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MONITORING AND CONDITION MAPPING FOR SUSTAINABLE USE OF SUMMER PASTURE

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Abstract

Remote sensing has the potential of improving our ability to monitoring and mapping pasture degradation. The article investigated and mapped the current status of pastures based remotely sensed data. Erosion-sensitive areas have also been identified. Digital Elevation Models and Sentinel-2 imageries have been used for research. Normalized difference vegetation index (NDVI), ratio vegetation index (RVI) and enhanced vegetation index (EVI) was calculated and mapped based on the Sentinel imageries for determine the level of erosion.

Keywords: *pastures, biodiversity, erosion, grazing, Landsat, DEM, remote sensing, NDVI, RVI, EVI.*

Introduction

Grasslands, including sown pasture and rangeland, are among the largest ecosystems in the world and contribute to the livelihoods of more than 800 million people. They are a source of goods and services such as food and forage, energy and wildlife habitat, and also provide carbon and water storage and watershed protection for many major river systems. Grasslands are important for in situ conservation of genetic resources (FAO). Using FAO's data and definition, it is possible to estimate the world area of Pasture and Fodder Crops at 3.5 billion ha in 2000, representing 26% of the world land area and 70% of the world agricultural area [10].

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The Ministry of Agriculture of Azerbaijan Republic estimates that, there are 3123417 ha pastures in Azerbaijan. There are including 1101668 ha winter, 547476 ha summer and 1474273 ha common village pastures [8]. There are the following problems in managing these pastures:

1. Absence of centralized management system
2. Lack of maps and databases reflecting the current condition of pasture areas
3. Deficiencies in - protection of user's rights, fulfillment of parties obligations, getting and using pasture areas on destination
4. Non-protection of natural feed sources and failure to take measures for their improvement
5. Poor feed availability due to non-improvement of pastures
6. Lack of a special fund for improvement and management of effective pasture
7. Poor development of intensive animal husbandry

The presence of such problems has a significant impact on pasture biodiversity. Two projects has implemented on pasture biodiversity conservation in Azerbaijan. First project is "Grassland extent and condition mapping in Azerbaijan" (GRAZE) funded by the Integrated Biodiversity Management Programme (IBIS) of GIZ in Azerbaijan [3]. Second project is SenSPa - Sentinels for Sustainable Pasture Management funded by European Space Agency and GIZ in Azerbaijan [4].

For the last decades, 'remote sensing' has offered new perspectives to complete the work in progress, taking advantage of the different spatial and temporal resolutions provided by different sensors. For the last decades, 'remote sensing' has offered new perspectives to complete the work in progress, taking advantage of the different spatial and temporal resolutions provided by different sensors.

For the last decades, 'remote sensing' has offered new perspectives to complete the work in progress, taking advantage of the different spatial and temporal resolutions provided by different sensors [2]. Generally, multispectral satellite imagery is an indispensable tool for monitoring biodiversity.

Study area

The study area is summer pastures located in the territory of Gusar region of Azerbaijan. These pastures are affected intensely anthropogenic impact. Particularly, tourism and livestock are predominant.

Methods and materials

The study used the imageries of the Sentinel-2 satellite, DEM (created in 2016, during orthophoto production), and the results of previous projects (Graze and SenSPa).

Vegetation indices obtained from remote sensing based canopies are quite simple and effective algorithms for quantitative and qualitative evaluations of vegetation cover, vigor, and growth dynamics, among other applications [5]. These indices have been widely implemented within remote sensing applications using Sentinel-2 data. B2 (blue), B4 (red) and B8 (near infrared-NIR) bands of imageries of Sentinel-2 satellite were used for the study.

It presents a study carried out to identify relationships between indicators of grassland functions and NDVI, which is estimated through analysis of satellite images to give an indication of "greenness". The premise is that NDVI is an indicator of vegetation health, because degradation of ecosystem vegetation, or a decrease in green, would be reflected in a decrease in NDVI value. Therefore, if a relationship between the quantity of an indicator – aerial biomass – in various forest ecosystems and the NDVI can be identified, processes of degradation can be monitored [11]. Because plants use as a source of energy in the process of photosynthesis so absorb solar radiation in the photosynthetically active radiation spectral region.

Considering these, the NDVI of the study area was established (1).

$$NDVI = \frac{B8 - B4}{B8 + B4} \quad (1)$$

Take into consideration of seasonal influences, NDWIs were established for different months of the year.

As NDVI is the most widely used [1], it has been picked to explore the effect of hail protection, and as the reference index to compare accuracy and sensitivity concerning LAI against the other VIs chosen. On account of its reputed lack of sensitivity at high LAI [6] and susceptibility to soil noise [7], indices derived from NDVI have been included for comparison to overcome both these shortcomings. RVI, an earlier ratio index known for its sensitivity, has also been included.

$$RVI = \frac{B8}{B4} \quad (2)$$

EVI has been found useful in improving linearity with biophysical vegetation properties and in reducing saturation effects found in densely vegetated surfaces, commonly encountered in the NDVI. However, EVI requires a blue band and is sensitive to variations in blue band reflectance, which limits consistency of EVI across different sensors [9]. The EVI was developed to optimize the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in atmosphere influences:

$$EVI = G * \frac{(NIR - RED)}{(B8 + C_1 * B4 - C_2 * B2 + L)} \quad (3)$$

where the coefficients adopted in the EVI algorithm are, L=1, C1=6, C2=7.5, and G (gain factor) =2.5.

Each three vegetation indices were calculated, mapped and classified in 4 classes. The combination of the three vegetation indices provides comprehensive information on grass canopy.

The study revealed that the level of the erosion depends from slope inclination. Therefore, the inclination rate of the slopes was take into consideration. The relationship between grass density and inclination to identify erosion-sensitive locations is defined as the table. The relationship between grass density and slope inclination at the happen of erosion is defined as the table *(Table 1)*.

Table 1. Weighted Overlay by vegetation indices (VI) and slope inclination (SI)

	Completely degraded	**Degraded**	**Less durable**	**Durable**
SI	< 10	< 10	< 10	< 10
VI	< 0.2	0.20-0.25	> 0.35	0.35-0.40
SI	10 – 30	10 – 30	10 – 30	10 – 30
VI	0.20-0.25	0.25-0.30	0.35-0.40	0.40-0.45
SI	30 – 60	30 – 60	30 – 60	30 – 60
VI	0.25-0.30	0.30-0.35	0.40-0.45	0.45-0.50
SI	> 60	> 60	> 60	> 60
VI	0.30-0.35	0.35-0.40	0.45-0.50	> 0.50

Vegetation indeces, slope inclination, LULC and test data were processed according to the methodology in table and figure *(Tab. 1 and fig. 1)*.

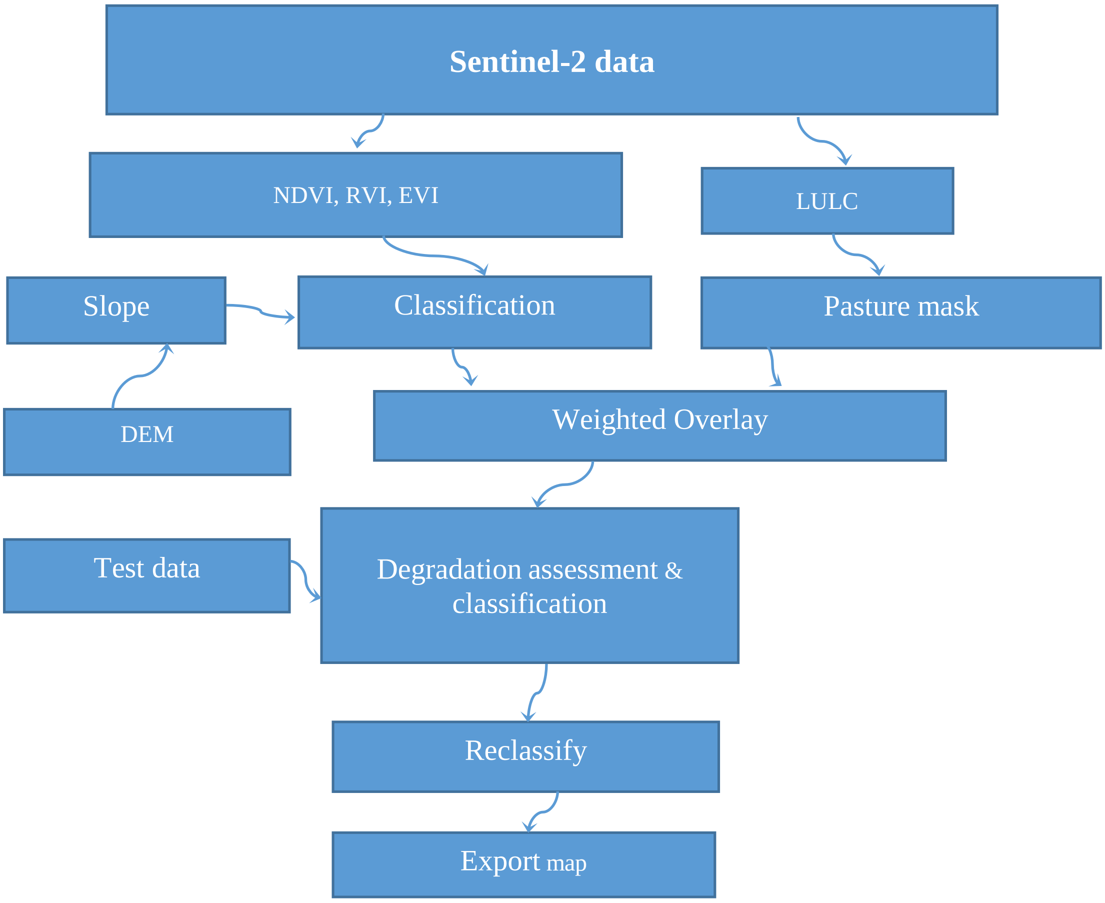

Fig. 1. Description of methodology

Results of study show that durable area of common area is less than 50% (Fig. 2).

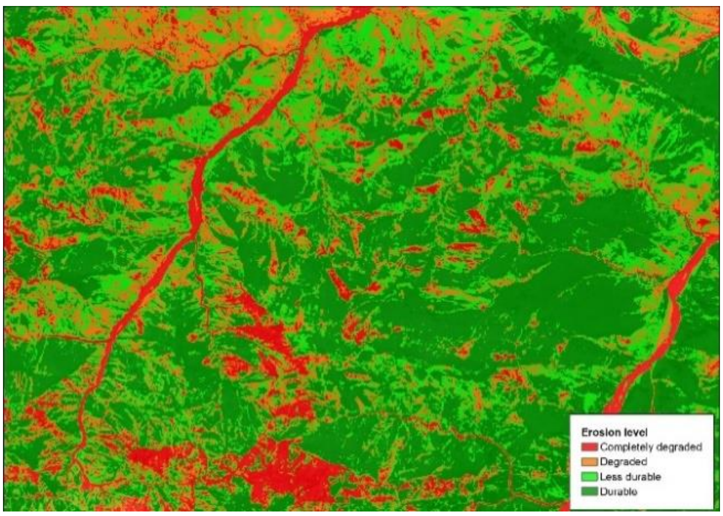

Fig. 2. Fragment of erosion level map

Detailed analysis of results show that we can apply the methodology to all summer pastures.

Result

The results of the study suggest that the environmental condition of the area under consideration is unsatisfactory. Study area: 46% durable, 22% is less durable, 19% degraded and 13% are completely degraded. This kind of study is needed to protect biodiversity and develop livestock.

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Yay otlaqlarının dayanıqlı istifadə edilməsi üçün monitorinq və xəritələşdirilmə

Xülasə

Məsafədən zondlama otlaqların deqradasiyasının monitorinqi və xəritələşdirilməsi prosesində bizim imkanlarımızı artırmaq potensialına malikdir. Məqalədə məsafədən zondlama məlumatları *əsasında otlaqların hazırki vəziyyəti araşdırılmış və xəritələşdirilmişdir. Həmçinin tədqiqatda eroziyaya həssas bölgələr də müəyyən edilmişdir. Tədqiqatda rəqəmsal yüksəliş modelləri və Sentinel-2 peyk təsvirləri əsas verilənlər kimi istifadə edilmişdir. Sentinel təsvirləri əsasında tədqiqat ərazisinin eroziya səviyyəsini müəyyənləşdirmək üçün* bitki örtüyünün normalaşdırılmış fərq indeksi *(NDVI),* rasional bitki örtüyü indeksi *(RVI) və* inkişaf etdirilmiş bitki indeksi *(EVI) hesablanmış və xəritələnmişdir.*

Açar sözlər: *otlaqlar, biomüxtəliflik, eroziya, otarma, Landsat, DEM, məsafədən zondlama, NDVI, RVI, EVI.*

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Мониторинг и картирование для устойчивого использования летних пастбищ

Резюме

Дистанционное зондирование может расширить наши возможности в процессе мониторинга и картирования деградации пастбищ. В статье исследуется и отображается текущее состояние пастбищ на основе данных дистанционного зондирования. В ходе исследования также были выявлены районы, чувствительные к эрозии. В качестве базовых данных в исследовании использовались цифровые модели всплытия и спутниковые снимки Sentinel-2. Для определения уровня эрозии района исследования на основе описаний Sentinel была рассчитана и нанесена на карту индекс нормализованной разности растительности *(NDVI),* рационального индекса растительности *(RVI) и* расширенного индекса растительности *(EVI).*

Ключевые слова: *пастбища, биоразнообразие, эрозия, выпас скота, Landsat, DEM, дистанционное зондирование, NDVI, RVI, EVI.*