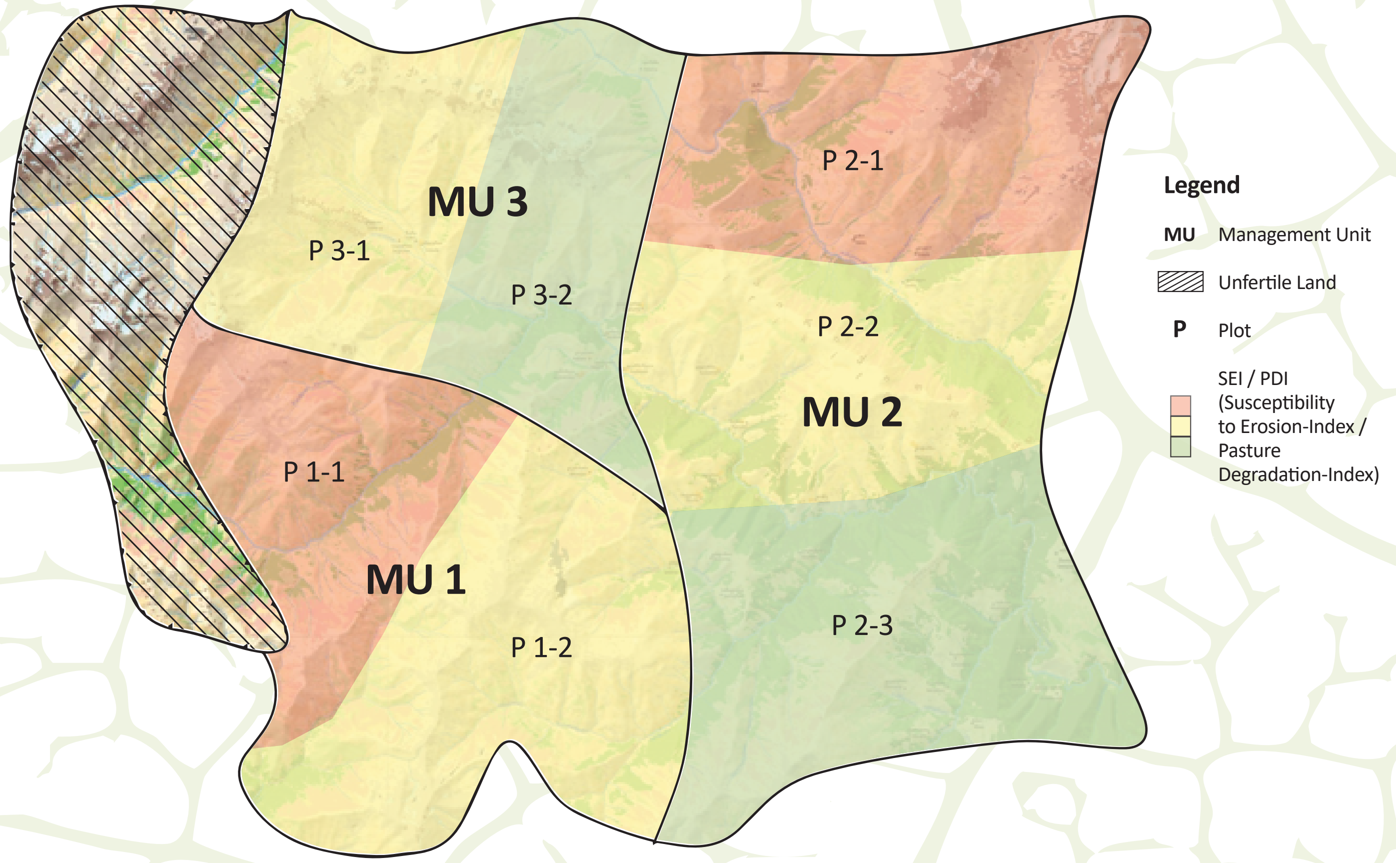
Table 4: Deriving stocking rate recommendations for mountain pastures from indices' calculations; for lowland pastures rates are half each.

Susceptibility to Erosion-Index (SEI)	Pasture Degradation-Index (PDI)	State of Pasture-Index (SPI)	Recommended stocking rate in relative terms[1]
5 (green)	5 (green)	10	100%
5 (green)	2.5 (yellow)	7.5	75%
5 (green)	0 (red)	5	50%
2.5 (yellow)	5 (green)	7.5	75%
2.5 (yellow)	2.5 (yellow)	5	50%
2.5 (yellow)	0 (red)	2.5	25%
0 (red)	5 (green)	5	50
0 (red)	2.5 (yellow)	2.5	25%

Figure 1: Example pasture with three management units (MU 1-3) and six plots assessed. Results from analyses are depicted in traffic lights for both indices.



[1] 100% implies the maximum legally defined number of sheep allowed for grazing. In Azerbaijan, following legal prescriptions (Cabinet of Ministers 2000), 100% means for highland pastures 8 sheep or 1.3 cows per ha, for lowland pastures - 4 sheep or 0.65 cows.
For Georgia, in Soviet times 4,5 to 6 sheep per ha were recommended for mountainous pastures (Didebulidze and Plachter, 2002; based on Kruashvili, 1984). However, this is not legally binding. At present the Georgian legislation, e.g., the Law on Soil Protection, refers to an "established allowed maximum headcount," but exact stocking rates are undefined ("Law of Georgia on Soil Protection," issued 12.05.1994, amended 19 November 2002, No. N 1751).

Outlook

So far, the pasture assessment approach has been applied in all three South Caucasian countries. Around 200 people from various administrations, including protected areas, scientific institutions and NGOs have been trained. The approach was successfully applied in Azerbaijan in Ismayilli district, in Armenia in Sisian and Gorayk, and in Georgia in the protected areas of Borjomi-Kharagauli, Lagodekhi, Tusheti and Vashlovani, as well as, in the framework of an international research project on village pastures in Kakheti (see Neudert et al., 2019).

The experience shows that the approach is suitable as an assessment and monitoring tool for well-defined, smaller areas, such as traditional use zones of national parks with clear pasture boundaries, village pastures or protected landscapes. If the condition of pastures and the risk of soil erosion needs to be assessed at a larger scale, e.g. for an entire municipality, it is highly recommended to combine the tool with remote sensing technologies. This combination has been successfully tested for the entire region of Tusheti and for Sagarejo municipality in Georgia (see Kirchmeir et al., 2019; Etzold & Mikeladze, 2019).

For future institutionalization, it is recommended to establish the tool as a national standard or guideline and to set up a specialized and well-trained field task force in each country for conducting the field assessments.

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Integrated Biodiversity Management, South Caucasus (IBiS)

Bio Topic

A pasture assessment approach for the South Caucasus countries

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This BioTopic introduces a practical pasture assessment and monitoring tool for resource managers. Combined with basic socio-economic information, comprehensive recommendations for sustainable pasture management can be derived. This approach can be adapted to various ecological and socio-economic settings. For assessing larger areas, such as entire municipalities, it should be combined with remote sensing technologies.

Background

Pastures in the South Caucasus represent the main resource for livestock keeping. Hence, they are important for income generation of the rural population. At the same time, these grasslands have an outstanding value for biodiversity. However, during the last three decades conservation of this resource has been challenged by the increased livestock numbers in many parts of the region. Meanwhile, the formerly official (Soviet) pasture management rules have largely deteriorated. As a consequence, pastures started to degrade where overstocking occurs, and unadjusted grazing management is practiced. Degradation means, on the one hand, a reduced fodder production potential of pastures for livestock, directly causing disadvantages for herders. On the other hand, pastures as ecosystems degrade with a significant decline of the habitat functions and number of species, i.e. biodiversity.

Degradation is a gradual process. To maintain the productivity and ecological functioning of grasslands, the tipping point leading to the irreversible transition to their degraded state should be prevented.

Therefore, the region has much to gain and much to lose in developing management and policy decisions for pastures. As sound knowledge about the current condition of pastures and their management provides the basis for informed decisions, this BioTopic offers insights about a new approach for pasture assessment and monitoring introduced in the South Caucasus.

Approach

The methodology, originally described by Etzold & Neudert (2013), was designed for assessing and monitoring the state of summer pastures in the Greater Caucasus of the Republic of Azerbaijan. The main aim was to provide management recommendations for sustainable pasture use to maintain and enhance the condition of pastures in the future.

The original intention was to keep the methodology as simple as possible, only relying on parameters assessable in the field (i.e. no laboratory or remote sensing analyses necessary). Introductory trainings were conducted to enable participants, such as staff from respective resource management administrations, rangers with monitoring duties, or even land users, carrying out the assessment on their own.

The approach can be used on highland pastures throughout the Caucasian mountains, as proven by its application in Georgia and Armenia. With Etzold et al. (2015), an adaptation to the different ecological conditions on the winter pastures in steppe and semi-desert ecosystems was undertaken and tested at selected sites in Azerbaijan and Georgia.

The approach includes an inquiry on certain socio-economic basic data (e.g. on herding organization, grazing management) to allow for goal-oriented recommendations. However, this BioTopic focusses only on the part with plot-based ecological assessment. Acquired data is used to calculate two indices, the Susceptibility to Erosion-Index (SEI) and the Pasture Degradation Index (PDI) that form the basis for the sustainable grazing schemes. As presented in Table 3, each index ranges between 0 and 100, with high values (green range) reflecting low erosion risk and low degradation, i.e. good pasture conditions.

Best results can be expected for well-defined areas like farm territories, but the methodology can be also adapted to village pasture or other territories.

Methods

Different sampling designs can be applied, depending on the socio-economic setting and knowledge of the pasture area under assessment.

Random and expert-based sampling designs
In the original application to the mountains in Azerbaijan (Etzold & Neudert 2013), a situation with exclusive access rights (usually guaranteed by lease contracts) to delimited pasture territories was encountered. However, a pasture cadaster with exact borders was not available. In such situations, a so called "mental map" for each pasture territory needs to be drawn, ideally with the help of the herders. Then the pasture territory is divided into two to maximum five management units (see example pasture with three management units in Figure 1). The division is based on the herders' knowledge of their pastures, reflected by different pasture qualities or grazing regimes, and the ecological understanding of the assessing personnel (regarding relative homogeneity of the management unit in terms of exposition, inclination, bedrock etc.).

More to SEI values...

Analyses revealed that the variable inclination is influencing erosion risk the most. Therefore, its importance is weighed with a value of maximum 60, while other, less important variables gained only maximum values of 10 or 20. If a steep slope is measured (e.g. on a mountain pasture with a slope steepness of more than 40°), the erosion risk is accordingly high, and a low value was assigned. In other words, low values mean "bad" conditions, or conditions causing high erosion risk. In contrast, a flat slope with inclination below 12° received a high value, up to 60, indicating "good" conditions, or conditions with low erosion risk.

Depending on the size and homogeneity of each management unit, one to three representative plots are chosen preferentially. In sum, five to maximum 15 plots would need to be sampled for each pasture territory, which is a feasible workload for an assessment team in one day.

More exact results can be expected, in case a (ideally GIS-based) pasture cadaster exists depicting the outline of the pasture territory. A GIS-based approach also allows for a random sampling design, in which number and location of plots are chosen based on defined algorithms. As a ground-truthing strategy, plot assessment of larger territories can be combined with remote sensing technology (piloted in Tusheti and Sagarejo in Georgia).

Compared to the expert knowledge-based approach (preferential), the disadvantage of random sampling is that more plots are required to capture site variations on pastures. Yet, random sampling is advantageous if there is a lack of assessing personnel, experienced in decision-making on the representativeness and, consequently, the plot location. Random sampling design is also the most feasible approach in case of (often de facto) open access settings with unclear borders and, subsequently, responsibilities (e.g. on village pastures). However, recommendations tailored to such pasture cases require more sophisticated sociological studies.

Plot assessment
A pasture plot measures 10 x 10 m and is ideally located in a circle with a radius of 50 m, meeting the homogeneity criteria in terms of inclination, aspect and the kind of vegetation cover.

Information collected on each plot encompasses physical site parameters, unalterable under the human or livestock-related impact (see Table 1). These parameters are used to calculate potential erosion on site, expressed in a Susceptibility to Erosion-Index (SEI). Furthermore, all variables contained have an influence on water availability to plants, which is of importance for regenerating after disturbances (e.g. grazing, trampling).

The specificities of the plot need to be considered, depending on whether a summer or winter pasture is assessed for SEI. One major difference is that hardness of bedrock is used for summer pastures, while soil texture is used instead on winter pastures.

Statistical analyses of more than 500 plots from mountain and lowland pastures in Azerbaijan as well as existing literature (e.g. Parker 1982) helped to choose and weight the variables used for calculating the two indices of the presented pasture monitoring approach.

Table 1: Physical site parameters used for calculating the Susceptibility to Erosion-Index (SEI) and their range of values.

SEI			
Mountain Pasture		**Lowland Pasture**	
Variable	**Values**	**Variable**	**Values**
Inclination a	0-60	Inclination	0-40
Altitude	0-20	Altitude	0-20
Inclination b	0-10		
Aspect	0-10	Aspect	0-20
Topographic position	0-20	Topographic position	0-20
Slope configuration	0-10	Slope configuration	0-10
Bedrock	0-40	Soil texture	0-20

In addition, parameters that can be affected by man and livestock are collected, reflecting the current state of the pasture. These parameters include those expressing erosion phenomena (see Table 2, brownish) and such representing the state of vegetation (greenish). These parameters are used to calculate the Pasture Degradation Index (PDI).

While in the original version for the mountain pastures only 9 parameters were considered, the PDI was extended to 15 parameters for the lowland pastures in semi-desert and steppe ecosystems (Etzold et al. 2015). These include pasture quality features expressed by dominant plant groups (feed value by vegetation), degradation processes like salinization, soil compaction (structure) or resilience against wind erosion (see 'roughness'). Selection and weighting were again based on own data and various literature (e.g. Shepherd 2010).

Table 2: Assessed parameters used for calculating the Pasture Degradation Index (PDI) and their range of values.

PDI				
	Mountain Pasture		**Lowland Pasture**	
Complex	**Variable**	**Values**	**Variable**	**Values**
Erosion/ de-grada-tion of soil surface	Bare Soil	0-10	Bare soil	0-5
	Rubble/scree	0-10	Bare stones	0-5
	Rocks	0-5		
	Livestock tracks	0-10	Livestock tracks	0-5
	Erosion tracks	0-10	Erosion tracks	0-10
			Salt indicators (salt crusts/ plants)	0-10
			Soil structure	0-10
Features of plants & grazing influence on them			Feed value by vegetation	2-10
			Roughness I: Vegetation height	0-5
			Roughness II: Vegetation density	0-5
	Browsing tracks	0-10	Grazing pressure I: Browsing tracks	0-5
			Grazing pressure II: Dung cover	0-5
	Cover grazing indicator species groups	0-10	Cover grazing indicator species groups	0-10
			Cover valuable plant species groups	0-10
	Flowering plants	0-5	Flowering plants	0-5
	Number of plant species	0-10	Number of plant species	0-10

Analyses and derived management recommendations
Both calculated indices are translated into traffic light colors (see Table 3 and Figure 1). Without further implications, the above-described methodology can serve for a simple monitoring of the pasture condition through repeated assessments of the once selected plots every 2-3 years over several years.

Index range	Risk to erosion/ degrada-tion level	Traffic light	Traffic light as numeric figure
68-100	Low	Green	5
34-67	Medium	Yellow	2.5
0-33	Strong	Red	0

For deriving management recommendations regarding stocking capacities and grazing regimes, the results from individual plots can be extrapolated to the level of their corresponding management units or even to the whole pasture territory, using mean values. The numeric traffic light figures of SEI and PDI are combined to the State of Pasture-Index (SPI) (see Table 4).

Considering the specific legal prescriptions for the respective pasture ecosystem (in Azerbaijan still based on the sound productivity research from the Soviet times), management units gaining the maximum SPI-value can be stocked with the upper limit of the prescribed stocking rates. Accordingly, units with lower values should be stocked with fewer animals to allow for pasture regeneration (PDI part) and/or safeguard the required care according to the vulnerability (SEI part). In conclusion, the carrying capacity of the whole respective pasture territory (sustainable amount of livestock units) is calculated.

Recommended livestock numbers for each of the management units can be translated into grazing times (considering their sizes and the specific grazing period for the respective pasture), and hence locally adopted rotational grazing schemes can be developed. Furthermore, findings of the assessment regarding grazing indicator species groups can be used to recommend pasture care measures like manual removal of pasture "weeds" (thistles, poisonous plants etc.) or encroaching bushes.