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An Assessment of Land Susceptibility to Soil Erosion on Biu Plateau, Borno State Nigeria

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Abstract
Soil erosion is a major driver of land degradation on the Biu Plateau, Borno State, Nigeria, where fragile soils, dissected topography, erratic rainfall and expanding human activity have accelerated the loss of productive land. This study evaluated erosion susceptibility on the Biu Plateau, with objectives to identify susceptible areas. The Revised Universal Soil Loss Equation was applied using the Lombardi relation for erosivity, a Digital Elevation Model for slope length and steepness, and classified Landsat imagery for cover management and support practice. The result revealed that soil loss ranged from 0 to 408.59 t/ha/yr, with 83.6 per cent of the plateau in the Very Low class and only 30.5 km² in the High and Very High classes, concentrated on steep slopes and escarpments. Variable importance analysis identified slope at 27.93 per cent and curvature at 21.99 per cent as the dominant controls and soil properties at 0.33 per cent as the least influential, indicating that erosion is transport-controlled rather than resistance-controlled. The study concludes that erosion on the plateau is transport-controlled rather than resistance-controlled. It recommends spatial rather than demand-led targeting, material support in place of sensitization in the worst-affected settlements and conservation planning extended to areas of emerging as well as existing risk.

Keywords: Land, Susceptibility, Soil, Erosion, Plateau

Introduction

Soil erosion is a global environmental challenge, significantly impacting agriculture, water resources, and ecosystem sustainability. On the Biu Plateau in Borno State, Nigeria, the combination of natural and anthropogenic factors has heightened erosion risks, leading to land degradation and loss of arable land. The plateau's unique terrain, characterized by steep slopes and shallow soils, amplifies erosion, particularly during the rainy season, when intense rainfall dislodges topsoil and fosters rapid runoff (Ali *et al*., 2021; Ogundele *et al*., 2019). This situation necessitates comprehensive studies to assess and model soil erosion susceptibility in the region.

Erosion processes are influenced by climatic variables, especially rainfall erosivity. The high intensity of rainfall in Northern Nigeria, including the Biu Plateau, contributes significantly to the detachment and transportation of soil particles. Research by Usman *et al*. (2020) highlights the vulnerability of semi-arid regions to water-induced erosion due to prolonged dry spells followed by torrential rains. Such climatic patterns, coupled with sparse vegetation, exacerbate the erosion susceptibility of the plateau. The role of topography cannot be overlooked in assessing erosion dynamics. Slope steepness and length significantly influence runoff velocity and soil displacement. Studies have shown that the Biu Plateau's rugged terrain predisposes it to gully and sheet erosion, leading to severe land degradation (Oyinlola *et al*., 2020; Ishaku *et al*., 2019). The absence of terraces and other slope-stabilizing structures worsens the situation, underscoring the need for targeted conservation strategies.

Human activities, including deforestation, overgrazing, and unsustainable farming practices, further accelerate soil erosion. These activities reduce vegetation cover, leaving the soil vulnerable to erosive forces. Dai *et al*. (2025) found that agricultural expansion in Northern Nigeria often prioritizes immediate productivity over long-term soil health, contributing to erosion and desertification. On the Biu Plateau, these practices have led to reduced soil fertility and diminished agricultural outputs, threatening food security. Soil properties, such as texture and organic matter content, also play a critical role in determining erosion susceptibility. Sandy soils, common on the Biu Plateau, are highly erodible due to their low cohesion and poor water-holding capacity (Abdullahi *et al.,* 2020). The depletion of organic matter through intensive cultivation further exacerbates soil erosion, reducing the land's resilience to natural and human-induced stresses.

Modern advancements in Geographic Information Systems (GIS) and Remote Sensing offer powerful tools for mapping and modeling soil erosion. By integrating spatial data with erosion models such as the Revised Universal Soil Loss Equation (RUSLE), researchers can identify high-risk areas and quantify potential soil loss. Nnaji *et al*. (2021) demonstrated the efficacy of GIS-based models in prioritizing intervention areas, highlighting their applicability for regions like the Biu Plateau. Climate change adds another layer of complexity to erosion dynamics on the Biu Plateau. Increased rainfall variability and extreme weather events intensify soil erosion processes, altering the natural equilibrium of the landscape. Mohammed *et al*. (2020) emphasized that adaptive management strategies are essential to mitigate the long-term impacts of climate change on soil erosion in Nigeria.

Materials and Methods

Study Area

The Biu Plateau is situated in the southern part of Borno State, Nigeria, extending into parts of the northeastern geopolitical zone of the country. It is a prominent volcanic plateau characterized by its elevated terrain, rugged landscapes, and unique geological and ecological features. The plateau lies approximately between latitudes 10°30′N and 11°30′N and longitudes 11°30′E and 12°30′E, covering an extensive area of about 5,200 square kilometers (Figure 1).

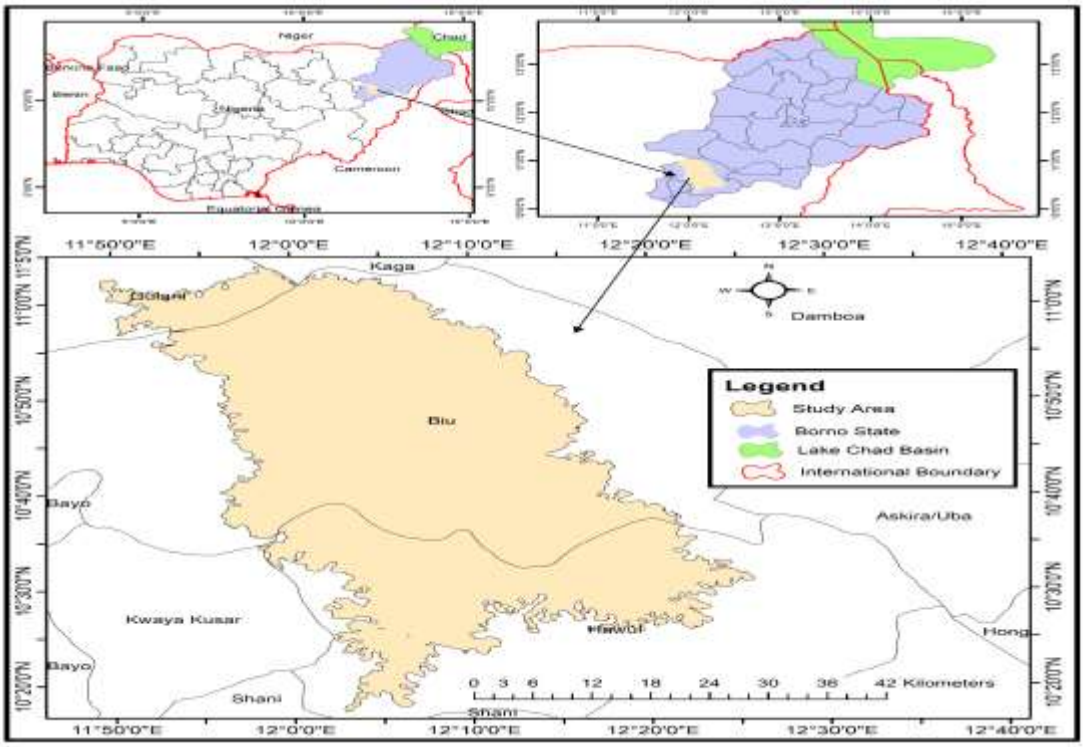


Figure 1: Study Area
Source: GIS Laboratory Analysis, 2026

The elevations ranging between 800 and 1,500 meters above sea level. It is a volcanic plateau characterized by rugged terrain, hills, and valleys formed by ancient lava flows. The relief significantly influences the region's microclimate and agricultural potential, with elevated areas experiencing cooler temperatures conducive to certain crops. The plateau's topography is marked by steep slopes that contribute to rapid surface runoff, increasing susceptibility to soil erosion and sedimentation in lower-lying areas (Ali *et al*., 2021). The drainage system of the Biu Plateau is defined by numerous seasonal streams and rivers, which originate from the highlands and flow towards the surrounding lowlands. Major rivers such as the Hawul and Gongola are crucial for water supply and agricultural activities in the region. These rivers are characterized by high variability in flow, with peaks during the rainy season and reduced flow in the dry season. This variability often impacts water availability for irrigation and domestic use, posing challenges for local communities (Audu *et al*., 2019).

The soils are largely influenced by the region's volcanic origin, topography, and semi-arid climate. Derived from basaltic parent materials, the soils are typically sandy to loamy in texture and are rich in iron and aluminum oxides, giving them a reddish appearance (Ali *et al.,* 2021). These properties make the soils moderately fertile, supporting crops like millet, sorghum, and groundnuts, which are staple crops in the region (Ogundele *et al*., 2019). However, the inherent fertility is often limited by nutrient leaching, particularly during the rainy season. Erosion is a significant concern for the soils of the Biu Plateau due to the steep slopes and heavy seasonal

rainfall. This results in the loss of topsoil, reducing agricultural productivity and affecting water quality downstream.

Methods

A Digital Elevation Model from which the drainage network and distance to drainage were derived. Landsat TM 5, ETM+ 7 and OLI 8 Collection 2 Level 2 surface reflectance imageries used for land use and land cover, road network obtained from OpenStreetMap used for distance to road and the satellite rainfall data at 0.05 degrees (CHIRPS archived) were obtained from the Nigerian Meteorological Agency and the Climate Hazards Group Infrared Precipitation with Station data archive, and climate projections from the WorldClim distribution of the Coupled Model Intercomparison Project Phase 6.

Identifying Areas Susceptible to Soil Erosion

Mean annual soil loss was estimated using the Revised Universal Soil Loss Equation (Renard et al., 1997):

$A = R \times K \times LS \times C \times P$ ……equation (1)

where A is mean annual soil loss in tonnes per hectare per year, R is rainfall erosivity, K soil erodibility, LS the combined slope length and steepness factor, C cover management and P support practice.

Rainfall Erosivity

Rainfall erosivity was computed from mean annual rainfall using a linear relation of the form R = aP, with the coefficient a set to 1.03:

$R = 1.03 \times P$ ……. equation (2)

where R is rainfall erosivity in MJ mm ha^{-1} h^{-1} yr^{-1} and P is mean annual rainfall in millimetres.

Soil Erodibility

Soil erodibility was computed for each of the fifteen composite samples using the nomograph equation of Wischmeier and Smith (1978):

$K_{US} = [2.1 \times 10^{-4} M^{1.14} (12 - OM) + 3.25(s - 2) + 2.5(p - 3)] / 100$ ..equation (3)

where K_{US} is soil erodibility in US customary units of t acre h (100 acre ft tonf in)$^{-1}$, OM is organic matter content in per cent, s is the soil structure code and p is the profile permeability code. The textural term M is:

M = (% silt + % very fine sand) × (100 − % clay) ……..equation (4)

Slope Length and Steepness

The slope length and steepness factor was computed from the Digital Elevation Model using the unit contributing area formulation of Moore and Burch (1986):

$LS = (A_s / 22.13)^{0.4} \times (\sin \beta / 0.0896)^{1.3}$ …….equation (5)

where A_s is the specific catchment area in metres, that is the upslope contributing area per unit width of contour, and β is the local slope angle in radians. The constants 22.13 and 0.0896 are the unit plot slope length in metres and the sine of the unit plot slope angle of 5.16 degrees, so that LS equals unity on the unit plot.

NDVI

The index was computed as:

$$NDVI = (\rho_{NIR} - \rho_{red}) / (\rho_{NIR} + \rho_{red}) \quad (3.8)$$

where ρ_{NIR} and ρ_{red} are surface reflectance in the near infrared and red bands.

Results and Discussions

Rainfall Erosivity Factor (R-Factor)

Rainfall erosivity on the Biu Plateau ranges from 792.69 to 1108.64 MJ mm ha^{-1} h^{-1} yr^{-1} (Table 4.1). These values were obtained from Equation 3.3 applied to the mean annual rainfall surface for 1995 to 2024, which ranges from 769.6 to 1076.4 mm per year across the plateau. Rainfall depth and rainfall erosivity are reported here in their own units and are not interchangeable: the figures in Table 1 are erosivity values and are not rainfall totals, although they are proportional to them.

Table 1: Areal extent of the rainfall erosivity factor

Erosivity class (MJ mm ha^{-1} h^{-1} yr^{-1})	**Equivalent rainfall (mm yr^{-1})**	**Area (km^2)**	**Area (%)**
792.69 – 848.45	769.6 – 823.7	555.59	22.27
848.46 – 916.59	823.7 – 889.9	490.81	19.67
916.60 – 978.54	889.9 – 949.9	472.52	18.94
978.55 – 1030.58	949.9 – 1000.6	787.28	31.55
1030.59 – 1108.64	1000.6 – 1076.4	189.01	7.57
Total		2495.21	100.00

Source: Author's analysis of NiMet and CHIRPS rainfall data, 1995–2024.

The largest single class is 978.55 to 1030.58 MJ mm ha^{-1} h^{-1} yr^{-1}, covering 787.28 km² or 31.6 per cent of the plateau, and the smallest is the highest class, covering 189.01 km² or 7.6 per cent (Figure 2). All five classes are extensive, and the spatial pattern is a broad north to south gradient rather than a set of localized maxima.

The spatial variation that does exist is attributable to rainfall gradient across the plateau and to orographic effect, in which moist air rising over the higher ground cools and produces heavier falls. Panagos *et al*. (2020) report that rainfall intensity and storm energy, rather than annual totals, are the primary determinants of erosivity, and Borrelli *et al*. (2021) emphasize the role of erosivity in initiating erosion where rainfall is strongly seasonal. Similarly, Arabameri *et al*. (2021), working on the main campus of the Federal University of Technology Minna, report mean annual rainfall of 483.706 mm for the largest part of their study area, which is a rainfall depth and is well below the 769.6 to 1076.4 mm found here, as would be expected from the difference in location. Luo *et al.* (2020) report a minimum erosivity of 3894 for Ado Ekiti, which is several times the maximum found on the Biu Plateau. Ado Ekiti receives substantially more annual rainfall than Biu, so a higher erosivity is expected, but part of the numerical difference reflects the formulation used rather than the climate.

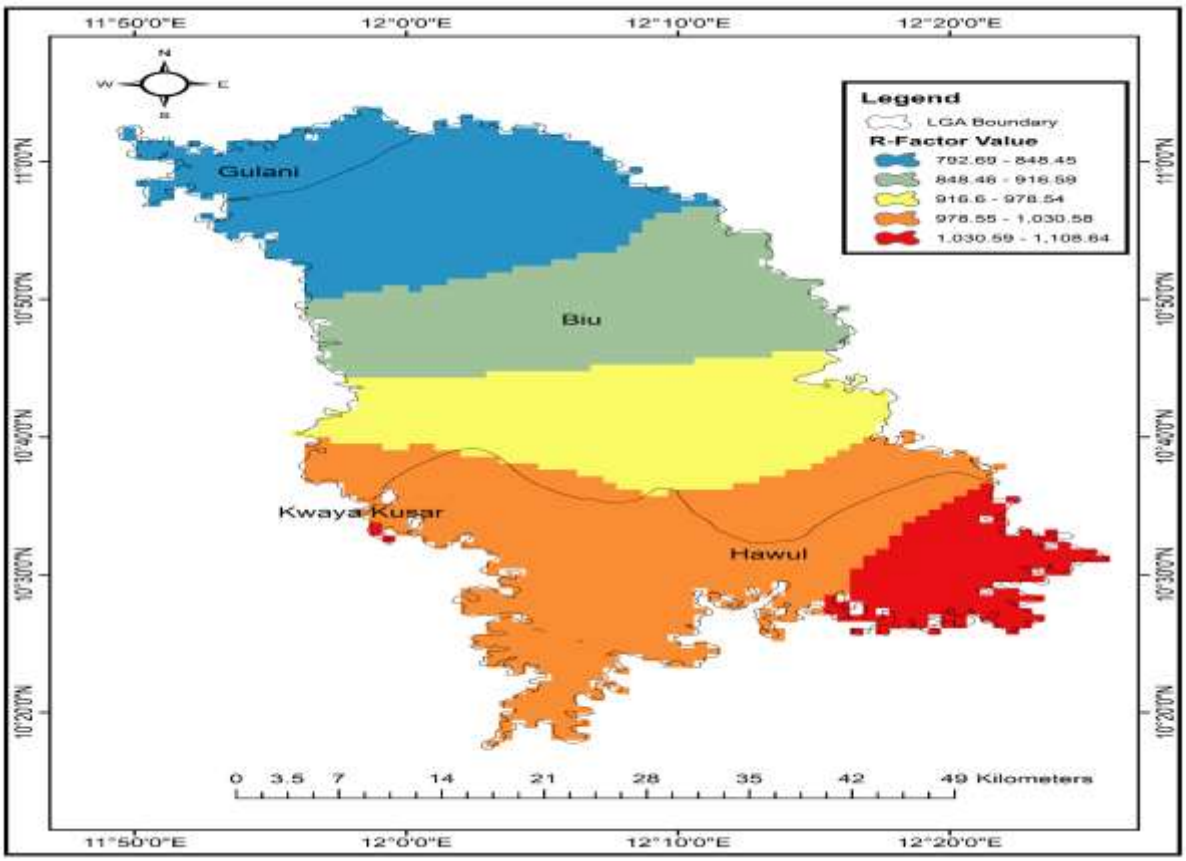


Figure 2: Spatial distribution of the rainfall erosivity factor (MJ mm ha^{-1} h^{-1} yr^{-1})
Source: Author's analysis of NiMet and CHIRPS rainfall data, 2025.

Soil Erodibility Factor (K-Factor)

Soil erodibility on the Biu Plateau ranges from 0.0175 to 0.0212 t ha h ha^{-1} MJ^{-1} mm^{-1} (Table 2).

Table 2: Areal extent of the soil erodibility factor

Erodibility class (t ha h ha^{-1} MJ^{-1} mm^{-1})	**Area (km^2)**	**Area (%)**
0.0175	155.34	6.23
0.0176 – 0.0192	165.50	6.63
0.0193 – 0.0197	170.99	6.85
0.0198 – 0.0212	2003.38	80.29
Total	2495.21	100.00

Source: Author's analysis of laboratory results, 2025.

Four fifths of the plateau, 2003.38 km², falls in the highest class, 0.0198 to 0.0212, and the three lower classes together cover 491.83 km² (Figure 3). The mapped surface is therefore close to uniform, and the reason lies partly in the soils. The soils are similar in origin due to the plateau being developed largely on basalt and its weathering products, so parent material varies little and the resulting topsoils are predominantly sandy loams and clay loams. The soil differences are large enough to produce a meaningfully wider erodibility range at point scale than the mapped surface shows.

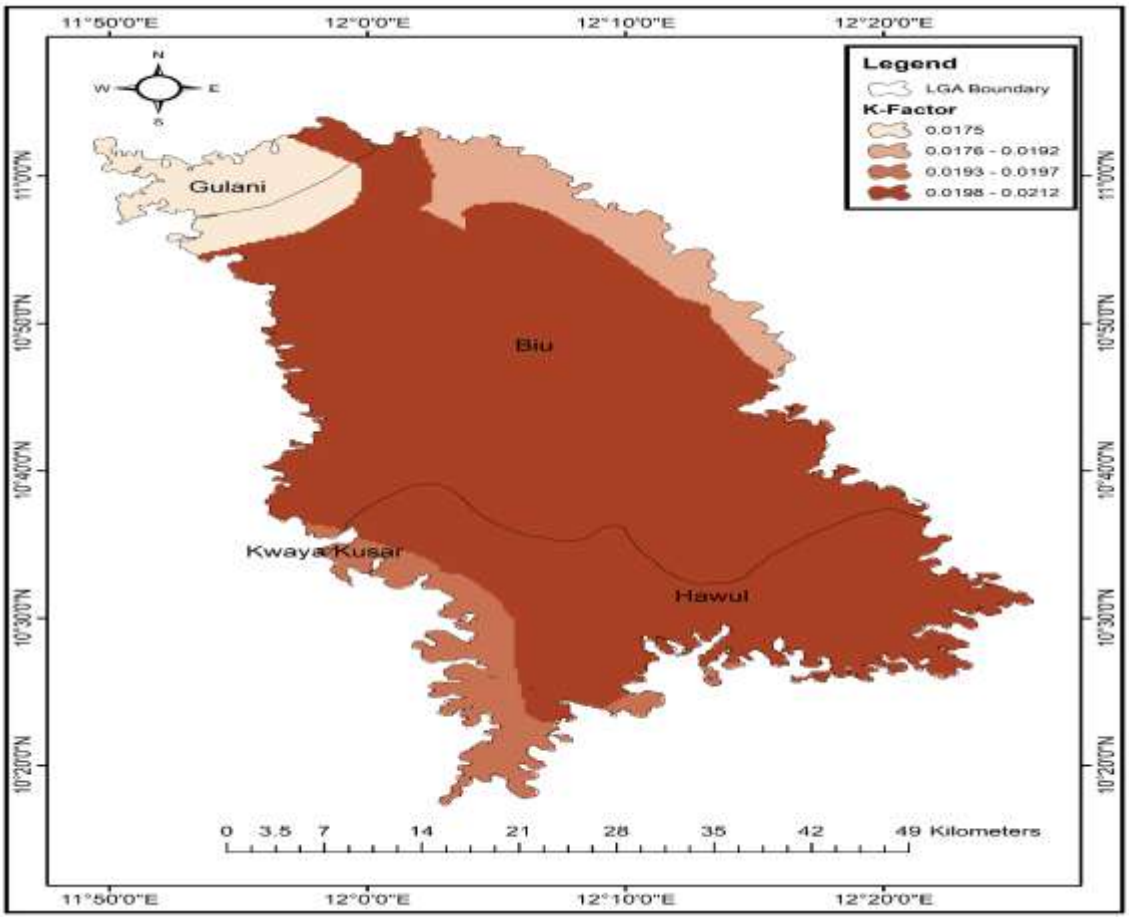


Figure 3: Spatial distribution of the soil erodibility factor (t ha h ha^{-1} MJ^{-1} mm^{-1})
Source: Author's analysis of laboratory results, 2025.

This implies that erodibility surface contributes little spatial differentiation to the soil loss estimate, so differences in estimated soil loss across the plateau are driven by the terrain, hydrological and cover factors. Ahmed (2021) notes that erodibility depends strongly on texture, organic matter and aggregate stability, and Alewell *et al*. (2020) report that soils low in organic matter and weakly aggregated detach more readily because particle cohesion is reduced. Both mechanisms are present on the plateau: organic matter in the most susceptible settlements averages 0.54 per cent, which is low by any standard, and low organic matter is precisely the condition in which detachment is easiest. Borrelli *et al*. (2021) observe that the influence of erodibility is often secondary to topographic and hydrological factors in plateau and mountain terrain, which is consistent with what the mapped surfaces show here.

Slope Length and Steepness Factor (LS Factor)

The slope length and steepness factor range from 0 to 179.28 across the Biu Plateau (Table 3). The factor is dimensionless and was computed from the filled 30 metre Digital Elevation Model.

Table 3: Areal extent of the slope length and steepness factor

LS class	Area (km²)	Area (%)
0 – 2.81	2247.17	90.06
2.82 – 10.55	194.61	7.80
10.56 – 24.61	43.00	1.72
24.62 – 56.24	9.12	0.37
56.25 – 179.28	1.31	0.05
Total	2495.21	100.00

Source: Author's analysis of the USGS Digital Elevation Model, 2025.

Ninety per cent of the plateau, 2247.17 km², has an LS value below 2.81, and the four higher classes together cover 248.04 km² (Figure 4). The highest class, 56.25 to 179.28, covers 1.31 km², which is one twentieth of one per cent of the plateau. The distribution is therefore extremely skewed: most of the plateau surface exerts little topographic influence on erosion, and a very small area exerts a great deal. The maximum value of 179.28 requires explanation, since a value that high multiplied will dominate the soil loss estimate wherever it occurs. LS rises with specific catchment area to the power 0.4 and with the sine of the slope angle to the power 1.3, and where a cell is both steep and receives concentrated flow the two terms compound. The maximum occurs in cells that combine slopes above 40 degrees, which the slope surface confirms it exist on the plateau up to 44.49 degrees, with a large accumulated contributing area. That combination occurs at incised channel heads and along escarpment gullies.

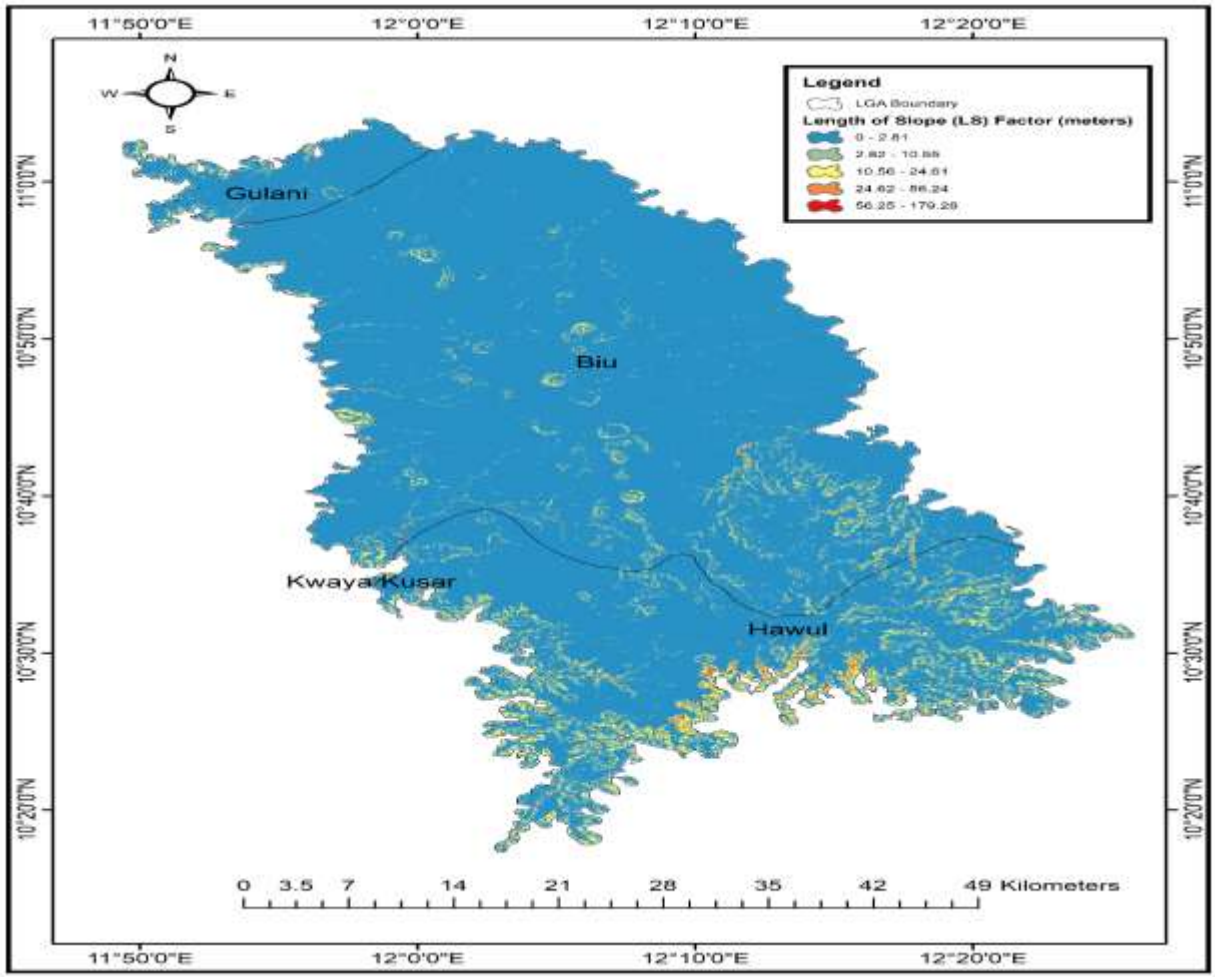


Figure 4: Spatial distribution of the slope length and steepness factor
Source: Author's analysis of the USGS Digital Elevation Model, 2025.

This suggest that resolution effect on a 30-metre grid, flow accumulation concentrates into single cell wide paths, so the specific catchment area at a channel cell is high while the same water on the ground is spread across a channel wider or narrower than 30 meters. A finer Digital Elevation Model would redistribute that accumulation over more cells and lower the peak LS values, while a coarser one would raise them. The extreme values are therefore partly a property of the grid, and the exact value of 179.28 should not be treated as a property of the landscape. The soil loss estimated in those 1.31 km² should be read as an upper bound on hillslope loss rather than as an estimate of what leaves the channel. Furthermore, steeper slopes raise runoff velocity and therefore its capacity to detach and carry particles, and longer slopes allow runoff to accumulate and gain energy downslope. Efthimiou and Lykoudi (2019) report that slope steepness substantially raises runoff velocity and erosion potential in mountain and plateau terrain, and Arabameri *et al*. (2020) find the LS factor to be among the most influential topographic variables in erosion susceptibility modelling because it carries both accumulation

and gradient. On the Biu Plateau the implication is that estimated soil loss should be concentrated along escarpments, valley sides and drainage pathways rather than spread across the plateau surface.

Cover Management Factor (C-Factor)

The cover management factor ranges from 0 to 0.6 across the Biu Plateau (Table 4). It was computed from the Normalized Difference Vegetation Index of the Landsat 8 OLI scene of 11 November 2024 with water bodies and rock outcrops masked to zero.

Table 4: Areal extent of the cover management factor

C class	Area (km²)	Area (%)
0	4.88	0.20
0.01 – 0.05	731.11	29.30
0.051 – 0.151	28.48	1.14
0.152 – 0.6	1730.73	69.36
Total	2495.21	100.00

Source: Author's analysis of Landsat 8 OLI imagery, 11 November 2024.

The result revealed that under seventy per cent of the plateau, 1730.73 km², falls in the 0.152 to 0.6 class, which corresponds to the lower NDVI values and therefore to the least protected ground: cultivated land, grassland and sparsely vegetated surfaces. The 0.01 to 0.05 class covers 731.11 km², corresponding to the higher NDVI values found in shrubland and the small areas of woodland. The zero class covers 4.88 km² of water and rock, and the intermediate class 28.48 km² (Figure 5). The cover management surface therefore represents the best-protected condition of the year because most erosive rainfall on the plateau falls between June and September, when cover is developing rather than complete, and because the early wet season finds fields recently cleared and freshly tilled, the true annual C value is higher than the value mapped here. A dry-season or early wet-season scene would give higher C values and higher estimated loss, and a multi-date annual mean would be preferable; the single date was used because it is the date for which cloud-free coverage of both Landsat footprints was available.

This indicates that as vegetation intercepts rainfall, it reduces the kinetic energy reaching the soil surface, raises infiltration and slows overland flow, and the protection increases non-linearly with cover density. Ganasri and Ramesh (2019) report that cover substantially reduces erosion through raindrop interception and increased infiltration, and Sharma *et al*. (2021) find markedly higher erosion rates on sparsely vegetated land than under forest. The relevance to the Biu Plateau is direct: as Section 5.2.6 shows, grassland covers 1832.11 km² and woodland only 16.50 km², so the protection available across most of the plateau is moderate rather than strong, and it is seasonal.

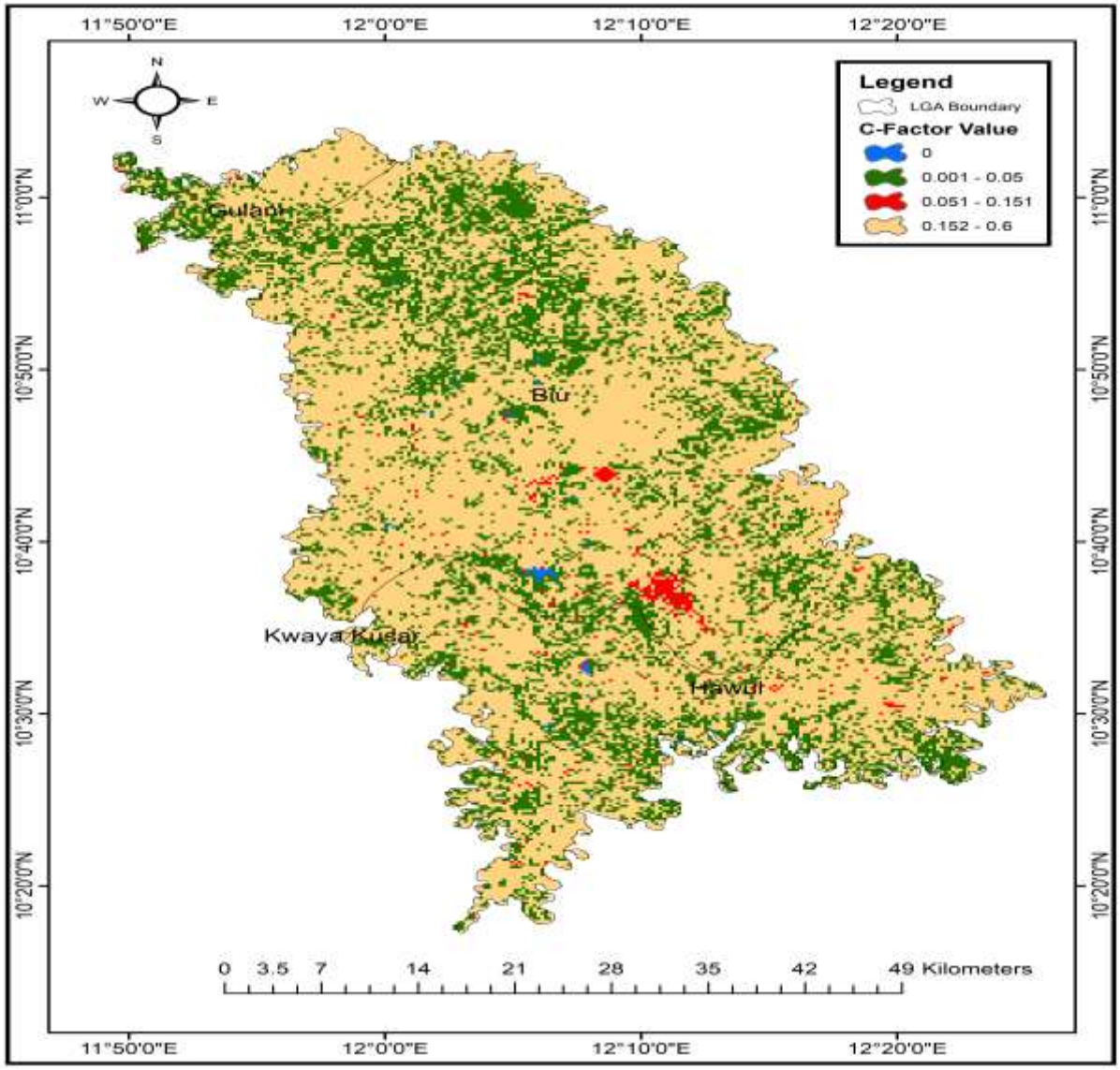


Figure 5: Spatial distribution of the cover management factor
Source: Author's analysis of Landsat 8 OLI imagery, 11 November 2024.

Support Practice Factor (P-Factor)

The support practice factor ranges from 0.55 to 1.0 across the Biu Plateau (Table 5). Values were assigned by slope class from the published contour cultivation values of Wischmeier and Smith (1978).

Table 5: Areal extent of the support practice factor

P class	Slope class assigned (% rise)	Area (km²)	Area (%)
0.55	0 – 7.0	1738.63	69.68
0.56 – 0.60	7.1 – 11.3	435.83	17.47
0.61 – 0.80	11.4 – 17.6	173.34	6.95
0.81 – 0.90	17.7 – 26.8	60.12	2.41
0.91 – 1.00	Above 26.8	87.29	3.50
Total		2495.21	100.00

Source: Author's analysis; P values from Wischmeier and Smith (1978).

The result of support practice factor revealed that seventy per cent of the plateau, 1738.63 km², carries the lowest value of 0.55, which is the published value for contour cultivation on slopes below 7 per cent rise. The higher values occupy progressively smaller areas, and 87.29 km², or 3.5 per cent, carries a value of 1.0, meaning no effective support practice (Figure 6).

This is because the value 0.55 is a published coefficient, not a measurement made on the plateau. It is the tabulated effectiveness of contour cultivation on gently sloping land, and its physical basis is that tillage across the slope creates roughness that detains water and promotes infiltration, whereas tillage along the slope creates linear depressions that concentrate runoff and behave as incipient rills. The decline in effectiveness with gradient, from 0.55 to 1.00, reflects the increasing likelihood that furrows overtop and breach, and the value of unity above about 27 per cent gradient reflects the finding that contour cultivation alone provides no measurable protection on such slopes.

Similarly, because P was assigned by reclassifying the slope grid, it carries no spatial information independent of slope. It scales soil loss by gradient class; it does not identify where conservation practice actually exists. This in line with Karydas and Panagos (2018) report that contour farming and terracing can reduce soil loss by up to half by reducing flow velocity and effective slope length, and Wang et al. (2020) find that strip cropping and contour tillage significantly reduce loss on sloping farmland. Both findings support the magnitude of the coefficients used. Neither establishes that the practices are in place on the Biu Plateau, and the survey results in Chapter Six show that adoption is partial, with residents adopting on average 1.46 of four measures.

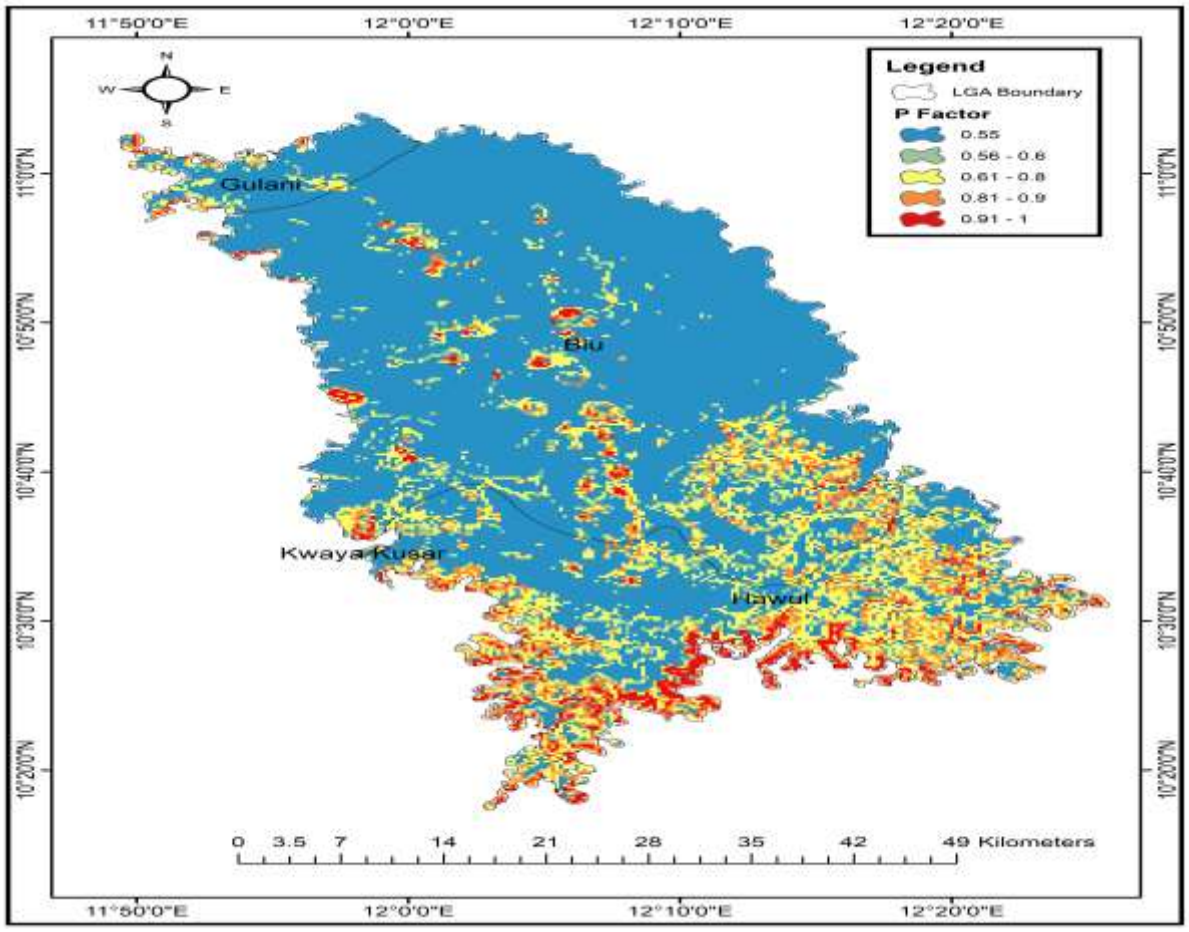


Figure 6: Spatial distribution of the support practice factor
Source: Author's analysis; P values from Wischmeier and Smith (1978).

Estimated Soil Loss and Erosion Susceptibility

The estimated mean annual soil loss on the Biu Plateau ranges from 0 to 408.59 t ha^{-1} yr^{-1} (Table 6). The surface was produced from the five factor surfaces described above and reclassified into five classes by the natural break method, with the class boundaries recorded for use in the sampling design. The five classes are classes of estimated soil loss, and they are used throughout the study as erosion susceptibility classes; the term susceptibility here means the modelled propensity of the land surface to lose soil under current conditions, and not observed erosion damage.

Table 6: Areal extent of estimated soil loss and erosion susceptibility classes

Susceptibility class	Soil loss (t ha^{-1} yr^{-1})	Area (km^2)	Area (%)	Share of total estimated loss (%)
Very Low	0.0 – 10	2086.71	83.63	28.8
Low	10.01 – 50	186.72	7.48	15.5
Moderate	50.01 – 100	191.29	7.67	39.6
High	100.01 – 200	22.10	0.89	9.1
Very High	200.01 – 408.59	8.38	0.34	7.0
Total		2495.21	100.00	100.0

Source: Author's analysis, 2025.

The result indicates that eighty-four per cent of the plateau, 2086.71 km², falls in the Very Low class with estimated loss below 10 t ha^{-1} yr^{-1}. The Low and Moderate classes cover 186.72 km² and 191.29 km². The High class covers 22.10 km² and the Very High class 8.38 km², so that together the two highest classes occupy 30.48 km², which is 1.22 per cent of the plateau (Figure 7).

This suggest that that erosion distribution on the plateau is spatially heterogeneous and that most of the area has relatively low estimated soil loss, while localized areas of high and very high loss are limited in extent but environmentally significant. Furthermore, the result revealed that extent and severity of erosion susceptibility are two different things. Taking the midpoint of each class as an indicative rate, and 304.3 t ha^{-1} yr^{-1} as the midpoint of the open upper class, the total estimated loss from the plateau is about 3.62 million tonnes per year, which is a plateau-wide mean of about 14.5 t ha^{-1} yr^{-1}. On that calculation the High and Very High classes, occupying 1.22 per cent of the area, account for about 16 per cent of total estimated loss, and the Moderate, High and Very High classes together, occupying 8.9 per cent of the area, account for about 56 per cent. A very small part of the plateau therefore carries a disproportionate share of the estimated loss.

The spatial pattern revealed that erosivity is broadly distributed and erodibility is close to uniform, so neither differentiates strongly between locations. Slope length and steepness varies over two orders of magnitude and cover management varies with vegetation density, and it is the coincidence of high LS with high C, on steep and sparsely covered ground, that produces the high and very high classes. Most of the plateau surface is gently sloping and moderately covered, which produces the Very Low class. Field observation confirms that the high loss areas correspond to escarpments, valley sides and channel heads, which are also the areas of highest LS value. This pattern was also reported by Gessesse *et al.* (2020) found that most of a watershed typically falls in low erosion classes while severe erosion concentrates in small areas of steep slope and poor cover. Similarly, Tamene *et al.* (2021) report that high soil loss values are typically associated with escarpments, valley slopes and drainage lines where runoff

accumulates. Tadesse *et al.* (2022) demonstrate that in plateau and mountain settings erosion is controlled mainly by gradient and land cover rather than by rainfall alone.

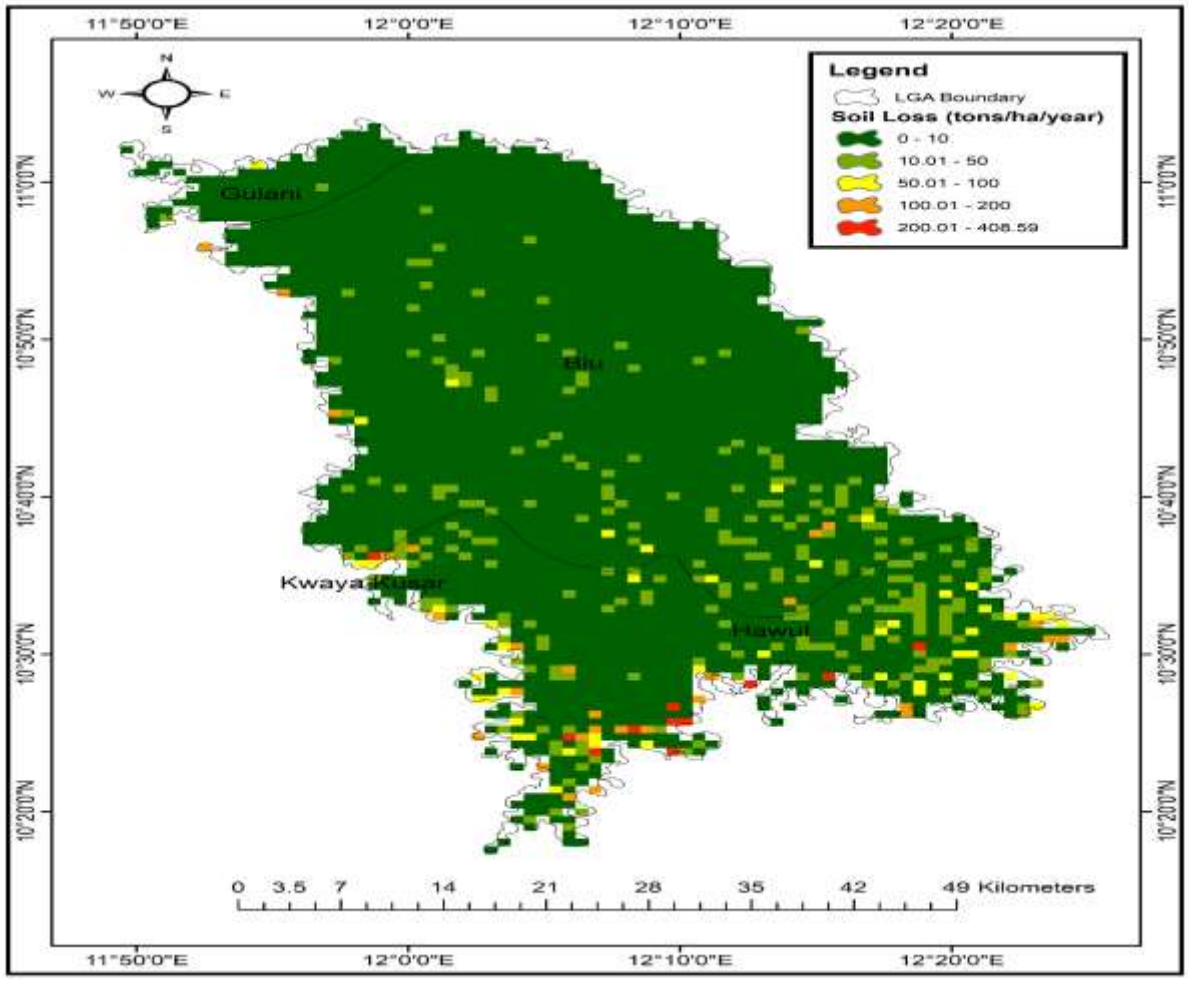


Figure 7: Spatial distribution of estimated soil loss, RUSLE model (t ha^{-1} yr^{-1})
Source: Author's analysis, 2025.

Conclusion and Recommendation

The study concludes that erosion susceptibility on the Biu Plateau is spatially concentrated rather than pervasive, with High and Very High classes confined to steep slopes and escarpments, a pattern validated by the Revised Universal Soil Loss Equation. Terrain morphology and runoff processes, particularly slope gradient, curvature, and hydrological indices exert dominant control over susceptibility, while soil properties exert the least influence, indicating that erosion is transport-controlled rather than resistance-controlled on Biu Plateau. The study recommends that Borno State Ministry of Environment and the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) project should use the susceptibility map produced in this study to prioritize the eight settlements identified as High and Very High susceptibility classes, namely

Shaffa, Bilatum, Paklama, Ndiragna, Mbuzimbur, Hareng and others, for immediate intervention. These settlements are demonstrably the least likely to seek assistance, and demand-led programmes will systematically under-serve them. The ACReSAL project's existing catchment management framework for the Hawul–Kilange catchment provides an operational delivery mechanism, and resources should be allocated following the susceptibility classification rather than expressed demand.

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