Adama Science and Technology University

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On

Soil Erosion Assessment Using GIS and RUSLE Model: Case of Adama Sub-Watershed in Upper Awash Valley

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List of Abbreviations

RS	Remote Sensing
GIS	Geographical Information System
RUSLE	Revised Universal Soil Loss Equation
SWC	Soil and Water Conservation
SES	Soil Erosion Susceptibility
OMC	Organic Matter Content
IBC	Institute of Biodiversity Conservation

ABSTRACT

Soil erosion is a worldwide environmental problem that degrades soil productivity and water quality, causes sedimentation and increases the probability of floods. It has economic, social and environmental implication due to both on-site and off-site effects. Erosion control requires a quantitative and qualitative evaluation of potential soil erosion on a specific site, and the knowledge of terrain information, soils, cropping system and management practices. The objective of the study was to estimate the soil loss using Revised Universal Soil Erosion Equation (RUSLE) and Geographical Information System (GIS) in the catchment of Adama sub watershed in Awash sub-basin. The study area covers 1478.52 ha. Accordingly, an erosion hazard and a susceptibility map were produced. It was observed that the erosion hazard or loss is relatively large at south-east (hill side) of Adama watershed. The maximum estimated annual soil loss from the study area was 100 –209 t ha^{-1} *year*$^{-1}$*. Therefore, the result shows that soil loss is very severe, thus it is recommended to create awareness about the effect of soil erosion to all the local farmers of the study area. The lack of understanding among community or their lack of participation in soil and water conservation practices may lead the sub watershed for more soil loss, flood problem thus it is recommend to practice Community-Based Integrated Watershed Management in the area.*

Keywords: soil erosion, RUSLE, GIS, Adama sub watershed

1. INTRODUCTION

1.1. Back Ground Information

Most of Ethiopia's land forms are of complex nature and are liable to degradation. Land degradation in this country has been seriously affecting livelihoods and food security of millions and threatens many more. Of the obvious causes of land degradation in Ethiopia the main ones are (1) high soil erosion rates as a result of steep slopes, continuous encroachment and cultivation of marginal lands; (2) long history of deforestation, overgrazing, and negative coping strategies.

Consequently, Awash Basin in general and specifically Adama sub-watershed has also the same characteristics of landscape and shares similar problems related to resource degradation especially in the upper catchments.

Land/ or soil degradation is the process which leads to the loss of biodiversity and production capacity of the land. In general land degradation has negative impacts on lands: the word land refers here to all components of the land escape; soil, vegetation cover, hydrologic systems and land use such as declining land productivity, Loss of biodiversity and increasing the sedimentation of reservoirs (Teklehaimanot, 2003).

Soil erosion remains one of the most serious environmental problems of the world today, because it severely threatens agriculture and national environments. A combination on site and off site measurements will be use to assess the extent and impact of soil erosion. Thus, it was estimated that the world's soils are being duplicated at the rate of 0.7% per year (Brown and wolf, 1984). Land or soil degradation and silt ration of inland water bodies resulting from soil erosion is a widely recognized problem in most parts of the world.

Land degradation is largely human induced and thus includes a strong influences of socio-economic or socio-cultural component (Teklehaimanot, 2003)

Human induced land degradation has been classified in to four types: water erosion, wind erosion, chemical and physical degradation. According to Lall and steward (1994) about 1.90 billion hectares of world's soils or land are affected by land degradation out of which about 1.1 billion hectares of land are affected by soil erosion. This shows that soil erosion caused by water is the prominent form of land degradation.

It is, therefore the knowledge of distribution of the extent of soil erosion in an area or watershed is paramount important in planning appropriate conservation and rehabilitation measures based on the degree of severity of the area. Thus, the assessment and monitoring of soil erosion for proper land use management may require different types of data to be collected and combined.

Revised Universal Soil Loss Equation (RUSLE) model is an empirical type of model that could combine erosion from all process in to one equation. There is simple evidence that RUSLE yields quite a good estimate of amount of detached soil (Wishmeier, 1978). RUSLE estimates soil loss per unit area with the erosive power of rain(R), the amount and velocity of runoff water, the erodibility of the soil, and mitigating factors due to vegetation cover, cultivation methods and soil conservation practices.

Hence, Revised Universal Soil Loss Equation (RUSLE) combined with GIS was used to deal with the erosion patterns and quantity erosion loss is indispensable at the sub-watershed.

1.2 Problem Statement

- Soil erosion caused by water is one type of land degradation which is a major environmental concern in developing countries like Ethiopia.
- As a first step in soil and water conservation (SWC) measures planning and implementation it is paramount important to determine the spatial pattern or distribution of soil erosion risk with in a watershed.

- ☞ Therefore, the need for assessing soil erosion remains to be our concern in the study area. This is the main reason that the Adama sub-watershed is taken as the research area for this study.

1.3. Research Objectives

The main objective of the study is to estimate the soil loss using RUSLE and GIS.

The specific objectives are:

- to identify the major factors which cause soil erosion in the sub water shed.
- to indicate alternative land use types which counteract soil erosion in the area.
- to apply the results for identification of priority areas for conservation measures planning.
- to generate Soil erosion Map of the study area

1.4 Research Hypothesis

- There is a significant difference in the magnitude of the soil erosion factors in causing soil erosion in the area
- There is a significant difference in soil erosion rate between land use/ or land forms
- Land crop management and biological conservation can be used best to control soil erosion.
- There is no significant difference between the predicted soil loss and soil loss tolerance of the area.

2. Literature Review

The importance of agriculture to the economies of developing counters like Ethiopia is well known. The main contributors to these economies are small scale farmers (Morgan, 1986) who deepened largely on low inputs for crops production. These farmers are faced with a number of problems, one of them being land degradation caused by water. (Morgan, 1986). The factors which influence the rate of erosion are rain fall intensity, slope, erodible materials (soil type), vegetation cover and presence or absence of land and crop management and conservation practice (Ringo, 1999). The fertility of Tropical Soil is variable but in general low and his declined under the existing continues cropping on the same piece (plot) of land. The organic matter decomposes rapidly in a warm moisture climate (Ringo, 1999). This leads to less vegetative cover and ultimately to increase soil erosion susceptibility (Ringo, 1999)

2.1 Soil Erosion

Soil erosion by water is the resultant of perturbations caused by different factors such as climate soil, drainage, topography and human activates (Morgan, 1995). It is a wide spread environmental problem mostly disturbing large areas of the agricultural land escape as well as abandoned areas where in agriculture is not practiced any more. It is the same as accelerated soil erosion, the name stress the loss of soil for agriculture, and the influence of man activities through overgrazing, cultivation on steep slopes or land without appropriate conservation measures, road construction, monocultures, etc, as an initiating factors. Even though erosion has been uncounted for more than 50 years, the causes of soil erosion are still poorly under stood studies on soil (Morgan, 1995). Whiles considerable research, particularly since 1740, has resulted in better knowledge of the mechanics of the erosion processes and their relationship with the physical environment, only recently has systemic research been under taken on the social, economic, political and intuitional factors that influence where and when erosion occurs (Morgan, 1995)

Rain fall, soil properties, topography (relief), land cover and management are interlinked causes for water erosion. The process and factors of soil erosion should be linked in order to define type's causes and effects in a particular area this may be the reason FAO/UNEP (1982) defines land degradation as a complex process in which several futures can be recognized as contributing for production reduction. The inter dependence of soil erosion on biological (land use, climate and land cover) and socioeconomic factors to consider in erosion assessment for proper land use management, (Morgan, 1995).

2.2 Soil Erosion Assessment

Erosion occurs at widely varying rates over the land use, landscapes, over a field and even along a slope profile with in a field (Teklehaimanot, 2003). Hence to understand soil erosion over an area, it is necessary to assesses soil erosion at different land uses and landforms. Soil erosion can be predicated by certain method that is reflected by a magnitude of soil loss or relative erosion rate for a given area .estimation of soil loss rate has to be done in order to assess whether a defined land use and/or landform have/has soil loss rate above or below the tolerance level. There are various ways of assessing soil erosion like soil erosion susceptibility (SES) erosion modeling and the like.

2.2.1 Soil Erosion Susceptibility (SES)

Soil erosion susceptibility is the soil loss expected under the influence of rain fall, relief (topography), soil properties, without land cover and management /or control practice (Hudson, 1981)

The assessment of the soil erosion susceptibility /SES/ of one area is strong full for planning and land development in other countries. SES assessment provides a basis for identifying appropriate type of land use and also provides valuable information to analyze the type, rate causes of erosion and the degree of damage to the soil.

2.3 Erosion Modeling

It is also another tool for soil erosion assessment. A model is a simplified representation of a complex system. Erosion models are many types. Two of the most utilized soil erosion models are the empirical and the process based models.

Empirical models are generally the simplest of all models types, which means that the computational and data requirements for such models are usually smaller than the process based models. Empirical models however, are often criticized for employing unrealistic assumptions about the physics at the catchment's system such as ignoring the heterogeneity of catchments input, and their characteristics (Teklehaimanot, 2003). Empirical models are based on the assumption that underlying conditions remain unchanged for the duration of the study period (Teklehaimanot, 2003).

The limitations of process based models aside from having greater data demand and computational requirements than the empirical models are their need to have measured parameter values both spatially and temporary within the catchments.

Application of process-based models are still in question whether it can better estimate soil erosion than the existing empirical models (Hudson, 1981) moreover, the applications of empirical models are more use full in dealing with the erosion Patters rather than quantifying erosion loss. This study will consider the empirical models (USLE) for erosion risk assessment in a sub-watershed of the lakes Awassa basin.

USLE is an empirical model with widespread use in land use planning extension and the design of cropping system and conservation practices. It allows and management conditions on different soils with a set of relatively simple parameters (wischmeier and smith, 1978). The methods of soil loss estimation based on a modified USLE by wischmeier and smith (1978). USLE estimates soil loss per unit area with the erosive power of rain(R), the amount and velocity of runoff water, the erodibility of the soil, and mitigating factors due to vegetation cover, cultivation methods and soil conservation practices. It takes the form of an equation where all of these factors are multiplied together;

A= R*K*L*S*C*P……………………………..1

Where:

A= Average /mean, long term annual soil loss (t/ha/y)

R= Rain fall erosive index (mt/ha/yr)

K= soil erodibility index (mt/ha/yr)

LS= A combined factor to account for the length and steepness of the slope.

C= Land use / cover

P= Land management/ conservation practice factors (-)

The model parameters were calculated from a defined set of natural and management conditions in the united state of America (USA). However recent data show that the USLE can be applied also to a wide range of tropical soils and correction can be made for most other soils (Hudson, 1981).The most urgent need exists now is obtaining reliable data on tropical cropping systems.

The USLE was designed to calculate and estimate annual soil loss from a given slope under specified land use and management conditions (wischmeier, 1976). So now it can be used for a watershed by subdividing in to smaller units where the USLE factor applied (wischmeier, 1976). The data has been applied in the Adama sub-watershed by divided in to various land use/ cover class.

2.4 Soil Loss Tolerance

Soil loss tolerance is the maximum rate of annual soil erosion that may occur and still permits a high level of crop productivity to be obtained economically and indefinitely (wischmeier and smith 1978). The determination of soil tolerance is intended to compare the expected soil loss with the soil loss tolerance. If the soil loss is less than original to the soil loss tolerance the soil loss can be still accepted. But if the soil is more than soil loss tolerance, measurement to reduce soil erosion should be taken in to consideration until a level of equal or less than the soil loss tolerance has been reached.

Hudson (1986) mentioned some important factors to be considered in determining soil loss tolerance. They are thickness of top soil, soil physical properties, decreasing organic matter and nutrient loss. The maximum soil loss tolerance for tropical region is 25t/hr (Arsyad, 1981, as cited in Ringo, 1999) and for temperate regions 13.7 t/ha/yr (Thomson, 1957, as cited in Ringo, 1999). A common used soil loss tolerance rate is 5-12t/ha/yr for shallow to deep soil (Ringo, 1999). However the current used rates for tolerable soil loss in tropical soils with low levels of fertility (Ringo, 1999).

It is also indicated that tolerance values for tropical soil have annual soil loss tolerance limits that are below 25t/ha/yr established (Hudson (1986).

3. MATERIAL AND METHODS

3.1 Materials

The materials, data and softwares which have been used in the study were:

- High Resolution satellite data or aerial photographs, Soil data, Rainfall data, Hydrologic Information, and other ancillary data;
- Surveying instruments such as: GPS, Measuring Tape, digging equipment and all equipment used for soil description;
- The software which were used for data processing: Arc GIS, Global mapper, Microsoft package.

3.2 Methods

3.2.1 The study Area

The study was conducted in central rift valley within Awash River sub basin, at Adama sub-watershed which is surrounded by plateaus, mountainous and ridged topography. It lies approximately between 8^0 33' to 8^0 36' North latitude and 39^0 11' 57" to 39^0 21' 15" East longitude, and covers an area of approximately 14.7852km^2(1478.52hectares) which is 99 km southeast of Addis Ababa on average. The altitude of Adama ranges from 1500 to 2300 meters above sea level (masl).

The mean annual rainfall and temperature is 838 mm and 20^oc, respectively. Its agro-climate Zone is categorized under Kolla.

3.2.2 Data Collection and Analysis

- Primary and secondary data were collected from different sources.
- Soil sample analysis: Soil samples taken from the field have been analyzed for OMC, particle size distribution (texture) and permeability. Likewise, the other in put parameter of the RUSLE have also be analyzed and compiled to estimate /or calculate the soil loss by Appling RUSLE (A = R* K* LS* C* P) together using ArchGIS.

- Data analysis, interpretation and execution have been carried out concurrently with the report writing using different softwares.

3.2.3 Revised Universal Soil Loss Equation (RUSLE)

i. Rain fall Erosive

Rain fall erosivity is the potential capability of the rain falls to cause soil erosion which varies in space and time (Hudson, 1981). It depends on the quantity and intensity of the rainfall.

In the absence of maximum 30 minute intensity (I_{30}) rainfall data for the computation of R factor, the established relationship between R factor and available rainfall data, such as monthly and annual precipitation are considered by putting the equation after Renard et al. 1997. The R factor has been calculated on the basis of:

$$R = -0.0334Pa + 0.006661Pa^2 \text{ ---------------------------- (2)}$$

Where: P_a = annual rain fall in mm

R is rainfall and runoff factor (in megajoules millimeter per hectare per hour per year) and P is the measured annual precipitation in millimeter.

This erosive regression equation developed by Renard et al. 1997 which has been successfully applied in the study area.

ii.Soil Erodibility, K

The erodibility of soil refers to the resistance of the soil to both detachment and transport by the eroding agent. Hudson (1964) defines erodibility as the specific property of soil which can be quantitatively evaluated as the vulnerability of the soil to erosion under specific circumstance. Here the term soil erodibility is limited to interrill (or sheet) and rill erosion. Wischmeier and smith (1978) related Soil Erodibility with Soil color as given below and the Organic Matter decreases with increase K factor.

Table 1: Soil Erodibility Factor

Soil color	Black	Brown	Red	Yellow	Grey	White
K factor	0.15	0.2	0.25	0.3	0.35	0.40

(Source: Wischmeier and smith, 1978)

iii. Topography, LS

Slope-length is defined as the distance from which the original over land flow begins to the point where either: one, the slope gradient decreases enough that deposition begins or two, runoff becomes concentrated in a well defined channel (Wischmeier and smith, 1978). The slope length is best estimated by pacing or measuring in the field by tape measure, while steep slopes should be converted to horizontal distance (Ringo, 1999).

The combined topographic factor (slope length* slope gradient –L*S) allowed to adjust soil loss on a given slope length, gradient and slope form to that of the control point. The common used equation in RUSLE is the one developed by Wischmeier and smith (1978).

$$LS = (l/22.1)^{m} * (0.065 + 0.045S + 0.0065S^2) \text{ -------------------------- } 3$$

Where: l = slope length in meter

m = Slope length exponent

S = slope gradient (%)

The slope length exponent (m) depends on the gradient and is smaller far low slopes than for steep slopes. This implies that the effect of slope length on soil loss is interrelated with slope steepness.

Table 2: Relationship between slope length exponents (m) with slope gradient

Slope Gradient (%)	"m" in meter
$\leq$ 0.5	0.15
0.6 – 1.0	0.20
1.1 – 3.4	0.30
3.5 – 4.9	0.40
$\geq$ 5	0.50

Source: Wischmeier, smith, 1978

iv. Land use /cover factor (C)

Morgan (1995) observed that different crop types and vegetation have different values depending on vegetative characteristics, where the difference are related to the length of the period needed to provide good cover. Crops that develop rapidly a good cover, like soybean, are more effective in reducing soil erosion than those that have slower rate of growth like cassava and maize. Morgan (1995), Lal (1979) as cited in Ringo (1999) concluded that in general leguminous crops have the ability to restore and improve soil structure and consequently reduce the erosion as compare to soil depleting crops such as cassava and maize.

In this study considering and study the types of crops and vegetation covered in the study area, then identifying the type of land /cover i.e. vegetation cover factor (c) from the table 3.

Table 3: Land use /cover factor, C

Land Use type	**Crop Management (C)**
open bushy wood land	0.003
dens bushy wood land	0.001
cultivated land	0.1
open grass land	0.05
open shrub land	0.009
urban built up	0.03
open grass land and open shrub land	0.004
shrubby grass land	0.01
forest woody	0.003

Source: Hudson, 1981

v. Land Management Factor (P)

By definition, the supporting practice factor (p) is the measure of soil loss with a specific support practice to the corresponding loss with up slope and down slope tillage. These practices principally affect erosion by modifying the flow pattern, grade or direction of surface run off and by reducing the amount of and rate of runoff (Takelehaimanot, 2003) for cultivated land, the support practices considered include contouring (planting on or near the contour), strip cropping terracing and sub surface drainage. This could also estimate from the table provided in USDA Handbook No. 282 (1981).

Table 4: P factor for different land cover types

S.No.	Land use/land cover classes	P values
1	Dense vegetation	1
2	Sparse vegetation	0.8
3	Built- up	1
4	Water bodies	1
5	Scrub land	1
6	Agricultural cropland	0.5
7	Fallow land	0.9
8	Bare soil/barren land	1

Source: USDA Handbook No. 282 (1981)

4. RESULT AND DISCUSSION

I. Rain Fall Erosivity (R)

Rain fall erosivity is the potential capability of the rain falls to cause soil erosion which varies in space and time (Hudson, 1981). Using the average annual rainfall of 30 years and the formula indicated below were used to calculate and the following result (R-Map out put) was obtained.

$$R = -0.0334Pa + 0.006661Pa^2$$

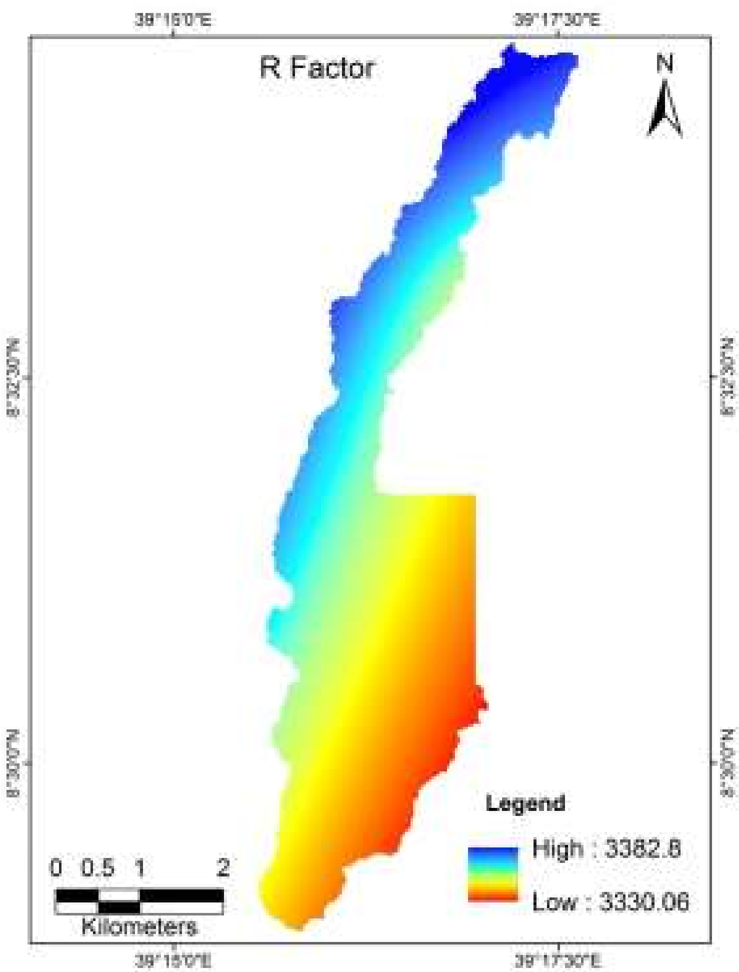

Figure 1: R-factor

From the map shown above it can be observed that the potential of the rainfall to cause soil erosion ranges between 3,330.06 to3,382.8 $MJmmha^{-1}$ $year^{-1}$ .In addition to this, the potential of the rain fall to cause soil erosion is less at south-east part of the sub watershed relatively to the north-east side where rainfall factor is high to cause soil erosion.

II. Soil Erodibility Factor (K_Factor)

The Erodibility of soil refers to the resistance of the soil to both detachment and transport by the eroding agent Hudson (1964).

Soil erodibility factor (K) represents both susceptibility of soil to erosion and the rate of runoff. Specifically, the K factor is a function of particle size distribution, organic matter content, structure, and permeability (Wischmeier and Smith 1978; Renard et al. 1997 and Renard and Freidmund 1994). It is also determined by the cohesive force between the soil particles and may vary depending on the presence or absence of plant cover, the soil's water content and the development of its structure (Wischmeier and Smith, 1978).

to analyze the soil erodibility factor (K-factor) Adama sub watershed boundary was clipping from upper awash basin soil map and obtained Mollic and osols (dark color) and Eutric fluvisols soil (red color). According to Wischmeier and Smith (1978), the Erodibility factor for the above soil type and color are 0.15 and 0.25 respectively.

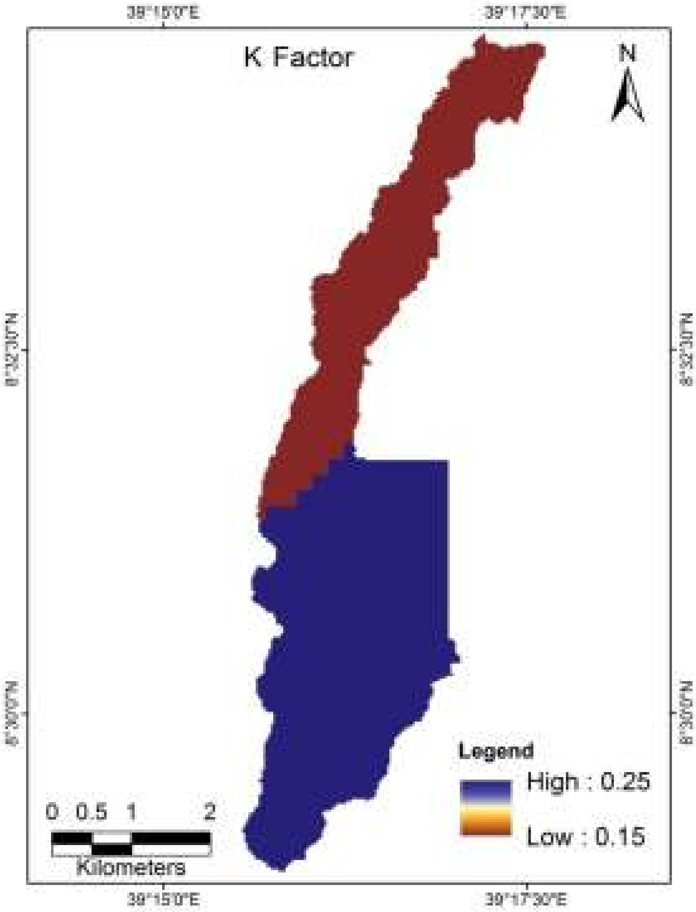

Figure 2: K-factor

By comparing the map results with that of table 5, it is possible to conclude that the study area has low to moderate soil erodibility that is it has good resistance to detach and transported by the detaching agent.

Table 5: Classification of K

Class	Range	Mean
very low	0.00 - 0.10	0.05
Low	0.10 - 0.20	0.15
Moderate	0.20 -.32	0.26
moderate high	0.32-.43	0.37
High	0.43-.55	0.49
very high	0.55-.64	0.61

Source; Ringo, 1999

III. TOPOGRAPHY FACTOR (LS)

The influence of topography on erosion is complex. Slope-length (LS) is defined as the distance from which the original over land flow begins to the point where either: one, the slope gradient decreases enough that deposition begins or two, runoff becomes concentrated in a well defined channel (Wischmeier and smith, 1978). For this research, an approach developed by Wischmeier and smith (1978) was used to compute LS factor. They developed an equation to compute length-slope factor:

$$LS = (L/22.1)^{m} * (0.065 + 0.045S + 0.0065S^2)$$

Where: L = slope length in meter

m = Slope length exponent

S = slope gradient (%)

The L and S factor were computed together from the digital elevation model (DEM). The slope length factor L computes the effect of slope length on erosion and the slope steepness or gradient factor S computes the effect of slope steepness on erosion which influences flow velocity and thus the rate of erosion. Hence, the effect of slope length and slope steepness on erosion is relatively large at south and south east part from the outlet (‘Migira’ pond).

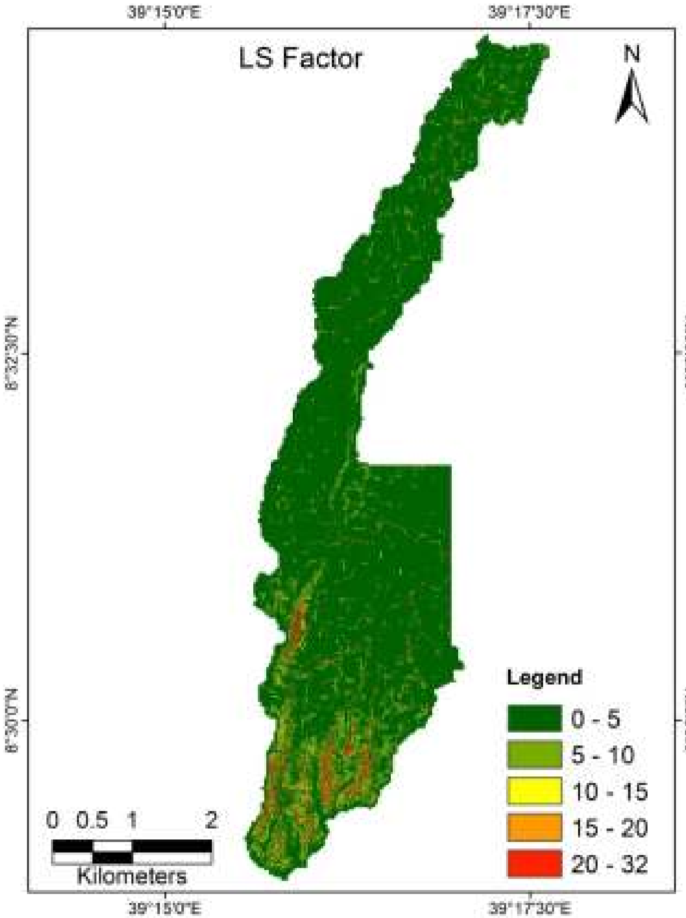

Figure 3: LS-factor

IV. Land use /Cover Factor (C)

Morgan (1995) observed that different crop types and vegetation have different values depending on vegetative characteristics, where the difference are related to the length of the period needed to provide good surface cover. Surface cover is material in contact with the soil surface that intercepts raindrops and slows surface runoff. Surface cover includes all cover that is present, including rock fragments, live vegetation, and plant residue.

In this study area the types of crops and vegetation covered in the field have been identified and related their numerical value from Morgan (1995) as it is shown in table 3 and C-factor map was generated, Figure 6.

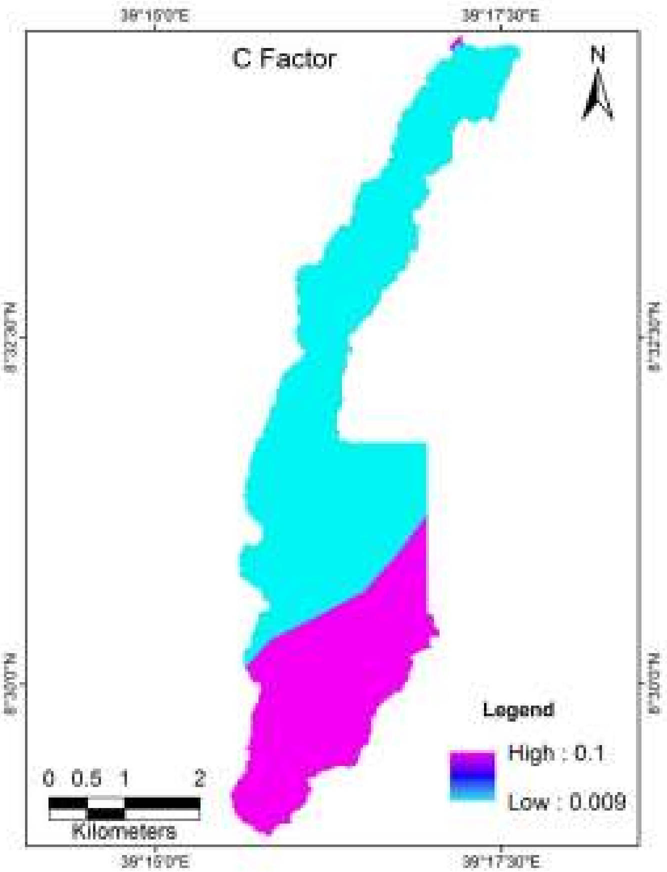

Figure 4: C-factor

From the map shown above larger parts of the area are covered with different land-use land-cover except the south and south east part of the watersheds which are more susceptible to erosion due to less vegetable cover.

C-factor of 0.1 represents the specified cropping management system; it signifies that the erosion will be reduced to 10 percent of the amount that would have occurred under continuous fallow conditions.

V. Support Practice Factor (P)

Support Practice Factor or Land Management Factor (P) is a measure of the effects of practices designed to modify the flow pattern, grade, or direction of surface runoff and thus reduce the amount of erosion. Common support practices are: cross slope cultivation, contour farming, strip-cropping, terracing, and grassed waterways.

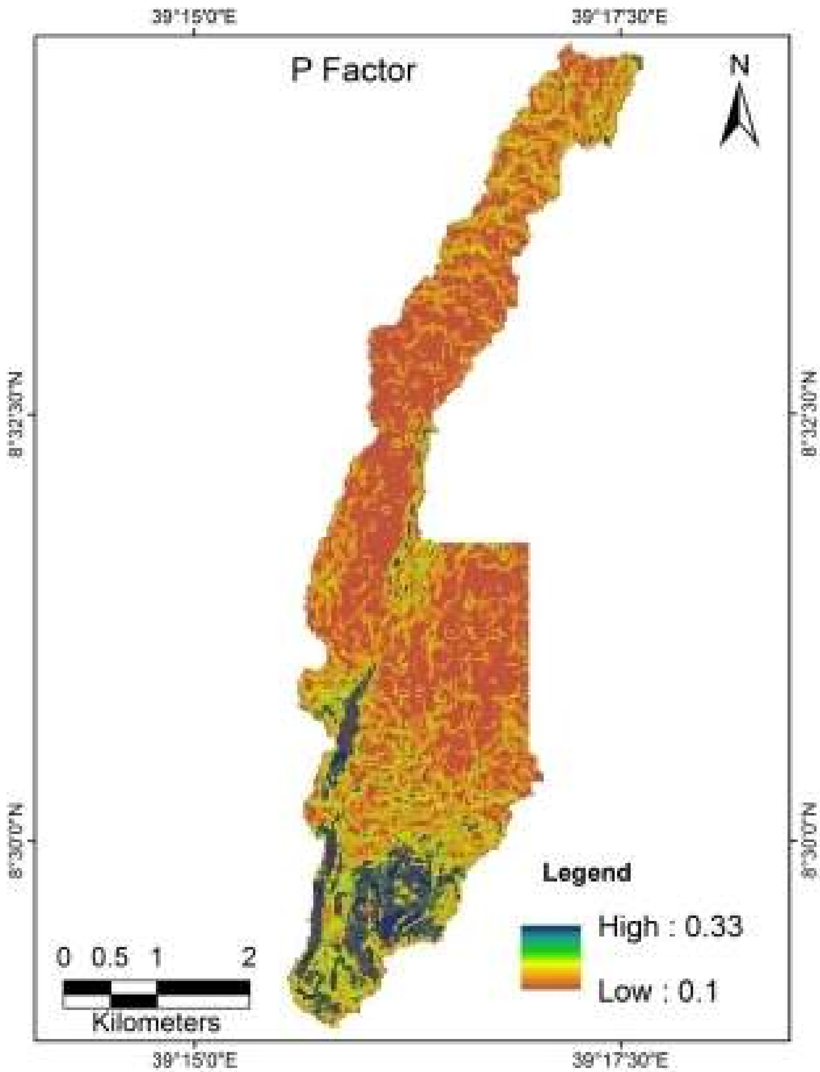

Figure 5: P-factor

The values of P factor was determined by clipping Adama sub watershed boundary from upper awash basin land use land cover map and found different land cover types as in Table 4. Table 4 shows the average values for P parameters for each land cover type on the basis of USDA handbook.

The P factor accounts for control practices that reduce the erosion potential of the runoff by their influence on drainage patterns, runoff concentration, runoff velocity and hydraulic forces exerted by runoff on soil (Renard et al. 1997).

4.1 Soil Loss Analysis

The soil erosion hazards are the actual soil erosion under the present condition has been estimated by incorporating all the factors discussed above in to the RUSLE using GIS to obtain the final erosion loss map below.

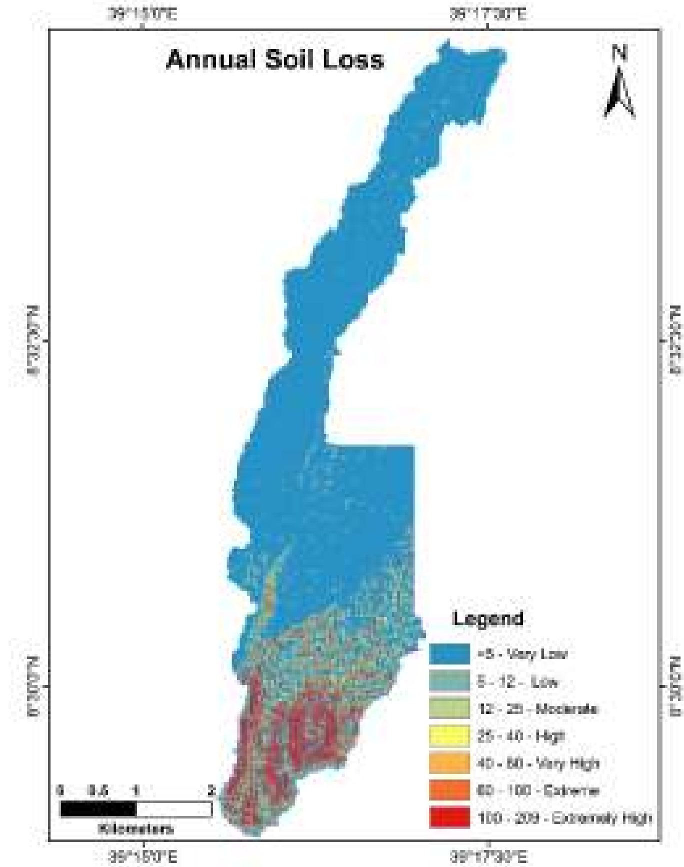

Figure 6: Soil Loss Map of Adama sub watershed

The estimated soil loss for Adama watershed varied from 0 - 209 t ha^{-1} $year^{-1}$.

There is no international soil tolerance level established for tropical soils. Different authors have tried to establish annual soil loss tolerance limits which vary between 0.2 and 25 t ha^{-1} $year^{-1}$ (Hudson, 1971, Hurni, 1980, El-Swaify and Hurni, 1996).

Table 6: Range of Soil loss

Class	Range of soil loss in t/ha/yr
Very low	<5
Low	5-12
Moderate	12-25
High	25-40
Very high	40-60
Extreme	60-100
Extremely high	>100

Source: Ringo, (1999)

By looking more closely to (Fig. 6), and according to Table 6 extreme to extremely high rates are associated with higher slope gradient factor, with degraded bare-land and grassland. Relatively, there is large amount of soil erosion or soil loss at south-east and -west (hill side) of Adama watershed.

5. CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

The study demonstrates that RUSLE together with Remote Sensing and Geographical Information Systems are useful tools to estimate soil loss over areas and facilitate sustainable land management through conservation planning. The method can thus be applied in other parts of Ethiopia for assessment and delineation of erosion-prone areas, for prioritization of areas for conservation.

Generally, the practice of removing plant residues, and ploughing the land several times, should be avoided in the high soil loss potential areas. Similarly, a lack of vegetative cover during the critical period of rainfall with high erosivity and the lack of support practices (contour planting, strip cropping and other vegetative barriers) which could reduce the effect of runoff on steep areas have been identified in this assessment as major causes of soil loss.

5.2 Recommendation

Implementing conservation measures on selected areas that are highly affected can significantly reduce great soil loss in the study area. Thus, it is necessary to prioritize highly affected areas for treatment with appropriate soil and water conservation measures.

The soil erosion problem in the study area can be solved by giving awareness to the community about soil erosion hazard and adopting conservation measures (like terracing ,strip cropping, check dam, vegetation cover ,proper drainage). The study area is surrounding by hills or mountains which generate high runoff from mountain and highland which make soil erosion hazard and sediment flow to the town. Therefore, those measures practiced at the upstream side of the catchment area could also used to protect downstream from flood problem.

The lack of understanding among community or their lack of participation in soil and water conservation practices may lead the sub watershed for more soil loss, hence it is to recommended to practice Community-Based Integrated Watershed Management in the area.

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<Verily, all praise is due GOD, the Almighty and supreme Authority>

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