Remote Sensing and GIS Method for Assess Erosion with Satellite Imagery at Citarik Sub-Watershed

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Abstract. Soil erosion represents one of the most severe land degradation problems, starting from the decrease in the level of productivity of the land to natural disasters that cause material casualties and losses. Assessment of erosion through remote sensing methods and GIS can assist in the provision of erosion data, which can later be integrated with the database so that it can present in an update. Landsat 8 satellite image obtained from the USGS data. The satellite image data analysis to obtain data NDVI vegetation canopy density, also performed with the interpretation that with supervised classification using Likelihood method to obtain the land use data. Then Landuse data tested the level of accuracy. The results showed that Landsat 8 could determine land use with accuracy 92.67% with approach Supervised Classification by Maximum Likelihood method, the results of interpretation produces seven classes of land use, land use fields dominating with an area of 114.01 hectares or 88.80% of the total area, while land use at least is a primary forest with an area of only 0.36 hectares or 0.28%, NDVI analysis shows that density of vegetation was dominated by areas of research. The land-use who potential to be degradation is farm/field

1. Introduction

Soil erosion is currently the most severe environmental problem in the world; the losses caused by this event are not only in eroded locations but occur in places where sediments stop. The losses incurred are substantial both in terms of material and non-material. Efforts to minimize erosion must be comprehensive from upstream to downstream so that repairs can be done effectively.

The quality of watersheds is strongly influenced by the events that occur therein, the conversion of land functions in the upstream area resulting in increased erosion rates in the area can reduce the quality of the watershed. This has become a major problem in watersheds in Indonesia today. Difficult to control the transfer of land functions until the lack of proper development of regional spatial planning rules becomes an obstacle in efforts to improve the watershed.

The Citarik watershed is part of the Upper Citarum watershed, the longest river in West Java, known as the dirtiest river in Indonesia. The poor quality of the watershed is a result of the poor quality of the Citarik sub-watershed.

Soil particles that have been released will be easily carried away by water when surface runoff occurs. Most of the released soil particles and carried away are the upper layers that have a dominant
nutrient content compared to the underlying soil layers, thus having a direct impact on the reduced nutrient content, which leads to a decline in the productivity of the soil.

Slopes significantly affect the motion of water that is on the ground surface. The steeper the slope, the water tends to move down to a lower area compared to seep into the ground. High surface runoff causes water to carry soil particles, which will be deposited as the surface flow slows. Soil particles are the top layer of soil that contains essential elements for plant growth so that the soil eroded by erosion will decrease the level of productivity.

Also, land use plays a role in determining the erosion of a place. This is influenced by both natural and artificial objects that can protect the soil from water-destructing energy caused by rainwater, and one example is the vegetation canopy. In areas with dense vegetation canopies the ground will be protected from rainwater harlot energy, whereas in open areas without rainwater, canopy vegetation will directly hit the ground and destroy soil aggregation. However, if the vegetation canopy is not dense it will increase the energy of rainwater destruction compared to areas with open land, there is a close relationship between the width of the leaf dropper tip and the volume of the droplet. The wider the leaf dropper tip the more significant the volume of the water droplets. This creates a greater destructive force than rainwater, which directly falls to the ground. This is proven by the research on the measurement of splash erosion under acacia trees in Jatiluhur [2] showing that splash erosion under tree stands not accompanied by litter and lower vegetation higher than spark erosion in open ground (without vegetation canopy closure).

The application of remote sensing and GIS to identify the spatial appearance associated with the factors causing erosion has been done in research studies such as the following. Mardin's research results [7] states that the use of remote sensing in this Ikonos satellite can identify urban objects with an accuracy of 95.09%. While the application of GIS by using Landsat satellites has been widely used in several interpretation studies, it is like in Loppies research [6], which analyzes land cover using Landsat 7 with the maximum likelihood classification method, the research stated that the level of accuracy reaches 99.56%.

Based on these studies, it can be concluded that remote sensing can be applied in assessing erosion by analyzing the factors causing erosion spatially.

2. Material and Methods

2.1. Study Area

The research area is located on the slopes of Mount Manglayang, which is included in the Citarik Sub-watershed, Upper Citarum Watershed. Administratively the research location is in the villages of Cileles, Cikeruh, and Hegarmanah, Jatinangor District, Sumedang Regency. In the north, the research site is bordered by Kiarapayung Campground, and in the south it is bordered by the University of Padjadjaran. The research site is at 810-914 mdp with slope ranging from <8% to 35%.

2.2. Research Methods

This research was conducted with descriptive, comparative, and survey methods. Landsat 8 satellite images were obtained from USGS data. The satellite imagery data was analyzed by NDVI to obtain vegetation canopy density data, also interpreted by supervised classification approach using the Likelihood method to obtain land use data. Contour and slope maps are obtained by processing elevation data from Google Elevation in the Arcgis application. A field survey was conducted to check the land use that had been interpreted to test the correctness of the results of the interpretation, in addition to that it also carried out a profile analysis and sampling to determine the type of soil and input data when calculating erosion predictions.
3. Result and Discussions

3.1. Slope

According to the elevation data processing results seen from the topography of the study site has four slope classes, ranging from flat to steep. The slope class is dominated by flat slope class (0% - 8%) covering 64.91 Ha or 50.38% of the total area, while the slope class (8% - 15%) is 56.20 Ha or the second largest after flat slope class with a portion of 43.62% of the total area. Areas with slope classes are rather steep (15% - 25%) having an area of 7.63 Ha or 5.92% of the total area, and curan slope class only has an area of 0.09 Ha.

Table 1. Slope Classification

| Code | Class      | Classification      | Areal (Ha) | %   |
|------|------------|---------------------|------------|-----|
| I    | 0% - 8%    | Gently Sloping      | 64.91      | 50.38 |
| II   | 8% - 15%   | Moderately Sloping  | 56.20      | 43.62 |
| III  | 15% - 25%  | Moderately Steep    | 7.63       | 5.92  |
| IV   | 25% - 45%  | Steep               | 0.09       | 0.07  |
| V    | >45        | Very Steep          | 0.00       | 0.00  |
|      | Total      |                      | 128.84     | 100.00|

In the study area has a radial slope pattern, the flat slope class is mostly at the top of the slope or topsoil, in the study area there are many stems extending from the north to the south of the location, this happens because the study area is the foot of the Manglayang mountain which has undergone a process of erosion and sediment for hundreds of years.
3.2. Climate
Judging from the climatic conditions of the study site, including climate type C (slightly wet) according to the classification of Schmidt and Fergusson. This causes the rainfall is still quite high in this area, so that enough potential for erosion. Based on data obtained from the nearest weather station (LAPAN, Tanjungsari), the average rainfall in the last ten years brackets is 1,437 mm / year, and the highest is 2,546 mm / year. The rainy season lasts from November to April, and the dry season lasts from May to October.

3.3. Soil
Based on the results of the profile description carried out in 2 pedons and laboratory analysis, the type of soil at the study site is Inceptisols. Inceptisols are immature soils with a weak profile development compared to mature soils, still resembling the nature of the parent material. Inceptisols found at the study site were derived from the parent material of the Holocene volcano rock.

However, of the two pedons, they have different subgroups. In pedon one, this soil has a Typic Humudepts subgroup with a sufficient depth of 140 cm, has a good drainage system, a moderate level of permeability with moderate surface flow. Pedon 2, with Typic Dystrudepts subgroup, has an effective depth of 148 cm, has a good drainage system, but its slow permeability results in high surface flow.
3.4. Landuse

Land use classification is done automatically using the maximum likelihood method based on the training sample data that has been made previously. This sample training data is useful as a reference for land use that has been determined. The color of the samples of pixels that have been grouped and determined by the type of land use becomes the basis in determining the land-use class, then all parts of the image have been divided into groups according to their land use.

The results of the maximum likelihood land use classification give rise to 8 types of land use, namely primary forest, secondary forest, developed the land, paddy field, fields / dry land, open land, grassland, and water body, but there are only seven types of land use in agriculture area. Land, namely primary forest, secondary forest, fields / dry fields, grasslands, rice fields, developed land and water bodies. Of the seven land uses, the most dominating area is land use / dry land area of 144.01 Ha or 88.80% of the total area while secondary forest has the second most extensive area after land / dry land area with 3.72 Ha or 2.90% of overall area. In the research area there are candlenut forests, candlenut trees having a rather dense canopy so that they are detected as secondary forests.
3.5. Normalized Difference Vegetation Index (NDVI)
Based on the results of the NDVI analysis, it can be seen that the high vegetation density is found in the western part of the study area, and at the top of Mount Manglayang, this can be seen from the increasingly solid red color. The fading of the red color, even the green color indicates even less and no vegetation in the area. Areas that have low vegetation density do not even vegetate mostly along river basins.

In the study area, most have medium vegetation density, this happens because in that area the majority have land-use classes / dry fields. Fields/moor that is overgrown with horticultural plants have a low vegetation density. However, in the southern part of the study area there are areas that have low vegetation density.

**Table 2. Landuse Classification**

| No | Landuse Classifications | Areal (Ha) | %  |
|----|------------------------|------------|----|
| 1  | Primary Forest         | 0.36       | 0.28 |
| 2  | Secondary Forest       | 3.72       | 2.90 |
| 3  | Field/Moor             | 114.01     | 88.80 |
| 4  | Grassland              | 0.54       | 0.42 |
| 5  | Paddy Land             | 0.81       | 0.63 |
| 6  | Construction           | 7.92       | 6.17 |
| 7  | Water Area             | 1.02       | 0.79 |
3.6. Erosion Analysis
Land degradation is a process in which the ability of land on a plot of land decreases or decreases (actual or potential) to produce an item or service. Land that has been degraded tends to decrease productivity [1,4,8]. Land degradation or soil damage can be caused by natural factors or human intervention factors. Natural factors are caused by topographic, hydrological, geological or pedological aspects of the land itself [4], whereas human intervention factors are caused by various human interactions with the land [9], for examples such as errors in the application of land management patterns [5], deforestation and others.

Erosion is the event of the transport of soil from one place to another by natural media [1]. The erosion event is characterized by the erosion of the surface part of the ground by rain or wind and then transported and deposited along with the reduced energy carrying the soil.

From the results of the erosion prediction calculation, it was found that the most potentially erosion land use is fields / fields planted with maize at a slope of 25-45% which are projected to have a very heavy erosion rate of 4436.97 tons / ha / year and for the same land use at a slope of 15-25% is projected to have an erosion rate of 1654.13 tons/ha/ year. Secondary land use with tree stands that have moderate vegetation density and without ground cover below has a high erosion rate, in the slope class 25-45% is projected to have an erosion rate reaching 99,064 tons/ha/ year and in the slope class 15-25 % is projected to have an erosion rate of 44,318 tons/ha/ year. Other land uses that have high erosion potential are grasslands. Meadows dominated by Brachiaria decumbers were only effective in resisting erosion in the flat and gentle slope classes, whereas for steep slopes (25-45%) it was projected to have an erosion potential of 88.85 tons/ha/ year.

4. Conclusion
Landsat 8 can determine land use with the Supervised Classification approach with the Maximum Likelihood method with a mapping accuracy level of 92.67%, from the results of the interpretation produces 7 classes of land use, land use / dry land dominates with an area of 114.01 Ha, while land use the narrowest is primary forest with an area of only 0.36 Ha. In terms of accuracy, land use / dry land has the highest accuracy of 92.74%, while the lowest is a body of water with an accuracy of only 2.13%. Most of the vegetation in the study area has a medium-density whose land use is dominated by fields /

![Figure 5. NDVI Result](image)
dry fields. Thus Landsat 8 satellite imagery with a spatial resolution of 30 m is less effective if it is used for a narrow/limited area.

Field / dry land use dominates the research location. The land use is very potential for land degradation because it has a low canopy height, low vegetation density and a tenuous canopy so as not to be able to suppress the level of erosion in the area especially during rain especially on slope classes rather steep to steep with erosion potential in the class the steep slope of 1654.13 tons / ha / year and the steep slope of 4436.97 tons / ha / year.

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