BioTopic

Sensitivity and Management Models of Pastures

Comprehensive knowledge of the condition of pastures is the basis for accurate policy decisions and consequent management.

Background

Summer pastures in Armenia are an important resource for feeding livestock and have an outstanding value for biodiversity. In Armenia, during the past 5 years, there has been a higher rate of soil erosion and decreased capacity of summer pastures because of the rapid increase of grazing livestock. The future situation of pastures in Armenia depends on accurate policy decisions and consequent management, which, in their turn, require sound knowledge and primary data about the conditions of pastures.

Aim and Objectives

Primary data availability plays a crucial role in selecting appropriate cost-effective methods for pasture assessment, monitoring, and planning. In Armenia the main obstacle for meeting this objective is the lack of detailed soil property maps as well as low density of meteorological stations. As erosion is a multi-temporal procedure, seasonal land cover and use affect the accuracy of any mapping results. Thus, several potential data sources should always be considered for obtaining seasonal land cover, soil characteristics, and rainfall estimations. The following methodology has been designed for a nationwide implementation of comprehensive and objective monitoring and planning of pasture conditions. The main aim of this work was to develop a GIS-based Revised Universal Soil Loss Equation Model (RUSLE) and to use Remote Sensing (RS) - based methods for assessing the state of pastures and the potential risk of soil erosion on Aragats Mountain.

Dataset

The data that was available for the implementation of this work comprised the following:

- A land cover map (Figure 1)
- A set of Rapid Eye (2011) and Landsat ETM (2011) satellite images (Figure 2)
- Generated Digital Elevation Model (DEM) (Figure 3)
- A geological map
- Monthly climatic average observations derived from three meteorological stations

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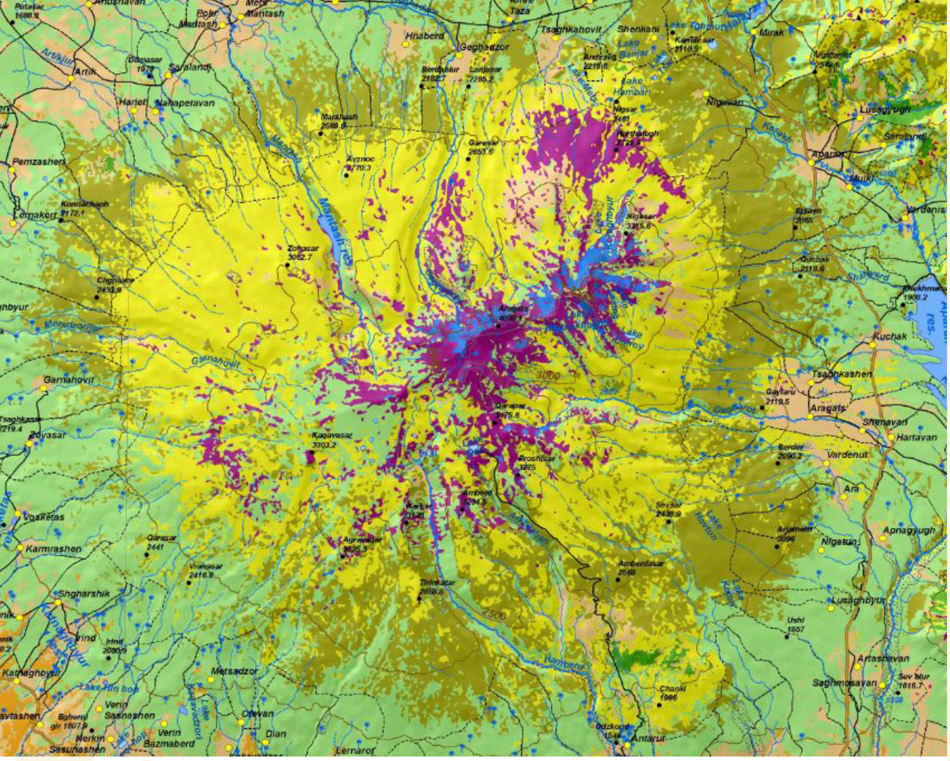


Figure 1: A land cover map.

Figure 2: A set of Rapid Eye (2011) and Landsat ETM (2011) satellite images.

Methodology

A large variety of models can be found in literature for soil erosion risk assessment. One of the most widely applied empirical models for assessing erosion is the Universal Soil Loss Equation (USLE), developed by Wischmeier and Smith in 1978. This model takes into consideration several determining factors, such as the soil erodibility factor, rainfall intensity factor, slope length and steepness factor, cover and management factor and support practice factor. USLE was developed mainly for soil erosion estimation in croplands or gently sloping topography. USLE estimates soil loss from a hill slope caused by raindrop impact and overland flow. A Revised Universal Soil Loss Equation (RUSLE) followed the same formula as USLE, but got several improvements in the determining factors and a broader application to different situations, including forests, rangelands and disturbed areas compared to USLE. RUSLE is a computation method that may be used for site evaluation and planning purposes and also for assisting in the decision process of selecting erosion control measures. It provides an estimate of the severity of erosion and also numerical results that can validate the benefits of planned erosion control measures in the risky areas.

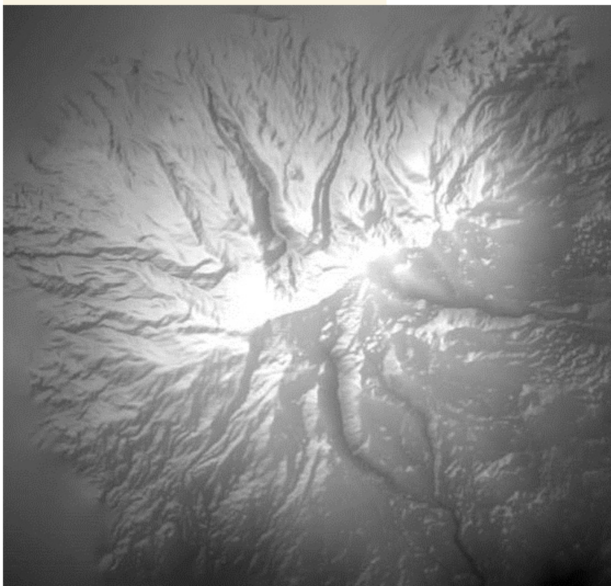
The methodology used in this work was the implementation of the RUSLE in a raster GIS environment after some modifications in the calculation of specific factors. RUSLE was developed as an equation of the main factors controlling soil erosion, namely climate, soil characteristics, topography, and land cover management. More specifically, RUSLE is expressed by the following formula:

$$A=R*k*LS*C*P$$

where A: mean annual soil loss, R: rainfall erosivity, k: soil erodibility, S: slope steepness, L: slope length, C: cover and management, P: support practices. USLE was applied in Aragats in the spatial domain using GIS, i.e., all RUSLE factors were derived as raster geographic layers after processing the original data, then they were multiplied together for calculating the final risk map (an overview of all the methodological steps is given in Figure 4).

> Internationally developed innovative model (RUSLE) has been adopted to calculate sensitivity of mountainous vegetation in Armenia.

Figure 3: Generated Digital Elevation Model (DEM).



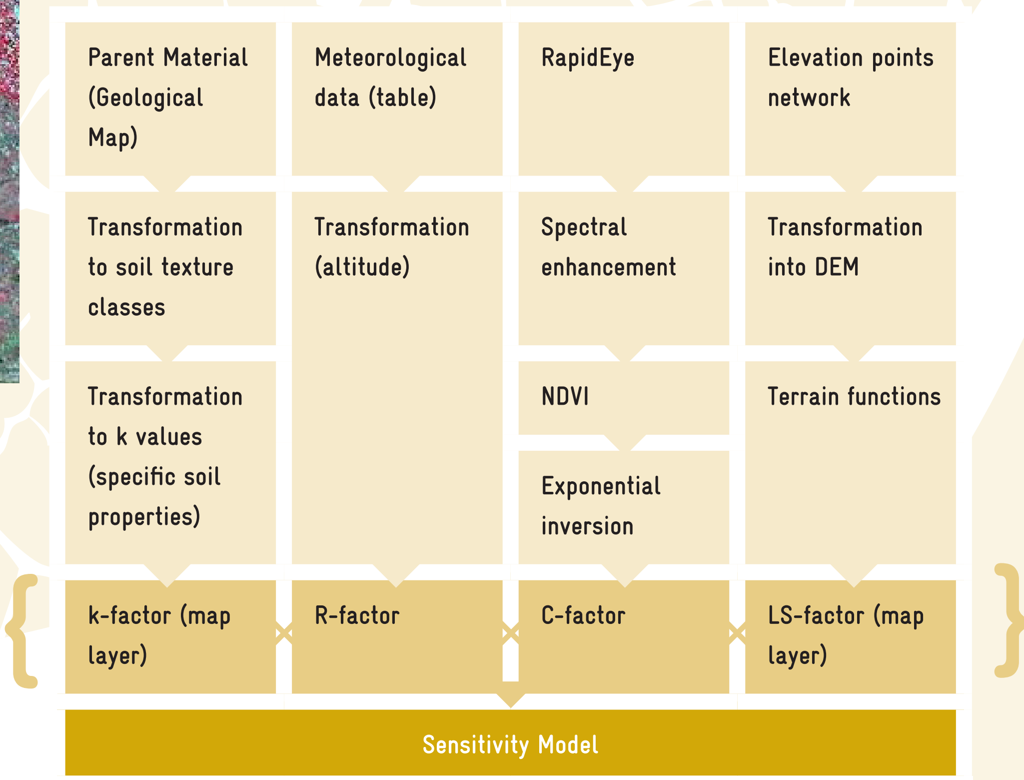


Figure 4: The scheme of the methodological steps for the calculation of the sensitivity model.

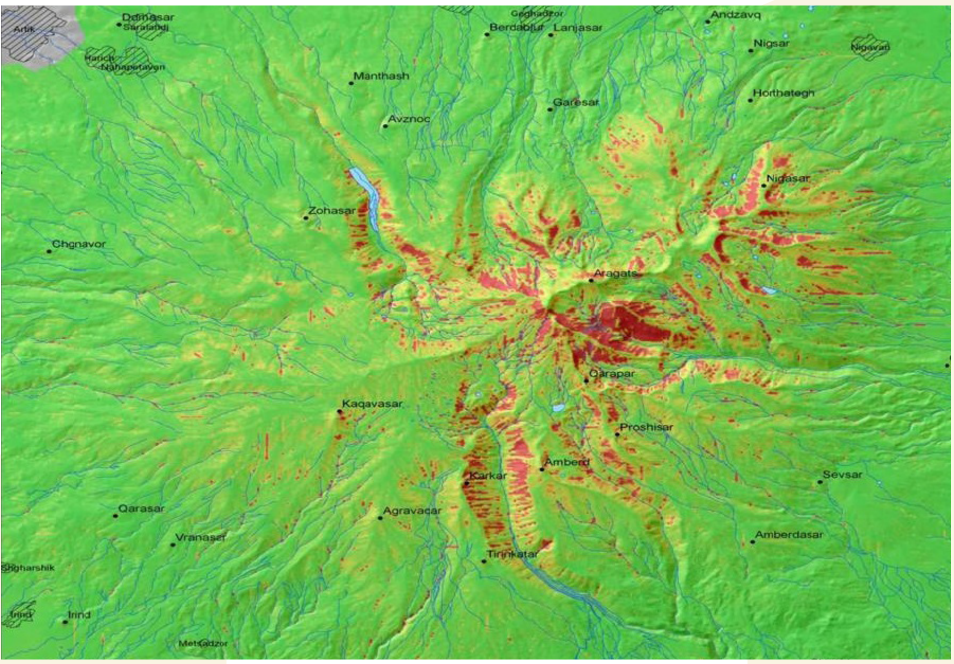


Figure 5: The erosion risk map for August 2011.

Results:

The results of the RUSLE implementation in the raster geographic domain comprised the maps of soil erosion risk of Aragats. The original values were classified in 9 classes of severity and were presented in a color scheme of green (low risk) to red (high risk) in erosion risk maps (Figure 5).

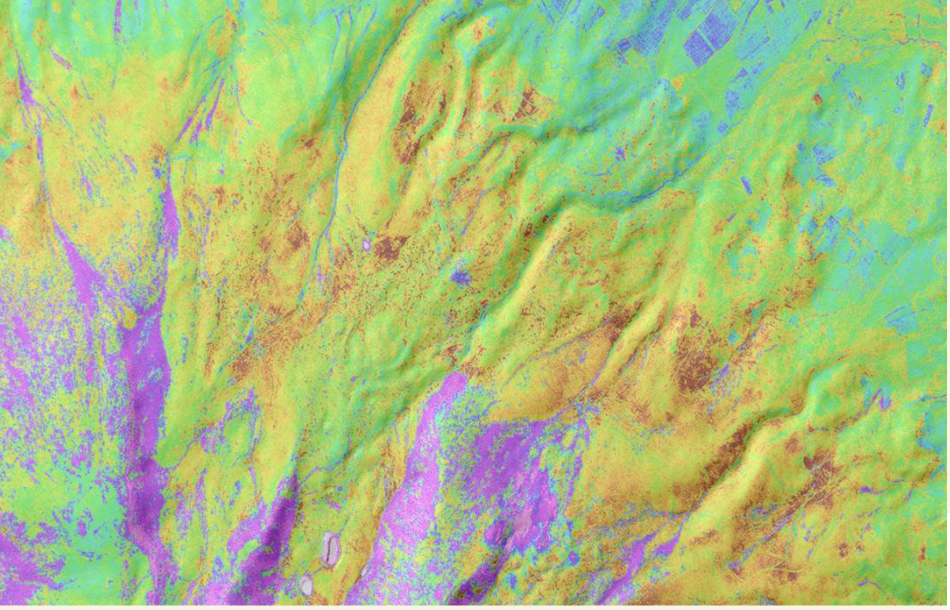


Figure 6: The state of pastures in August.

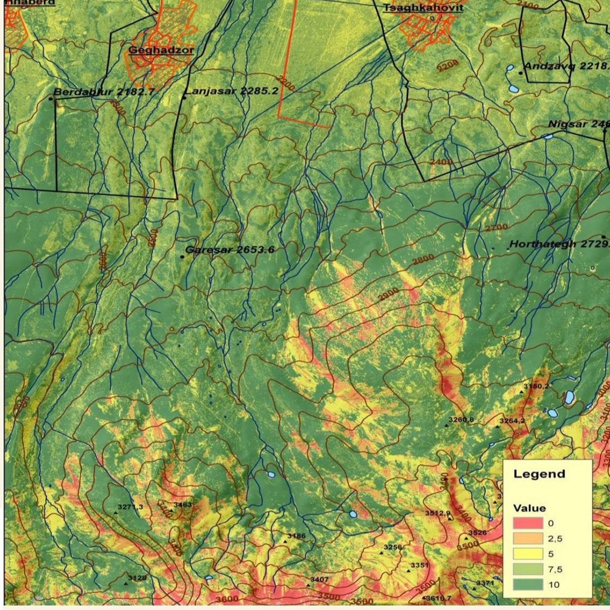


Figure 7: Map of pasture management planning.

Purple	Bare soil and rocks (big, stable)
Light blue and mixed yellow-green	Low vegetation on cattle tracks, grazing and hay-making sites
Light brown and brown	Unused areas with plenty of vegetation

The State of Pasture Sites

Based on biophysical and object-based RS-methods (Rapid Eye and Landsat images) the current level of erosion and the current state of a pasture site (intensity of grazing, hay-making, etc.) in Aragats is revealed. The above map (Figure 6) presents the state of pastures in different colors.

Based on the maps of erosion risk and the results of RS, a third map is produced based on which pasture management planning, including the grazing rotation and grazing capacity norms can be conducted. Figure 7 depicts the map of pasture management planning based on the allowed number of cattle units per ha (Figure 8).

Figure 8: Sustainable grazing capacity

Coefficients	Number of cattle (Stock Unit) per hectare
10	8 SU/ha
7.5	5 SU/ha
5	4 SU/ha
2.5	2 SU/ha

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