Tadulako Science and Technology Journal
Vol. 4, No. 2, 2023, pp. 19-30
e-ISSN 2776-4893

# Erosion Hazard Class Mapping in Dolago Das, South Parigi Sub-district

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ARTICLE INFO

**Keywords**
Class Mapping,
Danger of Erosion,
Das Dolago,
Parigi South

ABSTRACT

**Introduction**: Erosion can be caused by natural activities or human activities. Erosion events that occur naturally do not cause too many problems, but erosion events caused by humans can cause various problems of land damage or degradation and experience an accelerated rate of erosion. The Dolago watershed has an area of ±17,283.09 ha and is a priority watershed that needs attention because several natural disasters such as erosion, landslides, and floods have harmed the community when rainfall increases. **Method**: Based on the case above, researchers studied the erosion risk class of the Dolago watershed by combining erosion prediction methods, namely USLE and Geographic Information Systems. Erosion hazard class research was carried out in the Dolago watershed for 3 months, from September to November 2022 using the Universal Soil Loss Equation method and Geographic Information System, namely Overlay of several data (erosion determining parameters) to determine the erosion hazard class in the Dolago watershed. **Results and Discussion**: The results of research using the Geographic Information System and the Universal Soil Loss Equation method show that the amount of eroded soil in the Dolago watershed is 23,888.80 tons/ha/year and the erosion hazard class is divided into 5 classes, namely Class I (very light) erosion rate <15 tons/ha/year with an area of 15,111.55 ha, class II (light) erosion rate 15 - 60 tons/ha/year with an area of 175.52 ha, class III (medium) erosion rate 61 - 180 tons/ha/year with an area of 1,244.87 ha, class IV (heavy) erosion rate 180 - 480 tonnes/ha/year with an area of 491.66 ha and class V (very heavy) erosion rate >480 tonnes/ha/year with an area of 259.49 ha. **Conclusion**: Combining the geographic information system and the USLE method, five types of erosion hazard classes can be produced, namely class I classified as very light with an area of 15,111.55 ha percentage of 82.81%, class II classified as light with an area of 193.52 ha percentage of 1.12%, class III classified as moderate with an area of 1,815.52 ha percentage of 10.50%, class IV classified as heavy with an area of 682.32 ha percentage of 3.95% and class V classified as very heavy with an area of 279.56 ha percentage of 1.62%.



## 1. Introduction

A watershed is a complex system built on physical systems, biological systems, and human systems that are interrelated and interact with each other [1]. A watershed is a land area that is a unit with rivers and their tributaries, which functions to accommodate, store, and drain water from rainfall to lakes or to the sea naturally, whose boundaries on land are topographic separators and sea boundaries up to the waters affected by land activities.

Erosion can be caused by natural activities or human activities. Naturally occurring erosion events do not cause too many problems, but human-caused erosion events can cause various problems of land damage or degradation and accelerate erosion rates. The erosion process consists of three consecutive parts: dispersion (detachment), transportation, and deposition (sedimentation) [2]. Climatic factors that affect soil erosion are rain, temperature, and temperature. Rain is by far the most important factor. There are two main causes of erosion, namely raindrops and surface flow. Rain characteristics that have an influence on soil erosion include the amount, intensity, and duration of rain.

Dolago watershed has an area of ±17,283.09 ha and is one of the watersheds located in South Parigi District, Parigi Moutong Regency, Central Sulawesi Province. Dolago watershed is a priority watershed that needs attention because several natural disasters such as erosion, landslides, and floods have harmed the community when rainfall increases. Based on the above case, the researcher studied the erosion risk class of the Dolago watershed by combining erosion prediction methods namely USLE and geographic information system.

Based on the background that has been described, the problem formulation of this research is how much the erosion hazard class (TBE) that occurs in the Dolago watershed South Parigi District. The purpose of this research is to map the erosion hazard class using USLE (*Universal Soil Loss* Equation) and Geographic Information System in the Dolago watershed of the South Parigi sub-district. The usefulness of this research is expected to provide information and awareness for the government and the community on the importance of information related to erosion classes in the Dolago watershed.

## 2. Method

This research method uses the Universal Soil Los Equation (USLE) method and Geographic Information Systems, namely the overlay method of some data (erosion determining parameters) to determine the erosion hazard class in the Dolago watershed of South Parigi District. This research was conducted for 3 months, starting from September to November 2022, located in Dolago watershed, South Parigi sub-district.

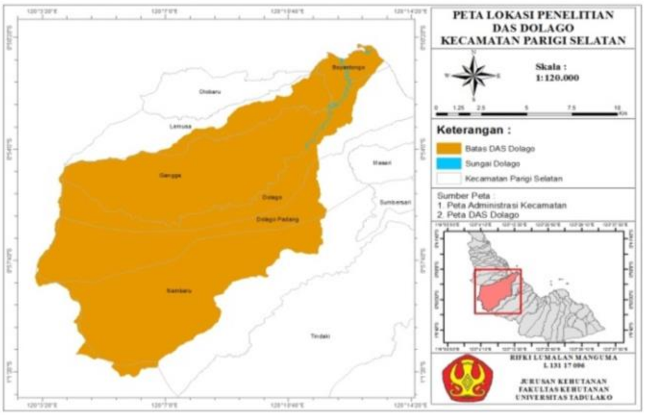


**Fig. 1**. Research Location

The tools used in this research are *Arcgis* 10.4 *software*, *Microsoft Office Excel,* GPS *(Global Positioning System),* soil sample ring, and camera. The materials used in this research are station data for the last 5 years, the 2020 soil type map, the 2020 land cover map, the 2020 slope class map, and stationery. The preparation stage, namely determining the research location, and literature study, is carried out to find out and study sources of information related to the research location. collecting data and information on the research location at this preparation stage.

Primary data in this research is soil physical properties including permeability, organic matter, and texture using ring samples in the Dolago watershed. Secondary data was obtained both verbally and in writing from relevant agencies/institutions such as land cover maps from BPKH (Forest Area Stabilization Center) Region XVI Palu, rainfall station data for the last 5 years from BWS

(Balai Wilayah Sungai) Sulawesi III Palu, slope maps and soil type maps from BPDAS HL (Watershed Management Center and Protected Forests) Palu - Poso and from literature studies to complement primary data.

## 2.1 Data Processing

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

a. Calculation of Rain Erosivity Value (R)

The ability of rain to cause or cause erosion in an area is called rainfall erosivity. The determining factors include rain intensity, the diameter of rain grains, the speed at which rain grains fall, and the wind speed factor. Rainfall data is obtained based on average rainfall data for 2021. The data was collected from climate observation stations or rainfall recorders around the Dolago watershed. Based on the maximum monthly rainfall data, the rainfall erosivity factor (R) can be calculated using the equation [3] as follows:

$$EI_{30} = 2.21\ R^{1,36}$$

Description:
$EI_{30}$ = monthly rainfall erosivity index
R = monthly rainfall (cm).

b. Soil Erodibility Value (K)

Before calculating the soil erodibility value, soil samples were first taken from three different soil types and then laboratory analysis was conducted to determine C-Organic, texture, and structure. To get the K value in this study, the calculation with the formula [3] is used as follows:

$$100K = 1.292\ [2.1M^{1,14}\ (10^{-4})\ (12^{-a}) + 3.25\ (b\text{-}2) + 2.5\ (c\text{-}3)]$$

Description:
K: Erodibility
M (% dust + %very fine sand) x (100 - % clay)
a percent organic matter
b soil structure class
c permeability class

c. Slope Value (LS)

The slope is obtained from slope class data. The steeper the slope, the greater the slope value and the easier the soil to erode. Determination of the slope value is done with the existence of slope class data that has been classified and based on the slope value (LS) which can be seen in Table 1 as follows:

Table 1. Slope Value (LS)

| Slope (%) | Description | LS Value |
|---|---|---|
| 0 - 8 | Flat | 0.4 |
| 8 - 15 | Ramps | 1.4 |
| 15 - 25 | Somewhat Steep | 3.1 |
| 25 - 40 | Steep | 6.8 |
| > 40 | Very steep | 9.5 |

Source: Kiranoto, *in* Humairah, 2021

d. Crop Management and Soil Conservation Value (CP)

The land cover factor describes the impact of agricultural activities and their management on soil erosion class [4]. Determining the value of crop management and soil conservation is obtained from land use data and matched with values from research results that have been conducted as presented in Table 2.

Crop Management and Soil Conservation (CP) Value

| Land Use | CP Value |
|---|---|
| Forest undisturbed | 0,01 |
| Forest | 0,001 |
| Mangrove forest | 0,001 |
| Primary dryland forest | 0,03 |
| Secondary dryland forest | 0,005 |
| Shrubs | 0,05 |
| Sawah | 0,02 |
| Dryland farming | 0,5 |
| Dryland farming mixed with shrubs | 0,43 |
| Open land | 0,02 |
| Plantation | 0,3 |
| Settlement/Residence | 1 |
| Mining | 1 |
| Pond | 0,001 |
| Alang - Alang | 0,02 |
| Fields | 0,28 |
| Lake/Fish/Betting | 0,001 |
| Swamp | 0,01 |
| River/Water body | 0,001 |

Source: Fahliza et al., in Taslim (2019).

e. Erosion Class Prediction

Prediction of erosion classes is done by overlaying maps to combine soil type data, slope data, and land use data and include after calculation and assessment of erosivity factors (R), erodibility (K), length and slope (LS), and crop management and soil conservation techniques (CP) to obtain the value of erosion rate (A), the USLE method and erosion class table are used as follows:

$$A = R \times K \times LS \times CP$$

Where:

A = The amount of soil eroded (tons/h/year).
R = Rainfall erosivity factor.
K = Soil erodibility factor.
LS = Slope length and slope factor.
CP = Ground cover vegetation, crop management, and soil conservation special measures factors.

Table 3. Erosion Hazard Class

| Class | Erosion Rate (tons/ha/year) | Description |
|---|---|---|
| I | <15 | Very light |
| II | 15 - 60 | Lightweight |
| III | 61 - 180 | Medium |
| IV | 181 - 480 | Weight |
| V | >480 | Very heavy |

Source: Kiranoto, 2003 *in* Humairah 2021

## 2.2 Field Survey

A field survey was conducted to observe field conditions directly by taking coordinate points using GPS (Global Positioning System), soil sampling, and documentation. After calculating the erosion class in the Dolago watershed with the overlay process and USLE method, it is necessary to check again.

# 3. Results and Discussion

## 3.1 Calculation of Rain Erosivity Value (R)

Rainfall data for the last 5 years obtained from BWS (Balai Wilayah Sungai) Sulawesi III Palu is known that the amount of rainfall each year in South Parigi District is different so the rainfall station data is determined by the rainfall erosivity value (R) as in table 5 below.

Table 4. Calculation Results of Rain Erosivity Value (R)

| Year | Total Rainfall (cm/year) | R-value |
|---|---|---|
| 2018 | 1.181,1 | |
| 2019 | 1.147,1 | |
| 2020 | 1.630,2 | 1.412.9 |
| 2021 | 1.546,6 | |
| 2022 | 1.559,5 | |

Source: Data Analysis Results

From the calculation of the table above, it is known that the highest rainfall occurred in 2020 with a total rainfall (cm/year) of 1,630.2, while the lowest rainfall occurred in 2019 with a total rainfall (cm/year) of 1,147.1. After calculating the rainfall erosivity (R), the average value of rainfall in each year is 1,412.9 cm/year.

## 3.2 Calculation of soil erodibility value (K)

Based on the Dolago watershed map, there are three different soil types which can be seen in the following figure:

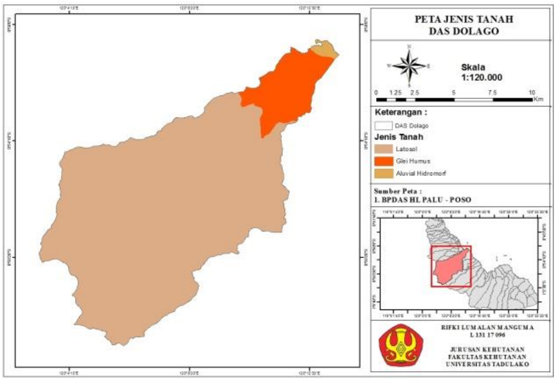


**Fig. 2**. Dolago watershed soil types

In the 3 types of soil above, soil samples were taken, and then soil physical properties and soil chemical properties were analyzed in the laboratory to determine the value of soil permeability, organic matter, and soil texture in Table 6 below:

Table 5. Laboratory Analysis Results

| Sample Code | Permeability (cm/h) | C-Organic (%) | Organic matter (%) | Texture (%) Coarse Sand | Fine Sand | Dust | See | Class Texture |
|---|---|---|---|---|---|---|---|---|
| Lithosols | 11,38 | 1,12 | 1,94 | 45,9 | 27,5 | 17,3 | 9,3 | Sandy Loam |
| Alluvial | 1,20 | 2,55 | 4,40 | 27,9 | 42,0 | 20,6 | 9,5 | Sandy Clay Loam |
| Glei Humus | 2,03 | 2,43 | 4,19 | 19,0 | 49,6 | 23,1 | 8,2 | Sandy Clay Loam |

Source: Soil Science Laboratory, Faculty of Agriculture, Tadulako University

Table 6 above shows the value of the analysis results, and the value of soil erodibility (K) was determined using the formula Wischmeier and Smith [9]. Then the value of soil erodibility (K) is classified into 3, which can be seen in the following table:

Table 6. Calculation results of soil erodibility value (K)

| NO. | Soil Type | K value | Classification | Area (Ha) | Percentage (%) |
|---|---|---|---|---|---|
| 1 | Lithosols | 0,46 | High | 15.502,59 | 90 |
| 2 | Alluvial | 0,35 | Low | 165,69 | 1 |
| 3 | Glei Humus | 0,45 | Medium | 1.614,81 | 9 |
| | | | **Total** | | **100** |

Source: Data Analysis Results

Table 6 The results of the calculation of the three soil erodibility values in the Dolago watershed, the soil erodibility value is obtained, namely the alluvial soil type has a sandy soil erodibility value of 0.35 Clay texture is classified as low, with an area of 165.69 ha, Glei humus of 0.45 sandy loam texture is classified as medium with an area of 1,614.81 ha, while the value of 0.46 for lithosol soil type with sandy loam texture is classified as very high with an area of 15,502.59 ha. The higher the soil erodibility value, the higher the soil sensitivity to erosion, conversely the lower the soil erodibility value, the lower the soil sensitivity to erosion.

### 3.3 Calculation of Slope Value (LS)

The slope of the Dolago watershed obtained from BPDASHL Palu - Poso which is divided into 5 slope classes can be seen in the following figure:

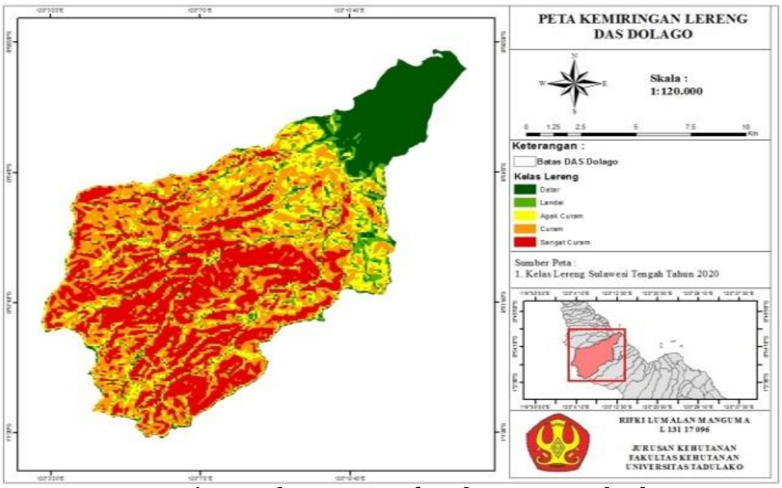


**Fig. 3.** Slope Map of Dolago Watershed

Referring to the figure above, the slope of Dolago watershed is divided into 5 classes namely flat, gentle, rather steep, steep, and very steep. After knowing the Dolago watershed slope class, the slope value is converted into LS, and then the LS slope value is obtained from the literature study which can be seen in the following table:

Table 7. Slope Value Results (LS)

| No. | Slope % | Description | LS Value | Area (Ha) | Percentage (%) |
|---|---|---|---|---|---|
| 1 | 0 - 8 | Flat | 0,4 | 2.364,75 | 13,7 |
| 2 | 8 - 15 | Ramps | 1,4 | 1.192,84 | 6,9 |
| 3 | 15 - 25 | Somewhat Steep | 3,1 | 2.581,75 | 14,9 |
| 4 | 25 - 40 | Steep | 6,8 | 5.353,73 | 31,0 |
| 5 | >40 | Very steep | 9,5 | 5.790,02 | 33,5 |
| **Total** | | | | **17.283,09** | **100** |

Source: Data Analysis Results

Based on the results of the analysis of the slope, it can be seen in Table 8 above that the slope of the Dolago watershed is dominated by a very steep slope with an area of 5,790.02 Ha while the least slope is a gentle slope with an area of 1,192.84 Ha. According to [5] the higher the slope value, the more sensitive the soil will be eroded. The statement is in accordance with the results of research that has been done where the Dolago watershed erosion hazard occurs on very steep slopes dominated by soil types that are easily eroded or eroded (Litosol).

### 3.4 Calculation of Crop Management and Soil Conservation (CP) Value

Values for crop management and soil conservation (CP) were obtained from land cover data in the Dolago watershed, as shown in the following figure:

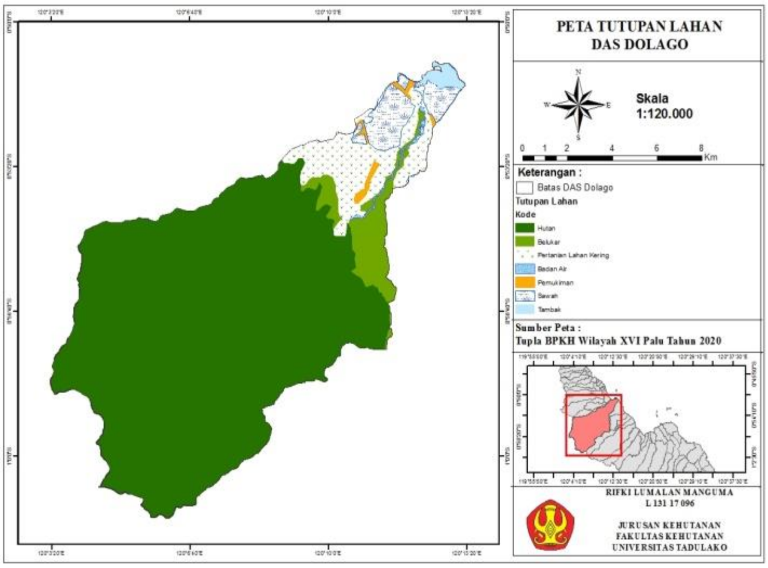


**Fig. 4**. Land Cover of Dolago Watershed

Based on the figure above, the Land Cover of the Forest Area Consolidation Center (BPKH) Region XVI Palu in 2020 is divided into 7 parts, namely forests, shrubs, dry land agriculture, water bodies, settlements, rice fields, and ponds. Once the Dolago watershed land cover is known, the value of crop processing and soil conservation (CP) can be determined, as shown in Table 9 below.

Table 8. Crop Management and Soil Conservation (CP) Value Results

| No. | Land Cover | CP Value | Area (Ha) | Percentage % |
|---|---|---|---|---|
| 1 | Forest | 0,001 | 14.243,38 | 82,4 |
| 2 | Belukar | 0,05 | 834,19 | 4,8 |
| 3 | Dryland Agriculture | 0,5 | 1.490,26 | 8,6 |
| 4 | Water Body | 0,001 | 47,93 | 0,3 |
| 5 | Settlement | 1 | 51,09 | 0,3 |
| 6 | Sawah | 0,02 | 436,27 | 2,5 |
| 7 | Pond | 0,001 | 179,97 | 1,1 |
| | **Total** | | **17.283,09** | **100** |

Source: Data Analysis Results

According to [6] land use types with excellent vegetation levels experience very little soil damage, while land use types that have poor vegetation, the soil will experience direct rainwater blows so that it experiences very high soil damage. Land use types with vegetation conditions in this case the density and stratification of vegetation from the best to the worst in order are primary forests, secondary forests, mixed gardens or plantations, shrubs, settlements, and fields. Based on the table above, the Dolago watershed has 8 land covers, namely forests with a total area of 14,243.38 Ha, shrubs with an area of 834.19 Ha, dry land agriculture with an area of 1,490.26 Ha, water bodies with an area of 47.93 Ha, settlements with an area of 51.09 Ha, rice fields with an area of 436.27 Ha and the last is a pond with an area of 179.97 Ha.

### 3.5 Erosion Class Prediction Calculation

To determine the erosion class in the Dolago watershed, overlaying the soil type map, slope class map, and land cover map and entered the rainfall erosivity value (R), soil erodibility value (K), slope value (LS), and the value of crop processing and soil conservation (CP) then performed calculations using the USLE method and determine the erosion class based on table 3, the resulting calculation table can be seen as follows:

Table 9. Results of *Overlay* and USLE Method Calculation

| R-value | K value | LS Value | CP Value | A |
|---|---|---|---|---|
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,05 | 12,99 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,05 | 45,49 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,05 | 100,73 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,05 | 220,97 |
| 1412,9 | 0,46 | 9,5 | 0,001 | 6,17 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,05 | 12,99 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,05 | 45,49 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,05 | 100,73 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,05 | 220,97 |
| 1412,9 | 0,46 | 9,5 | 0,001 | 6,17 |
| 1412,9 | 0,46 | 9,5 | 0,05 | 308,71 |
| 1412,9 | 0,45 | 0,4 | 0,05 | 12,71 |
| 1412,9 | 0,45 | 0,4 | 1 | 254,32 |
| 1412,9 | 0,45 | 0,4 | 0,001 | 0,25 |

| | | | | |
|---|---|---|---|---|
| 1412,9 | 0,45 | 0,4 | 0,5 | 127,16 |
| 1412,9 | 0,45 | 1,4 | 0,05 | 44,50 |
| 1412,9 | 0,45 | 1,4 | 0,5 | 445,06 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,05 | 12,99 |
| 1412,9 | 0,46 | 0,4 | 1 | 259,97 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,5 | 129,98 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,05 | 45,49 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,5 | 454,95 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,05 | 100,73 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,5 | 1007,39 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,05 | 220,97 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,5 | 2209,77 |
| 1412,9 | 0,46 | 9,5 | 0,001 | 6,17 |
| 1412,9 | 0,46 | 9,5 | 0,05 | 308,71 |
| 1412,9 | 0,46 | 9,5 | 0,5 | 3087,18 |
| 1412,9 | 0,45 | 0,4 | 0,05 | 12,71 |
| 1412,9 | 0,45 | 0,4 | 1 | 254,32 |
| 1412,9 | 0,45 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,45 | 0,4 | 0,5 | 127,16 |
| 1412,9 | 0,45 | 0,4 | 0,02 | 5,08 |
| 1412,9 | 0,45 | 1,4 | 0,5 | 445,06 |
| 1412,9 | 0,45 | 3,1 | 0,5 | 985,49 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,5 | 129,98 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,5 | 454,95 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,5 | 1007,39 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,5 | 2209,77 |
| 1412,9 | 0,46 | 9,5 | 0,001 | 6,17 |
| 1412,9 | 0,46 | 9,5 | 0,5 | 3087,18 |
| 1412,9 | 0,45 | 0,4 | 0,05 | 12,71 |
| 1412,9 | 0,45 | 0,4 | 1 | 254,32 |
| 1412,9 | 0,45 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,45 | 0,4 | 0,5 | 127,16 |
| 1412,9 | 0,45 | 0,4 | 0,02 | 5,08 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,05 | 12,99 |
| 1412,9 | 0,46 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,46 | 0,4 | 0,5 | 129,98 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,05 | 45,49 |
| 1412,9 | 0,46 | 1,4 | 0,001 | 0,90 |
| 1412,9 | 0,46 | 1,4 | 0,5 | 454,95 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,05 | 100,73 |
| 1412,9 | 0,46 | 3,1 | 0,001 | 2,01 |
| 1412,9 | 0,46 | 3,1 | 0,5 | 1007,39 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,42 |
| 1412,9 | 0,46 | 6,8 | 0,05 | 220,97 |
| 1412,9 | 0,46 | 6,8 | 0,001 | 4,41 |
| 1412,9 | 0,46 | 6,8 | 0,5 | 2209,77 |
| 1412,9 | 0,46 | 9,5 | 0,001 | 6,17 |

| | | | | |
|---|---|---|---|---|
| 1412,9 | 0,46 | 9,5 | 0,05 | 308,71 |
| 1412,9 | 0,35 | 0,4 | 0,02 | 3,95 |
| 1412,9 | 0,35 | 0,4 | 0,001 | 0,19 |
| 1412,9 | 0,45 | 0,4 | 0,05 | 12,71 |
| 1412,9 | 0,45 | 0,4 | 1 | 254,32 |
| 1412,9 | 0,45 | 0,4 | 0,001 | 0,25 |
| 1412,9 | 0,45 | 0,4 | 0,5 | 127,16 |
| 1412,9 | 0,45 | 0,4 | 0,02 | 5,08 |
| 1412,9 | 0,45 | 0,4 | 0,001 | 0,25 |
| **Total** | | | | **23.888,80** |

Source: Data Analysis Results

From the results of *Overlay* (overlapping) in the table above and the results of the calculation of the USLE method, it is known that the amount of soil eroded (A) Dolago watershed is 23,888.80 Ton/Ha/year. Meanwhile, the erosion hazard class is divided into five classes, which can be seen as follows:

**Table 10. Erosion Hazard Class in Dolago Watershed**

| Class | Erosion Rate (tons/ha/year) | Erosion Hazard Class | Area (Ha) | Percentage (%) |
|---|---|---|---|---|
| I | <15 | Very Light | 15.111,55 | 87,44 |
| II | 15 - 60 | Lightweight | 175,52 | 1,02 |
| III | 61 - 180 | Medium | 1.244,87 | 7,20 |
| IV | 181 - 480 | Weight | 491,66 | 2,84 |
| V | >480 | Very Heavy | 259,49 | 1,50 |
| **Total** | | | **17.283,09** | **100** |

Source: Data Analysis Results

The results of the calculation of the erosion hazard class in Table 11 show that the value of the erosion hazard class is based on the total area of the study site, so it can be seen that 87.44% of the erosion hazard class is classified as very light with an area of 15,111.55 ha, 1.02% in the erosion hazard class is classified as light with an area of 175.52 ha, 7.20% in the erosion hazard class is classified as moderate with an area of 1,244.87 ha, 2.84% in the erosion hazard class is classified as heavy with an area of 491.66 ha and finally 1.50% in the erosion hazard class is classified as very heavy with an area of 259.49 ha.

The most dominating erosion hazard class in the Dolago watershed is class I (very light) with an erosion rate <15 (tons/ha/year) covering 15,111.55 ha while the lowest erosion class is class III (light) with an erosion rate of 15 - 60 (tons/ha/year) covering 259.49 ha. After overlaying and calculating the erosion hazard class using the USLE method, the data produced a map of the erosion class in the Dolago watershed which can be seen in the following figure:

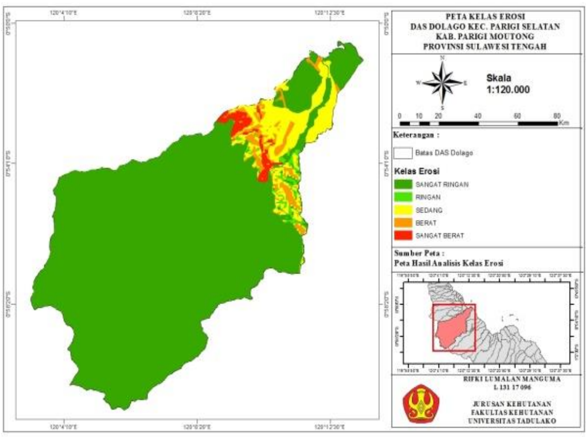


**Fig. 6.** Erosion Class of Dolago Watershed

Based on the results of the calculation analysis of the prediction of erosion hazard class in Dolago watershed, it is known that:

Erosion class, I (very light) is found in land cover namely forests, ponds, water bodies, shrubs, and rice fields on slopes that are flat, sloping, slightly steep, steep, and very steep on lotosol, glei humus, and hydromorphic alluvial soil types with a total amount of rain of 1,412.9 cm/year.

Erosion class II (light) is found in land uses, namely rice fields, shrubs, and dry land farming on slopes that are flat, sloping, steep, and very steep on lithosol and glei humus soil types with a total amount of rainfall of 1,412.9 cm/year, erosion class II (light).

Erosion class III (moderate) is found in land use, namely, shrubs, rice fields, and dry land agriculture on slopes that are flat, sloping, slightly steep, steep, and very steep on lithosol, glei humus and hydromorphic alluvial soil types with a total amount of rain that is 1,412.9 cm/year.

Erosion class IV (heavy) is found in land uses, namely shrubs, settlements, and dry land agriculture on slopes that are flat, sloping, slightly steep, steep, and very steep on lithosol and glei humus soil types with a total amount of rain that is 1,412.9 cm/year.

Meanwhile, class V erosion (very heavy) is found in land use, namely dry land agriculture and shrubs on slopes that are gentle, rather steep, steep, and very steep on lithosol soil types with a total amount of rain of 1,412.9 cm/year.

The research results above, show that the erosion hazard class in Dolago watershed class V (very heavy) is dominant in dryland agricultural areas with steep category slope areas.

Slope is one of the causes of high and low erosion classes [8]. Soil occurs as a product of fragments of rock undergoing mechanical or chemical weathering. Mechanical weathering occurs when the rock changes into smaller fragments without a chemical change with influencing factors, namely climatic influences, exfoliation, erosion by wind and rain, abrasion, and organic activities. Chemical weathering involves the change of rock minerals into new mineral compounds with processes occurring such as oxidation, *solution*, and *leaching*. Geomorphology and geology are parameters that trigger land movement. Geomorphological factors such as slope play an active role in controlling soil movement. The steeper the slope, the greater the driving force of the soil or rock masses that make up the slope. In addition to increasing the velocity of surface water, the steeper the slope, the increase in the amount of surface flow also means an increase in water transport energy. The location of the slope also affects the surface flow class. Water flowing from the top of the slope will collect at the bottom, which will cause more water to flow at the surface and accelerate the flow rate to the bottom of the slope, the more sloping the slope will be the number of soil grains that are splashed down by the impact of rain grains more and more.

So that the area needs soil conservation measures according to [7] with several soil conservation methods, among others:

1. Vegetative Methods:
   a. Reforestation, this activity is intended to restore forest function in an area that was once a protected forest area. This activity is focused on areas with slopes of 0 - 8% with land cover in the form of shrubs, then slopes of 25 - 45%, and slopes > 45% with land cover in the form of forests.
   b. Tree Planting, The recommended tree species to be planted in erosion-prone areas are montong durian and transgenic sengon. It is expected that these two types of plants not only serve to prevent erosion but are also expected to help the economy of the local community. This activity is focused on areas with slopes of 8 - 15%, slopes of 15 - 25%, slopes of 25 - 45%, and > 45% with land cover in the form of shrubs.
   c. Garden Making, Garden Making aims to avoid the occurrence of erosion events in residential areas. The conservation direction of making parks is focused on residential areas in each slope class ranging from 0 - 8% to > 45% slope that has empty land without vegetation or minimal vegetation. People can plant several trees, flowers, and most importantly grass. The recommended grass is mini elephant grass because this grass is quite cheap, does not require much maintenance, and is weather resistant.
2. Mechanical method, The purpose of the mechanical method is to engineer the length of the slope in order to minimize the surface flow rate and increase water infiltration. This conservation effort is carried out in areas with slopes of 25 - 45% and >45% with land use in the

form of residential areas. From this mechanical method, there are several efforts that can be made to reduce the actual erosion value in an area, such as making bench terraces, individual terraces, garden terraces, terrace mounds, and swales.

## 4. Conclusion

Based on the research results, it can be concluded that combining 30 geographic information system and the USLE method can produce five types of erosion hazard classes, namely class I classified as very light with an area of 15,111.55 ha percentage of 82.81%, class II classified as light with an area of 193.52 ha percentage of 1.12%, class III classified as moderate with an area of 1,815.52 ha percentage of 10.50%, class IV classified as heavy with an area of 682.32 ha percentage of 3.95% and class V classified as very heavy with an area of 279.56 ha percentage of 1.62%.

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