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Research Article

Evaluating Soil Loss for Identification of Land Risk Area in the Kabe Watershed of Ethiopia

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Soil erosion is the main cause of topsoil loss in farming land, which results in reduction in cropland productivity. Soil loss estimation is crucial for developing soil and water conservation strategies for Ethiopia. The investigation aimed to estimate the soil loss in various intensifications of land use patterns, including slope categories, using the soil estimation model associated with the ArcGIS process. It is analyzed in Ethiopian conditions based on erosivity, soil erodibility, vegetative cover (*C*) remote sensing data, slop-length factor (LS), and management practices (*P*). The mean soil loss was relatively high (20.01 t $ha^{-1}yr^{-1}$) in the cultivated land, whereas it was lowest (0.17 t $ha^{-1}yr^{-1}$) under forest land. Soil loss in the watershed shows a significant variation under slope classification. Moreover, the land having a greater slope angle, or the upper slope of the watershed, contains maximum soil erosion, while the lower slope position has a minimum soil erosion rate. The validation shows that there is an insignificant variation between the predicted model and the experimental data. Therefore, this confirms that the model can be applied in the study watershed or elsewhere with similar agroecology to the study area. This research is also used to prepare an erosion management strategy for the conservation of soil and water in the watersheds.

1. Introduction

Soil erosion has various effects on the environment, society, and economy [1, 2] since it removes fertile topsoil, which reduces the productivity of the crop field, and finally, it is the source of food production loss [3]. The sediment transported in waterbodies could be the cause of the decline in water quality and freshwater bodies [4, 5]. Heavy metals, contaminants, and chemicals that are generated from erosion in a landscape are transported with soil particles, causing higher sediment levels which eventually lead to water eutrophication and disturbance of delicate aquatic ecosystems [6]. The excessive silt export caused by severe soil erosion that is deposited in water bodies results in disturbances of life in the water bodies and a decline in the quality of the water bodies [7].

Soil erosion is recognized as a serious threat to agricultural land's ability to operate sustainably since soil erosion can decrease the productivity and production of agricultural land by reducing soil nutrients and soil fertility [8–11]. Moreover, when the eroded soil reaches the water bodies, it can cause eutrophication, in which poisonous and injurious ingredients build up and decrease liquified oxygen, which affects the hydrological ecosystems and biodiversity.

The study conducted by the Global Soil Partnership (GSP) indicated that the rate of soil loss was greater than 75 billion t yr^{-1} [9]. Moreover, the economic cost of annual soil loss associated with crop fields is approximately US$400 billion around the globe [10]. The annual assessment of soil loss varied around the world because of environmental and socioeconomic factors. For example, the annual erosion rate of soil in the US was 16 t $ha^{-1}yr^{-1}$, and in Africa, Asia, and South America, it ranged from 20 to 40 t $ha^{-1}yr^{-1}$ [14, 15]. In

India and Syria, the erosion of soil in a year was 16.4 t $ha^{-1}yr^{-1}$ and 5 t $ha^{-1}yr^{-1}$, respectively. According to Das et al. [16], the annual soil loss predicted by the RUSLE model in Arunachal Pradesh, India, was 1.38–59.05 t $ha^{-1}yr^{-1}$, whereas the soil loss in some watersheds of Ethiopia was 42 t $ha^{-1}yr^{-1}$ [15] and 43 t $ha^{-1}yr^{-1}$ in the upper Omo Gibe Basin of Ethiopia [17].

Many research findings on soil erosion show that different approaches and methods were followed, such as field experiments, the InVEST model, the WEPP model, and the RUSLE model, with the support of GIS technology. For example, Aneseyee et al. [17] used the InVEST sedimentary delivery ratio model, and Hussien [18] used the RUSLE model. Each of the models that apply in different watersheds has its limitations and drawbacks.

The global cultivated land was affected by soil erosion siginficantly [19], which impacts billions of people around the globe, particularly the population of Africa and less developing countries [20]. In Ethiopia, the rate of soil loss could be greater than 300 t $ha^{-1}yr^{-1}$ [8, 21], which indicates that Ethiopia is the most affected country by soil erosion on the globe [15]. The total soil loss is estimated at 1.5 billion t $ha^{-1}yr^{-1}$ for the whole country, but agricultural land is the main source of soil erosion [22]. The study in Ethiopia's highlands indicated that more than two million hectares of land were lost to rehabilitation [22]. Therefore, the management of soil erosion is the key issue for environmental conservation and improving food stability [20, 21].

Greater than 85% of the Ethiopian population depends on agriculture, which indicates that agriculture is the backbone of the Ethiopian economy [25]. Agricultural farming provides a massive opportunity to create jobs for the majority of the population; it covers half of the country's GDP and also is the major source of foreign exchange income but farming activities have recorded low yields due to a decline in soil fertility and reduced agricultural field productivity, which leads to incapable of achieving food self-sufficiency [24, 22].

To assess soil erosion risk and apply suitable soil and water conservation (SWC) technology on degraded land, several soil loss models have been advanced in recent years. To evaluate the soil loss, GIS and remote sensing data were acquired and significantly associated with the biophysical data [23, 24]. The RUSLE model is the well-identified empirical soil erosion model used throughout the globe [25]. It is estimated soil loss with the input of different raster and vector data, even if it has its drawbacks such as the lack of hydrological connectivity and the inability to estimate the sediment export capacity of a given watershed.

The origin of land degradation in Ethiopia is caused by farming on sloping land, poor practices of SWC measures, erratic patterns of rainfall, the absence of fallow land, a low supply of nutrients to the plant, vegetation, and forest degradation [17, 30, 31]. Therefore, the mismanagement of land by human activities such as poor cultivating practices and understanding the fluctuation of rainfall are significant influences for defining the concentration and impact of soil loss [32]. Therefore, resource degradation, declining agricultural productivity, aggravating poverty, and food security are major challenges for the country. As a result of these, the struggle could be aimed at preserving the soil resources for maximizing the productivity and production of land, which would lead to improved livelihoods and sustainable use of the ecosystems.

Different soil and water conservation (SWC) measures have been introduced and implemented over the last decades by governmental and nongovernmental institutions to increase food production in the country [33]. The emphasis has been largely on the construction of structural SWC measures in cultivated fields and the afforestation of hillsides to restore degraded land [34]. Conservation measures were opted in watersheds, leading to a decrease in runoff and a considerable increase in groundwater recharge [35]. Moreover, the implementation of SWC has been triggered to improve crop production, increase vegetation cover, reduce soil erosion, and improve the food security and livelihoods of rural communities [36].

Regardless of the erosion severity and its effects in the Kabe watershed, there is a lack of studies conducted to compute erosion rates for better management of the land. The land has a varied sensitivity to erosion based on its slope and land-use types features. Moreover, soil erosion predictions have been undertaken by many researchers at different times but their results show significantly varied. Therefore, estimating the soil loss rates and expressing the spatial mapping of soil erosion at the Kabe watershed is helpful for the planning of watershed development and for decision-makers. This research aims to (1) evaluate the soil loss rate in various patterns of land use systems, (2) explore the soil loss in different slope classes, and (3) validate the model to show the applicability and error of the model in the watershed.

2. Methods and Materials

2.1. Description of the Study Area. The research was undertaken in the Kabe watershed, which is part of the Blue Nile Basin of Ethiopia. The study area is located 470 km from Addis Ababa, the main city of Ethiopia. Kabe watershed has different kebeles/villages/and its longitude is located at 39°41′10.713″E to 10°89′14.098″N and the latitude is located at 39°47′8.6279″E to 10°82′35.788″N (Figure 1). The elevation ranges are also based at 1428–2752 m above sea level, with a mean annual rainfall of 1130 mm, while the mean minimum and maximum temperatures of the district are 9 and 21°C, respectively. The main types of crops grown are wheat, fenugreek, barley, and teff [37]. The main economic activity in the study area was agriculture, which depends on rainfall farming. Moreover, traditional methods used to improve soil fertility, such as the application of farm residue manure and crop rotation, have been abandoned in the area. The organic sources, such as crop residues, are completely removed from farmlands for animal feed, traditional fueling, and house construction purposes. Cow dung, which is supposed to be used as farm residue manure, is a major source of household energy sources. Crop yields under rainfed conditions are low due to the combined effects of limited input use and poor agronomic practices. The

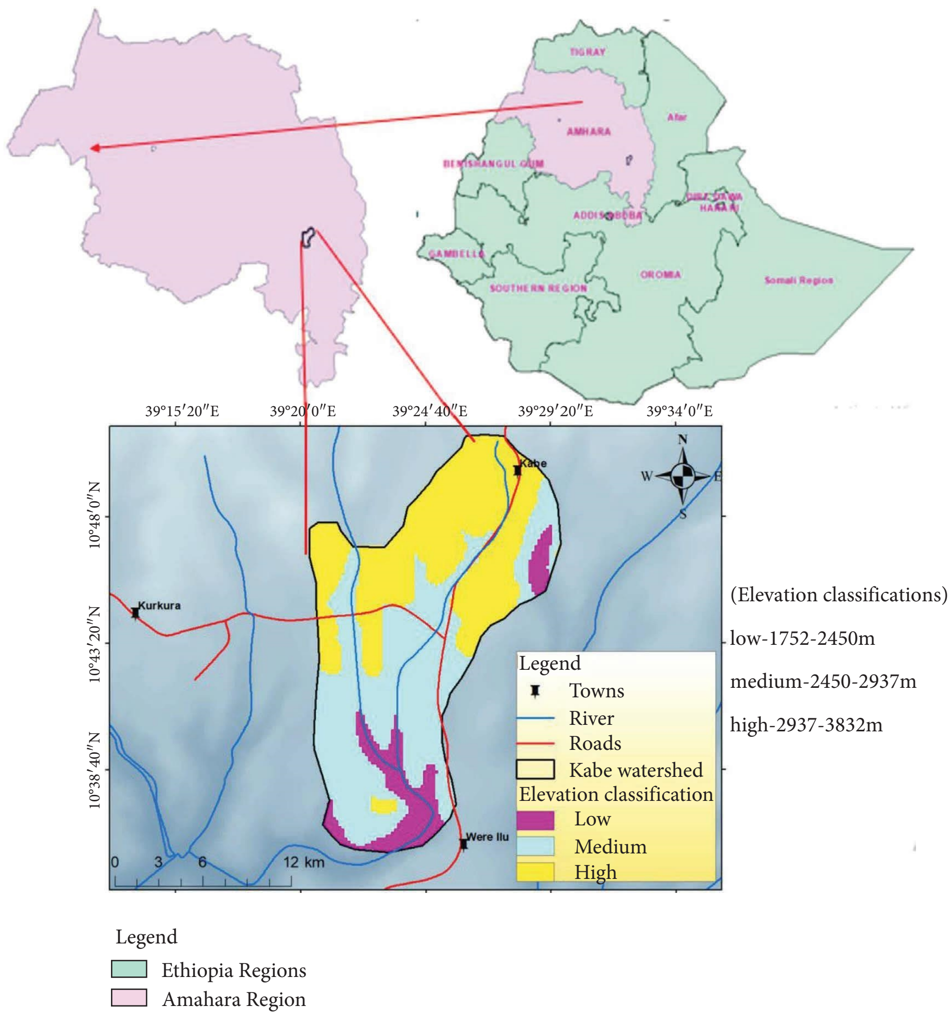

Figure 1: Location of Kabe watershed (study area).

degradation of the environment, such as soil erosion and nutrient depletion, causes a decline in agricultural production in the study area. Moreover, continuous drought, poverty, and crop failures were the common challenges, all of which in turn triggered a chronic shortage of food. The study area has different topographic features with a wide range of altitude variations (see Figure 1). Consequently, different biodiversity exists in the watershed.

2.2. Estimation of Soil Erosion at the Watershed. A RUSLE equation has the capability of estimating soil loss by using erosivity, erodibility, topography, vegetation cover, and conservation practices [38]. The five parameters were used to estimate soil erosion on the model, such as erosivity (R), erodibility (K), slope and steepness (LS), crop cover (C), and conservation (P). The RUSLE has computed the mean erosion rate in different land use systems and slope classifications, as given in the following equation:

$$A = R \times K \times \mathrm{LS} \times C \times P, \tag{1}$$

where A is the eroded soil expressed in tons per hectare per year (t $\mathrm{ha}^{-1}\mathrm{yr}^{-1}$), R is rainfall erosivity (MJ $\mathrm{Mm}^{-1}\mathrm{ha}^{-1}\mathrm{yr}^{-1}$), K is soil erodibility ($\mathrm{ha}^{-1}\mathrm{yr}^{-1}$), LS is the length of slope and steepness, C is the vegetation cover (dimensionless), and P is conservation practice (dimensionless) (Figure 2).

2.2.1. Classifying Land Use Types. For the current land use/land cover analysis, Landsat satellite imagery such as Enhanced Thematic Mapper Plus (ETM+) was acquired from the United States Geological Survey (USGS) (https://earthexplorer.usgs.gov/) for the current year. All the selected images were reprojected in the WGS84, in the cartographic system of the Universal Transverse Mercator (UTM) projection fuse of 37N, where Ethiopia belongs. Moreover, baseline data were collected from published documents and an in-depth discussion with local experts to recognize the land use/land cover (LULC) classes.

To get good-quality images, preprocessing techniques such as radiometric, geometric, and atmospheric corrections have been applied using the software ArcGIS 10.3 and ENVI 5.3. The image of ETM+ bands 1 to 7 was atmospherically corrected following the Raster

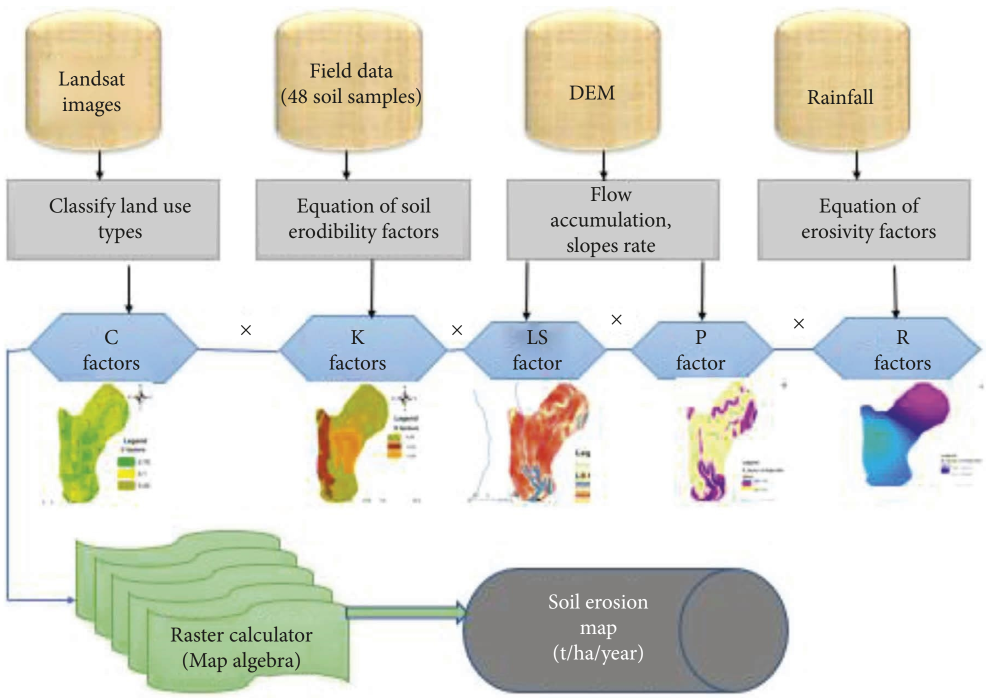

Figure 2: Modelling soil erosion.

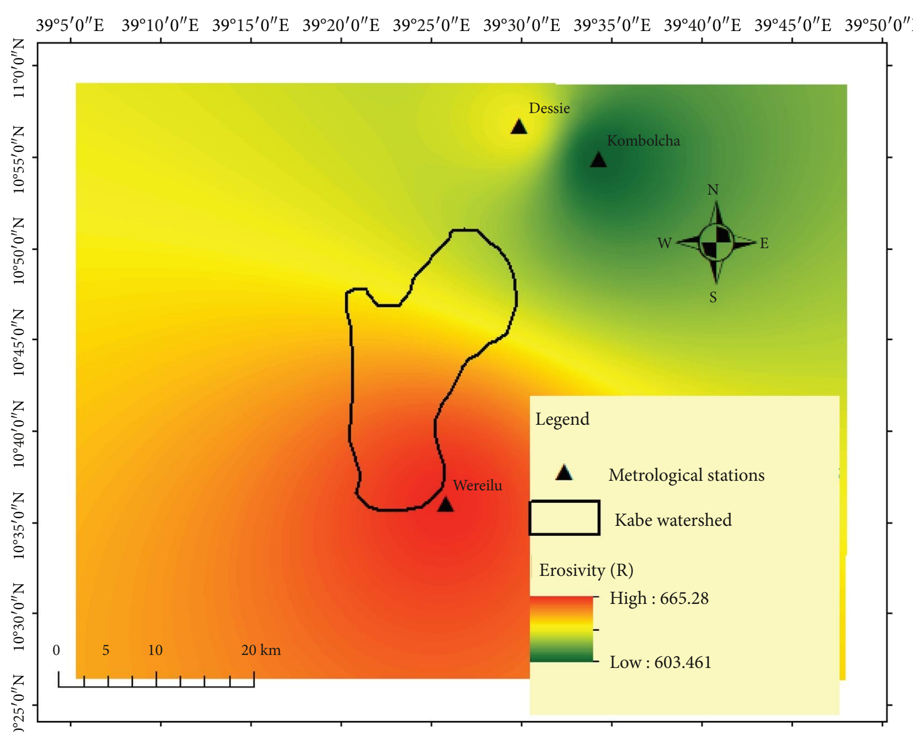

Figure 3: Erosivity (R-Factor) map of Kabe watershed.

Calculator (Spatial Analyst) tool of ArcGIS 10.4 [39]. A maximum likelihood classification method of supervised classification was used to identify the land use patterns of the investigated watersheds. During the field visit, ground control points (GCPs), which represent the different land cover classes, were taken using handheld GPS. The taking of GCPs was used to sample representative regions of interest (RoI) (signatures) for the different land cover types to regulate the accuracy of the image classifications.

2.2.2. Erosivity (R). Rainfall erosivity denotes the energy that began with the sheet, then rill erosion, and finally creates gully erosion. The erosivity estimates in the rainfall data are a straight raindrop influence and are partly due to the runoff that rainfall produces.

Estimating erosivity is based on Hurni's [40] equations, derived from a spatial analysis regression Helldén [41] adapted for Ethiopia using annual precipitation, but there are many different computational techniques to compute erosivity factors in the world.

$$R = -8.12 \times 0.56P, \quad (2)$$

where R = the annual rainfall erosivity and P = the mean annual precipitation of nearby stations acquired over the last 30 years.

To compute the R factor, a formula based on the average yearly rainfall was used. Interpolation has been performed to show the spatial surface distribution of soil erosion based on average 30 -year (1986–2015) mean annual precipitation data. Based on the Hurni [40], as provided in equation (2), the average rainfall and erosivity of the three stations were 1145 mm and 634 MJ $Mm^{-1}ha^{-1}yr^{-1}$, respectively (Figure 3) and Table 1.

2.2.3. Erodibility of Soil (K). The erodibility of soil (K) is determined based on the soil type, which is affected by the structure and texture of the soil, organic matter (OM) contents, and soil permeability (see equations (3)–(7)). For this study, the FAO soil map was used to derive the data on soil properties. The study area has three major soil types. In each soil type, soil properties were studied using standardized laboratory methods by taking 48 soil samples using systematic sampling techniques. In other words, sixteen (16) soil samples were taken from the three soil types based on systematic sampling techniques to analyze the organic carbon matter content and soil textures (silt, loam, and clay). Based on the Norman et al. [42] equation, a fraction of sand, silt, clay, and organic carbon content for the watershed has been taken as 0.37. After establishing the value of the K factor, it was put into the geo-database based on Kouli et al. [43] to create a raster map with a spatial resolution of 30 m cell size (Figure 4).

$$K = Fc\text{sand} \times Fsi - cl \times Forgc \times Fhi\text{sand} \times 0.1317, \quad (3)$$

where

$$Fc\text{sand} = \left[0.2 + 0.3\exp\left(-0.0256\,\text{SAN}\left(1 - \frac{\text{SIL}}{100}\right)\right)\right], \quad (4)$$

$$Fsi - cl = \left[\frac{\text{SIL}}{\text{CLA} + \text{SIL}}\right]^{0.3}, \quad (5)$$

$$Forgc = \left[1.0 - \frac{0.25C}{C + \exp\ (3.72 - 2.95C)}\right], \quad (6)$$

$$Fhi\text{sand} = 1.0 - \frac{0.70\text{SN1}}{\text{SN1} + \exp(-5.51 + 22.9SN1)}, \quad (7)$$

where SAN, SIL, and CLA are % sand, silt, and clay, respectively; C = the organic carbon content; SN1 = sand content subtracted from 1 and divided by 100; *Fc*sand = soil erodibility factor for low; *Fsicl* = soil erodibility factor for high clay to silt ratio; *Forgc* = factor that reduces soil erodibility for soil with high organic content; *Fhi*sand = factor that reduces soil erodibility for soil with high sand content.

2.2.4. Topographic Factors (LS). The slope of the land influences the velocity and level of runoff. In other words, a higher slope triggers a higher velocity of runoff, which aggravates soil erosion. There are diverse topographic features in the land use system, such as high and low slopes, flat land, and steep slopes.

The slope was classified into six in the Kabe watershed (Figure)5. With this data, slope length and steepness factors can be investigated for their effect on soil erosion [44]. DEM from the USGS was important to compute the slope length factors with the help of the ArcGIS environment. According to Moore and Burch [45], the LS factor was analyzed using the following equation:

$$\text{LS} = \text{Power}\left(\text{Flow accumuation} \times \frac{\text{Cell size}}{122.13}\right), 0.4 \times \text{power}\left(\sin\left(\text{slop in degree} \times \frac{0.01745}{0.09, 1.4}\right) \times 1.4\right), \quad (8)$$

where LS is the collective slope length and steepness factor. DEM was used to develop flow accumulation with a resolution of 30 m and sin of slope (degree). The LS factor for the Kabe watershed was computed, and it was 4.94 at the maximum and 0 at the minimum value (see Figure 6).

2.2.5. Vegetative Cove Factor (C). Soil erosion could be different depending on rainfall erosivity and the morphology of the plant cover. The falling rainfall protected by vegetation cover could reduce soil erosion on certain land. The protecting plants could be crops, weeds, or trees. Different stages of crop growth affect the generation of crop management factors and the need for the growth period and year of the plants.

To determine crop management factors (C), data on land use was produced from Landsat images of 30 m resolution (see Table 2). To classify the land use system, GIS and remote sensing applications such as the maximum likelihood classification algorithm were carried out on the remote sensing data. The crop management factor values associated with Ethiopian contexts based on the available land use maps were performed using Hurni [40] and set into a geo-database (see Figure 5).

Table 1: The average rainfall and erosivity.

No	Metrological station	Average rainfall (mm)	Erosivity (MJ Mm^{-1} ha^{-1} yr^{-1})
1	Dessie	1,145	634.37
2	Were Ilu	1200	665.28
3	Kombolcha	1090	603.46
	Average	1,145	634

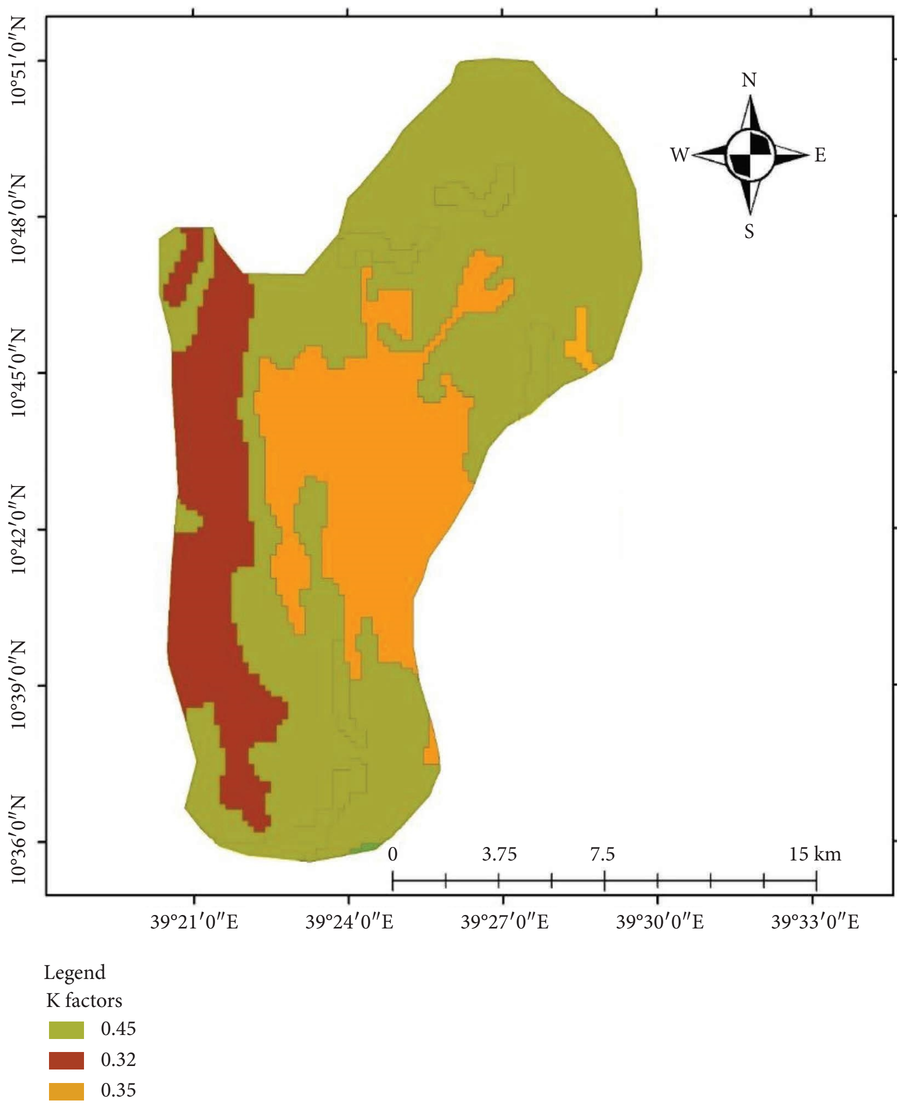

Figure 4: Erodibility (*K*-factor) map of Kabe watershed.

2.2.6. Conservation Practice (P-Factors). Conservation practices (*P*-value) are considered the application of soil conservation practices on the landscape, like terracing, mulching, and gulley control. If no erosion control practice is found in a landscape, then the *P*-value is equal to one, which indicates that the landscape has a high capability of reducing soil erosion. The *P*-value indicates a range between 0 and 1. Ploughing the farmland on high, sloppy land could increase soil erosion instead of reducing it. Therefore, the farming system in the landscape needs to apply different SWCs with different *P* factors. According to Hurni [40], the conservation practices (*P*-factors) values for different conservation practices in a land use system were provided (Table 3).

Based on Hurni [40], the management practices collected during field observation have classified the watershed as indicated in Table 4, and it has been put into the geodatabase; hence, *P*-value was analyzed using Arc GIS (see Figure 7).

2.3. Model Validation. The RUSLE model was computed to compare simulated and observed data. The observed data was obtained from the Ministry of Water and Energy of

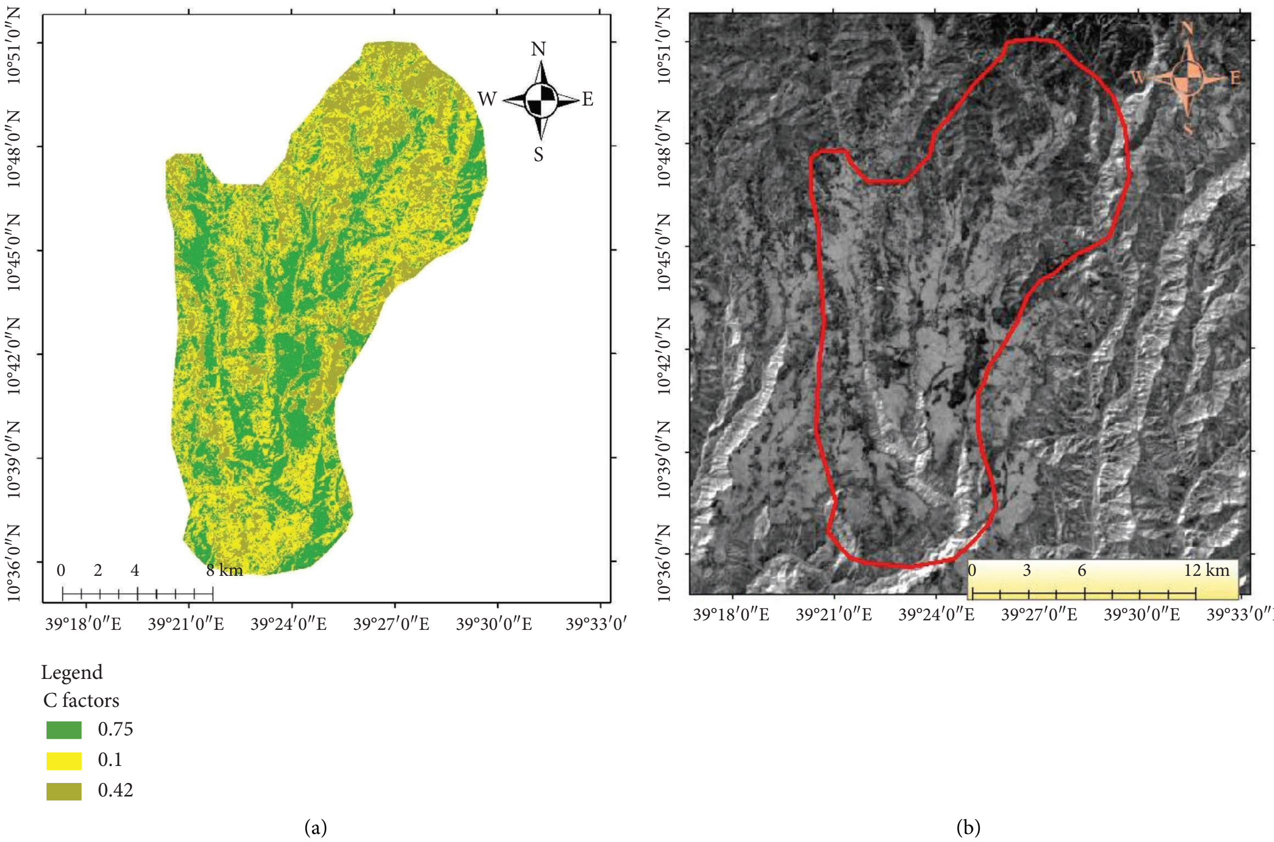

Figure 5: Crop management (*C*-factor) map of the study watershed (a) and Landsat image of the study watershed (b).

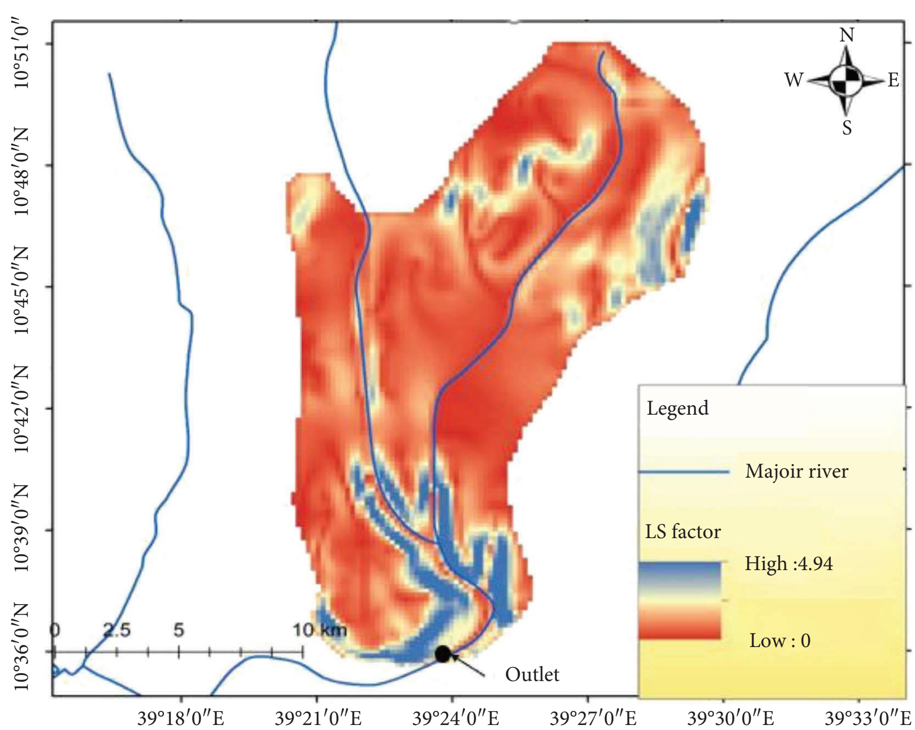

Figure 6: LS-Factor map of Kabe watershed.

Table 2: The C Factors (crop management factors).

	Crop management factors (C)
Forest land	0.01
Cultivated land	0.25
Grazing land	0.15

Source: Hurni [40].

Table 3: Management Practice was developed by [40].

Conservation practices (P-factors)	p-value
Ploughing sloppy land	1
Contour ploughing	0.9
Mulch	0.6
Intercropping	0.8
Strip cropping	0.8
Grass strips	0.8
Bunds	0.9

Table 4: Estimated management practices of the Kabe watershed.

Land cover	P-factors
Forest land supported by terraces and bunds	0.6
Cultivated land supported by contour ploughing	0.9
Grazing land practiced by overgrazing	0.8

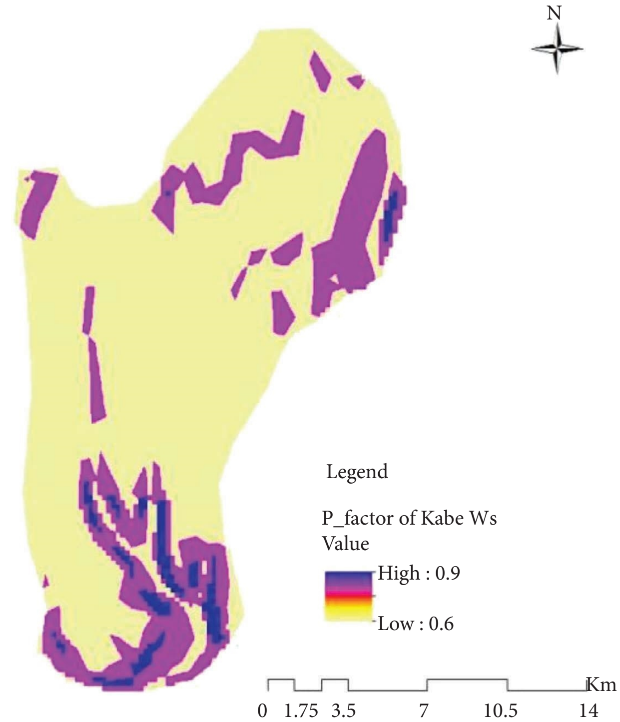

Figure 7: The conservation practice (P-factor) map.

Ethiopia. The unit for model output (simulated) was expressed on an annual basis, i.e., t ha^{-1}yr^{-1}, and the observed data described by streamflow and suspended sediment concentration data were expressed on a daily basis by m s^{-3} and g ml^{-1}, respectively. Therefore, the unit for the observed and predicted data requires to make a similar unit for consistent analysis. The observed data were computed using the streamflow and sediment concentration based on the following equation for the gauged stations, as introduced by Sadeghi et al. [46]:

$$SC = bQ^c, \tag{9}$$

where SC (t day^{-1}) refers to soil erosion, Q refers to the rate of streamflow (m s^{-1}), and b and c are constants, obtain from the analysis of the streamflow and sediment concentration (g ml^{-1}) data.

The coefficient of determination (R^2), mean Percentage Bias Error (PBIAS), and Residual Root Mean Square (RRMSE) were used to check the model's performance [47, 48]. If the statistical value indicates a high value, then the performance of the model becomes very good and applicable to the watershed [48, 49].

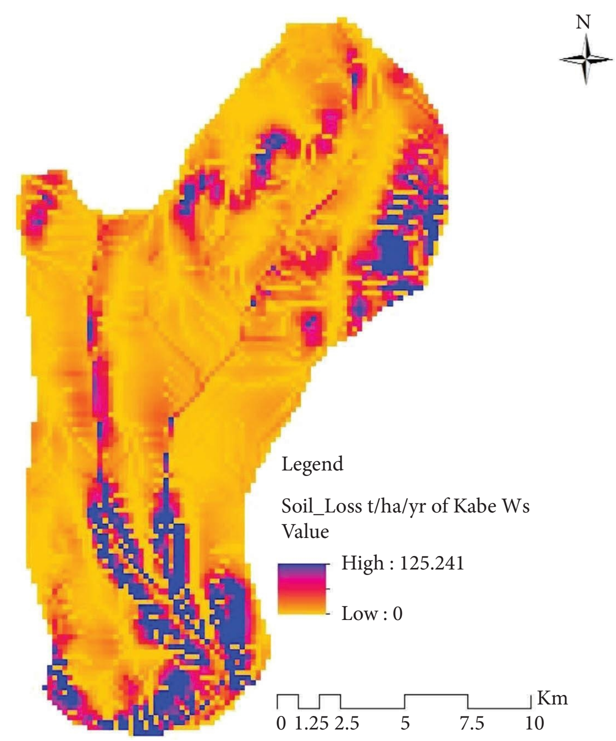

Figure 8: The soil loss in the study area.

3. Result and Discussion

The model of RUSLE used to estimate soil loss in the study area is provided in Figure 8. The overall maximum soil erosion assessed was 0 to 125.24 t ha^{-1}yr^{-1} because of continuous cultivation on a steep slope, forest cover reduction, loss of organic matter, and the absence of appropriate conservation measures. Moreover, the north-western and southern parts of the watershed have the highest risk of soil loss due to the lack of modern types of soil conservation structures.

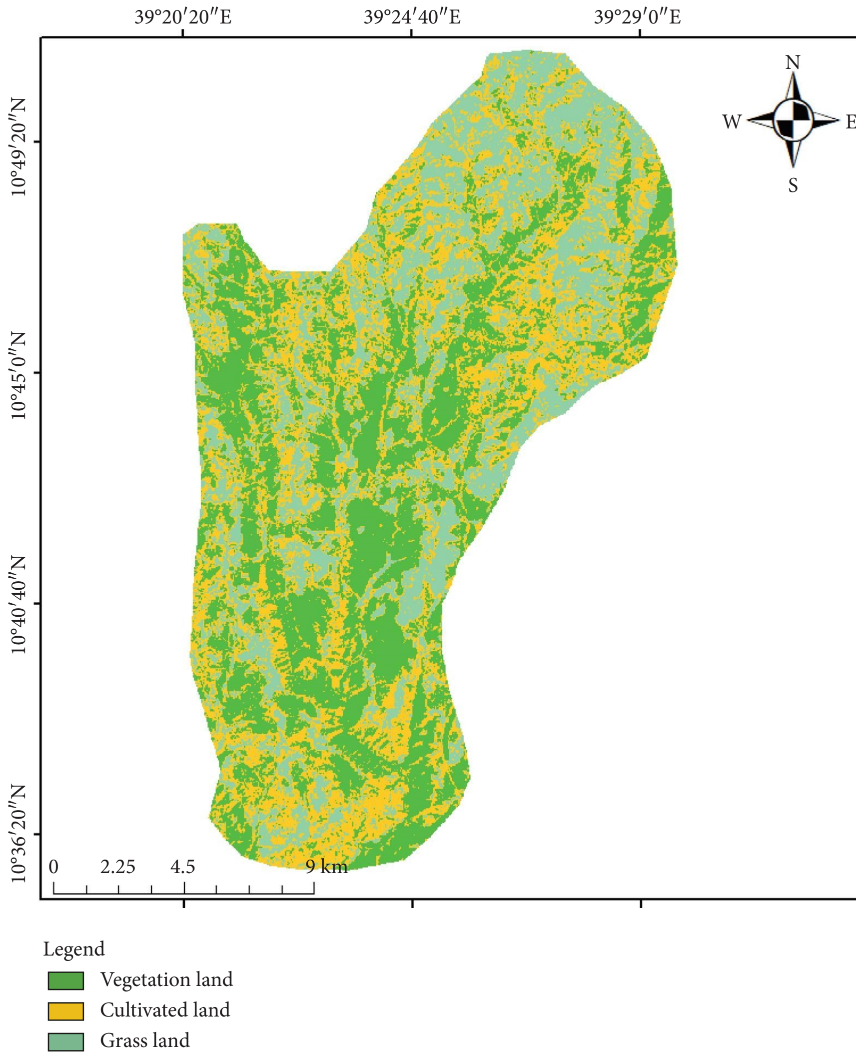

Figure 9: Land use land cover patterns in the Kabe watershed.

3.1. Effects of Land Use Systems on Soil Erosion. The study area has three land-use types (Figure 9). The mean soil erosion was relatively high (20.01 t $ha^{-1}yr^{-1}$) in cultivated land, while it was lowest in forest land (0.17 t $ha^{-1}yr^{-1}$). The overall average soil erosion was 6.95 t $ha^{-1}yr^{-1}$ for the entire watershed (Table 5). The study shows a lower average soil erosion of 6.90 t $ha^{-1}yr^{-1}$ (Table 5) compared to the tolerable rate of soil erosion (10 t $ha^{-1}yr^{-1}$) [40], and it also showed a lower tolerable soil loss rate in tropical Africa of (11 t $ha^{-1}yr^{-1}$) [50]. The maximum soil loss rate in the watershed was 125.24 t $ha^{-1}yr^{-1}$. This is the highest soil loss due to a slope greater than 75% and a high slope length and steepness value. The forest land soil loss was lower because of the protective ability of the vegetation and the OM added to the soil that makes the soil stick together. However, on cultivated land, soil loss is highest because continuous cultivation of land could be triggered by the loss of organic matter and top fertile soil, which are easily eroded by wind and water.

Generally, the simulated erosion of soil and the description of spatial mapping is accurate, as related to other studies conducted in preceding times. For example, Mati et al's. [51] study shows the mean soil loss of Ethiopia's highland was 100 metric t $ha^{-1}yr^{-1}$ in cropland. Of course, this is not a similar estimate to our studies. The soil erosion was enormously high in Ethiopia's highlands, which is a computed mean soil loss of 20 t $ha^{-1}yr^{-1}$ [40]. According to Hurni [52], the average soil erosion in the field of cultivated land was 42 $ha^{-1}yr^{-1}$. The soil erosion computed annually in the watershed of Medego in Ethiopia was 9.63 t $ha^{-1}yr^{-1}$ [53], and the average soil loss in a year for the watershed of Chemoga in the Blue Nile Basin of Ethiopia was 93 t $ha^{-1}yr^{-1}$ [54]. Therefore, this finding indicated that there are inconsistencies in estimating the rate of soil erosion.

Table 5: Average soil loss (t $ha^{-1}yr^{-1}$) in the Kabe watershed for different land-use types.

LUC	Max	Min	Mean	Standard deviation of mean
Forest land	12.24	0.02	0.17	1.74
Cultivated	125.24	0.5	20.01	7.13
Grassland	15.09	0.006	0.69	0.45
Overall	50.85	0	6.96	2.74

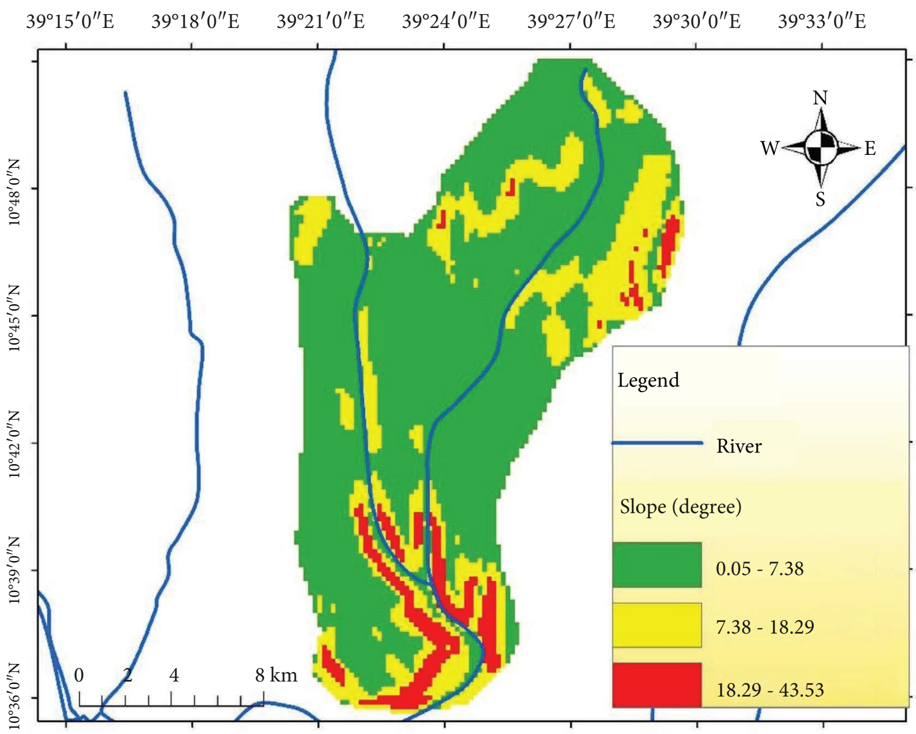

Figure 10: Slope classification map of Kabe watershed.

3.2. The Effects of Slope on Soil Erosion in the Kabe Watershed. The Kabe watershed was classified into six slope classes (Figure 10). The slight place of the study area was on a very high slope (>75%), and most areas were found under (0–15%) gentle slope positions.

Nevertheless, the low slope conditions affect average soil erosion insignificantly (Table 6). The analysis showed that the average loss from erosion under different slope positions is significantly different. The analysis showed that the highest (13.71 t ha^{-1}yr^{-1}) soil loss was observed under the upper slope position (Table 6), whereas the smallest soil erosion (1.69 t ha^{-1}yr^{-1}) was found under the lower slope position of the watershed. Similar studies were conducted in the Tigray Region of Ethiopia [55], which showed the maximum soil erosion was found on the upper slope and the minimum soil loss was observed under the lower slope position.

3.3. Model Validation in the Kabe Watershed. The observed and simulated data have shown an insignificant variation in soil loss in the Kabe watershed ($P < 0.05$, Figure 11). Therefore, the model used in this watershed is suitable for estimating soil erosion in the watershed. The observed mean soil erosion values of the three gauged stations were 7.72 t ha^{-1}yr^{-1}, 7.29 t ha^{-1}yr^{-1}, and 7.45 t ha^{-1}yr^{-1}, respectively, which is reliable with results derived from the existing model.

The experimental and predicted erosion of soil were 7.49 and 6.95 t ha^{-1}yr^{-1}, respectively, with a variation of 0.54 t ha^{-1}yr^{-1}. The very few inconsistencies (error = −3.4%) of soil erosion recommend that land use/cover and other climatic factors have been adequately recognized by the RULSE.

Table 6: The average soil erosion in t ha^{1}yr^{1} Kabe watershed for different slope positions.

Slope class	Max	Min		Standard deviation of mean
Lower (<%7.38)	12.28	0.012	1.69	0.43
Middle (7.39–18.29%)	60.88	0.045	3.14	1.17
Upper (>18.30%)	125.24	0.06	13.71	5.34

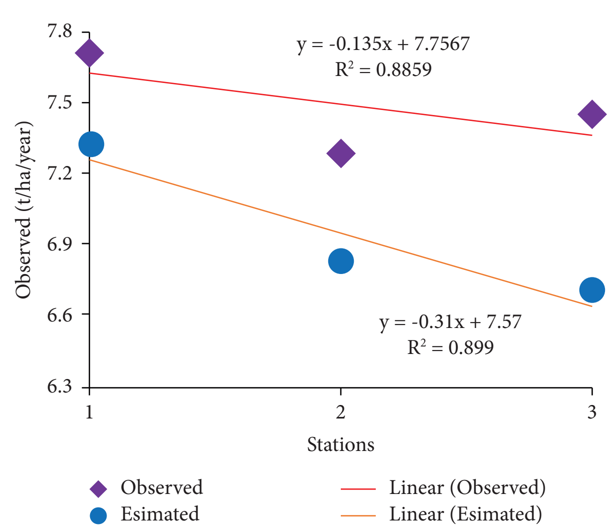

Figure 11: Observed and predicted soil erosion in the watershed.

Thus, the performance of the RUSLE model indicates a very good performance based on the statistical analysis (PBIAS = −3.22%, R^2 = 0.86 and RRMSE = 0.84). Therefore, it indicates that the experimental data from the study watershed is a good fit with the RULSE models' predictions.

4. Conclusion

The study analysis indicates that there was a significant rate of soil loss because of the significant dynamics of land use systems, which are contributed by climate variabilities such as increasing temperature and rainfall fluctuation. The analysis also shows cultivated lands have generated a higher soil erosion rate because the protective capacity of the land becomes low and the absence of forest cover. Moreover, in the vegetation and grazing land, the soil loss declined due to the protective capacity of the vegetation and grassland. The analysis shows that a higher sloppy area has shown a higher soil loss, whereas a lower soil loss has triggered in the lower slope area. The RUSLE model in the Kabe watershed predicted a lower rate of average soil erosion compared to the tolerable soil erosion rate estimated for Ethiopia and tropical Africa. Therefore, a watershed with high soil erosion needs to provide urgent interventions to decline soil erosion using conservation strategies, appropriate planning, community participation, and integrated approaches.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

FA collected, analyzed, and interpreted the data and made the final write up. AB wrote and edited the paper and performed GIS analysis; TS and EA edited the final manuscript. All authors read and approved the final manuscript.

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