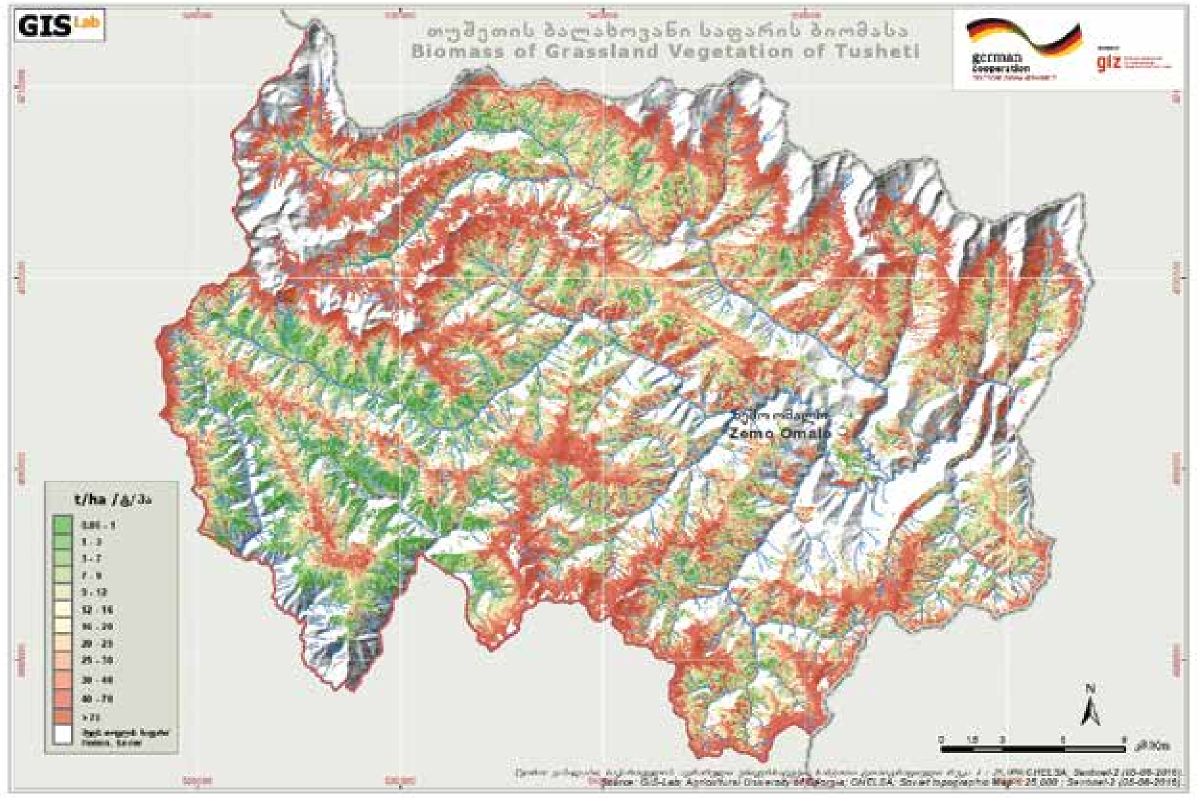
Land cover map
The map classifies deciduous and coniferous forests, shrubland, grassland with different biomass content, bare soil, water, snow, glaciers, and villages. It was calculated based on the different spectral bands of the Sentinel - 2 satellite image. This was done by a Support Vector Machine (SVM) classification which was trained with field sample plots.



Biomass map
The map presents the amount of above-ground biomass (tons per ha) available as fodder for livestock. The biomass was calculated from the Sentinel - 2 red and infrared bands based on the images from August 2016 and June 2017. The spectral information from the Satellite was calibrated by 88 biomass sample collected on Tusheti in 2016 and 2017.

Benefits and possibilities

The Soil Erosion Risk Model can be used on different scales, while the accuracy mainly depends on the quality of the input data. Soil loss maps produced by combining remote sensing with ecological parameters (climate, elevation, soil data...), can be helpful for sustainable land use planning. E.g. pasture use planning with aim to exclude high erosion risk area from grazing. This will influence on maximum number of livestock per pasture unit and the lease contracts with shepherds can be adjusted accordingly.

The maps also show where the productive pastures are located, and which areas are threatened by erosion. Rangers can thus guide shepherds according to the erosion risk map and prevent further vegetation damage by trampling and grazing in sensitive areas. Furthermore, future development of pastures, tourism and agriculture can be planned in such a way that shepherds benefit from the side activities, e.g. infrastructure development and better marketing of their products.

Sources

Kirchmeir, H. (2019). Implementation of an Erosion Risk Assessment tool on pilot regions in the Southern Caucasus. Report - Integrated Biodiversity Management, South Caucasus. 11 p. Accessible at: https://biodivers-southcaucasus.org/uploads/files/Regional%20Adaptation%20of%20Sensitivity%20Model.pdf

Mikeladze G. & Nikolaeva E. (2016): Development of Land Cover and Erosion Risk Map based on Remote Sensing for Tusheti Protected Areas (Georgia). Project report within the GIZ-Program "Integrated Biodiversity Management in the South Caucasus" (IBiS). Implemented by GIS-Lab Georgia. 24p https://biodivers-southcaucasus.org/uploads/files/Tusheti_Report_2016_v2.pdf

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Integrated Biodiversity Management, South Caucasus (IBiS)

Bio *Topic*

Assessing Soil Erosion Risk

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Figure 1: Jvarboseli village in Tusheti

The Programme "Integrated Biodiversity Management, South Caucasus (IBiS)" was financed by the German Federal Ministry for Economic Cooperation and Development (BMZ). In Georgia, IBiS contributed to the biodiversity conservation through the rehabilitation of degraded areas and the protection of natural resources from human-induced erosion processes. To assess the current state and soil erosion risk in the Tusheti Protected Areas, geoinformation technology based tool - the Soil Erosion Risk Model was developed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with national experts.

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Figure 2: Pasture land in Shenako, Tusheti

Soil Erosion

Soil erosion is a process driven by water runoff and wind. In the event of heavy rainfall or wind, the upper soil layer is removed and transported to a new location. As soil is a crucial production factor for plant growth, its erosion has a great impact on agriculture. Loss of soil means loss of productivity of the land. The natural regeneration of soil is a very slow process that takes centuries to develop a few centimetres of productive soil layer. To maintain the productivity of the land (for agriculture, pastoralism, forestry), it is important to protect the soil layer from erosion.

From a land management perspective, the following questions are of interest:

- Do the soil layers erode?
- What is the spatial dimension of these erosion processes (where is the erosion located)?
- Does the degree (intensity, size of the affected area) change over time?

In the subalpine and alpine regions of Georgia (e.g. Tusheti), the traditional sustainable land-use system changed during the Soviet era and traditional ploughland became pastureland. Overgrazing, deforestation and trampling of mountain grassland ecosystems (pastures) by cattle led to the degradation of the protective vegetation cover. The consequence was soil erosion, intensified by wind and runoff water from rainfall, streams and intensive snowmelt. This led to a nutrient depletion that now affects the quality of the pastures and their ability to sustain future livestock production.

Methodology

Remote sensing constituted a critical part of the methodology aimed at assessing the current erosion level and risks. Sentinel-2 satellite images provided an up-to-date information on vegetation cover by analysing different spectral bands of the images (red, near infrared). Climatic data and precipitation maps indicated the amount of rainfall for specific regions. Digital elevation models provided information on slope inclination and length. Based on these input data and using the Soil Erosion Risk Model developed by the experts from the Caucasus region with the support of GIZ, erosion risk maps were produced. Using these maps, land use adaptation strategies can be developed to control erosion and monitor erosion processes over time.

> **Remote sensing** *is the technology of obtaining information about objects or areas from a distance, typically from airplanes or satellites. The method contrasts with on-site observation and is used to explore the Earth's surface.*

> *At an altitude of 786 km, two* **Sentinel-2 satellites** *orbit the earth. They are operated by the European Space Agency (ESA) and images can be taken every 5 days from any point on the planet.*

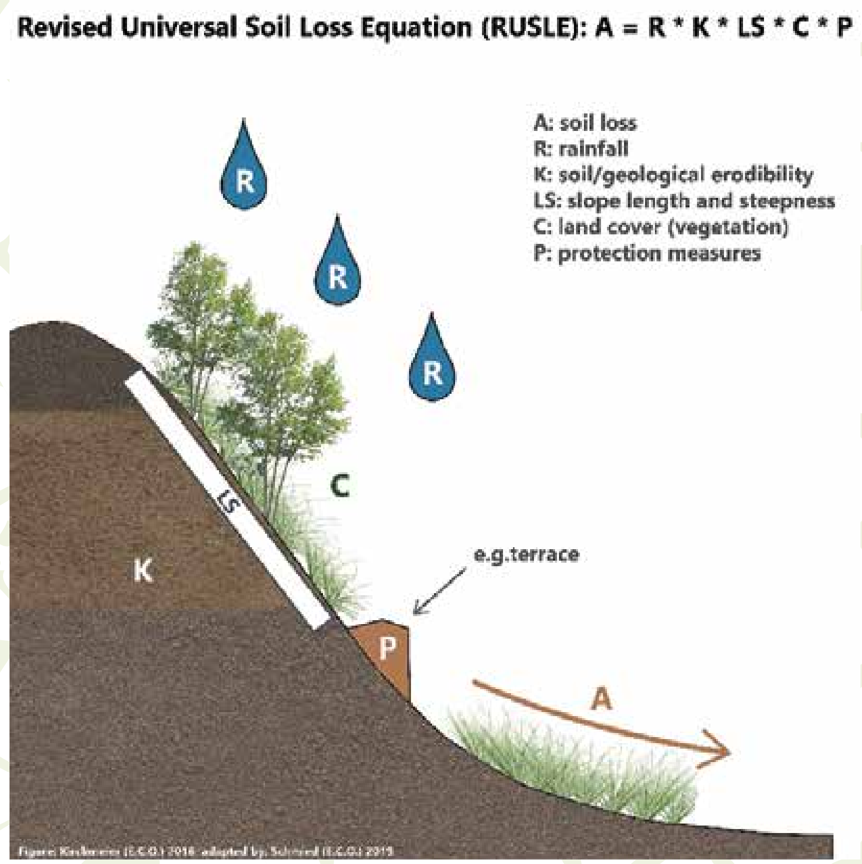


Figure 3: The Soil Erosion Risk Model was based on the RUSLE – Revised Universal Soil Loss Equation (Renard et al. 1996).

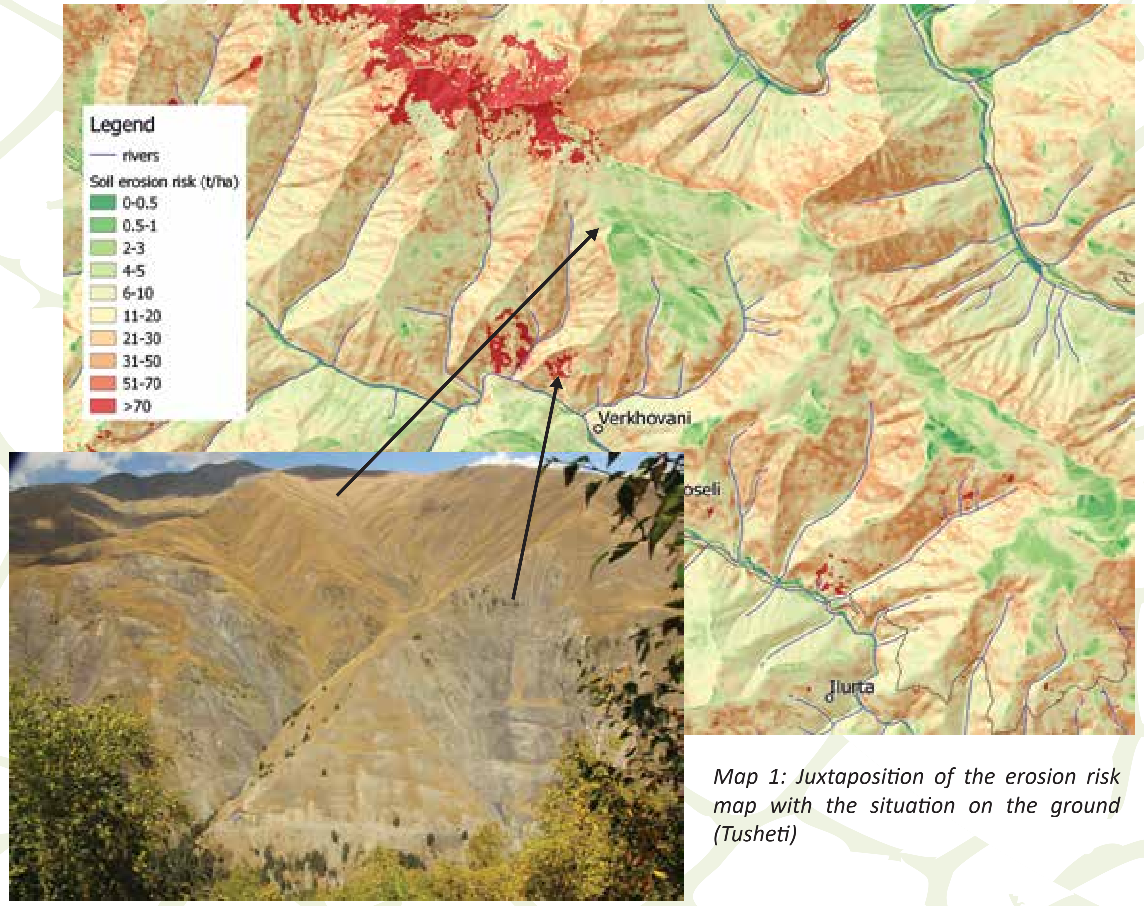
The Soil Erosion Risk Model incorporates a combination of different factors. Some factors describe the energy of erosive water influence, others - the resistance provided by the vegetation cover and soil against it. Human activities influence vegetation cover the most, therefore protection measures can prevent soil loss. However, protection measures are rarely considered in soil erosion risk modelling at large scale, since they are difficult to estimate with high accuracy. The Soil Erosion Risk Model is thoroughly described in the reports (Kirchmeir, 2019, Mikeladze, 2016) on its implementation in the pilot regions in the Southern Caucasus.

Outputs

The following maps were produced during the pilot application in Tusheti.

Soil Erosion risk map

The map indicates the erosion risk by rainfall and surface water runoff. It was calculated for the entire territory of the Tusheti Protected Area using data on rainfall, soil type, slope length and steepness, and vegetation cover.



Map 1: Juxtaposition of the erosion risk map with the situation on the ground (Tusheti)

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