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Spatial Distribution of Erosion on Corn Fields in Boalemo Regency, Gorontalo Province

Achmad Nur Fahry Machmud[a], Fitryane Lihawa[b], M. Fahry Djuraini[c], M. Luthfi A.S Ibrahim[d]

[a, d] *Environmental Science Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Gorontalo, Indonesia*

[b] *Doctoral Program of Environmental Science, Postgraduate Program, Universitas Negeri Gorontalo, Gorontalo, Indonesia*

[c] *Program Planning and Management of Coastal Area and Watersheds, Faculty of Geography, Universitas Gadjah Mada, Yogyakarta, Indonesia*

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Corresponding author:
Achmad Nur Fahry Machmud
Email: fahry.machmud@ung.ac.id

ABSTRACT

The spatial distribution of surface erosion on corn fields in Boalemo Regency, Gorontalo Province is a significant concern. Boalemo Regency is known for its corn production, but the land clearing for corn cultivation, especially on steep slopes, has led to land degradation, triggering floods and landslides. This study aims to examine the spatial distribution of surface erosion on corn agricultural land in Boalemo Regency, covering all corn plantations in an area of 181,672.83 hectares. The RUSLE (Revised USLE) method was used to analyze soil erosion. The analysis of surface erosion levels was conducted based on the stages of corn planting, including the land preparation and planting stages. The results indicated that the total erosion during the land preparation stage was 2474870411 tons per year, while during the corn planting stage, it was 1150961410 tons per year. The level of erosion was found to be very severe, covering an area of 46706.92 hectares (25.71%) during the land preparation stage and 33852.80 hectares (18.63%) during the planting stage.

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1. INTRODUCTION

Soil erosion is a significant environmental issue in various regions worldwide, particularly in areas dominated by agricultural activities. Poorly managed land cultivation, especially in areas with steep topography, can trigger high rates of soil erosion, leading to land degradation. Land degradation is one of the most serious environmental problems today. Changes in land use are a primary driver of land degradation (Chaidar et al., 2017; Getu Engida et al., 2021; Huang & Lo, 2015; Lundekvam et al., 2003). The effects of land degradation due to erosion are not limited to soil fertility loss but also have broader implications for food production sustainability, food security, and ecosystem stability (Huang & Lo, 2015). (Chalise et al., 2019) highlighted that land degradation is a critical issue in Nepal. Population growth, conventional land management practices, and excessive chemical fertilizer use are key factors contributing to erosion. Land degradation manifests in various forms, such as soil acidification, alkalinization, nutrient depletion, soil erosion, and biodiversity loss.

In Indonesia, soil erosion is worsening due to agricultural intensification, particularly in steeply sloped areas like Gorontalo Province. As one of the largest corn-producing provinces in Indonesia, Gorontalo has a significant area of corn plantations, many of which are established on steep and very steep slopes. For instance, in Boalemo Regency, approximately 20% of the total agricultural land area consists of land on steep slopes, covering a total of 64,145.46 hectares

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(Machmud et al., 2023). The land in this region is cleared at a high intensity to meet the demand for corn, both for local consumption and export. However, improper land management, especially without adequate soil conservation techniques, has triggered increased soil erosion. This has led to land degradation, characterized by declining agricultural productivity and increased risks of disasters such as floods and landslides (Chaidar et al., 2017; Getu Engida et al., 2021).

Soil erosion in agricultural land is often caused by rapid land cover changes, as highlighted by (Hirsan, F.P;Susanti, F; Ridha, 2021) in their study in Dompu Regency. Their research revealed that converting forests into cornfields has led to an increased risk of flooding in the region. Another study by (Ferdianyah, D; Sahidu, A; Juniarsih, 2023) in Wawo District, Bima Regency, found that land conversion to cornfields triggered severe erosion and reduced access to clean water sources. This trend is also evident in Gorontalo Province, where the rate of land use change continues to accelerate. According to (Machmud et al., 2023), the agricultural land area in Gorontalo increased from 119,094 hectares in 2013 to 205,631 hectares in 2021. This significant increase in land conversion, particularly from forests and shrublands to agricultural land, has directly contributed to the degradation of forest ecosystems, which play a vital role in hydrological regulation and erosion mitigation (Anwar et al., 2011).

The main issue faced in land degradation in Boalemo Regency is the rise in soil erosion caused by land cultivation without proper conservation techniques. According to a study by (Fatema & Chakrabarty, 2020), land on steep slopes is more susceptible to erosion than flat land, particularly when it lacks sufficient vegetation cover. In Boalemo Regency, many cornfields have been opened on steep slopes without considering proper land management techniques, leading to accelerated soil erosion. This not only contributes to land degradation but also alters surface water flow patterns, ultimately increasing the risk of flooding in the region (Anwar et al., 2011).

Various conservation solutions have been proposed and implemented. One of the commonly adopted solutions is soil and water conservation techniques such as terracing, strip cropping, and the use of cover crops (David, 1988). These techniques are effective in reducing erosion rates by slowing surface water flow and enhancing water infiltration. However, despite their effectiveness, the application of these conservation techniques in the field is often limited by farmers' lack of knowledge and resources. Consequently, soil erosion and land degradation remain serious challenges in corn farming areas such as Boalemo Regency.

Although various conservation solutions have been implemented, there remain research gaps on the most effective ways to address land degradation and erosion, particularly in areas with complex land characteristics like Boalemo Regency. These gaps relate to the lack of specific studies on the impact of land cover changes on soil erosion and the insufficient implementation of comprehensive conservation strategies. Most existing studies tend to focus on the impact of greenhouse gas emissions from agricultural activities, while the effects of soil erosion are often overlooked (Harimurti et al., 2019). Therefore, further research is needed to specifically examine the relationship between land cover changes, land management patterns, and soil erosion to formulate and implement more effective conservation solutions in the field.

This study aims to address these gaps by conducting an in-depth examination of the impact of soil erosion in Boalemo Regency. Through this study, it is expected that a better understanding of the factors influencing soil erosion rates in cornfields can be achieved, and solutions that can be implemented to mitigate land degradation and maintain agricultural productivity in the region can be identified.

2. METHOD

2.1 Research Location

This study was conducted in Boalemo Regency, Gorontalo Province, Indonesia. Astronomically, Boalemo Regency is located between 0° 23’ 55’’ - 0° 55’ 38’’ North Latitude and 122° 01’ 12’’ - 122° 39’ 17’’ East Longitude. Geographically, the northern part of Boalemo Regency is bordered by Gorontalo Utara Regency, while the southern part is bordered by the Tomini Bay.

To the west, it is bordered by Pohuwato Regency, and to the east, it shares a border with Gorontalo Regency.

2.2 Data Collection Methods

The data used in this study consist of both primary and secondary data. Rainfall data were collected from 14 rain gauge stations spread across the study area. These stations provided long-term rainfall data, which are essential for calculating rainfall erosivity. The soil erodibility factor was obtained from secondary data, specifically from the Soil Erodibility Map provided by the Bone Bolango Watershed Management Agency (BPDAS Bone Bolango). Topographic data, including slope length and slope steepness, were obtained from the Shuttle Radar Topography Mission (SRTM) imagery interpretation. Meanwhile, land cover data were acquired using Google Earth Engine, a platform that provides access to global satellite imagery, particularly Sentinel-2A satellite imagery, which is well-suited for high-resolution, wide-coverage multispectral mapping (Gorelick et al., 2017).

2.3 Data Analysis Methods

The method used for soil erosion analysis is the Revised Universal Soil Loss Equation (RUSLE), as formulated by (Wischmeier & Smith, 1978). The RUSLE model estimates the average annual soil loss (A) per unit area (ton/ha/year) based on several factors, as expressed in equation (1):

$$A = R \times K \times L \times S \times C \times P \quad (1)$$

Where:

A = Soil loss per unit area per year (ton/ha/year)
R = Rainfall erosivity
K = Soil erodibility
L = Slope length
S = Slope steepness
C = Land cover
P = Conservation practice

Rainfall Erosivity Factor (R)

The rainfall erosivity factor (**R**) is calculated using equation (2) based on the empirical formula developed by Babu et al., (2004):

$$R = 81.5 + 0.38P \quad (2)$$

Where:

R = Rainfall erosivity
P = Annual rainfall (mm)

This formula estimates the erosive potential of rainfall events based on the total annual rainfall. In this study, rainfall data from the 14 stations were used to compute the erosivity factor.

Soil Erodibility Factor (K)

The soil erodibility factor (**K**) represents the susceptibility of soil particles to detachment and transport by rainfall and surface runoff. The **K** values were derived from the Soil Erodibility Map provided by BPDAS Bone Bolango. This factor is critical because soil texture, structure, organic matter content, and permeability all contribute to how easily soil erodes. The use of the soil erodibility map ensures that the data accurately reflect local soil characteristics.

Slope Length and Slope Steepness Factors (LS)

The slope length and steepness factors (**L** and **S**) represent the effect of topography on soil erosion. The combination of these two factors, commonly referred to as **LS**, was calculated using equation (3), which is based on the relationship between slope steepness and erosion rate developed by David (1988)

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$$LS = a + b \times S_L^{4/3} \quad (3)$$

Where:
a = 0.1 (constant)
b = 0.21(constant)
S_L = Slope steepness (%)

This formula highlights the increased susceptibility to erosion on steeper and longer slopes. Areas with steep slopes, particularly in the study area, are expected to have higher **LS** values, indicating higher erosion potential.

Land Cover Factor (C)

The land cover factor (**C**) reflects the ratio of soil loss from an area with specific land cover and management to the soil loss from bare ground. **C** values vary depending on land use and cover, as they affect soil exposure to erosive forces. For example, during the land preparation stage, the **C** value is set at 1, indicating maximum vulnerability due to the lack of protective vegetation. In contrast, during the corn planting stage, the **C** value is adjusted to 0.55, representing a more stable condition with partial land cover. The values of **C** used in this study were drawn from the literature (David, 1988) and adjusted based on local conditions in Boalemo Regency, as shown in Table 1.

Table 1. Land Cover Factor (C) Values for Corn Farming in Boalemo Regency

Land Cover Type	Land Preparation	Planting
Water	0	0
Forest	0.003	0.003
Swamp	0.001	0.001
Agricultural Land	1	0.55
Bare Land	0.1	0.1
Settlements	0.2	0.2

Source: (David, 1988)

These **C** values provide insight into how different land cover types contribute to erosion. For instance, forested areas have low **C** values, indicating that they effectively protect the soil from erosion, whereas agricultural land in the preparation phase is more prone to erosion due to the lack of protective cover.

Table 2. Conservation Practice Factor (P) Values for Corn Farming in Boalemo Regency

Land Cover Type	Land Preparation	Planting
Water	1	1
Forest	0.8	0.8
Swamp	1	1
Agricultural Land Slope <3%	1	0.6
Agricultural Land Slope 3-9%	1	0.5
Agricultural Land Slope 9-13%	1	0.6
Agricultural Land Slope 13-17%	1	0.7
Agricultural Land Slope 17-21%	1	0.8
Agricultural Land Slope 21-26%	1	0.9
Agricultural Land Slope >26%	1	0.95
Bare Land	1	1
Settlements	1	1

Source: (David, 1988)

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Conservation Practice Factor (P)

The conservation practice factor (**P**) reflects the ratio of soil loss under specific conservation practices to the loss from conventional farming. **P** values are influenced by slope steepness and the type of conservation practice employed. For instance, contour plowing and terracing can significantly reduce erosion by slowing water runoff and promoting infiltration. Table 2 shows the **P** values for different slope conditions during both the land preparation and corn planting stages in Boalemo Regency.

Erosion Analysis

Erosion analysis was conducted under two main scenarios: land preparation and planting stages. During the land preparation stage, **C** and **P** factors were both assumed to be 1, representing the highest erosion potential due to the exposed soil and absence of conservation practices. During the planting stage, the **C** and **P** factors were adjusted to reflect the more stable conditions of land cover and management practices. These values were derived from the relevant literature (David, 1988) to illustrate the variability in erosion rates based on different land management practices.

By applying the RUSLE model under these two scenarios, the study aimed to quantify the differences in soil erosion during the land preparation and planting stages and to provide insights into the effectiveness of various conservation practices in mitigating soil erosion.

3. RESULTS AND DISCUSSION

The impact of surface erosion caused by corn farming activities was evaluated using the Revised Universal Soil Loss Equation (RUSLE) method. The erosion assessment was conducted in two phases: the land preparation stage and the corn planting stage. Rainfall erosivity data were derived from a 12-year analysis (2010–2022) of rainfall data collected from 14 rain gauge stations distributed across Boalemo Regency and surrounding areas. Rainfall was analyzed using the isohyet approach to determine the spatial distribution of rainfall in the region (see Figure 1). Detailed rainfall and erosivity data for Boalemo Regency are presented in Table 3. The erosivity map of Boalemo Regency is shown in Figure 1.

Table 3. Average Rainfall and Erosivity Values in Boalemo Regency

Rainfall Station	Average Rainfall (mm) 2010-2022	Erosivity (R)
ARR Boliohuto Bulontio	27747.03	1125.37
MRG DAS Langgula-Lamu	2265.84	942.52
ARR Paguyaman Mohiolo	3535.40	1424.95
ARR Paguyaman Lakeya	3804.31	1527.14
ARR Paguyaman Tangkobu	2288.69	951.20
ARR Bendungan Paguyaman - Olimohulo	2188.14	912.99
ARR Paguyaman Saritani	3571.83	1438.79
ARR Paguyaman Pantai	1425.45	623.17
ARR Paguyaman Dulupi	1302.09	576.29
ARR Tilamuta Modelomo	1388.83	609.25
ARR Tilamuta Piloliyanga	1882.52	796.86
ARR Tabulo Bendungan	1648.75	708.02
ARR Paguat Bunuyo	1974.67	831.87
ARR Bumbulan Karya Baru	3291.35	1332.21

Source: Analysis results, 2023

3.1 Rainfall Erosivity and Soil Erodibility

The erosivity factor (R) for the study area was derived from rainfall data and exhibited significant spatial variation across Boalemo Regency, with values ranging from 576.29 mm to 1527.14 mm. This variation highlights the influence of rainfall intensity and distribution on erosion potential (see Figure 1). The spatial distribution of erosivity also illustrates the areas where rainfall exerts the greatest erosive force on the landscape, making them particularly vulnerable to soil erosion (Borrelli et al., 2021; Nearing et al., 2011)

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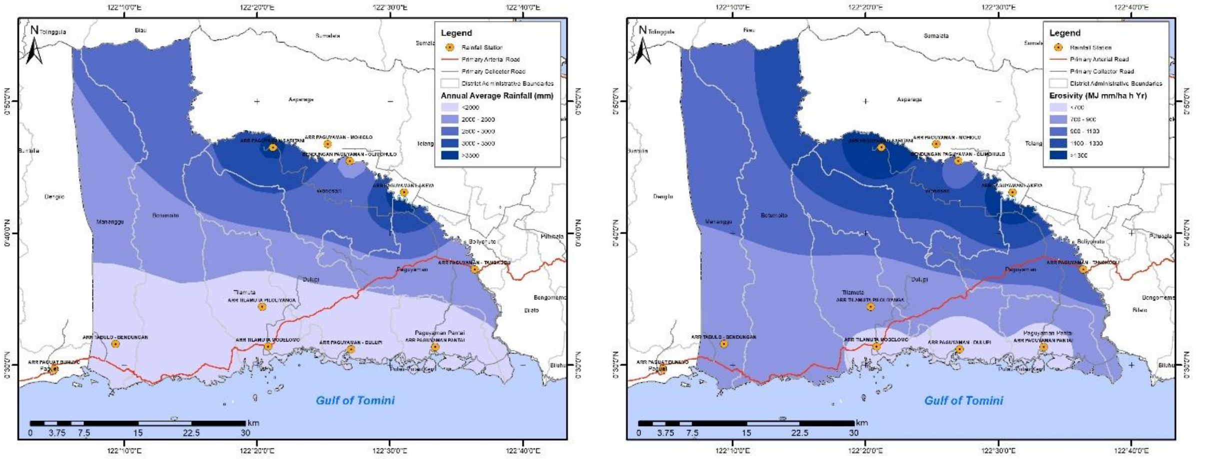


(a) (b)

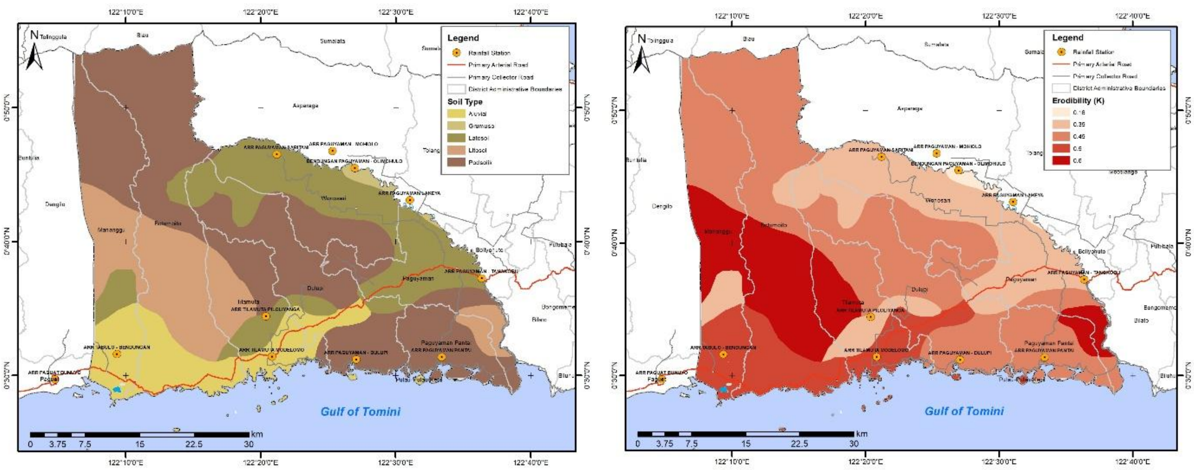
Figure 1. Rainfall Map (a) and Erosivity Map (b) in Boalemo Regency

In terms of soil erodibility (K), data were obtained from soil maps provided by the Bone Bolango Watershed Management Agency (BPDAS Bone Bolango). The results show that alluvial soils, with a K value of 0.5, exhibited the highest erodibility, making them more susceptible to erosion compared to other soil types such as grumusol, which had a lower K value of 0.16 (see Table 4). The spatial distribution of soil erodibility is shown in Figure 2, which demonstrates how different soil types influence erosion rates across Boalemo Regency.

Table 4. Soil Erodibility Value in Boalemo Regency

Soil Type	K Value
Aluvial	0.5
Grumusol	0.16
Latosol	0.39
Podsolik	0.49

Source: Soil map analysis, 2023



(a) (b)

Figure 2. Map of Soil Types (a) and Erodibility Map (b) in Boalemo Regency

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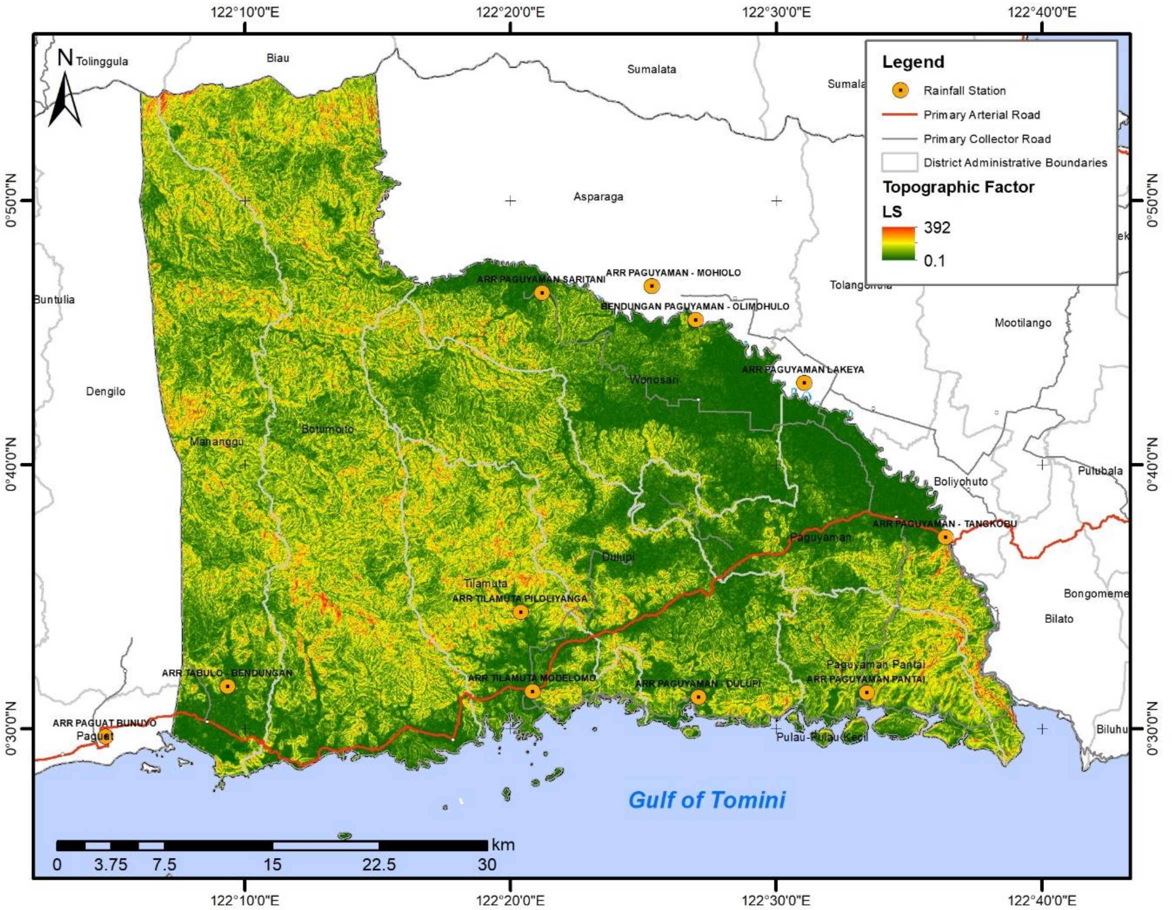

Figure 3. LS Factor Distribution Map in Boalemo Regency

3.2 Slope Length and Steepness Factor (LS)

The slope length and steepness factor (LS) is a critical determinant of erosion risk, as areas with long and steep slopes are more prone to severe erosion. The LS factor in Boalemo Regency ranged from a minimum of 0.1 to a maximum of 392.664 (Table 5), with the highest LS values occurring in areas with steep and extended slopes. Figure 3 illustrates the spatial distribution of LS values, with the highest erosion risks concentrated in regions with high topographic variation.

Table 5. Slope Length and Steepness Factor (LS) in Boalemo Regency

LS Factor	Value
Minimum	0.1
Maximum	392.664

Source: Analysis results, 2023

3.3 Land Cover Factor (C) and Conservation Practices (P)

The land cover factor (C) reflects the extent to which vegetation and other land cover types protect soil from erosion. In Boalemo Regency, C values were adjusted based on different land use stages. For instance, during the land preparation stage, C was set to 1, indicating maximum vulnerability to erosion, while during the corn planting stage, the C value was reduced to 0.55, representing a more stabilized condition with partial vegetation cover (David, 1988). The spatial distribution of land cover is shown in Figure 4.

Conservation practices (P) measure the effectiveness of erosion-reducing techniques, such as terracing and contour plowing. In areas with steep slopes, these practices significantly reduce erosion, as reflected in the P values assigned based on slope gradients. For instance, agricultural land on slopes between 3% and 9% has a P value of 0.5 during the planting stage, indicating reduced erosion risk compared to bare land (David, 1988). Figure 5 depicts the spatial distribution of land cover across the study area.

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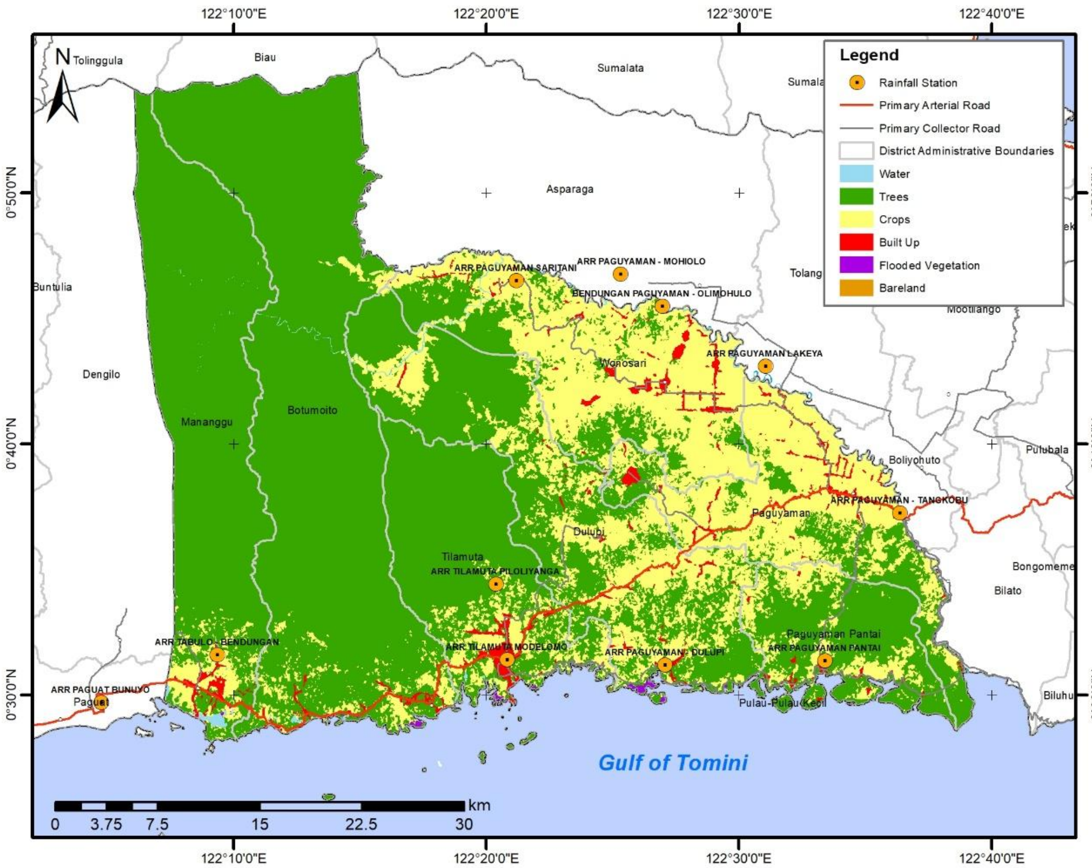

Figure 4. Land Cover Map in Boalemo Regency

3.4 Soil Erosion during the Land Preparation Stage

The total soil erosion during the land preparation phase in Boalemo Regency amounted to 2,474,870,411 tons/year, with an average erosion rate of 13,622.68 tons/ha/year (Table 6). The spatial distribution of soil erosion during this phase is shown in Figure 5. Erosion was particularly severe in areas with steep slopes and high rainfall erosivity, with 25.71% of the total agricultural land in Boalemo Regency experiencing "very severe" erosion, affecting 46,706.92 hectares of land. These findings underscore the vulnerability of land without adequate soil conservation measures during the preparation stage (Getu Engida et al., 2021; Nurdin et al., 2023; Wischmeier, W H and Smith, 1978).

Table 6. Surface Erosion Levels, Land Area, and Total Erosion during the Land Preparation Stage in Boalemo Regency

Erosion Level	**Classification (ton/ha/year)**	**Area (ha)**	**%**	**Total Erosion (ton/year)**
Very Light	<15	39658.10	21.83	370637.53
Light	15-60	80847.79	44.50	1111912.57
Moderate	60-180	9165.21	5.04	2965100.24
Heavy	180-480	5294.82	2.91	7412750.59
Very Heavy	>480	46706.92	25.71	2463010010.06
Total		**181672.83**	100	2474870411

Source: Analysis results, 2023

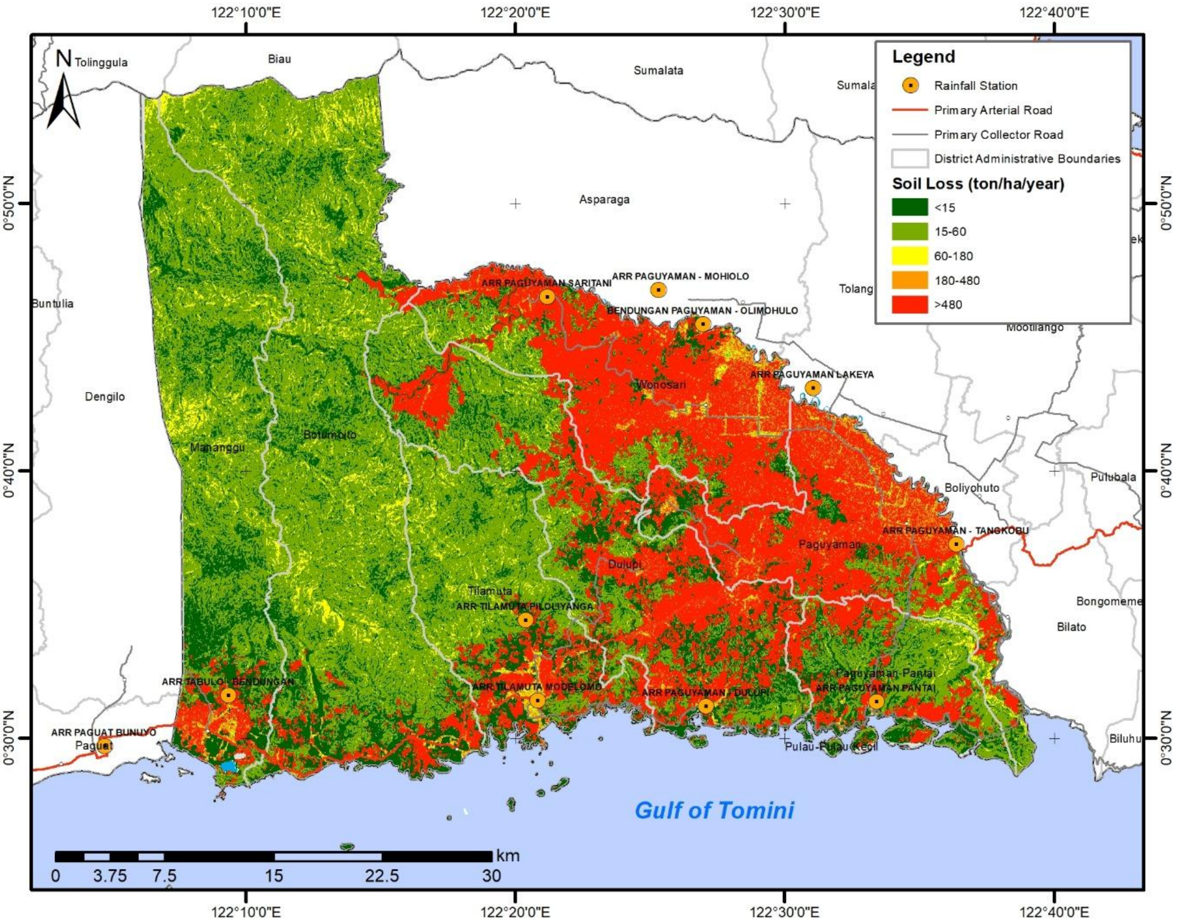

Figure 5. Spatial Distribution Map of Erosion in the Corn Land Preparation Stage in Boalemo Regency

3.5 Soil Erosion during Corn Planting

During the corn planting stage, total soil erosion decreased to 1,150,961,410 tons/year, with an average erosion rate of 6,335.36 tons/ha/year (Table 7). Despite this reduction, "very heavy" erosion still affected 25.37% of the total agricultural land in Boalemo Regency, particularly in areas with steep slopes. This decrease in erosion can be attributed to better land cover during the planting stage, as vegetation such as corn provides protection against rainfall-induced erosion (Babu et al., 2004). The spatial distribution of erosion during the planting stage is shown in Figure 6.

Table 7. Erosion level, area and magnitude of surface erosion at the corn planting stage in Boalemo Regency

Erosion Level	Classification (ton/ha/year)	Area (ha)	%	Total Erosion (ton/year)
Very Light	<15	39983.30	22.01	329891.70
Light	15-60	81125.96	44.66	989675.13
Moderate	60-180	14473.65	7.97	2639133.65
Heavy	180-480	12236.85	6.74	6597834.11
Very Heavy	>480	33852.80	18.63	1140404875.42
Total		181672.56	100	1150961410

Source: Analysis results, 2023

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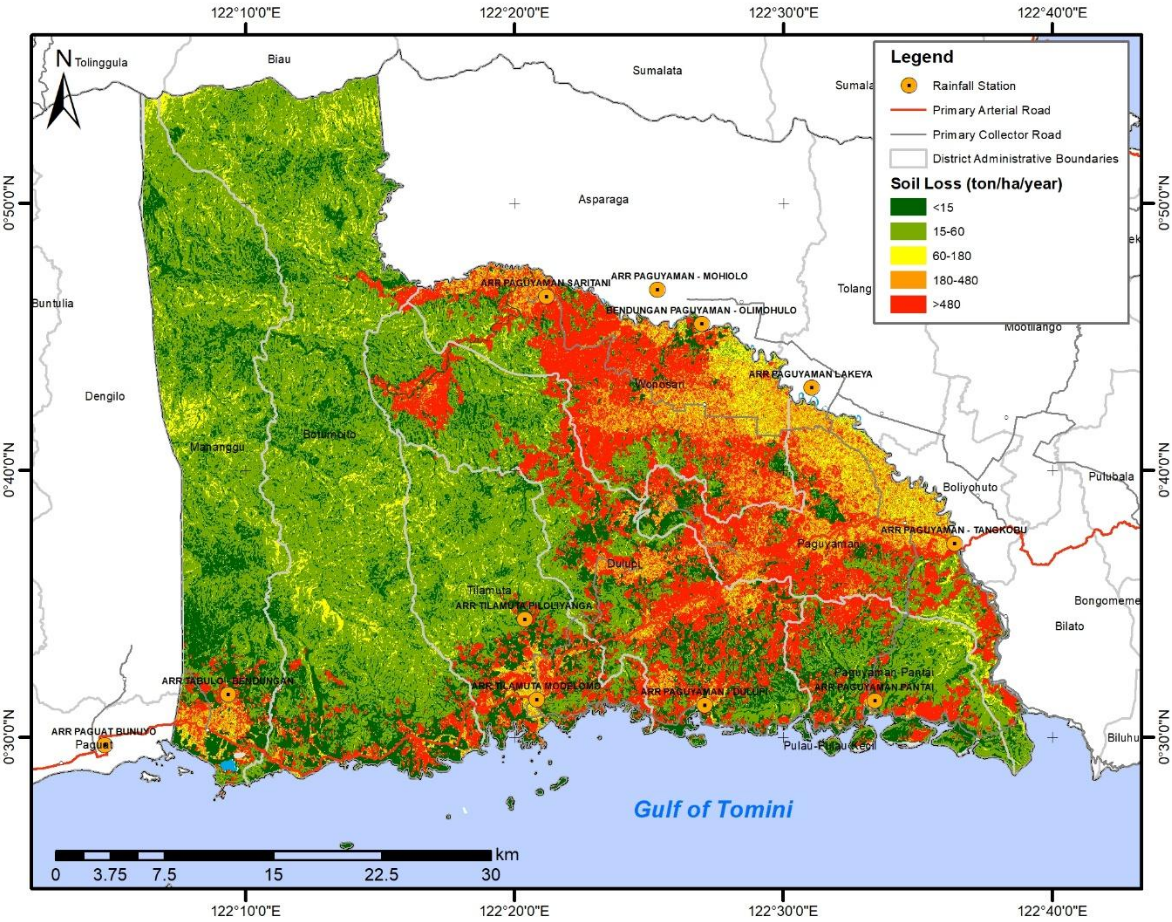

Figure 6. Spatial Distribution Map of Erosion at the Corn Planting Stage in Boalemo Regency

3.6 Implications for Land Management

The results of this study highlight the urgent need for more intensive soil conservation measures, particularly during the land preparation stage for corn farming. Areas experiencing "very heavy" erosion during both the preparation and planting stages require immediate attention, with the adoption of conservation practices such as terracing, strip cropping, or the use of cover crops (Hirsan, F.P;Susanti, F; Ridha, 2021). Moreover, a spatially-based land management approach, which accounts for slope gradients and rainfall distribution, is crucial for better land management planning. (Fatema & Chakrabarty, 2020) suggest that spatially-targeted land management can significantly improve erosion prevention, particularly in areas with high erosion risk like Boalemo Regency.

4. CONCLUSIONS

Based on the analysis of soil erosion during the land preparation and planting stages in Boalemo Regency, it can be concluded that corn farming practices without adequate soil conservation measures lead to severe erosion, especially on steep and highly erodible lands. Therefore, a more sustainable and strategic land management approach is required, considering the spatial distribution of erosion risk factors. Implementing better soil conservation methods, such as terracing and cover crops, can significantly reduce soil erosion and maintain agricultural productivity in Boalemo Regency. Further research is needed to evaluate the effectiveness of various conservation techniques in this region to minimize the negative impacts of surface erosion on agricultural land.

5. REFERENCES

Anwar, M., Pawitan, H., Murtilaksono, K., & Jaya, I. (2011). Respons Hidrologi Akibat Deforestasi di DAS Barito Hulu , Kalimantan Tengah Hydrologycal Response Due to Deforestation in Barito Hulu Watershed , Central Kalimantan. *Jurnal Manajemen Hutan Tropika*, *XVII*(3), 119–126. http://jurnal.ipb.ac.id/index.php/jmht/article/view/3985/2724

Babu, R., Dhyani, B. L., & Kumar, N. (2004). Assessment of erodibility status and refined iso-erodent map of India. *Indian Journal of Soil Conservation*, *32*(3), 171–177. https://eurekamag.com/research/004/049/004049045.php

Borrelli, P., Alewell, C., Alvarez, P., Anache, J. A. A., Baartman, J., Ballabio, C., Bezak, N., Biddoccu, M., Cerdà, A., Chalise, D., Chen, S., Chen, W., De Girolamo, A. M., Gessesse, G. D., Deumlich, D., Diodato, N., Efthimiou, N., Erpul, G., Fiener, P., … Panagos, P. (2021). Soil erosion modelling: A global review and statistical analysis. *Science of the Total Environment*, *780*. https://doi.org/10.1016/j.scitotenv.2021.146494

Chaidar, A. N., Soekarno, I., Wiyono, A., & Nugroho, J. (2017). Spatial analysis of erosion and land criticality of the upstream citarum watershed. *International Journal of GEOMATE*, *13*(37), 133–140. https://doi.org/10.21660//2017.37.34572

Chalise, D., Kumar, L., & Kristiansen, P. (2019). Land degradation by soil erosion in Nepal: A review. In *Soil Systems* (Vol. 3, Issue 1). https://doi.org/10.3390/soilsystems3010012

David, W. . (1988). Soil and Water Conservation Planning: Policy Issues and Recomendations. *Philippine Journal of Development*, *XV*(I–c). https://www.pids.gov.ph/publication/philippine-journal-of-development/soil-and-water-conservation-planning-policy-issues-and-recommendations

Fatema, S., & Chakrabarty, D. A. (2020). Land Use/Land Cover Change With Impact On Land Surface Temperature: A Case Study Of Mkda Planning Area, West Bengal, India. *GEOGRAPHY, ENVIRONMENT, SUSTAINABILITY*, *13*(4), 43–53. https://doi.org/10.24057/2071-9388-2020-62

Ferdianyah, D; Sahidu, A; Juniarsih, N. (2023). *Dampak Alih Fungsi Hutan sebagai Lahan Pertanian Jagung Terhadap Kerusakan Lingkungan di Kecamatan Wawo Kabupaten Bima*. http://eprints.unram.ac.id/39712/2/Jurnal_DICKY FERDIANSYAH_C1G018027.pdf

Getu Engida, T., Nigussie, T. A., Aneseyee, A. B., & Barnabas, J. (2021). Land Use/Land Cover Change Impact on Hydrological Process in the Upper Baro Basin, Ethiopia. *Applied and Environmental Soil Science*, *2021*. https://doi.org/10.1155/2021/6617541

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. *Remote Sensing of Environment*, *202*, 18–27. https://doi.org/10.1016/j.rse.2017.06.031

Harimurti, D., Hariyadi, H., & Noor, E. (2019). Analisis sumber utama emisi gas rumah kaca pada perkebunan kelapa sawit dengan pendekatan life cycle assessment. *Jurnal Pengelolaan Lingkungan Berkelanjutan (Journal of Environmental Sustainability Management)*, *3*(2), 318–330. https://doi.org/10.36813/jplb.3.2.318-330

Hirsan, F.P;Susanti, F; Ridha, R. (2021). Analisis Hubungan Perubahan Penggunaan Lahan Untuk Komoditas Jagung dan Degradasi Lingkungan di Kabupaten Dompu. *Perencanaan Dan Pemanfaatan Ruang Berbasis Pengurangan Risiko Bencana*, 42–47. https://journal.ummat.ac.id/index.php/PRPE/article/view/3988

Huang, T. C. C., & Lo, K. F. A. (2015). Effects of land use change on sediment and water yields in yang ming shan national park, taiwan. *Environments - MDPI*, *2*(1), 32–42. https://doi.org/10.3390/environments2010032

Lundekvam, H. E., Romstad, E., & Øygarden, L. (2003). Agricultural policies in Norway and effects on soil erosion. *Environmental Science & Policy*. https://www.sciencedirect.com/science/article/pii/S1462901102001181

Machmud, A. N. F., Lihawa, F., Dunggio, I., & Djuraini, M. F. (2023). Spatial Distribution of Maize Plantation Based on Slope and Critical Land in Boalemo Regency, Gorontalo Province. *Universal Journal of Agricultural Research*, *11*(6), 1032–1042. https://doi.org/10.13189/ujar.2023.110610

Nearing, M. A., Wei, H., Stone, J. J., Pierson, F. B., & ... (2011). A rangeland hydrology and erosion model. *Transactions of the …*. https://elibrary.asabe.org/abstract.asp?aid=37115

Nurdin, Rauf, A., Rahim, Y., Adam, E., Musa, N., Jamin, F. S., Dude, S., Rahman, R., & Katili,

H. A. (2023). Determination of Land Suitability Criteria for Maize Hybrid in Boalemo Regency Based on Optimum Yield and Selected Land Quality. *Applied and Environmental Soil Science*, *2023*, 1–18. https://doi.org/10.1155/2023/3800877

Wischmeier, W H and Smith, D. . (1978). *Predicting Rainfall Erosion Losses: a guide to conservation planning* (Agricultur). United States Department of Agriculture. https://play.google.com/books/reader?id=rRAUAAAAYAAJ&pg=GBS.PP1&hl=id

Wischmeier, W. H., & Smith, D. D. (1978). *Predicting rainfall erosion losses: a guide to conservation planning*. books.google.com. https://books.google.com/books?hl=en&lr=&id=rRAUAAAAYAAJ&oi=fnd&pg=PA1&dq=erosion&ots=cvsutSrnTZ&sig=ehFlg31nzcxEg5TOS8zJlnktA5o