Integrated Biodiversity Management,
South Caucasus

Preparation, coordination and implementation of the remote sensing concepts on erosion control and management of mountain ecosystems in Az

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Report

April- December 2017

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DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

The Programme „ Integrated Biodiversity Management, South Caucasus “ Preparation, coordination and implementation of the remote sensing concepts on erosion control and management of mountain ecosystems in Az is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry of Economic Cooperation and Development (BMZ) with co-funding in Armenia and Georgia from the Austrian Development Cooperation (ADC)

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Executive summary.

Soil erosion is becoming serious problem arising from agricultural intensification, land degradation and other anthropogenic activities. Assessment of soil erosion can provide useful in planning and conservation works in a watershed or basin. Modelling can provide a quantitative and consistent approach to estimate soil erosion and sediment yield under a wide range of conditions. The purpose of the report is to identify the erosion of the existing soils in the Ismailli region of Azerbaijan.The most progressive method for detecting erosion is to use geographic information systems and remote sensing technologies.Within the scope of the project, the above mentioned technologies, existing data, RapidEye satellite images, DEM, digital data about forests, residences, hydrographic objects and other were used.

In this study, the RUSLE (Revised Universal Soil Loss Equation) model, which is one of the most widely used models for estimating soil erosion in the region, is used.Erosion maps were drawn using the RUSLE model and GIS technologies. With the help of maps, it will help to predict where is more or less risk of erosion.

Methodology for assessment of current status of eroded areas based on remote sensing information

The methodology is proposed to prepare maps indicating which areas are affected by erosion. Erosion maps prepared by using remote sensing data can be used to identify areas of potential erosion risk. On the other hand, these erosion risk maps can be used to identify erosion risk areas and erosion prevention plans. The time series could be used to monitor changes in erosion. It is possible to determine the zones where the erosion rate is higher in the regions, where risk erosion risky areas are compared with the existing erosion risky lands in 2100.

Methodology for erosion risk mapping

When mapping erosion applied General cartographic principles of mapping. Source the data were obtained by calculation according to the model RUSLE the factors causing erosion and then multiplying these factors. And was also used topographic maps of Ismayilli district.The aim of this methodology is to identify areas of risk by erosion. In this model, it is possible to find risky erosion area.

Methodology for an assessment of landslide risks

Ismailli district is characterized with high activity of landslides. Besides the fact that it contributes to the development of erosion, and also have a very negative impact for planning of roads and settlements, identification of potential hazard zones and for planning and prioritizing erosion mitigation measures. The proposed methodology will help to build up a landslide inventory. The assessment delivers a digital map of existing and historic landslide areas.

Changing erosion risks from a climate change perspective

Due to climate change in the 21st century due to the adaptation of the growing season of agricultural products to climatic conditions, due to changes in soil cover, strong rainfall patterns and erosion threats are expected.

Climate change is one of the main factors leading to increased erosion risk. This methodology focuses on correcting the types of vegetation cover and relief climate change patterns and maps in the project area. The methodology includes the preparation of high resolution maps modelling climate-change induced changes in land-cover and vegetation types

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List of Abbreviations

TOR	Terms OF Reference
GIS	Geographic Information System
DEM	Digital Elevation Model
RUSLE	Revised Universal Soil Loss Equation
USLE	Universal Soil Loss Equation
IIASA	The International Institute for Applied Systems Analysis
USA	United States of America
FAO	Food and Agriculture Organization
NDVI	Normalized Difference Vegetation Index
NIR	Near Infrared
GCM	Global Climate Model
RCP	Representative Concentration Pathways
NASA	The National Aeronautics and Space Administration
ESDAC	European Soil Data Centre
IPCC	Intergovernmental Panel on Climate Change

1. Introduction

Soil erosion is an important social and economic problem and an essential factor in assessing ecosystem health and function. Estimates of erosion are essential to issues of land and water management, including sediment transport and storage in lowlands, reservoirs, estuaries, and irrigation and hydropower systems. (FAO, 2011).

When we look at the Azerbaijan situation about erosion, erosion damages mountain and foothill lands seriously: 3,610,100 hectares (41.8 percent) of the country has been affected by erosion to a certain extent, including 48.6 percent of cultivated land and 20 percent of forests(Fao,2017). Such a situation may cause shortage in water resources, worsening of climate, desertification of arid zones, and break of ecological balance. In recent years soil fertility has been falling because of inappropriate cropping systems. Much crop land is on mountain slopes of 2°-12° even 15°. Therefore, a wide range of crops are grown in conditions of vertical and horizontal land zonality (Fao,2017). Because of that important problems Erosion must investigate and take precautions against of the erosion in Azerbaijan.

We have analyzed in İsmailli region erosion possibilities and tried to discover annual soil loss distribution in İsmailli. When we are doing that we have used RUSLE model to analyze Ismailli. RUSLE Model's recommended in the TOR and has given meaningful results in Georgia. RUSLE model using important 5 parameters; rain fall effects, land cover, slope, soil erosivity, these parameters have explained with detail in reports. These parameters delivered from different sources and analyzed erosion according to the RUSLE parameters formulas.

Climate change is main problem for the entire world in the feature. Many part of the world is under desertification risk and also tropical lands under more effective tropical storm risk because of the rising temperature. North Ice Sea and Antarctica losing ice every day because of the increasing temperature. We have assessed Global Climate Change Model(GCM) for our working area Ismailli and discussed effects on rainfall changes. After estimating rainfall (R-factor) we have run RUSLE model again for the feature estimates according to the climate changes.

1.1 Expected Outputs

Assessment for Land cover maps and Land cover classification.

NDVI map and classification

Erosion assessment using RUSLE model

Erosion assessment according to the Global Climate Change

2. Methodology and Materials

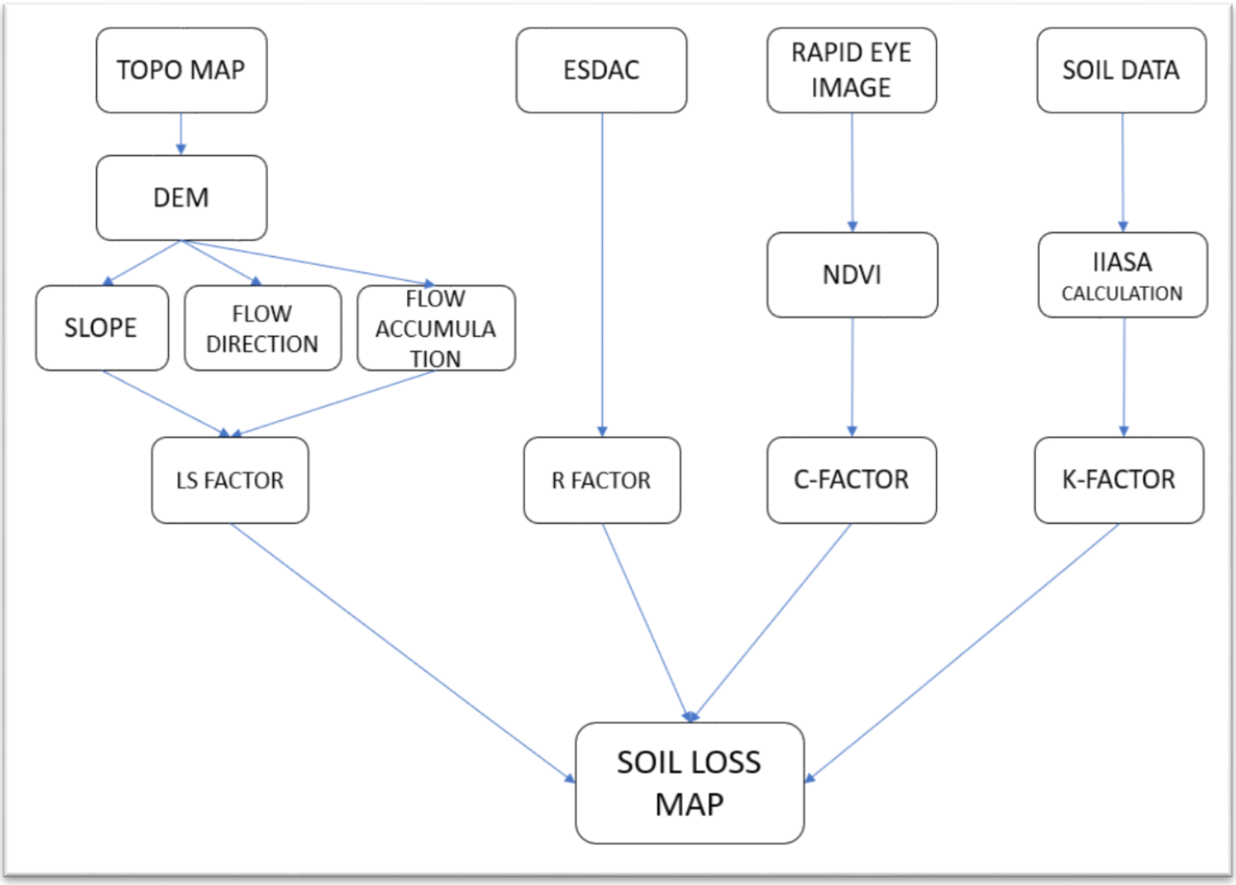
According to Terms of Reference, “The RUSLE (Revised Universal Soil Loss Equation) is one meaningful approach to set up a model on soil erosion risk caused by rain and surface run-off.” Because of this recommendation in TOR, we decided to use RUSLE model for our project area. At the same time, RUSLE model was already applied by GIZ in Azerbaijan’s neighborhood country Georgia and gave meaningful results.

RUSLE model the Universal Soil Loss Equation (USLE) was first developed in the 1960s by Wischmeier and Smith of the United States Department of Agriculture as a field scale model (Wall et. Al). It was later revised in 1997 in an effort to better estimate the values of the various parameters in the USLE (Renard et. al. 1997). There are five major factors that are used to calculate the soil loss for a given site. Each parameter is the arithmetic estimate of a specific condition that affects the severity of soil erosion at a particular location. The calculated erosion values reflected by this model can vary significantly due to fluctuating weather conditions. Thus, the erosion values obtained from the RUSLE (Revised Universal Soil Loss Equation) more accurately represents long-term averages. The RUSLE uses the simple equation ($A = R \times K \times LS \times C \times P$). Where ‘A’ is the average annual soil loss in tons/acre/year, ‘R’ is the rainfall-runoff erosivity factor, ‘K’ is the soil erodibility factor, ‘LS’ is the slope length and degree, ‘C’ is the land-cover management factor, and ‘P’ is the conservation practice factor (Renard et. al. 1997). We will explain each parameter with more detail.

Another advantage of a selection of RUSLE is that the parameters of this model can be easily integrated with GIS for better analysis. The main aim of present study is to integrate RUSLE model with remote sensing and GIS techniques for assessing the erosion risk in Ismailli region.

Remotely sensed images at the different level of resolution from different types of sensors have been extensively and successfully used for crop mapping and identification since the first earth observation satellite Landsat- 1 was launched in 1972 (Bauer and Cipra 1973, Jewell 1989, Mulla 2013). Increasing demand of deriving quick, accurate, up-to-date and cost-effective information about the land cover has pushed the countries to launch new earth observation satellites such as RapidEye (2008), GeoEye-1 (2008), WorldView-2 (2009), Landsat8 (2013), SPOT-7 (2014) as optical imaging and, TerraSAR-X (2007), Sentinel-1A (2014) and ALOS-2 (2014) as radar imaging. The common point of the optical sensors launched for environmental monitoring and assessment such as agriculture and forestry is to incorporate the near-infrared (NIR) band. RapidEye, is the first high-resolution multispectral satellite system incorporating the red-edge band which is sensitive to vegetation chlorophyll content (Schuster et al. 2012). This satellite imagery has been successfully used for classification of vegetation, forestry and agricultural areas recently (Eitel et al. 2011, Schuster et al. 2012, Tigges 2013, Löw et al. 2013).

Figure 1: RUSLE Model Process Schema



Digital Elevation Model(DEM) was generated from Ismailli topographic data. We have created slope map using DEM and also, we have created flow direction and created flow accumulation using DEM and flow direction data. We have calculated LS-factor using these outputs.

We have downloaded R-factor from ESDAC web site and clipped our working area.

We have used rapid eye images for NDVI and Land Cover analysis in this work. Image captured in 2014-Jul-12.

All Factor data and satellite Images processed using ArcGIS for desktop software.

3. Analysis

3.1 Image Analysis

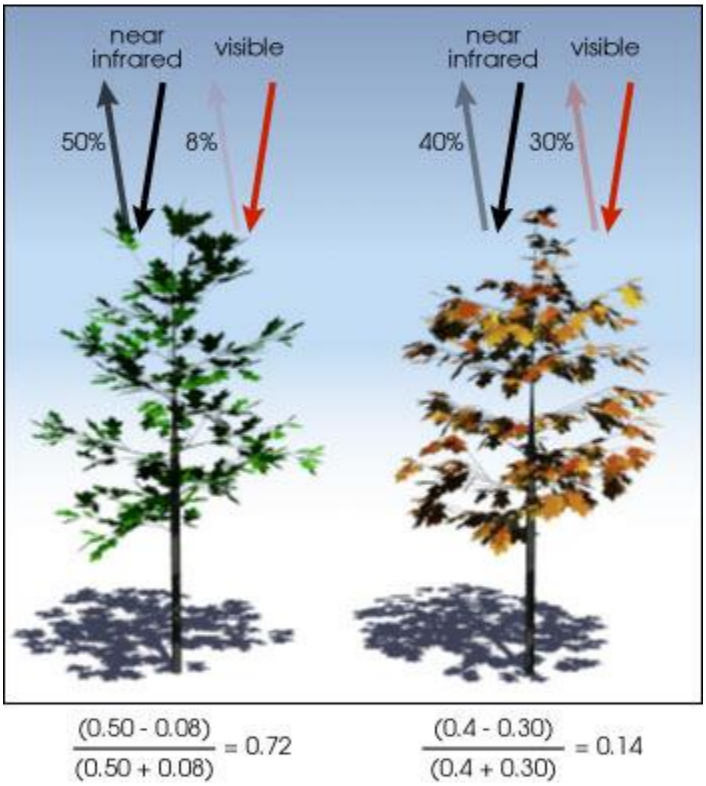
3.1.1 NDVI Analysis

NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. The numbers on the figure above are representative of actual values, but real vegetation is much more varied. (NASA 2017).

Nearly all satellite Vegetation Indices employ this difference formula to quantify the density of plant growth on the Earth — near-infrared radiation minus visible radiation divided by near-infrared radiation plus visible radiation (Figure 1) (NASA 2017). The result of this formula is called the Normalized Difference Vegetation Index (NDVI). Written mathematically, the formula is:

NDVI = (NIR — VIS) / (NIR + VIS) (NASA 2017)

Figure 2: NDVI Calculation Algorithm. (NASA 2017).

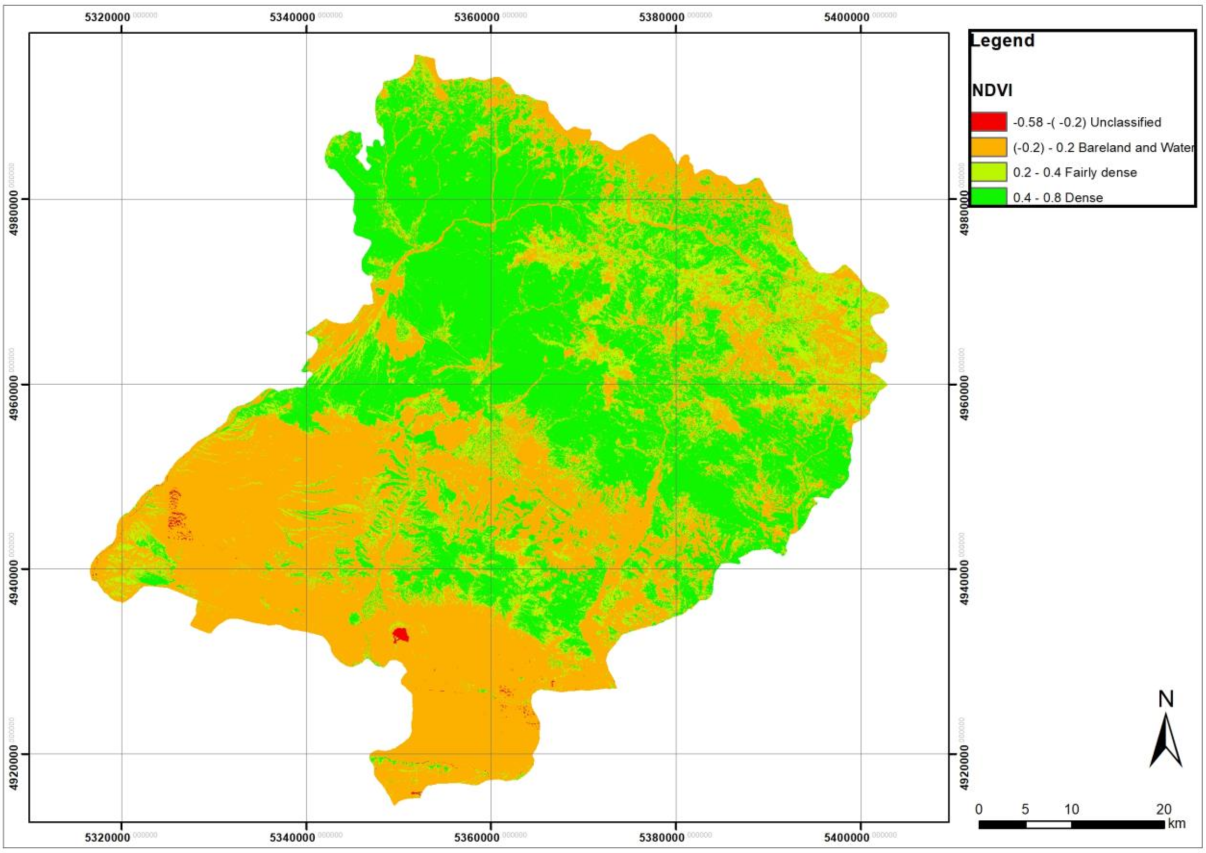


Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves give a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves.

In this study, we have used rapid eye images to analyze NDVI. NDVI shows us vegetation high and low densities and helps us to create RUSLE Model C-factor.

For the creating NDVI map Ismailli we used Rapid Eye satellite image (5Band, Cell size-5:5).NDVI.The coefficients are divided into 4 classes.Resalution=5*5

Figure 3: NDVI Map for Ismailli Region



3.1.2 Land Cover Analysis

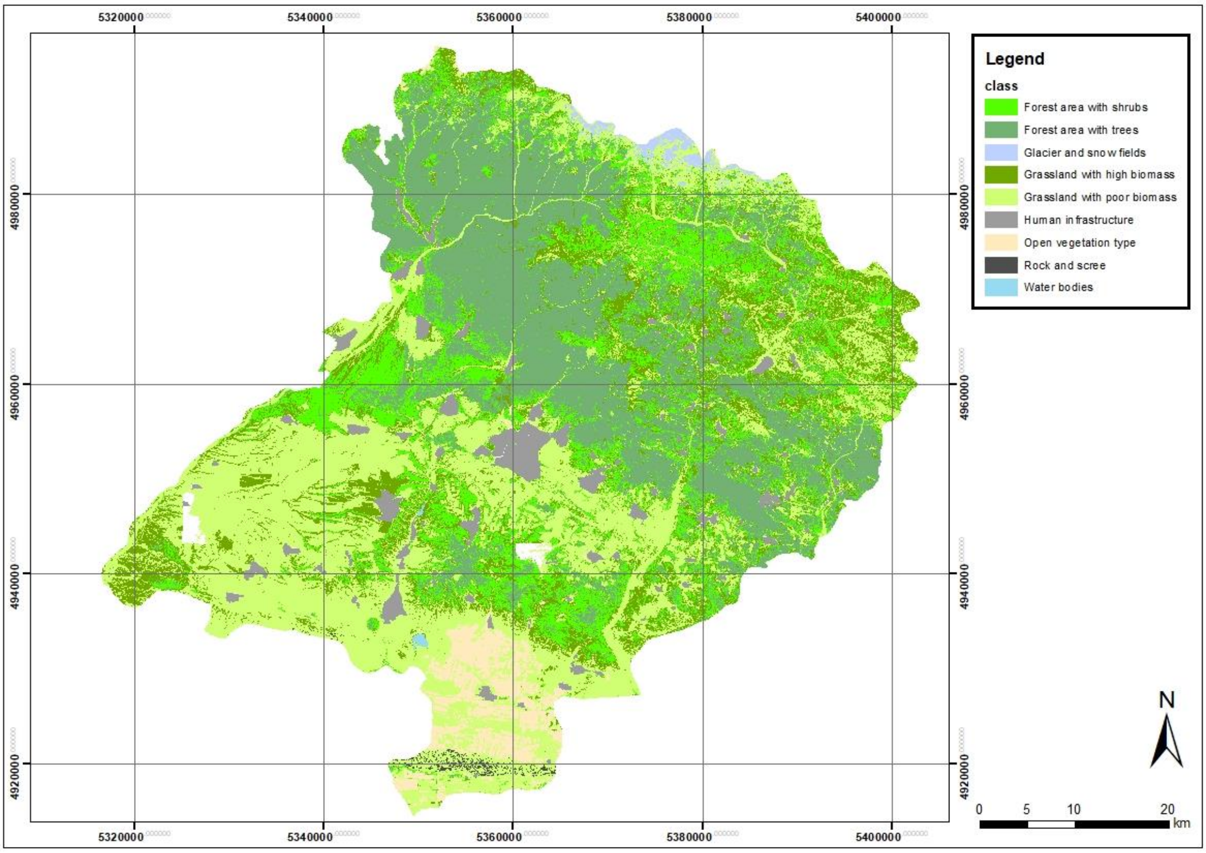
We have tried two type image classifications. Supervised classification is first of them and unsupervised classification is second of them.

In supervised classification, the image processing software are guided by the user to specify the land cover classes of interest. The user defines "training sites" – areas in the map that are known to be representative of a particular land cover type – for each land cover type of interest. The software determines the spectral signature of the pixels within each training area, and uses this information to define the mean and variance of the classes in relation to all of the input bands or layers. Each pixel in the image is then assigned, based on its spectral signature, to the class it most closely matches. It is important to choose training areas that cover the full range of variability within each land cover type to allow the software to accurately classify the rest of the image (Creutzburg, M. K., 2017).

In unsupervised classification, image processing software classifies an image based on natural groupings of the spectral properties of the pixels, without the user specifying how to classify any portion of the image. Conceptually, unsupervised classification is similar to cluster analysis where observations (in this case, pixels) are assigned to the same class because they have similar values (Creutzburg, M. K., 2017).

We decided to make supervised classification, because we could not take meaningful results from unsupervised classification results from rapid eye. We have defined 8 training sites in working area and made supervised classification using ArcGIS Desktop. We have converted data to vector format and made edits for human infrastructure and glacier and snow fields after classification process

Figure 4: Land Cover Map for Ismailli



According to our land cover analysis “Forest Area with Shrubs” is the most space-consuming in our working area. “The Water Bodies” and “Glacier and Snow Fields” are lowest space-consuming area in Ismailli Region.

Table 1: Land Cover Types in Ismailli

Forest area with shrubs	350.06 km^2
Forest area with trees	244.39 km^2
Grassland with high biomass	318.63 km^2
Grassland with poor biomass	322.32 km^2
Human infrastructure	72.09 km^2
Open vegetation type	66.28 km^2
Rock and scree	4.66 km^2

Water bodies	1.27 km^2
Glacier and snow fields	13.17 km^2

3.2 RUSLE Model Analysis for Water Erosion

There are many models in the world that determine soil erosion; the most common of which is the RUSLE (Revised Universal Soil Loss Equation) model. The RUSLE was developed in the U.S. based on soil erosion data collected beginning in the 1930s by the U.S. Department of Agriculture (USDA) Soil Conservation Service (now the USDA Natural Resources Conservation Service.

This model was used to determine the risk of erosion in the Ismailli area. In order to implement this model, firstly, erosion factors have been used.We used (LS, R, K, C) for the Ismailli region Rapid Eye sateliite image, DEM, Rainfall data, Soil data. then we calculated the erosion factors as shown below.

3.2.1 LS Factor

LS factor can describe as slope steepness that calculated using DEM products. Slope, flow direction and flow accumulation calculated using DEM.

Slope length (*L*) is the effect of slope length on erosion. The slope length is defined as the distance from the point of origin of overland flow to the point where either the slope decreases to the extent that deposition begins, or runoff water enters a well-defined channel. Thus, the soil loss per unit area increases as the slope length increases. Slope steepness (*S*) represents the effect of slope steepness on erosion. The effects of slope steepness have a greater impact on soil loss than slope length. Steeper the slope, the greater is the erosion. The worst erosion occurring between 10 and 25% slope. Therefore, the topographic factor is calculated using Equation.

In the USLE and RUSLE, the L factor is calculated according to the following general equation:

$L = (\lambda/22.1)^m$

in which λ = slope of any length, m; 22.1 = standard slope length of the plot, m; and m = exponent related to the steepness of the terrain (0.5 for slope ≥0.05 m m-1; 0.4 for slope from 0.035 m m-1 to 0.045 m m-1; 0.3 for slope from 0.01 m m-1 to 0.03 m m-1; and 0.2 for slope

$m = \beta / (1 + \beta)$

in which β = ratio between erosion in the rill and erosion interrill. In soil conditions moderately susceptible both to erosion in rill and to erosion interrill, β is calculated by the following equation:

$$\beta = \frac{\left(\frac{sen\theta}{0.0896}\right)}{[3(sen\theta)^{0.8} + 0.56]}$$

Modification of the model to the RUSLE version, with inclusion of the value of β for calculation of the m exponent, resulted in an increase in the predictive ability of the RUSLE in relation to the USLE, especially on slopes up to a length of approximately 100 m (Renard et al., 1997).

To calculate the S factor of the RUSLE the following equation was used:

$$S_{(i,j)} = \begin{cases} 10{,}8 \sin \beta_{(i,j)} + 0{,}03 & \tan \beta_{(i,j)} < 0{,}09 \\ 16{,}8 \sin \beta_{(i,j)} - 0{,}5 & \tan \beta_{(i,j)} \geq 0{,}09 \end{cases}$$

L factor and S factor are usually considered together. LS factors = the slope length factor L computes the effect of slope length on erosion and the slope steepness factor S computes the effect of slope steepness on erosion. Values of both L and S equal 1 for the unit plot conditions of 72.6 ft. length and 9 percent steepness. Values of L and S are relative and represent how erodible the particular slope length and steepness is relative to the 72.6 ft long, 9% steep unit plot. Thus some values of L and S are less than 1 and some values are greater than 1. Stripcropping or contouring does not affect the LS value.(Source: http://www.iwr.msu.edu/rusle/lsfactor.htm)

Figure 5: L-S Factor Map for Ismailli

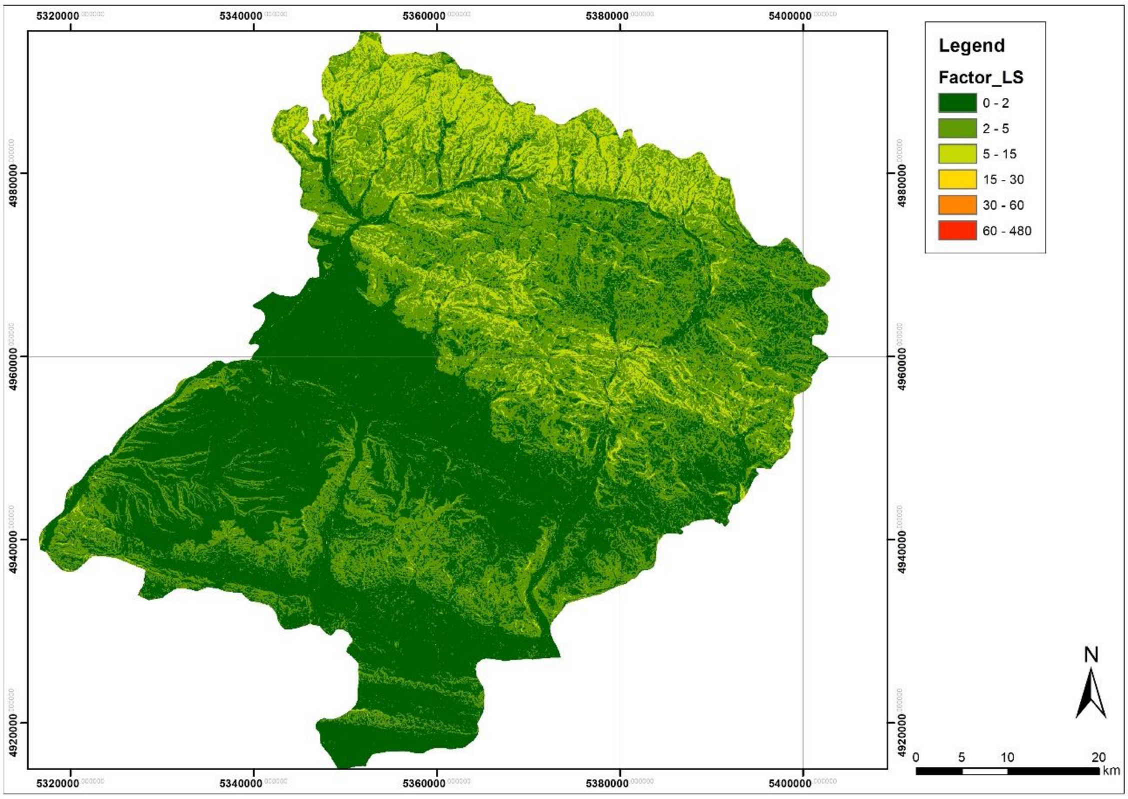


Table 2: LS Factor Intervals and Areas for Ismailli

Interval	Area km^2
0 - 2	4493.81
2- 15	1874.73
15 - 30	3.39
30 - 60	0.81
60 - 480	0.26

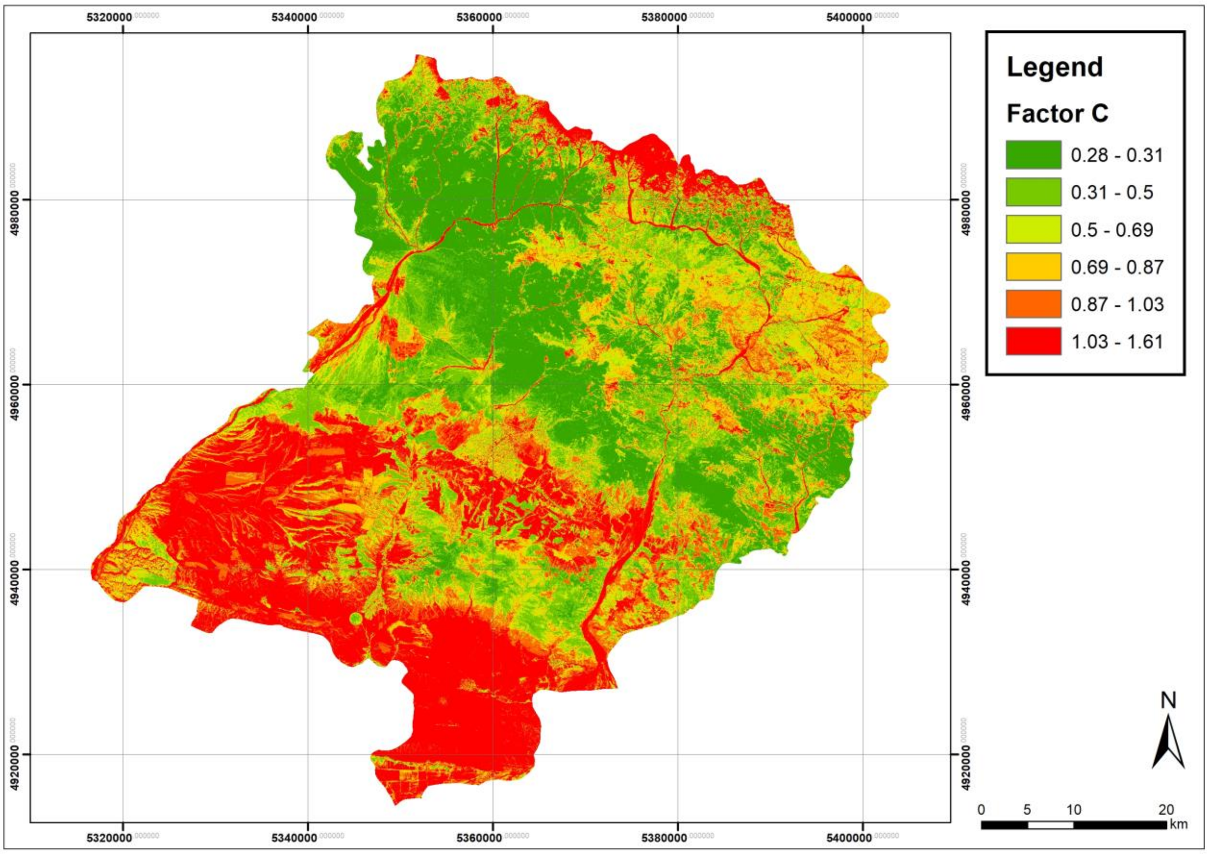
3.2.2 C- Factor

The *C*-factors are the most important factor for erosion risk assessment. In our work C-Factor calculated using NDVI from Rapid Eye satellite images. C- Factor can show us to easily where is the vegetation is high and where is the low. The main reason here RUSLE formulas; "LS*K*C*R= Soil Loss Risk" because of this equation, C-factor high values must show non-forest area, on the other hand low values must show forest area. Final erosion risk map high values can show potential erosion area with this way.

The regression equation as (Karaburun 2010);

C factor = 1.02– 1.21 * NDVI

Figure 6: C Factor map for Ismailli (Calculated from Rapid Eye)



3.2.3 K Factor

The soil erodibility factor (K-factor) is a quantitative description of the inherent erodibility of a particular soil; it is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. For a particular soil, the soil erodibility factor is the rate of erosion per unit erosion index from a standard plot. The factor reflects the fact that different soils erode at different rates when the other factors that affect erosion (e.g., infiltration rate, permeability, total water capacity, dispersion, rain splash, and abrasion) are the same. Texture is the principal factor affecting Kfact, but structure, organic matter, and permeability also contribute. The soil erodibility factor ranges in value from 0.02 to 0.69 (Goldman et al. 1986; Mitchell and Bubenzer 1980).

Soils high in clay have low K values, about 0.05 to 0.15, because they resistant to detachment. Coarse textured soils, such as sandy soils, have low K values, about 0.05 to 0.2, because of low runoff even though these soils are easily detached. Medium textured soils, such as the silt loam soils, have a moderate K values, about 0.25 to 0.4, because they are moderately susceptible to detachment and they produce moderate runoff. Soils having a high silt content are most erodible of all soils. They are easily detached; tend to crust and produce high rates of runoff. Values of K for these soils tend to be greater than 0.4.

For the calculation Estimated soil erodibility (K factor) of Ismailli region we downloaded from official web site of The International Institute for Applied Systems Analysis (IIASA) harmonized world soil database and Soil Raster Map.

Table 3: Structure Soil type of Ismailli region.

(Source: http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/HWSD_Data.html?sb=4)

MU_GLOBAL	T_SAND	T_SILT	T_CLAY	T_OC	T_OM
27720	45	31	24	0.87	1.4964
28026	53	26	21	0.75	1.29
28035	45	31	24	0.87	1.4964
28041	44	37	19	0.72	1.2384
28042	42	26	32	0.93	1.5996
28044	42	26	32	0.93	1.5996

Then we can find the K factor values for the Ismailli region from the texture we show below.

Table 4: Estimated soil erodibility (K factor) texture.

(Source: http://data.naturalcapitalproject.org/invest-releases/documentation/3_0_1/sediment_retention.html)

Estimating soil erodibility (K) based on soil texture and organic material content.

Textural Class	Spanish Texture Class	Soil composition			Mean K (based on % organic material)		
		Sand	Silt	Clay	unknown	< 2%	≥ 2 %
Clay	*Arcilloso*	0-45	0-40	40-100	0.22	0.24	0.21
Sandy Clay	*Arcilloso arenoso*	45-65	0-20	35-55	0.2	0.2	0.2
Silty Clay	*Arcilloso limoso*	0-20	40-60	40-60	0.26	0.27	0.26
Sand	*Arenoso*	86-100	0-14	0-10	0.02	0.03	0.01
Sandy Loam	*Franco arenoso*	50-70	0-50	0-20	0.13	0.14	0.12
Clay Loam	*Franco - arcilloso*	20-45	15-52	27-40	0.3	0.33	0.28
Loam	*Franco*	23-52	28-50	7-27	0.3	0.34	0.26
Loamy Sand	*Franco arenoso*	70-86	0-30	0-15	0.04	0.05	0.04
Sandy Clay Loam	*Franco arenso arcilloso*	45-80	0-28	20-35	0.2	0.2	0.2
Silty Clay Loam	*Franco limoso arcilloso*	0-20	40-73	27-40	0.32	0.35	0.3
Silt	*Limoso*	0-20	88-100	0-12	0.38	0.41	0.37
Silty Loam	*Franco limoso*	20-50	74-88	0-27	0.38	0.41	0.37

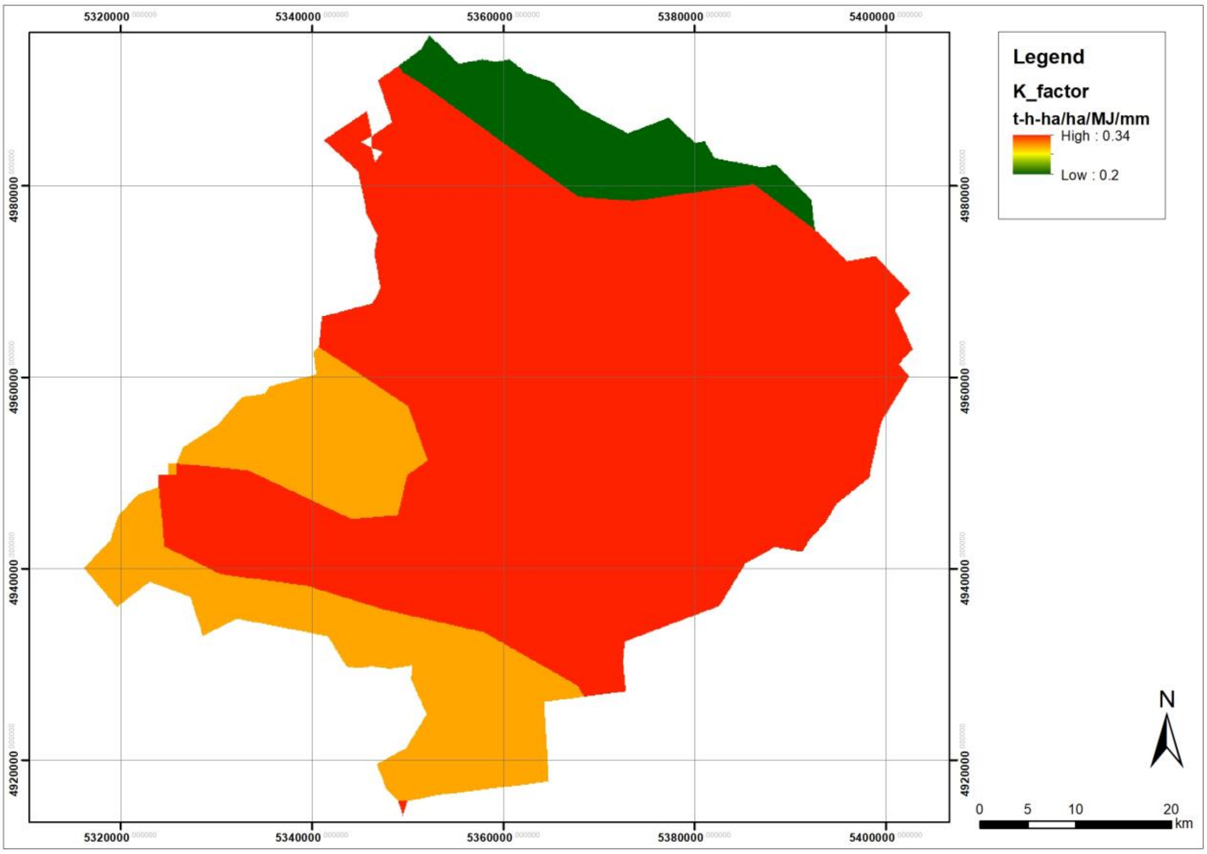
When we look texture above, K factor in Ismailli soil is like below.

Table 5: Estimated soil erodibility (K factor) Ismailli soil.

(Source: http://webarchive.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/HWSD_Data.html?sb=4)

MU_GLOBAL	T_SAND	T_SILT	T_CLAY	T_OC	T_OM	K factor
27720	45	31	24	0.87	1.4964	0.34
28026	53	26	21	0.75	1.29	0.2
28035	45	31	24	0.87	1.4964	0.34
28041	44	37	19	0.72	1.2384	0.34
28042	42	26	32	0.93	1.5996	0.33
28044	42	26	32	0.93	1.5996	0.33

Figure 7: K factor map from soil data



3.2.4 R Factor

The rainfall erosivity factor (*R*) reflects the effect of rainfall intensity on soil erosion, and requires detailed, continuous precipitation data for its calculation (Wischmeier and Smith, 1978). *R* is an indication of the two most important characteristics of a storm determining its erosivity with amount of rainfall and peak intensity sustained over an extended period. Previous studies indicate that soil loss from cultivated fields is directly related to the energy and intensity of each rainfall. The value of rainfall erosivity factor used in RUSLE must quantify the effect of raindrop impact and must also reflect the amount and rate of runoff likely to be associated with the rainfall. Rainfall data were used to calculate the *R* factor from the following Equation. developed by Wischmeier and Smith (1978):

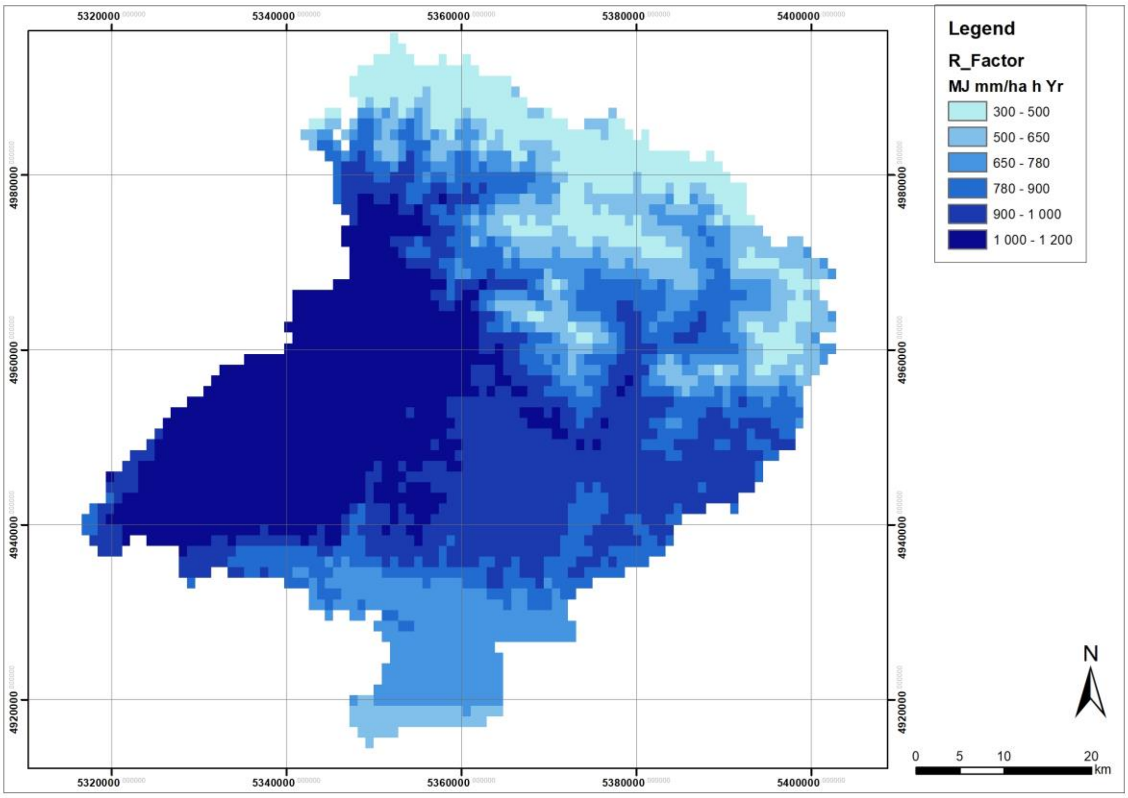
$$R=\sum 1121.735\times 10^{(1.5\log 10(Pi/P)-0.08188)}$$

where *R* is a rainfall erosivity factor (MJ mm ha^{-1} h^{-1} per year); P_i is monthly rainfall (mm); *P* is an annual rainfall (mm).

R factor data captured from “European Commission Global Rainfall Erosivity Database”. The Global erosivity map (GeoTIFF format) at 30 arc-seconds (~1 km) resolution is available for free download in the European Soil Data Centre (ESDAC) These data measurement unit is “MJ mm ha^{-1} h^{-1} per year”

Figure 8: R Factor(rainfall erosivity)

(rainfall data source: https://esdac.jrc.ec.europa.eu/content/global-rainfll-erosivity)



4. **Conclusion**

4.1 Water Erosion

As a result, we have created a map of the risk zones of erosion risk in the Ismailli region from the erosion-causing factors. As shown in the map below, the risk of erosion is higher in the high areas of the Ismailli region, especially on the hard mountain slopes. It's impossible to stop the wind from blowing or the rain from pouring down, but you can minimize their effects on your hillside in various ways to keep soil from eroding. The best way to stop soil erosion is to use all the methods at your disposal - planting shrubs and ground covers with strong root systems; building terraces; installing drip irrigation systems.

One of the best ways to prevent soil erosion is to increase vegetation. Plants and trees grow above the surface, protecting soil from erosion, and their roots meander down through the soil and become like bars in a prison, locking the soil particles in place, making it hard for them to escape and be carried away by water.

Other way to prevent soil erosion is Terracing. Terracing is generally reported as successful in limiting the soil erosion by water rate. Its efficiency in limiting the soil erosion rate is connected to reducing the volume and speed of rain surface runoff because the amount of lost soil is directly related to surface water flow. There are available several literature reports concerning the efficiency of terracing in limiting soil erosion compared to erosion rate for untransformed slopes in the same soil and climatic conditions for various regions of the world

Figure 9: Erosion risk map of Ismailli region.

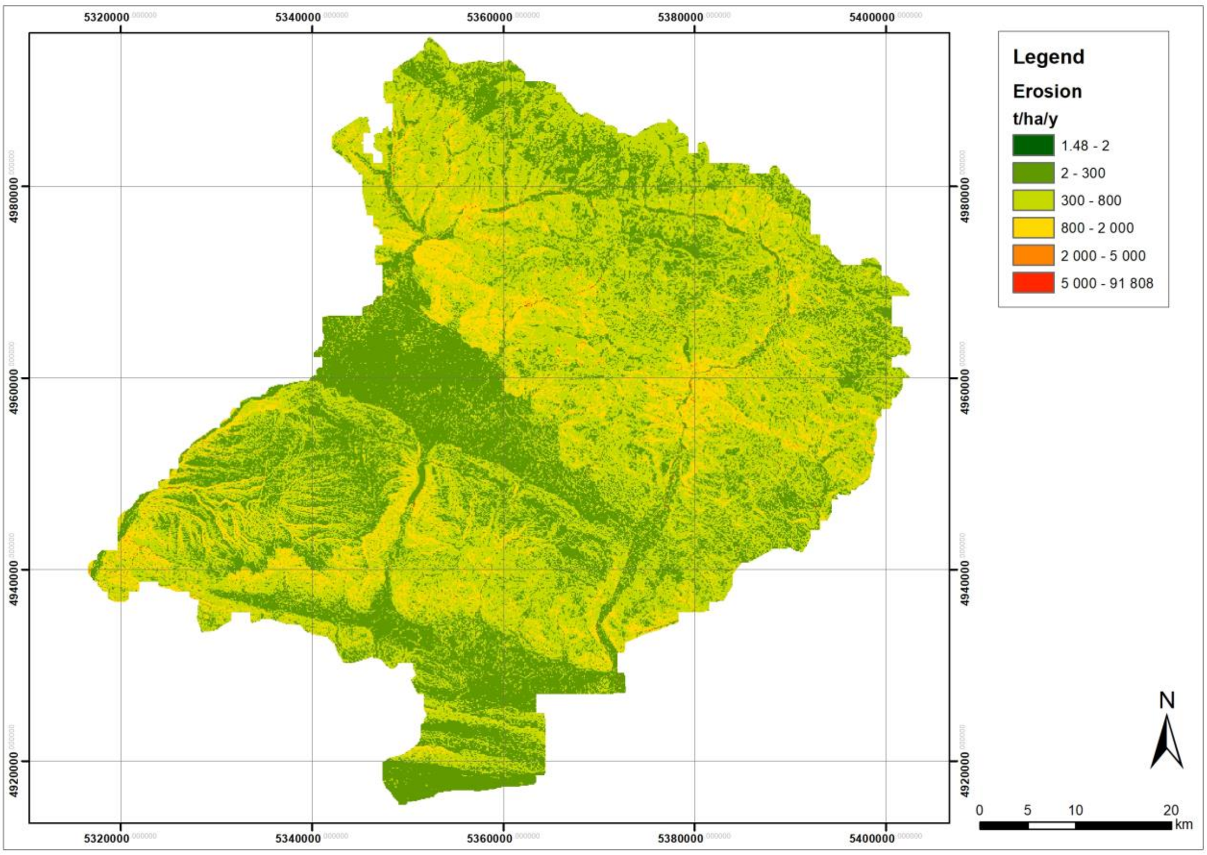
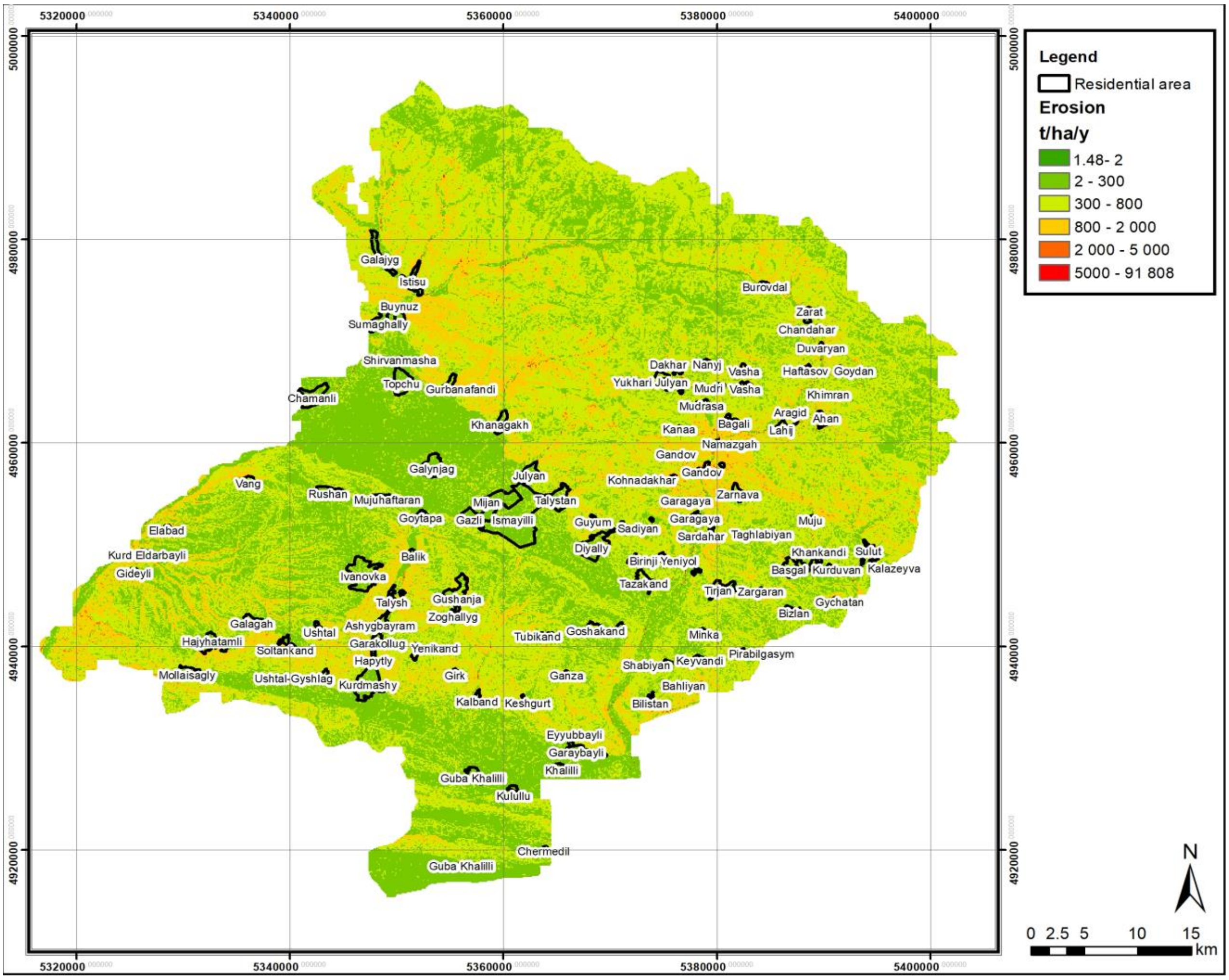


Figure 10: Erosion risk map of Ismailli region with residential area.



it is possible to see the areas with the highest erosion risk from the above maps close to the residential areas.An example of this is the areas near Namazgah, Gandov, Lahij, Duvaryan, Mushgamir, Burovdal, Galajig etc. villages are the most risky erosion areas.

Figure 11: Most riskiy area and Settlements sample 1

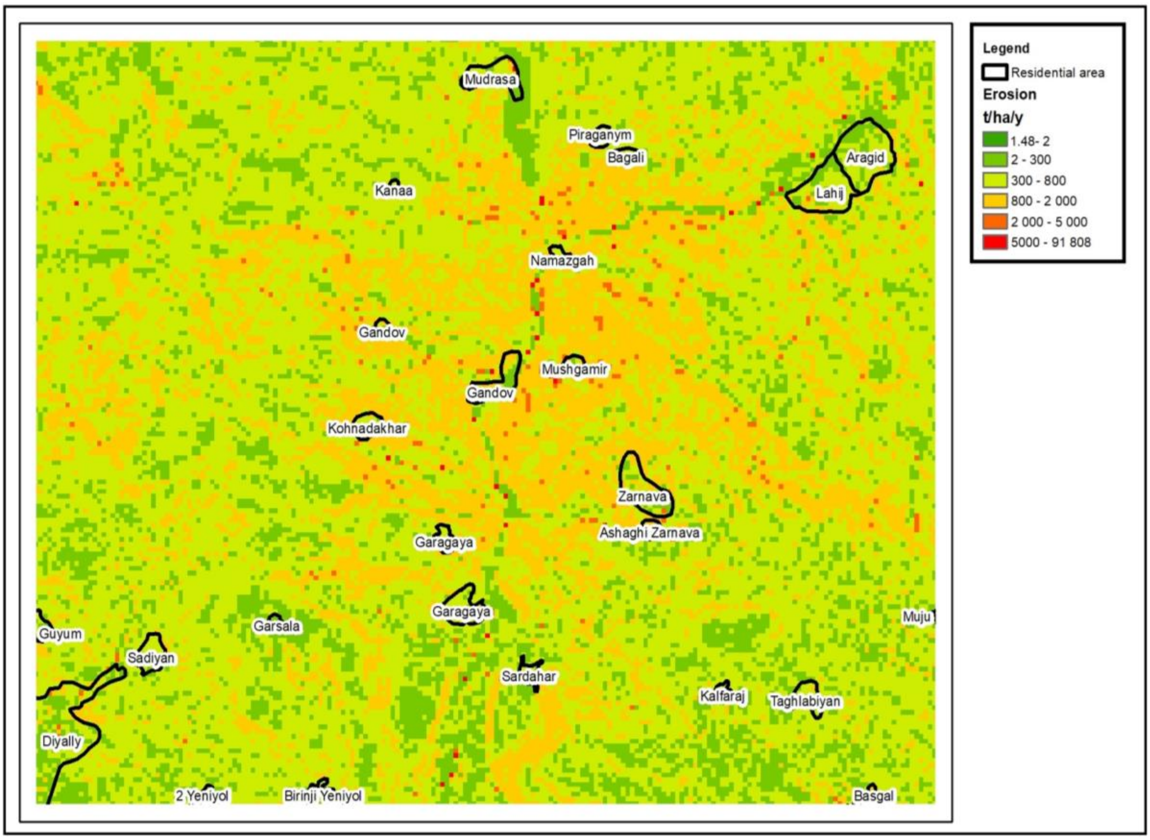
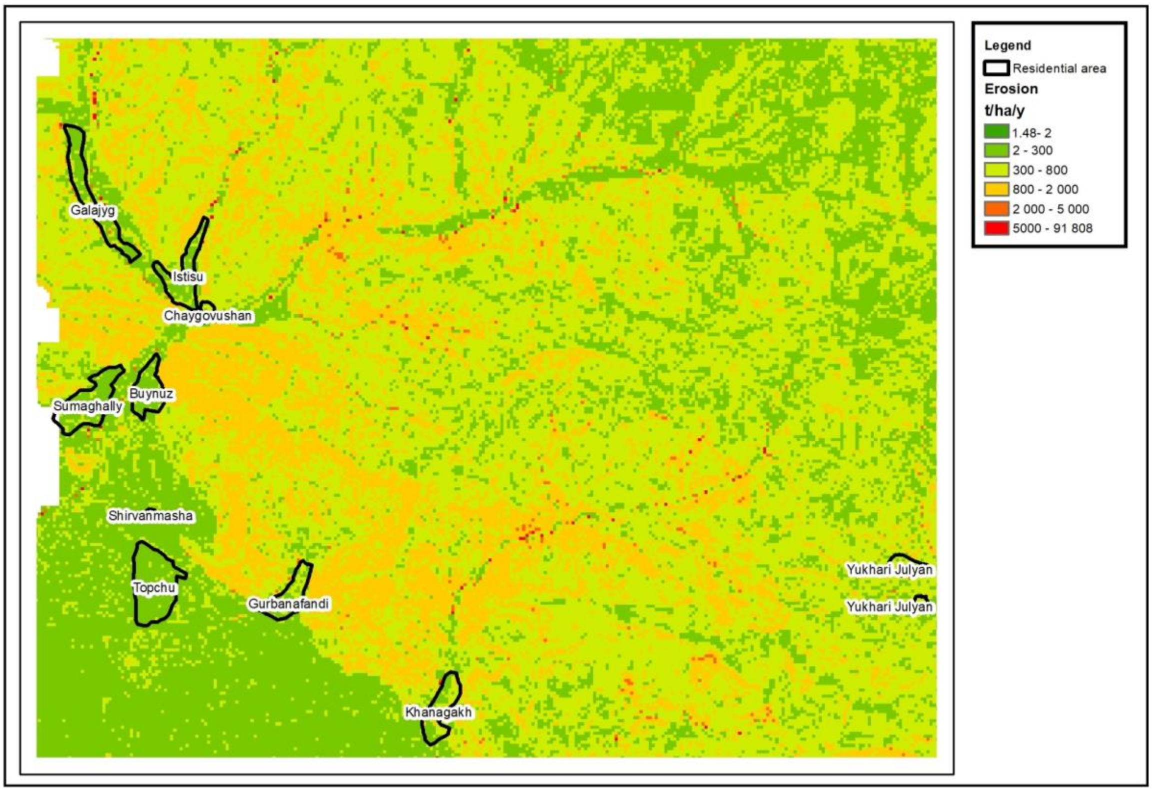


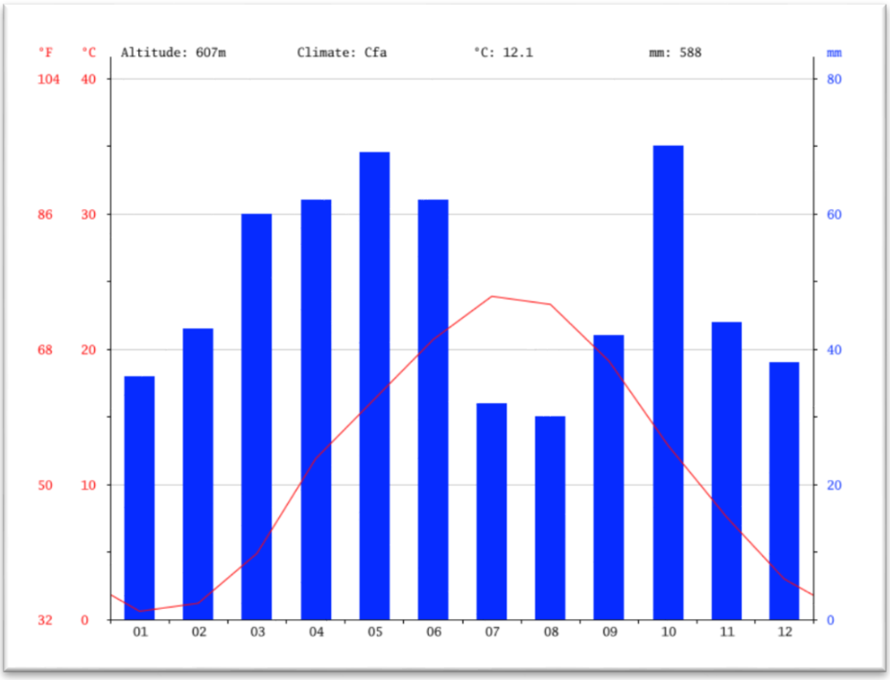
Figure 12: Most Risky area and settlements sample 2



4.2 Wind Erosion Assessment

In this study, we have deeply investigated water erosion in Ismailli Region because of the Ismailli climate is warm and temperate. The rainfall in İsmailli is significant, with precipitation even during the driest month. According to Köppen and Geiger, this climate is classified as Cfa (Humid subtropical climate). In İsmailli, the average annual temperature is 12.1 °C. The average annual rainfall is 588 mm.(https://en.climate-data.org/location/28489/).

Figure 13: Ismailli Precipitation and Temperature (https://en.climate-data.org/location/28489/)



According to the Figure 10 Ismailli does not have any month without rainfall. Rainfall cannot let move sand and other land material with wind. On the other hand, when we check the wind speed in Ismailli, that every month lower than 12 km/h without a few days. Because of these reasons we cannot clearly describe wind erosion that kind of low wind speed and humid area but we will try to show possible lands.

Figure 14: Ismailli Wind Speeds

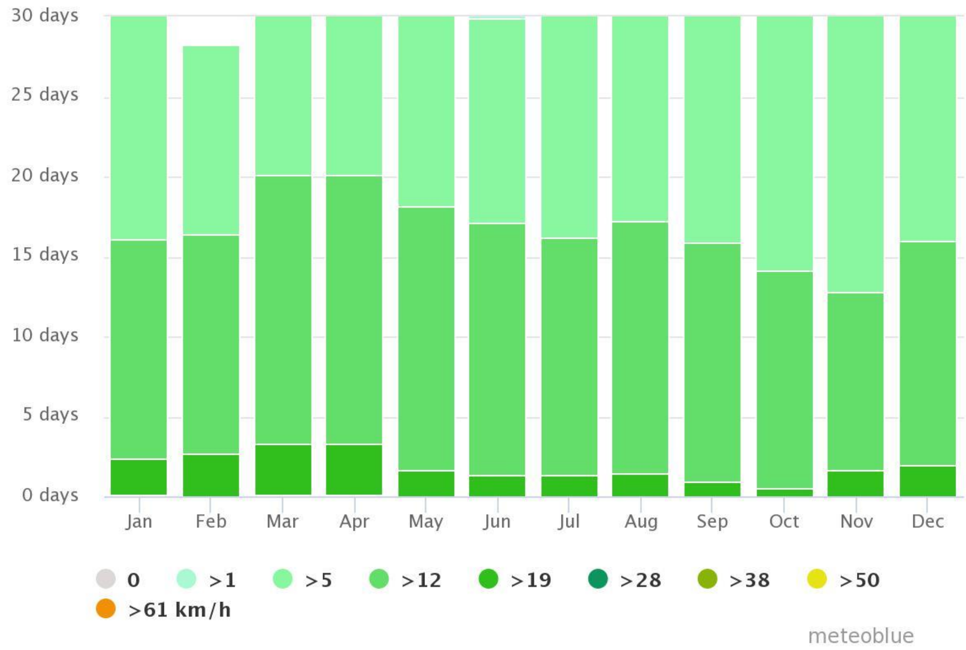
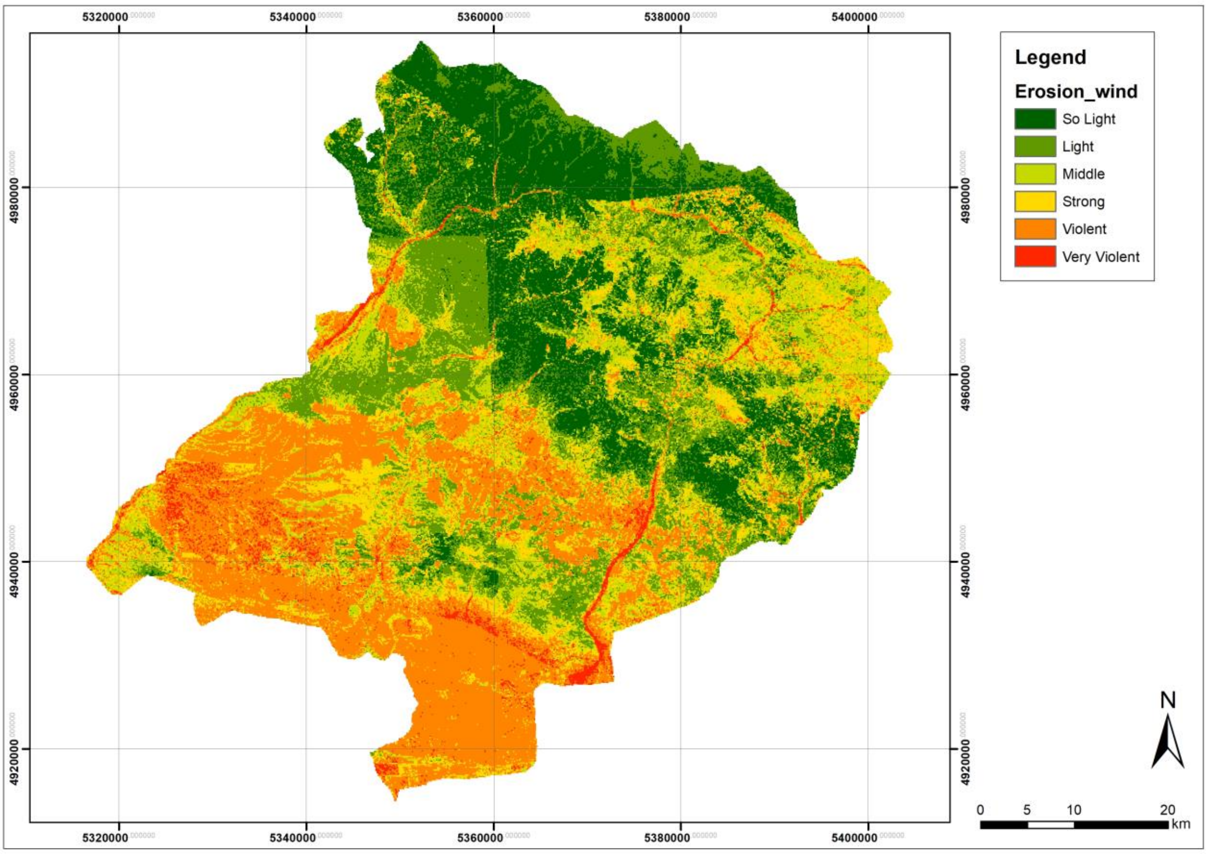


Figure 15: Ismailli Potential Wind Erosion Map



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Ismailli wind speed and direction data source: Ministry Of Ecology and Natural Resources Of Azerbaijan Republic

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