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A survey of farmer approach to grazing: A case study of the Curvature Subcarpathians, Romania

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Abstract: This study aims to investigate how grazing is perceived across the Curvature Subcarpathians (Romania) by farmers. We investigate farmers' attitudes toward and understanding of grazing practice and associated processes involving small ruminants (sheep and goats). Additionally, we review the scientific literature and new discussions about grazing vs overgrazing terms and changes in the Romanian small ruminant livestock. Results of the survey on the total of 101 case studies from villages in 3 counties (Dambovița, Buzau, and Vrancea) show that: (i) grazing is differently perceived; (ii) most of the areas designated for grazing are located near riverbanks (over 55%); most of the respondents reported that the areas intended for grazing are quite close to the inhabited areas; distances are less than 2.5 km; and over 60% of respondents believe that the areas are continuously subject to soil degradation processes; (iii) answers given in connection with the issues addressed provide both relevance to the Curvature Subcarpathians (6792 km^2) and the potential impact of higher pressure of grazing on local areas due to the discouragement of specific transhumance policies (more than 60% required subsidies). The average stocking density is about 4.7 head per ha. In general, beyond different farmers' perceptions, a scientific question remains open regarding the quantitative impact of grazing on hydrological processes. Hence, a field survey (e.g., rainfall-runoff experiments) to assess grazing pressure on water and soil resources will be performed.

Keywords: Curvature Subcarpathians, grazing, human perception, hydrology, regional studies, small ruminants

INTRODUCTION

Livestock grazing is considered a geomorphological driver due to significant changes that the factor can generate on the landscape (e.g. removal of herbaceous cover) and the resulting hydrologic process [Pulido *et al.* 2018]. Pasture lands are the most common farming practice in several parts of the world, such as the British Isles (see Evans *et al.* [2006]), Australia, Poland, and Romania [Morales *et al.* 2019]. Unsustainable grazing triggered a series of negative chain effects on other environmental components, for example soil compaction or soil erosion [Fick *et al.* 2020; Yu *et al.* 2019]. So far, several methods were used to determine land degradation due to heavy grazing, for example within the Subcarpathians in Poland [Flis 2014]. The share of permanent pasture at 16.3% is nearly double the national average of about 8.5% and it highlights that large numbers of ruminants, mainly sheep, graze freely in the Subcarpathian Province. In recent years, the sheep population has been about 20,000, which was one of the

highest in Poland, at 3.1 sheep per 100 ha [Flis 2014]. The land use and landscape history based on cartographic data led to the establishment of ecotonal conservation measures on grassland-woodland interfaces in formerly pastured cultural landscapes [Wolański *et al.* 2021]. There was a clear separation of communities defined by their herb layer composition per a habitat type (woodland vs. grassland). It is well-known that grassland species survive within the oak woodland and forest species occur out in the grassland. According to Wolański *et al.* [2021], under the less intense grazing pressure, the more shade-tolerant trees (such as beech) tend to establish dense groves segregated from grassland, while the heavier grazing pressure results in vast ecotone areas sparsely wooded by less shade-tolerant species.

Transhumance is a very old habit of the Curvature Subcarpathians (Romania). According to historical documents shepherds from the other side of the mountains (Covasna and Bârsa Land), who had crossed the region along the old transhumance routes, would settle down in the already existing settlements or would find new villages or hamlets at the southern foot of the Outer Carpathian Curvature (at interface between Teleajen, Buzău and Vrancea mountains and the Subcarpathians) [Muică 1993]. At present, the Romanian Carpathians and Subcarpathians have a diversified landscape pattern, introduced by a high anthropogenic transformation of the primary land cover: forest fragmentation, deforestation, intensive grazing, the fragmented pattern of agricultural plots around villages and town built-up areas [Rujoiu-Mare 2017].

The farmers' perception of grazing restriction policies, grassland environment, and ecological management that follows the implementation of environmental protection policies have been studied by some authors in the most recent publications, for example Chen and Zhou [2016] for northern China. In Europe, studies addressing different issues examine how German dairy farmers perceive advantages and disadvantages of grazing and how it relates to their milk production systems [Becker *et al.* 2018] and analyse farmer practices and perceptions of zero-grazing on Irish dairy farms [Holohan *et al.* 2021]. The perception of grassland experts (occurrence, importance, constraints, solutions, and future of grazing of dairy cows in Europe) was studied in great depth by van den Pol-van Dasselaar *et al.* [2020]. They found that there was a clear trend of reduced grazing in Europe. In Romania, data on grazing impact may be found at a local level (see Török-Oance and Török-Oance [2012] and Nicu [2018]) and no studies are conducted on farmers' perceptions, or at least, they are scarce like in other countries, such as Iran [Mohammadzadeh Chenar *et al.* 2021].

In this context, we assume that (i) grazing as a term is not properly used in the scientific literature in a similar vein to overgrazing, and (ii) small ruminants (sheep and goats) grazing lead to an increased volume of surface runoff and soil erosion. To test these assumptions, the main goals of this study are to (i) assess the term "grazing" in the literature; and (ii) to develop a questionnaire on farmers' practices and the perception of grazing in the Curvature Subcarpathians (Romania).

MATERIALS AND METHODS

Geospatial environmental data (e.g. morphometric map, hydrography dataset), territorial administrative units (localities database), small ruminants (average densities), mapping and questionnaires have been used to conduct the following analysis. Mapping, spatial analysis and predicts values (e.g., stock density), were done in QGIS 3.16 software.

A literature review, as a research methodology, was conducted using the most reliable databases (Web of Science, Google Scholar, PubMed, and Scopus). Electronic library explorations were conducted using a combination of keywords to identify all available papers. According to Trimble and Mendel [1995] approach, our literature research focuses on evidence of grazing by small ruminants (sheep and goats).

The understanding of the local perception is crucial for efficient conservation policy and has become a requirement for improving environmental management around the world [Bouahim *et al.* 2015]. Despite the existing debate regarding the relative usefulness of data-gathering through interviews/questionnaires [Cornish, Dunn 2009], some qualitative information cannot be gathered in any other way [Cohen-Shacham *et al.* 2015]. When this information is combined through a mixed-methods approach, robust results can be obtained, which are both comprehensive and quantifiable, adding an invaluable perspective to the development of appropriate risk mitigation and adaptation strategies [Bird 2009; Cerdà, Rodrigo-Comino 2021]. To have a clearer assessment of the grazing process perception in Romania, we selected as a case study of the Curvature Subcarpathians. The questionnaire was formulated so that answers could highlight opinions and values of local stakeholders and inhabitants. The perception among farmers regarding the grazing practice with small ruminants (sheep and goats) was evaluated through multiple field campaigns by face-to-face discussions during springtime of 2021. Additionally, we used optional anonymous, semi-structured personal interviews with farmers and sometimes followed by visual assessments.

The Curvature Subcarpathians (6792 km^2), bordering the Carpathians Mountains (Curvature Carpathians) in the central part of Romania, include an alternation of hilly ridges (up to 1000 m a.s.l.) and depressions, which are crossed by a network of transverse (e.g. Putna, Ramnicul Sarat, Buzau rivers) and longitudinal (e.g. Ialomita River, Cricov River, Teleajen River) valleys (Fig. 1). This area is located between latitudes 46°12' and 44°54' N, and longitudes 25°11' and 27°08' E (Fig. 1) and it is recognized to be prone to land degradation (e.g. denudation, riverbank erosion) due to both natural and socio-economic features [Chendeș 2011; Zaharia *et al.* 2011].

As it was synthesized by Chendeș [2011], Armaș [2012], Micu [2017], and Jurchescu *et al.* [2020], the erosion at hillslopes is due to the predominance of little cohesive rocks (associations of clays, marls, sands, and schistose sandstones, including salt and salt breccia), sandy clay loam and clay soils, and active neotectonic movements (general uplift, frequent earthquakes). Deforestation at the slopes, which continues nowadays, has stimulated gravitational processes. Broad-leaved forests were replaced on large areas by secondary grasses, orchards, vineyards, and croplands. Roads default and interrupt the hillslope processes and their growing network increased the disequilibrium of natural dynamics.

The annual precipitation reaches up to 600–700 mm. The precipitation regime is characterized by high values in May–July (up to 100 mm·month^{-1}) and low values in autumn and winter. Characteristic for the summer is the occurrence of heavy rains that are transformed into overland flow especially on bare soils

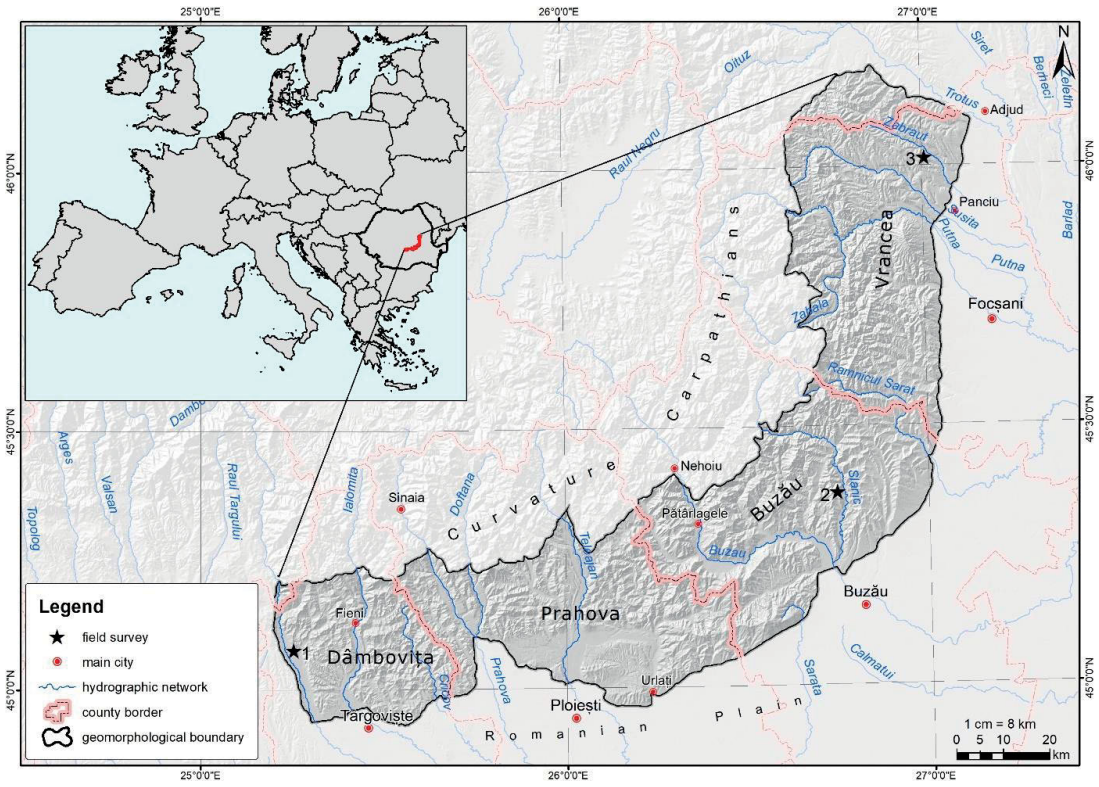

Fig. 1. Survey area in the Curvature Subcarpathians (Romania) and its location; source: own elaboration

and these rains are quite aggressive and promote erosion [Chendeș 2011]. Cheval *et al.* [2012] included this study area among those with the highest national maximum intensity of rainfall with duration of 5 minutes and 1:10 years return period (e.g. 1.48–1.86 mm·min^{-1}).

Consequently, rivers draining the Curvature Subcarpathians transport large amounts of sediment load, predominantly suspended load [Olariu *et al.* 2014]. Some of these rivers form a sandy braided pattern that is laterally unstable [Ioana-Toroimac 2016]. As it was synthesized by Zaharia *et al.* [2011], the study area is characterized by the highest suspended sediment yield in Romania. The mean specific suspended sediment yield exceeds 20–25 Mg·ha^{-1}·y^{-1}, and the sediment concentration exceeds 25,000 g·m^{-3} [Zăvoianu *et al.* 1996]. The highest suspended sediment transport occurs during spring–summer, generally, during the high-water phase of the hydrological regime or during floods, when the erosion processes along the slopes and within the channels are more intense.

According to Zăvoianu *et al.* [1996], within the Romanian Subcarpathians, there is an obvious tendency of increasing the pressure on hillslopes by turning former hayfields or orchards into cropland or abandoned land. In the very short run, this could produce severe imbalances. This phenomenon has occurred because, over time, the discovery and use of natural resources have inherently attracted people to the Subcarpathians, which in turn increased the pressure on the environment, sometimes exceeding the carrying capacity. The most complex landscapes, with a higher degree of fragmentation, fall within a diversified landscape pattern introduced by a high anthropogenic transformation of the primary land cover: forest fragmentation, intensive grazing, and fragmented pattern of agricultural plots around villages. The most predominant land uses are pastures and hay pastures that also have less productivity per hectare, followed by forests and agricultural land use [Bălteanu *et al.* 1996]. If we refer to the age of grazing in the Curvature Subcarpathians, a recent study on Paleoenvironment Data and Vegetation History established that in the range between 3200 and 2600 yr BP, the presence of plants such as *Plantago lanceolata* suggests an anthropic pressure exerted mainly by grazing [Vasilică *et al.* 2018].

RESULTS AND DISCUSSION

A BRIEF LITERATURE REVIEW CONSIDERING THE GRAZING TERM AND ITS USE

We noticed that asserting about the grazing concept needs more caution and requires a science-based validation. Substantial support exists to guiding scholars in the "overgrazing" concept can be found in Coughenour and Singer [1991], Fuller [1996], Huss [1996], van de Koppel *et al.* [1997], Perevolotsky and Seligman [1998], Mysterud [2006], Allen *et al.* [2011].

According to Graf [1988] quoted in Evans [1998], the effects of grazing animals can be confused or compounded with climate effects (e.g. severe droughts) on the landscape that can cause the deterioration of the vegetation cover.

Pengelly [1963] cited in Coughenour and Singer [1991] proposed a comprehensive evidence range for overgrazing assessment: i) reduced plant cover; ii) more runoff; iii) less organic matter on the ground; iv) drier soil; v) a drier type of vegetation; vi) less fescue and blue bunch wheatgrass; vii) more space between bunchgrasses; viii) greater relative abundance of more short-statured grass species; ix) increase in perennial forbs; and x) increased wind erosion. Huss [1996] considers that the stocking rate that exceeds grazing capacity, even slightly or for a short time, is commonly called "overgrazing". A stocking rate

less than grazing capacity is commonly called "undergrazing". More reflectively, Coughenour and Singer [1991] provided comprehensiv research from an ecological viewpoint on the perception of "overgrazing" and drew attention to the correct use of terminology and eliminate any potential confusion. In an analysis of the concept of overgrazing, Mysterud [2006] found that misperception can be avoided by classifying overgrazing into different types (e.g. a range ecology baseline). Overall, it seems that the overgrazing pressure is not uniformly distributed all over a region (e.g. "the Mediterranean rangelands and it is certainly higher in the south than in the north", see Papanastasis [undated]). Therefore, most often the right term is grazing or intensive/severe grazing instead of "overgrazing". Moreover, grazing intensities range widely according to local environmental conditions, e.g. climate, vegetation, and soil [Evans 1998]. Whatever it is referred to as unsustainable grazing, it can be a disturbing factor to humans, wildlife, and the environment [Prăvălie 2016; 2018].

Related to overgrazing, we found in the literature review some points to be improved to avoid any misunderstanding among researchers with little experience in this topic. For example, in the "World atlas of desertification" [Cherlet *et al.* 2018], published under the European Commission framework, in a total of 25 instances the authors have mentioned overgrazing as a driving factor to the reduction in grass cover, destruction of perennial grass species, land change or land degradation, accelerated erosion, etc. However, there is a lack of explanation or definitions of the term (e.g. scale, range, environmental indicators). Additionally, the FAO has constantly promoted negative social and environmental consequences of grazing in a series of excellent works (e.g. Huss [1996], Kelley [1990], Rosales and Livinets [2005]). However, we noted that this term is not directly defined and delivered little information to support many claims concerning overgrazing term. In another useful publication by Oldemann [1992], the author stated: "overgrazing is the obvious causative factor", which could generate confusion considering interesting factors that were included in the work. Wood *et al.* [2000] based on the global study GLASOD [Oldeman *et al.* 1991] did not include any methods and distinctions about this affirmation "…35% for human-induced degradation to overgrazing". Further, Foley *et al.* [2005] based on Wood *et al.* [2000] state that "… up to ~40% of global croplands may also be experiencing some degree of soil erosion, reduced fertility, or overgrazing".

From a hydrologic point of view, based on a rigorous analysis by Bilotta *et al.* [2007], we systemize the hydrologic impact induced by heavy grazing in pastureland under dry conditions (Fig. 2). A comparative animal pressure on feed resources (e.g. how much vegetation animal needs) called "animal-unit" is one head of cow equivalent to 8 sheep, 11 goats, 13 kangaroos, 133 rabbits (Harrington *et al.* [1984] cited in Hinnant [1994]). Yet, a hydrologic measure for animal pressure (e.g. small ruminants) on soil with hydrologic impact requires more field experiments, and data in European literature is very limited. The runoff and soil loss increase and water pollution are expected to support the influence of heavy grazing (Fig. 2). The development of a hydrologic scale/range impact to measure grazing effects represent a real challenge for scientists, e.g. field approach of Ries *et al.* [2013].

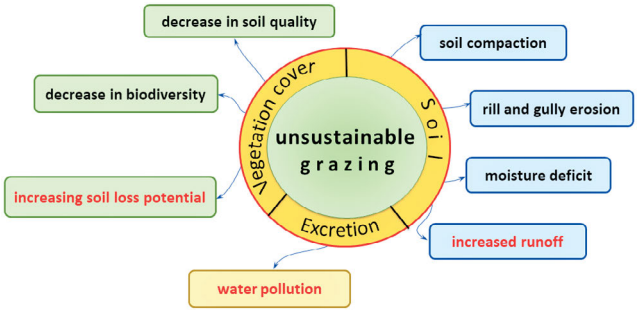

Fig. 2. Hydrologic impact induced by heavy grazing in pastureland under dry conditions; source: own elaboration

FARMER'S PERCEPTION SURVEY

According to the official statistics, the share of pastures and managed grasslands is about 15.2% of the total land area of territorial administrative units (TAU) in the study area. This can be compared with the share at the national level (13.7%), and it results in more land available for grazing [NIS 2021]. The average density of livestock is about 4.7 units (sheep and goats) per ha for the Curvature Subcarpathians region (Fig. 3), while the Romanian average is about 3.66 units per ha [INSSE 2020]. Therefore, the region could be considered a region with higher pressure on grazing land compared to the national values.

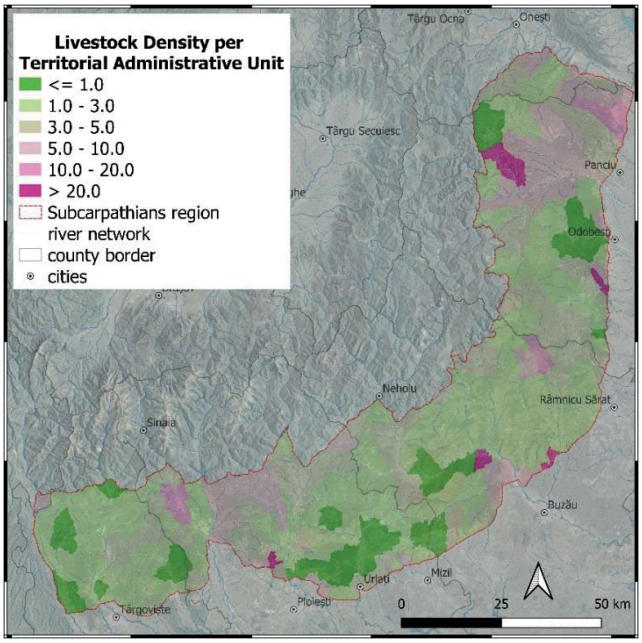

Fig. 3. Average small ruminants' density (head·ha^{-1}·TAU^{-1}) in Curvature Subcarpathians region; source: own elaboration

SURVEY ANALYSIS

To understand the human perception regarding the environmental impact of grazing, especially among sheep and goats breeders (respondents), we develop and carry out a social questionnaire survey (see Tab. 1; survey location in Fig. 1). It contains 13 questions, some having a more general and others more specific character (e.g. which is the relief form where grazing is provided? Does the area designated for grazing satisfy

the need of herds held?). Additionally, information about the age of the farmer and the locality where the questionnaire survey was applied, were also included. The survey included 101 people (mostly farmers) from the area of several counties (Dâmbovița, Buzău, and Vrancea; see Fig. 1). Most of the interviewees were in the Vrancea County (39 out of a total of 101), a Romanian county most exposed to erosion.

Table 1. Farmers perception on hydrological effects of pasture on the water and soil erosion (number of questionnaires 101)

A set of questions	Response category	Yes (No.)
Organization type	household system	54
	organized form	47
Pasture surface	<10 ha	35
	10–20 ha	25
	20–50 ha	22
	>50	19
Landform	slopes	33
	riverbanks	55
	vast meadows	13
Away from the inhabited area	<2.5 km	43
	2.5–5.0 km	28
	>5.0 km	30
Grazing area is subject to degradation	yes	62
	no	39
Does overgrazing amplify a flood?	significant	44
	insignificant	57
Processes influenced	landslides	8
	soil degradation and erosion	61
	water quality	13
	agricultural activities	12
	no one	7
The degree of damage due to soil erosion	significant	53
	insignificant	48
	crop rotation	68
	a temporary stopping of grazing	10
	increasing grazing areas	13
	vegetation restoration	10
Financial support	yes	62
	no	39
Type of support requested	higher subsidies	18
	to get the money directly to the breeders	25
	overseeding	29
	maintaining grassland	29

Source: own study.

Based on the analysis of the answers received, we determined further features.

1. Over 54% of the respondents have raised sheep and goats in the household system with a rather small number of herds (below 50). In the case of an organized system, the number of herds is up to 200 (in 20% of the surveyed cases), and between 201 and 500 for 29% of the people surveyed. At the county level, in Dambovita, the breeding of sheep and goats is considered tradition and take place more in an organized form, while in Vrancea and Buzau counties, grazing is an activity that has been carried out mostly in the household system.
2. Most areas intended for grazing were framed by respondents at less than 10 ha when done in a household system, and exceeded 50 ha an organized association.
3. A very important aspect reported by the interviewees was the fact that most grazing areas are near riverbanks (over 55%), on slopes, and have fewer floodplains. Following discussions with respondents, we found that the land they received to carry out this activity is practically insufficient, compared to the number of staff they have. In the Vrancea County, these areas correspond to river banks or watercourses and slopes which are more easily subject to degradation, being exposed to surface runoff and thus erosion. In the area of the Străoane commune (area with pastoral tradition; see Phot. 1), the farmers state that, in recent years, they have not been granted areas in the mountains to promote transhumance. Therefore, they are forced to remain with the sheep. Throughout the year, when shepherding is done, in the area near the locality, the overgrazing began to intervene. According to answers received, this led to land degradation and especially to decreased animal productivity. In Photo 1 (left), it can be observed the *in situ* placement of a sheepfold from this locality, and on the right slope can be noticed the area designated for grazing, which is subjected to erosion.
4. Most of our respondents reported that the pasture areas are quite close to inhabited areas, less than 2.5 km (in 43 of the cases surveyed). The only county where areas intended for grazing are at a larger distance from the residential area (over 5.0 km) was the Buzau County (over 18 answers).
5. Moreover, 60% of respondents believe that the areas they have allocated for grazing are continuously subject to degradation processes, and of these the most frequently reported were those related to soil erosion and landslides. Measures reported by farmers to reduce these processes were crop rotation (68% of respondents), temporary discontinuation of grazing (10%), increasing grazing areas (13%) and vegetation restoration (10%); to implement these and other measures, over 60% of farmers stated that they would need financial support, but that it could be accessed directly by farmers and, in most cases, it could be used for overseeding pastures, their maintenance, and the establishment of watering systems for small ruminants.
6. Since unsustainable grazing could amplify runoff, it could have an impact on flash-flood or flooding occurrences. Most of the respondents (over 55%) did not report any link between heavy grazing and the occurrences of such hydrological phenomena.

Phot. 1. View of the impact of small ruminants on the sheepfold/paddock and bare soil (left) and a local field survey (right) in Vrancea County (Străoane commune) (phot. *G. Necualu*)

CONCLUSIONS AND FURTHER CHALLENGES

The present regional-scale study, performed in the Curvature Subcarpathians (Romania), has assessed the grazing term and the farmers' perception of the hydrological effects. This issue is important in the Curvature Subcarpathians which are prone to erosion and slope degradation processes even in natural conditions. Consequently, the survey involved approximately 101 respondents (e.g. farmers, families, and owners of small farms) in the study area. It highlighted grazing practices, their effects, but also potential measures to reduce negative effects of grazing. Grazing represents one of the most important agricultural activities in the Subcarpathian region. In most cases, it involves small farms (family owned) on pastures between 5 and 20 hectares (62%), while the most likely herd size is less than 100 heads (49%), whereas those in big farms (more than 1000 heads) were represented by less than 4% of respondents. Despite the high density of livestock in the Subcarpathian region, the level of acceptance is not high regarding the impact of overgrazing on erosion/land degradation (question 9–52%). However, there is almost an equal share of farmers who consider it necessary to extend grazing areas. Hence, they suggested they need more land for grazing (49%). Water bodies (river) play an important role in livestock farming, and most of the herds are watered on river banks. For more than 60% of respondents, the grazing activity takes place near the floodplain or in the vicinity of rivers. Most of the interviewed farmers responded that alternating grazing, seeding the grasslands along with seasonal grazing are good practices that can mitigate the grazing impact on land erosion, while the great majority (61%) consider that there is more room for subsidies to improve the grassland management practices such as fertilizer acquisition. The results of the interview suggest that in the perception of farmers grazing has a limited impact on soil erosion, while the grazing area needs to be extended. This suggests that the region needs more space for grazing.

Moreover, floods bring a heavy sediment load to the study area. In case of the lack of vegetation, rainfalls certainly contribute to erosion, especially in overgrazed areas on steep slopes. Therefore, unsustainable grazing appears to be one of the factors that stimulate high sediment transport in the study area. Grazing on river banks, which is very frequent in the opinion of the respondents in the study area, does not allow shrubs to develop. This lets the river to erode and migrate laterally, maintaining the river dynamics. This is important especially for rivers that cross the Curvature Subcarpathians. These rivers had their channels narrowed in the last century. Moreover, the development of riparian vegetation could enhance river incision, and trigger further degradation of the hydrosystem. From this single perspective, grazing on river banks could be an example of a good practice. In areas where grazing is no longer possible, invasive species colonize river banks and further damage the ecosystem. Consequently, grazing can certainly be beneficial for the ecosystem under current conditions. Yet, it is very difficult to find equilibrium between grazing practices and other environmental issues in the catchment (natural versus damaging processes, natural vegetation restoration versus invasive species colonization in the vicinity of river banks).

Firstly, we believe that a good understanding of the processes is necessary. This should be followed by further negotiations with farmers. Farmers have know-how and experience, and they are able to propose local measures to stop land degradation and erosion, e.g. crop rotation. Secondly, they are capable of identifying other causes of land degradation and erosion. Although crop rotation might not be the most suitable solution to the problem of land degradation and erosion in the Curvature Subcarpathians, it proved to be an effective traditional practice at the local scale. Finally, results of the questionnaire survey show that the farmer's knowledge about grazing has largely declined. There is a strong need to improve advisory systems and to pay more attention to information and training. More precisely, national authorities should support farmers (e.g. through subsidies) in restoring traditional transhumance.

In general, to address an epistemic challenge of the key concept of "overgrazing" and various perceptions of the quantitative grazing impact on the hydrologic process based on Pengelly [1963] approach, we established field experiments (e.g. rainfall-runoff experiments) to assess grazing intensity in terms of quantity and quality of the process (e.g. intense, moderate, and light).

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