tools used to simulate these processes and are widely applied in detecting and attributing changes within watershed systems (Opiyo, 2025). Controlling sedimentation in the upstream areas is crucial for managing downstream damage in a watershed (Dunggio and Ichsan, 2022). Therefore, when developing watershed management plans, essential data components such as erosion and sediment data are necessary (Rahmad et al., 2017). For areas that are difficult to access for direct sediment measurement, hydrological modeling can be utilized (Amalia et al., 2022). In accordance with perspective, watershed issues can be addressed through hydrological processes using a comprehensive, integrated approach (Ramadhan's, 2020).

2. MATERIAL AND METHODS

2.1 Research Location

The research location is situated in the Tanralili Sub-watershed, part of the Maros Watershed, covering an area of approximately 26,343.4 hectares. Administratively, the study area is located in Maros Regency, encompassing four districts: Tompobulu, Tombolo Pao, Tanralili, and Cenrana. Astronomically, the Tanralili Sub-watershed lies between 5°0’-5°12’ S and 119°34’-119°56’ E. The Tanralili Sub-watershed plays a crucial role as a clean water supplier for the eastern and northern regions of Makassar. However, forest degradation has led to high sedimentation from erosion and a significant reduction in the Lekopancing River's water discharge, reaching 80%, from 1000 liters/second to 200 liters/second (Surahman, 2017).

2.2 Testing Method

As a hydrological modeling tool, SWAT can analyze sediment yield, assess the impact of land use on both water quality and quantity, and account for climate conditions as well as biodiversity within a region (Christanto et al., 2018). The analysis SWAT (Soil and Water Assessment Tool) model is well-suited for simulating surface runoff and sediment yield under various land use scenarios (Kavathekar, 2025). The SWAT model requires both spatial and temporal data to accurately simulate hydrological processes. The spatial data includes the Digital Elevation Model (DEM), soil data, and land cover information, while the temporal data comprises climate and streamflow records. The 30-meter resolution DEM, obtained from the Shuttle Radar Topographic Mission (SRTM), was used to delineate the watershed boundary and stream networks, as well as to generate slope maps. These slope maps were used to define Hydrological Response Units (HRUs) in combination with soil and land use data (Worku et al., 2021). The evaluation of hydrological processes simulated by SWAT uses the water balance equation as follows (Neitsch et al., 2011; Sujarwo et al., 2020):

$$SWt \ = \ SW_0 + \sum_{n=1}^{t} (R_{day} - Q_{surf} \ - \ E_a - W_{sepp} - Q_{gw}$$

Where SWt represents the soil water content in millimeters (mm), SW0 is the initial water storage (mm), Rday denotes rainfall (mm), Qsurf is surface runoff (mm), Ea a refers to evapotranspiration (mm), Wseep indicates percolation (mm), Qgw accounts for groundwater flow, base flow, or return flow (mm), and t represents the time in days. The researcher in hydrological processes, rainfall is partitioned into three main components: evapotranspiration, soil water storage, and streamflow (Widiatmoko et al., 2020). Streamflow itself is divided into three types, namely surface runoff, lateral flow, and baseflow. Meanwhile, sediment yield in the SWAT model is determined using a specific equation, as presented by (Neitsch et al., 2011; Sujarwo et al., 2020).

This research hydrological processes, rainfall is distributed into evapotranspiration, soil water storage, and streamflow (Widiatmoko et al., 2020). Streamflow consists of three components: surface runoff, lateral flow, and baseflow. Meanwhile, sediment yield in the SWAT model is calculated using the following equation (Neitsch et al., 2011, in Sujarwo et al., 2020):

$$Sed = (11.8(Q_{surf} \, . Q_{peak} \, . Area_{HRU})^{0.56} . K_{usle} \, . P_{usle} \, . C_{usle} \, . L_{usle} \, . CFR$$

The variable Sed represents the sediment yield in tons, while Q_surf refers to the surface runoff measured in millimeters per hectare (mm/ha). Q_peak is the peak runoff rate in cubic meters per second (m^3/s), and 〖Area〗_HRU denotes the area of the Hydrological Response Unit in hectares (ha). The soil erodibility factor is represented by K_usle, measured in $ton \cdot m^2 \cdot hr/m^3$, while C_usle is the factor for land use and management. P_usle represents the support practice factor, and L_usle is the topographic factor and CFR is the coarse fragment factor. SWAT employs the MUSLE (Modified Universal Soil Loss Equation) model to predict sediment yield. This model uses runoff factors to estimate sediment yield, making sediment delivery ratio (SDR) data unnecessary. This is because the runoff factor already accounts for the energy required to detach and transport sediments (Nugroho et al., 2015).

2.3 Specifications Material Test

The research variables required for identifying sedimentation rates using SWAT in the Tanralili Sub-watershed include an 8-meter resolution Digital Elevation Model (DEM), slope gradient data, soil type data, land cover data, and climate data. Data collection was conducted through observation and documentation. Observations were carried out to gather information about the physical conditions of the study area, while documentation was used to obtain secondary data from institutional sources. The secondary data, comprising spatial and non-spatial datasets, include the following:

a) 8-meter resolution DEM data downloaded from the Geospatial Information Agency (BIG) website.

b) Soil type data derived from the 1:250,000-scale RePPProT land system map, which was further refined through soil sampling for physical and chemical soil characteristic analysis.

c) Slope gradient data generated from DEM processing. Based on the DEM analysis, the slope gradients in the Tanralili Sub-watershed are categorized into five classes: flat (0-8%) covering 9.81%, gentle (8-15%) covering 12.46%, moderately steep (15-25%) covering 18.46%, steep (25-45%) covering 31.5%, and very steep (>45%) covering 27.69%.

d) Land cover data obtained from the 2019 land cover map by the Ministry of Environment and Forestry (KLHK) and updated using 2022 satellite imagery from Google. The land cover of the Tanralili Sub-watershed consists of open land (1.17%), built-up areas (1.11%), dryland agriculture (15.31%), paddy fields (8.59%), water bodies, forests (68.02%), and shrubs (5.08%).

e) Climate data for the past 10 years (2013-2022), downloaded from NASA's MERRA satellite, including daily rainfall, temperature, solar radiation, humidity, and wind speed. The Tanralili Sub-watershed is classified under climate category C (Moderately Wet).

2.4 Testing Scheme

a) Sub-Watershed Deliniation

The SWAT model performs watershed delineation automatically, where the delineation is based on DEM data using the threshold method. This method determines the number of river networks and sub-watersheds formed. Watershed delineation is executed using the automated Watershed Delineation tool, which integrates river network and DEM data as variables for sub-watershed formation. The delineation process results in watershed boundaries, subwatershed boundaries, and river networks (Rahmad et al., 2017; Purwitaningsih and Pamungkas, 2017).

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b) HRU Formation

HRUs are formed from the overlay of land use, slope, and soil type data automatically in SWAT. HRUs are used in SWAT simulations to simplify the model, which helps improve the accuracy of the simulation results. Once the HRUs are formed, the next step is to define the HRUs by selecting the multiple HRUs option, as all HRUs are considered in the analysis process. Each HRU contains information such as sub-watershed, HRU number, land cover type, soil type, and HRU area (Purwitaningsih and Pamungkas, 2017; Soma et al., 2021; Rahmad et al., 2017).

c) Design and Integration of Climate Data

The climate data obtained from NASA websites must first be manually processed to prepare it for analysis by SWAT. The processing of climate data is divided into two types: one as input for the SWAT model (weather stations) and the other as climate generation data (weather generator) for the database (Soma et al., 2021).

d) SWAT Simulation

The SWAT hydrological model simulation is performed after integrating the hydrology network data, HRU data, and climate data. This step is carried out by setting the time or period to be simulated in the Run SWAT mode, which is found in the SWAT simulation menu. To save the output of the simulation data, the option Read SWAT Output is selected. The output from the SWAT simulation process can be daily, monthly, or annual data, which can be adjusted according to the needs of the simulation process (Rahmad et al., 2017). The sediment calculation from the SWAT running simulation in this study includes sediment from all HRUs and sub-watersheds over a simulation period of 10 years (2013-2022).

3. Results And Discussion

3.1 Watersheds Deliniation

In the SWAT delineation process, watershed boundaries, sub-watershed boundaries, and river networks are formed. The result of the SWAT delineation process from DEM data is the formation of 41 subbasins or sub-subwatersheds in the Tanralili sub-watershed area, which are based on the river network. The watershed delineation was conducted using a threshold of 350 ha, with the consideration that all river networks within the Tanralili sub-watershed have been covered.

Table 1: Area of Tanralili Sub-Sub-Watersheds

Sub-Sub-Watersheds	Area (Ha)	(%)	Sub-Sub-Watersheds	Area (Ha)	(%)
1	297.51	1.09	22	1,491.81	5.44
2	397.43	1.45	23	511.04	1.86
3	1,311.88	4.79	24	1,293.55	4.72
4	298.54	1.09	25	220.83	0.81
5	329.13	1.20	26	541.49	1.98
6	2,02.15	7.37	27	1,333.84	4.87
7	502.05	1.83	28	193.91	0.71
8	463.36	1.69	29	302.30	1.10
9	263.53	0.96	30	1,523.77	5.56
10	1,029.17	3.76	31	548.04	2.00
11	332.48	1.21	32	1,102.18	4.02
12	51.15	0.19	33	294.05	1.07
13	791.72	2.89	34	467.09	1.70
14	1,792.58	6.54	35	1,198.65	4.37
15	523.95	1.91	36	632.56	2.31
16	290.26	1.06	37	431.32	1.57
17	228.22	0.83	38	616.94	2.25
18	665.94	2.43	39	724.54	2.64
19	254.59	0.93	40	898.62	3.28
20	447.51	1.63	41	401.22	1.46
21	385.87	1.41			
Total	27,405.77				

The SWAT model results reflect sediment yield, which is assessed based on the accumulation of sediment within the watershed. The sediment yield of a watershed is influenced by the total amount of erosion and the transportation of eroded soil material leaving the watershed or sub-watershed. Essentially, sediment yield indicates the volume of sediment transported by flow at a specific monitoring point within the watershed ecosystem. The amount of sediment can be calculated by determining the weight or volume of sediment per unit area of the watershed over a given period. The most commonly used unit to express sediment yield is tons per hectare per year (Asdak, 2022).

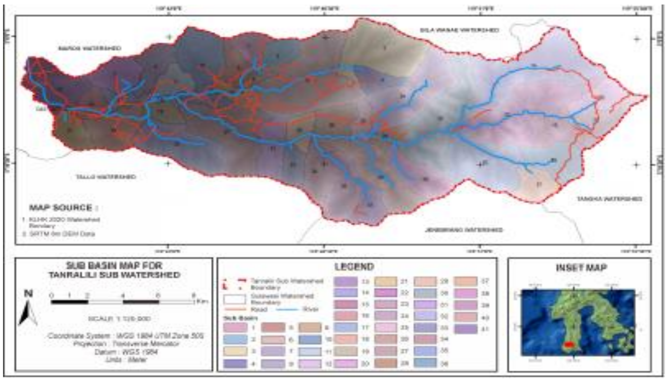

Figure 1: Deliniation result of Tanralili watershed in 2023

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3.2 Sediments Yield

Based on Table 10, the results of SWAT modeling using a 10-year data period (2013-2022) indicate that the Tanralili Watershed has a total sediment yield of 7,618.85 tons/ha/year across 41 sub-watersheds. The sediment yield in each sub-watershed of Tanralili ranges from 4.67 tons/ha/year to 625.87 tons/ha/year. The majority of the sediment is contributed by Sub-watershed 38 while the smallest sediment yield is produced by Sub-watershed 9.

Table 2: Clasification of Sediment Yield in Tanraili Sub Watersed

Sub-Watershed	Sedimen (ton/ha/th)	Classification	Sub-Watershed	Sedimen (ton/ha/th)	Classification
1	22.10	Low	22	70.85	Medium
2	156.44	Medium	23	230.59	High
3	87.78	Medium	24	425.10	High
4	473.02	High	25	357.57	High
5	19.39	Low	26	522.29	Very High
6	157.35	Medium	27	532.80	Very High
7	198.83	High	28	426.61	High
8	220.59	High	29	218.21	High
9	4.67	Very Low	30	102.46	Medium
10	95.98	Medium	31	97.7	Medium
11	84.96	Medium	32	15.17	Low
12	100.97	Medium	33	115.95	Medium
13	60.2	Medium	34	84.12	Medium
14	171.56	Medium	35	60.41	Medium
15	373.3	High	36	217.00	High
16	66.02	Medium	37	176.88	Medium
17	114.01	Medium	38	625.87	Very High
18	141.76	Medium	39	293.02	High
19	95.10	Medium	40	87.78	Medium
20	60.41	Medium	41	179.19	Medium
21	74.21	Medium			
Total	7,618.85				

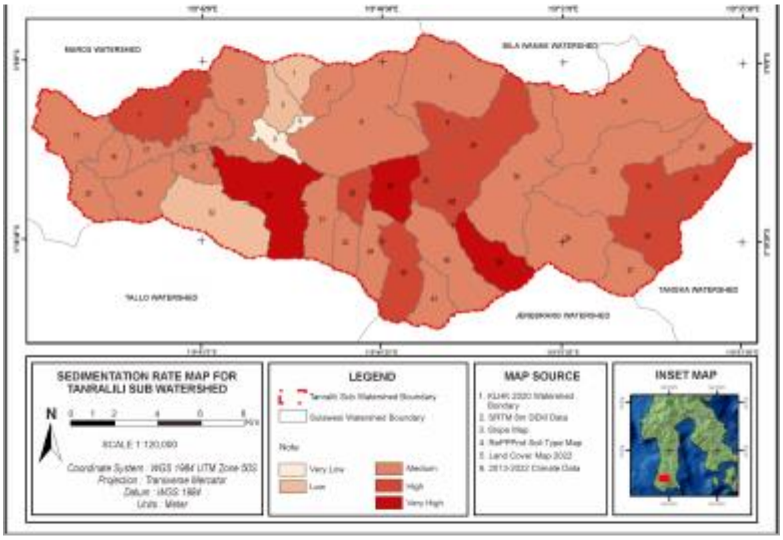

Figure 2: Sedimentation Rates of Tanralili Sub-Watershed in 2022

Based on the sediment rate modeling results for the Tanralili sub-watershed presented in Table 4.8, at least 14 sub-watersheds are classified as having high to very high sediment yields. These conditions are observed in Sub-watersheds 7, 8, 36, 29, 23, 39, 25, 15, 24, 28, 4, 26, 27, and 38, which are characterized by land cover comprising dryland agriculture, shrubs, and forests located on steep slopes. Among these, three sub-watersheds—26, 27, and 38—are categorized as having very high sediment yields. The hydrological characteristics of Sub-watersheds 26, 27, and 38 reveal that they are predominantly utilized for agricultural purposes, situated on slopes with gradients ranging from 25% to over 45%, and are composed of inceptisol soil types.

This study highlighted that land cover plays a crucial role in determining the level of erosion and sedimentation within a watershed (Sariyani, 2020). Land used for mixed dryland agriculture tends to experience higher erosion rates due to intensive farming practices, which lead to soil compaction, reduced permeability, and increased surface runoff. Furthermore, monocultural land use with seasonal crops exacerbates soil loss during each planting and harvesting cycle (Arifin et al., 2022). Also emphasized that a significant factor contributing to elevated erosion rates and sedimentation in dryland agriculture is the lack of ground cover vegetation, which is essential for preventing erosion and minimizing surface runoff (Apriani et al., 2021).

Sub-watersheds with very high sediment rates, particularly Sub-watersheds 27, 28, and 38, are situated on steep to very steep slopes. That Researcher explained that high-intensity rainfall in areas with non-forest land use and steep slopes leads to increased surface runoff, which erodes and transports soil layers (Aryani et al., 2022). This is further supported, who stated that land with a higher slope gradient tends to enhance surface flow and transport energy (Lesmana et al., 2021). The greater transport energy or surface runoff velocity results in a larger quantity of soil particles being eroded by rainfall. Consequently, steeper slopes are more susceptible to severe erosion, which in turn increases sediment rates (Rizky et al., 2022; Wijayanti, 2017).

Sub-watersheds 4, 15, 24, 25, 28, 36, and 39, based on their combined hydrological units, have land cover predominantly consisting of forests located on steep slopes ranging from 25% to over 45%. Although these sub-watersheds are dominated by forests, which are generally effective in reducing erosion, the steep slopes still increase the potential for erosion (Apriani et al., 2022). To analysis steeper slopes elevate soil erodibility, making the soil more vulnerable to erosion (Yuliana et al., 2015). Other studies have shown that even in areas with dense tree canopies and forest litter, erosion can increase with prolonged and high-intensity rainfall. Such conditions cause soil saturation, thereby increasing the volume of surface runoff (Lihawa, 2017). Another factor, as highlighted is the critical role of understory vegetation and forest litter in protecting soil surfaces from erosion by (Asdak, 2022). When understory vegetation and litter are removed from forest stands, the forest becomes more susceptible to increased runoff and erosion, even if the tree canopy cover is substantial (Asdak,

2022). These factors are also considered to represent the sediment rate conditions classified as moderate in Sub-watersheds 2, 3, 6, 14, 22, 30, 31, 33, 34, 35, 37, 40, and 41, which are located on steep slopes with predominantly forested land cover.

The study soil characteristics significantly influence erosion, which in turn impacts sedimentation (Arsyad, 2006; Osok et al., 2018). The 14 sub-watersheds classified as high to very high sediment contributors are predominantly composed of inceptisol soils. Inceptisols have a wide range of textures, from coarse to fine, influenced by the degree of weathering of the parent material (Arviandi et al., 2015).

Based on detailed soil type analysis conducted in the laboratory, the soil texture in the Tanralili Sub-watershed is predominantly clay and clay loam (Appendix 2). Clay soils with low organic matter content are more susceptible to erosion because the smaller particle size of clay, compared to silt and sand, results in soil pores being primarily filled with micropores. Consequently, clay soils have lower infiltration rates compared to soils with silt or sandy textures (Banuwa, 2013; Kusdian and Primawardhana, 2021).

This research fine-textured soils have lower infiltration capacities compared to coarse-textured soils, except under dry conditions (Azizah et al., 2019; Nurhawaidah et al., 2019). This low infiltration capacity increases surface runoff volume, even during low-intensity rainfall. As a study stated that soil sensitivity to erosion, or soil erodibility, is influenced by the soil's resistance to external destructive forces and its infiltration capacity (Utomo, 1994; Nurhawaidah et al., 2019). Soil erodibility is determined by factors such as organic carbon content, texture, and soil permeability. Higher silt content, lower permeability, and low organic matter content result in increased soil erodibility, and vice versa.

High organic matter content improves soil structure by binding soil aggregates, which enhances water infiltration. Organic matter plays a crucial role in improving soil structure and permeability (Widyantara et al., 2015). Laboratory tests on 16 disturbed soil samples in the study area revealed that organic matter content tends to be low. This analysis organic matter content decreases as slope gradients increase (Yulina et al., 2015).

The high of annual rainfall in the Sub-Watershed Area of Tanralili also contributes to the increased sedimentation rate. The upstream of Tanralili Sub-Watershed are mountainous, making it prone to orographic rainfall, resulting in high rainfall volumes. This study erosion, sedimentation, and surface runoff values are primarily determined by the slope length and gradient, as well as the large volume of rainfall (Sun et al., 2022; Dunggio and Ichsan, 2022). Areas with high rainfall amounts lead to increased water movement down the slope (Lesmana et al. 2021). High rainfall intensity affects the increase in peak discharge values. Directly, this increased discharge will carry soil particles that ultimately undergo sedimentation in riverbeds. As the discharge increases, the amount of eroded soil transported and sedimented also rises (Sujarwo et al. 2020). Soil layers detached by the kinetic energy generated by rainfall are carried by surface runoff towards the lower slope, where they accumulate and form sediment deposits (Lesmana et al. 2021).

Sediment rates ranging from very low to low are found in Sub-watersheds 1, 5, 9, 20, and 32. These areas are primarily dominated by forest cover and are located on slopes that are not very steep. As a researchers the highest sediment rates are generally found on very steep slopes (Ramadhan, 2020). Land with steep gradients has faster surface flow, which reduces water absorption by the soil and hinders root growth. In contrast, flatter land can retain more water, allowing it to be absorbed by the roots, thus promoting better vegetation root growth (Alfiyah et al., 2020).

Research shows that vegetative cover and forested areas with conservation practices significantly reduce erosion by up to 11.9% (Dunggio and Ichsan, 2022). Vegetation improves infiltration, thereby reducing surface runoff (Apriani et al., 2020). Additionally, these sub-watersheds typically have Ultisol soil types, which have very low erodibility and are less prone to erosion. However, soil erodibility can change significantly during rainfall events, as rain can alter the physical and chemical characteristics of the soil, leading to erosion (Asdak, 2022).

Moderate sediment rates, particularly in areas dominated by agricultural land and with slopes ranging from 0-8% to 25-45%, are observed in Sub-watersheds 10, 11, 12, 13, 16, 17, 18, 19, and 21. The outlet of the Tanralili Sub-watershed, located downstream in Sub-watershed 13, has a sediment rate of 60.92 tons/ha/year. The sediment rate in Sub-watershed 13 is lower and classified as moderate compared to the sub-watersheds located upstream. This is primarily due to the slopes in Sub-watershed 13 being relatively gentle (0-8%), but it is also influenced by sedimentation occurring before reaching the watershed outlet. This is consistent with who explains that soil that has already experienced erosion on the surface will only partially reach the monitoring area (Asdak, 2022). This is due to the physical characteristics of the watershed, which cause variation in sedimentation rates.

4. CONCLUSION

The sediment yield estimation using the SWAT hydrological model shows that the Tanralili Sub-Watershed has a total sediment of 7,618.85 tons/ha/year from 41 Sub-Sub-Watersheds. The sediment yield classified as very high occurs in Sub-Watersheds 26, 27, and 38, which are dominated by dryland agricultural and paddy field cover, located on slopes of 25-45%. Meanwhile, the smallest sediment yield occurs in Sub-Watershed 9, which is dominated by forest land cover and located on slopes of 15-25%.

AUTHOR CONTRIBUTIONS

Ichsan Invanni Baharuddin: Research methodology, Data curation, Project administration; Rusli HAR: Corresponding Author, Data analysis, Supervision; Uca: Quality control, Grammar and scientific writing, Methodology; Erman Syarif & Nurlinda: Surveyor, Data collection; Wahyu Riang Adeko : Research design; Wahyu Riang Adeko: Research draft; Sri Sovia Duha Ananda: editing

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