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PASTURE RESILIENCE TOWARDS LANDSCAPE CHANGES: ASSESSING PASTURES QUALITY IN THE CONTEXT OF LAND-USE AND LAND-COVER CHANGES IN ROMANIA

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Abstract

The current global context (the expansion of urban concentration, the need to produce green energies, the aging of rural population) and often, the volatile legislative framework create opportunities for irreversible landscape and, implicitly environmental changes. Pastures are under continuous pressure due to the expansion of built-up areas. The expansion of several infrastructures or the refurbishment of the existing ones, decreases the quality of the natural and semi-natural ecosystems. The aim of the current paper consists in identifying which is the impact of land use change over the quality of pastures. The results presented in this paper emphasize that the occurrence of different land use and land cover changes, disturbs the quality of pastures in various ways, depending on the new land use and land cover developed in these primary ecosystems. One of the major outcomes of the study underlines that the continuous decrease of pastures' surface is a dynamic process that in an indirect way affects the quality of life within society. In this case, a diachronic analysis of the evolution of pastoral areas (by eloquent case studies), as well as a current assessment of their support capacity are, in addition to the existing studies, creating an overall picture that is scientifically valid in future efforts of territorial and zonal planning.

Keywords: *pastures, resilience, Romania, phytocoenosis, landscape dynamics, quality assessment*

1. INTRODUCTION

Romanian pastures represent approximately 3.2 mil. ha (National Institute of Statistics, 2014) and the amount of grazing areas is shrinking due to reasons such as the urbanization process (Suditu et al, 2014; Hennig et al, 2016; Gavrilidis et al, 2015), land abandonment (Pătru-Stupariu et al, 2015; Grădinaru et al, 2015) or fragmentation (Pătru-Stupariu et al, 2015; Lindenmayer & Fischer, 2006; Fahrig, 2003). As the Romanian livestock has decreased in the last 30 years, many pasturelands were abandoned or are lacking a proper management. The decrease of livestock is explained through the globalization process and the membership towards the European free markets. Thus, there was cheaper for the consumer to buy products imported from other countries than the local ones.

Pasture abandonment led to different land use changes depending on where the pastures were located. The ones located in the proximity of major urban cores were affected by the urban sprawl phenomenon, being fragmented or entirely transformed in built-up areas (Doblas-Miranda et al, 2017; Wittig et al, 2010; Bičík et al, 2001). The same happened with the pastures located in touristic areas which were covered by buildings as an expansion of the touristic infrastructure. Soon as the national regulations have allowed that national grants to be given for sustainable energy projects, patches of pasturelands were the terrain and climate conditions were proper enough were covered with wind turbines and solar panels. For the remote pasturelands, where the land fragmentation is not suitable for construction or where the geomorphological processes are active, the afforestation process occurred.

In this paper we emphasize the impact generated by the lack of pasture management and conversion towards other land uses has over the phytocoenosis quality. We used four study areas spread all over the country to match each of the challenges presented before (Figure 1, Table 1).

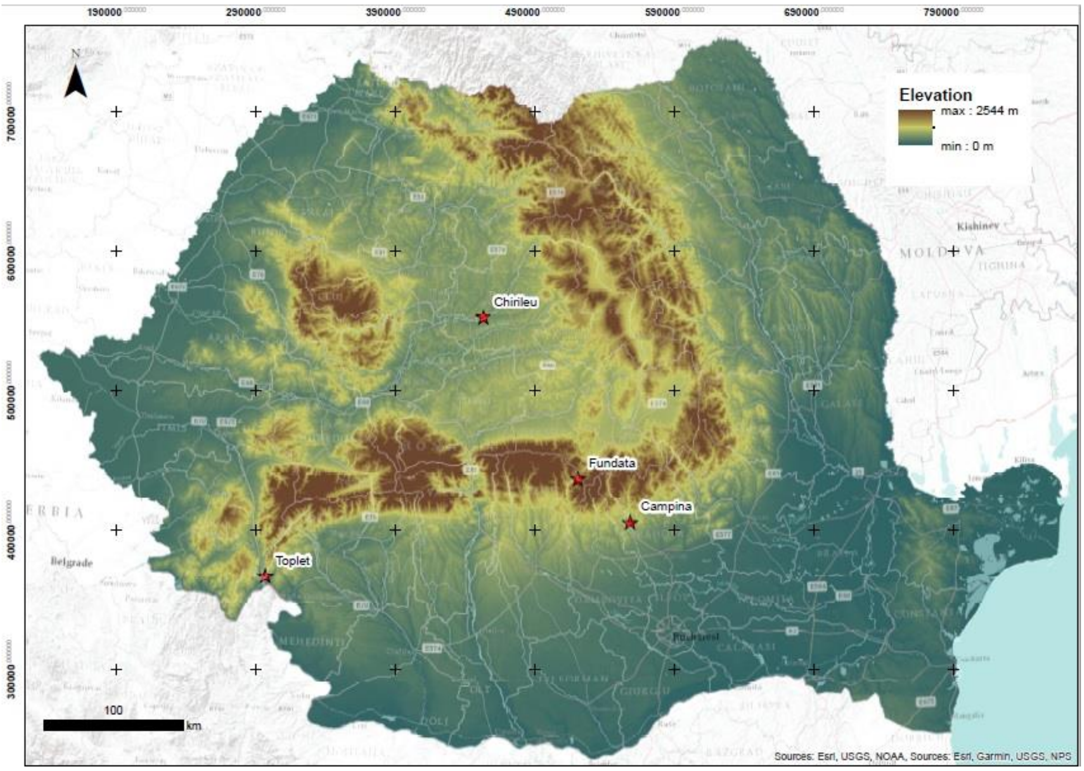

Figure 1. Study areas

Table 1. Study areas - descriptive characteristics

	AVERAGE ELEVATION	AVERAGE SLOPE	SLOPE ORIENTATION
S1 (Campina)	505 m	4°	SV
S2 (Chirileu)	287 m	0°	S
S3 (Fundata)	1240 m	1.5°	S
S4 (Toplet)	490 m	6°	S

2. BACKGROUND

Due to the current living conditions, many techniques and technologies have been developed to improve quality of life, ignoring the decrease of the environmental quality. The current tendency to replace the classical energy production solutions with renewable energy ones is not always seen as a green approach, without any impacts over the environment. Another global challenge is the urban sprawl phenomenon (Hennig et al, 2016). Throughout the urbanization process the natural and semi-natural landscapes edging the major and medium cities across the world are shrinking (González, 2017). Natural and semi-natural areas are constantly converted into built-up areas, deepening the urban environmental issues. Grădinaru et al. (2015) considered that productive land abandonment is a first symptom of urban sprawl.

Since the transition process during the post-communist years in Romania, the planning policies faced major flaws and breaches that permitted throughout the time some unsustainable developments with irreversible effects (Suditu et al, 2014). Agricultural and pastures have been heavily abandoned in the last 30 years, especially near urban areas as the real estate market have bloomed in the country. After 2008 when the real estate markets have fallen, the abandoned lands remained with an uncertain status.

The current national legal framework obliges the local governing bodies (city halls) to prepare pastoral management studies, specifying: the current conditions of phytocoenosis, the optimal livestock load, the works that need to be carried out for biodiversity conservation and the obligations of those who wish to lent the respective lands (Law 44/2018; Government Decision 78/2015). Also, the legislation prohibits the alienation of the grazing area without a specific documentation and the surface temporarily or permanently removed from the crop to be recovered from non-productive land (Law 44/2018; Law 231/2018)

2.1. Literature review

After it was first introduced by Holling (1973), the “resilience” concept became a worldwide topic addressed in various scientific publications, and due to the large field of application (from the medical area to technical studies) the concept became more and more confusing and incoherently used (Cumming, 2011; Müller et al, 2016). The “resilience concept” is acknowledged by the wider scientifically community as a “cloud” with tools and concepts that explains the changes in socio-ecological systems (Lade et al, 2017).

The authors using the concept in scientific projects and articles provide their own indicators which quantifies resilience, in line with their objectives and research questions. There is no standard methodology to quantify resilience of a system towards certain factors (Abhay & Patra, 2018) and choosing the correct methods and indicators represents a challenge for scientists, when working with this concept.

A study developed by Beller et al. (2018) regarding the landscape resilience of highly modified landscapes, uses seven relevant dimensions in address to ecological resilience: setting, process, connectivity, complexity, redundancy, scale and people. Resilience can be used as a dynamic indicator (Müller et al, 2016), emphasizing the behavior and performance of a system when different factors interact with it. Some anthropic activities can modify the level of resilience by increasing or decreasing it. Depending on the factors (exogenous or endogenous), the land can resist and recover its functions depending on the level of perturbation. Landscape degradation depends on susceptibility and resilience, hence, it can determine the vulnerability of the land towards degradation. High susceptibility to deterioration, means low resilience towards perturbing factors, but if the resilience is high and the susceptibility is high, the system will be more resistant to perturbation and degradation (Abhay & Patra, 2018).

A study conducted by Abhay & Patra (2018) designed to evaluate resilience from farmer’s perception in different communities, uses 9 indicators to describe land degradation: terracing, land fallowing, land manure, crop rotation, modern farm implementation, other soil conservation measures, chemical fertilizers, inexhaustive agriculture and market-oriented agriculture.

The periurban agrarian land faced great pressure in Europe in the decades before 2000. Urban sprawl is determined by new patterns for housing (residential area) and the major changes were projected in the territorial pattern, with great consequences in habitat connectivity. Bad planning or inefficient planning determines major pressures on land, natural landscapes and to all categories of ecosystem services (González, 2017). Urbanization is a multidimensional process that addresses the challenges driven by the society requirements and needs. The presence of urbanization in all categories of landscapes, far from urban cores, makes it an omnipresent characteristic and provide more meaning than the dichotomous position urban-rural. To better understand the urbanization, we need to consider the spatial characteristic and the importance of the scale (Inostroza et al, 2019).

If we think about pastures' resilience, we need to consider the landscape scale, to better understand the components' relation and all the ecological flows (informational or material). By definition, landscape resilience represents the ability of a landscape to sustain over time natural and anthropogenic stressors by still maintaining its biodiversity and ecological functions (Beller et al, 2018).

Pastures represents an important resource for the anthropogenic community and always humans invest in increasing green mass productivity (Lade et al, 2017) or they don't invest enough leading to overgrazing. The open characteristic of pastures makes them vulnerable to forest expansion and afforestation, if they are not grazed (Plieninger & Bieling, 2013). Maintaining them open (Lucash et al, 2017) and conserving the phytocoenosis biodiversity it's important for herbivores and for invertebrates (Schmitt & Rákosy, 2007; Durău et al, 2010).

We can define the influence of landscape dynamics over pasture resilience using the spatial resilience concept (Cumming, 2011), explaining spatial variations of internal and external components in both temporal and spatial scale.

Worldwide we find different methods to evaluate the quality of pastures, some of them use the score method which implies giving a rank to different biotic or abiotic indicators (Cosgrove et al, 2001). In Romania the legal framework offers a guide to evaluate quality of pastures for public or private owners (Marușca et al, 2014). Other studies assess quality using experimental plots and calculating pastoral value for them (Durău et al, 2010; Krahulec et al, 2001).

Monitoring vegetation changes is compulsory, mainly because in the last decades the functions and structures on ecosystems has been changed with consequences in land cover (Mokarram et al, 2016). Landscape changes represent one of the major challenges for the environment, as large amounts of natural and semi-natural areas are being reduced and fragmented, projecting serious environmental issues.

The research question used in the current paper was whether the expansion of built up area and the afforestation process have any impact over the quality of nearby pastures. Thus, we aimed to 1) asses the landscape dynamics and 2) the phytocoenosis quality in our selected study areas.

3. ANALYSIS

3.1. Methods

The study areas consisted of pastures influenced by two categories of factors (Table 2): land abandonment due to demographic changes which leads to afforestation and conversion into built-up area. In Romania pastures represents approximately 3.2 mil. hectares, in which we identified, using Google Earth Pro, a number of 281 solar parks (occupying almost 582 ha of pastures) and 1127 wind turbines (most of which are located on farmland).

Table 2. Summary of case studies

CASE STUDY	*T0*	*STUDY CASE (HA)*	*LOSS (HA)*	*DISTURBING FACTOR*
CAMPINA	2007	40.15	7.7	expansion of residential and recreational space
CHIRILEU	2012	12.01	7.0	built of solar park
FUNDATA	2008	6.63	3.2	afforestation
TOPLET	2012	92.24	0.4	built of wind park

For our study we used a diachronic analysis (Pătru-Stupariu et al, 2011; Gavrilidis et al, 2015)(Figure 2), which is focused on vegetation cover and the land use and land cover dynamics. To get a clear picture of the pasture phytocoenosis, for each case study, field trips were carried out and in-situ observations sheets were made to obtain an inventory of species and climatic and geomorphological characteristics. Applying the quadrate method, random sampling points were used to record vegetation (green mass /m2, species richness, vegetation height, etc.). Using the collected data, we applied the Ellenberg et al. (1992) method adapted by Sârbu et al. (2013) and we calculated habitat index for each of the identified species. This index can range between 0-10 and represent the ecological requirements of the species on light, temperature, humidity and soil response as well as the amount of mineral nitrogen in the soil. Another step of the analysis is represented by the pastoral value of the identified species. The species were grouped into 8 categories according to animal feed preferences and divided to the total number of species identified in the study case (Marușca et al, 2014).

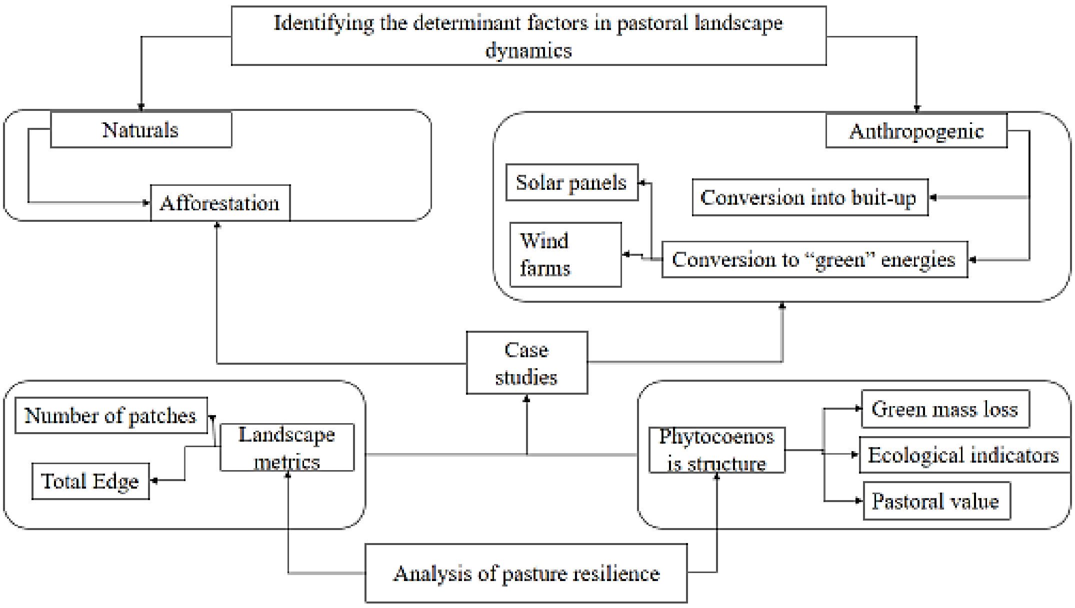

Figure 2. Workflow for the study

The second focus of our analysis was to capture the landscape dynamics using satellite images for each case study from three years: 2005, 2008 and 2018. Using the information extracted from the satellite images we generated land-use maps using ArcMap 10.3.1. Land-use classes were analyzed using the Patch Analyst tool which yielded several parameters, such as number of patches and total edge.

3.2. Results

Regarding the inventory of species, we identified 66 species in S1, 49 species in S2, 65 species in S3 and 91 species in S4 (Annex 1). Using the inventory and the data sampling we were able to determine vegetation parameters and the habitat type (Table 3).

ANNEXES1. Interpretation matrix of the ecological indicators

Indicator value	Light	Temperature	Soil moisture	Soil reaction	Amont of N mineral in the soil
3	shadow	predominantly on the subalpine floor	dry soils	on acidic soils	especially on poor soils
5	semium-brine, which has moderate shading	in temperate (hilly, submontane)	moderately moist soils, ravens	on moderate-weak acid soils	moderate content
7	of light, that barely support shadow	in warm areas (plains)	damp-damp soils, well drained, but not wet	on neutral soils (weak-acid to low-alkaline)	especially on rich soils
9	full light	in extremely hot areas (mediterranean)	wet soils, often poorly ventilated	only on neutral and basic soils, always rich in limestone	only on excessively rich soils; indicates storage, pollution

Table 3. Habitat type and vegetation parameters

Study case	Habitat type (Gafta & Mountford 2008)	Vegetation coverage (%)	Height max. (cm)	In-situ species richness	Plot green mass quantity (kg / m2) measured in-situ	Study case area (ha)	Green mass quantity (t / ha)	Area lost after spatial conversion (ha)	Amount of green mass lost after spatial conversion (t/year)
S1	6240* Sub-pannonic steppic grasslands	90	75	66	**0.364**	40.15	3.64	**7.74**	**28.1736**
S2	6440 Alluvial meadows of river valleys of the *Cnidion dubii*	85	75	49	**0.294**	12.01	2.94	**6.99**	**20.5506**
S3	6230* Species-rich *Nardus* grasslands	80	45	65	**0.136**	6.63	1.36	**3.3**	**4.488**
S4	6520 Mountain hay meadows	99	60	91	**0.286**	92.24	2.86	**0.4**	**1.144**

Secondly, we calculated the ecological indicators (3, Annex 1) of the species identified in each case study and we observed that some species in S4 study area, which is influenced by the presence of two wind turbines, can suffer from shading phenomenon due to the movement of wind turbine blades. Also, species in S2 requires light and can suffer from the shade provided by the existence of solar panels.

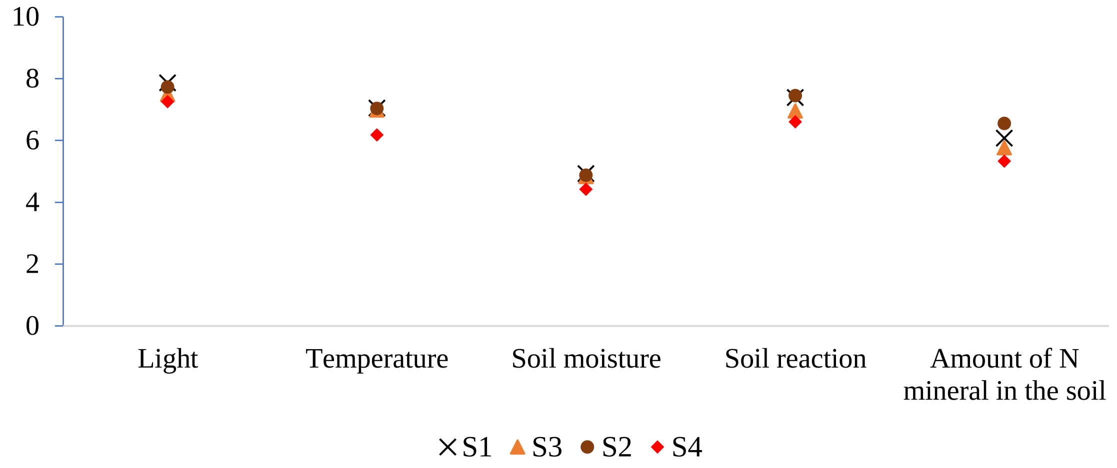

Figure 3. Ecological indicators of the species identified in each case study

In S4 pasture we identified one rare species, Orchis morio, dispersed in the area. S1 pasture has the highest number of graminee species which gives this pasture a good pastoral value, although this pasture is heavily affected by the conversion into built up area and afforestation in some parts (Table 4).

Table 4. Calculated pastoral value (Category/Species in plot)

Study case	Number of species	Graminee fodder	Feed fodder	Fodder species from other botanical families	Non-consumable or low-consumption species	Toxic and harmful species	Species that harm animal products	Species damaging the grassy rug of the meadows	Rare species
S1	66	0.1818	0.0758	0.1667	0.3636	0.0303	0.1364	0.0455	0.0000
S2	49	0.1633	0.1224	0.2041	0.2653	0.1020	0.1020	0.0408	0.0000
S3	65	0.0769	0.1231	0.1385	0.3385	0.0769	0.0462	0.2000	0.0000
S4	91	0.1099	0.0769	0.1868	0.3516	0.0549	0.0220	0.1868	0.0110
	MEAN	0.1330	0.0996	0.1740	0.3298	0.0661	0.0766	0.1183	0.0027
	STD	0.0482	0.0268	0.0282	0.0442	0.0306	0.0521	0.0869	0.0055

The spatial analysis emphasized that on average more than 20% of the pasturelands was lost over the analyzed period. Land use dynamics (Figure 4) shows increased fragmentation and pasture conversion into built-up area (residential, roads, recreational area) and afforestation. Open pastures are important especially if they are located near forests, because they represent habitat for invertebrates, lepidoptera's and feeding area for herbivorous animals. In S3 pasture the afforestation occurs due to demographic factors (aging population and a decreasing number of livestock) and the forest expansion. Although in S4 pasture (influenced by two wind turbine) the conversion in other categories is low in numbers, the infrastructure of the wind park scatters the pasture increasing the total edge (**Error! Reference source not found.**-a) of the land use classes.

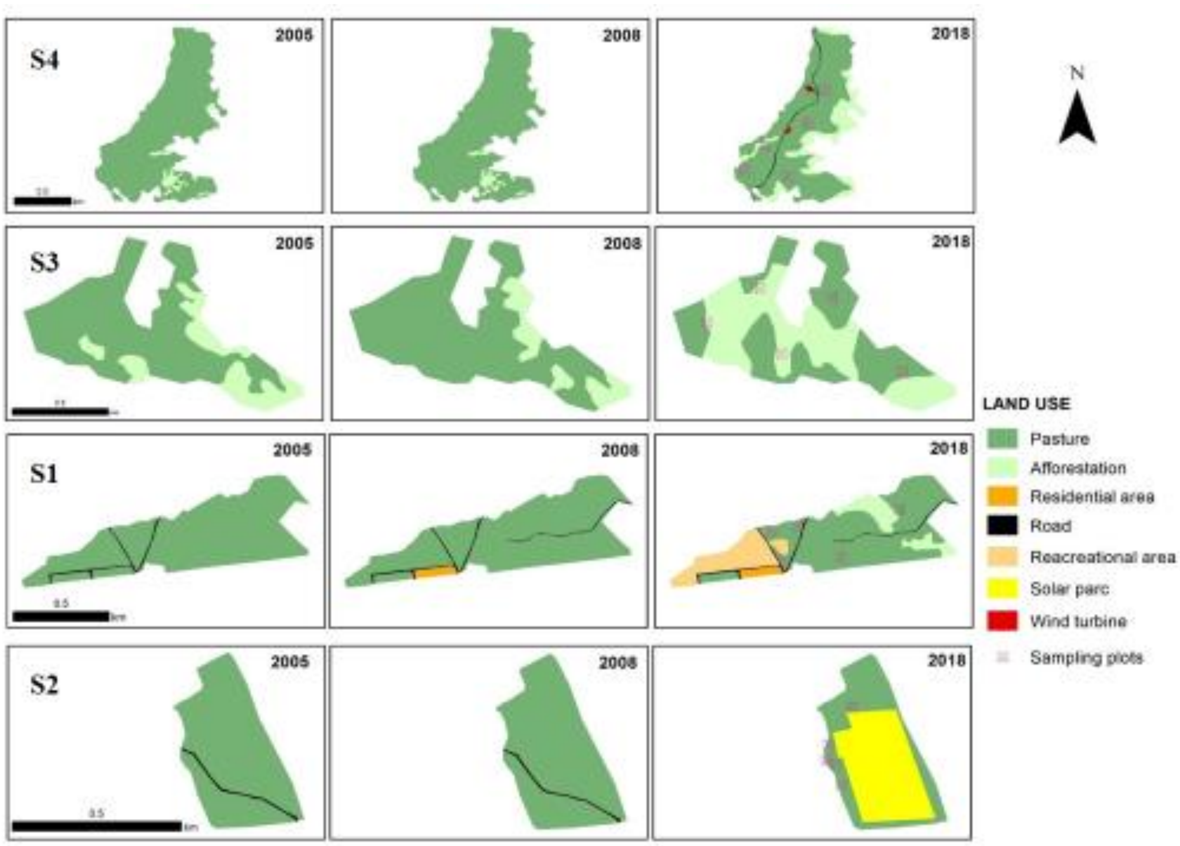

Figure 4. Land use dynamics by category during 2005-2018

Regarding the landscape metrics analysis (Figure 5, Table 5), the total edge indicator is increased showing the landscape's complexity due to high anthropization and landscape fragmentation. Fragmentation and complex ecological processes are better explained by edge-based metrics than patch-based metrics, because they explain the ecological changes (Zeng & Wu, 2005). Also, using edge-based metrics we can explain the heterogenity of the landscape: components and ecological processes. The increased number of patches indicator may determine spatial dispersed subpopulation, which decreases the population genome availability (McGarigal & Marks, 1995).

Table 5. Landscape metrics used in analysis

LANDSCAPE METRICS	SIGNIFICANCE
TOTAL EDGE	Total edge (m) of a patch class (class level)
NUMBER OF PATCHES	Total number of patches of a patch class (class level)

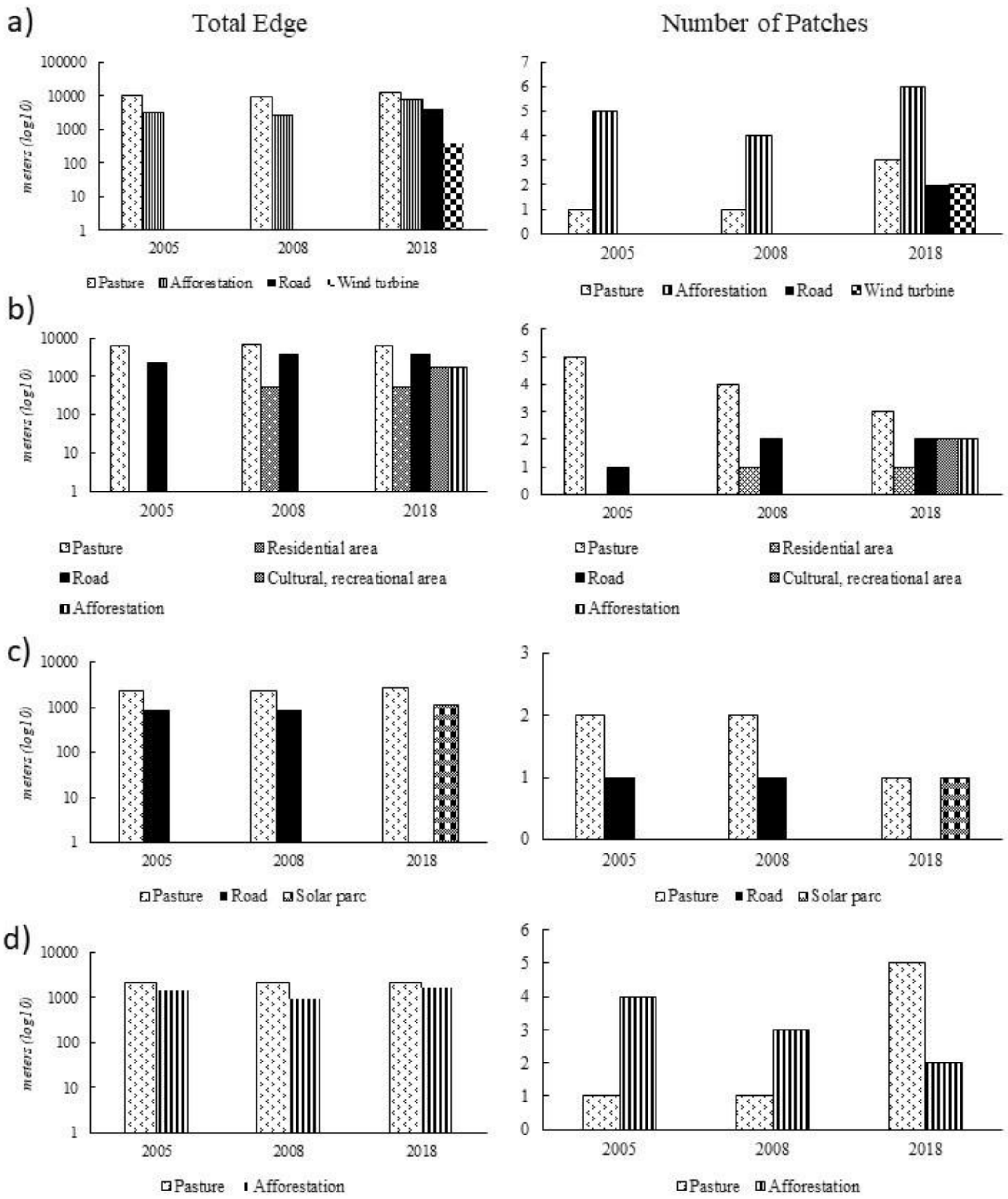

Figure 5. Landscape metrics for a) S4; b) S1; c) S2; d) S3

4. DISCUSSION AND CONCLUSIONS

4.1. Discussion

4.1.1. Pasture quality

Our findings emphasize that there is significant impact of land-use conversion on pasture surface. The loss of grazing areas towards build-up areas has an irreversible effect over the quality of the soil and vegetation. Prior land abandonment and lack of management led to a decrease of phytocoenosis quality that was projected over the amount of livestock and the variety of derived products. Grassland production capacity is the motivation for conversion to pastures. Biomass grown on their surface is used as fodder in the cold season for domestic animals. Most pastoral areas of the country are subject to traditional pastoral management and, in the absence of proven scientific rules, the phenomenon of degradation and decline in biodiversity may occur. Also, actions such as deforestation or abandonment of pastures (which often bear the afforestation phenomenon) decrease productivity and provide habitat conditions for exotic species, most often degrading their vegetation cover (Pătru-Stupariu et al, 2015; Peringer et al, 2016). Conversion of pastures for different activities, removal of soil mass and non-sowing with native species is another factor of degradation of pastures.

Degradation of phytocoenosis may be a key factor for the welfare of the entire ecosystem as they are primary producers. S1, represents the sub-pannonic steppe grasslands (6240*) and have partial natural origins and partial anthropogenic (Doniță et al, 2005; Gafta & Mountford, 2008). The location of the pasture is in a city that have the sunniest days in a year, which confirms the habitat requirements, showed by the ecological indicators identified for the species identified. The habitat identified for the S2 pasture, 6440, alluvial meadows of river valleys and represents a transitional habitat between hygrophile and xerofile pastures, although this habitat is not strictly observed in Romania, some of the authors considers Cnidion dubii synonymous with Agrostis stoloniferae, which is the phytocoenosis type identified for this study area (Doniță et al, 2005; Gafta & Mountford, 2008). 6230* (S3) habitat type represents species rich Nardus grasslands, on siliceous substrates in mountain areas (Gafta & Mountford, 2008). The pasture is deteriorating because forest species is invading the pasture and closing it. The most problematic species is Juniperus communis, because the grazing cattle can't eat it and it's eliminating in-situ species. Other problem spotted in the field is that the pasture is near the forest and forest managers are using the pasture for lumber activities. However we spotted that between 2006-2008 maintenance works were made to keep the pasture opened and to stop the spreading of shrub and tree species. For this pasture we also need to consider the demographic factor as the human community near the pasture is small and aged and the number of grazing animals is decreasing. For the S4 pasture we identified Festuco rubrae – Agrostetum capillaris as phytocoenosis type, which is representative for 6520 habitat type, mountain hey meadows (Gafta & Mountford, 2008). This pasture is traditionaly managed, some animals grazing in herds or they are lead by shephards. Beeing surounded by forest there is a great pressure for the pasture in the proximity because of the spreading shrub and tree species, as is showed by the land use dynamics analysis. Field observations identified that there are many ruderal and degrading species (Xanthium spinosum, Euphorbia cyparissias, Urtica dioica) near the access roads built when constructing the wind turbines.

The ecological indicators we used to see the habitat requirements for the identified species show that the species are sensitive to microclimate changes and this process is called calibration by ecological indices and they could also be used for pasture management as bioindicators (Păcurar & Rotar, 2014). Throughout the scientific community these indicators are known as Ellenberg's indicator values (EIVs). For the species identified in S2 and S4 areas the shadow from the solar panels and the moving wind turbine blades represent a real threat. Also, for S4 is necessary to consider the fact that the wind turbines affect the microclimate in their vicinity due to increased airflows, which can create habitat conditions for exotic species. Other studies use the EIVs to prove the habitat conditions or to calibrate them for different study areas and species. Szymura et al. (2014) compared predicted EIVs with measurements in an oak forest and concluded that despite all perturbing factors that may occur, the numbers are correlating and can be used as bioindicators. Other study by Chmura et al. (2017) showed that EIVs cannot be used as a bioindication for fallen trees but emphasize that the EIVs can be intercorrelated. A study conducted by Valjavec et al. (2018) on karst depression, showed that EIVs can be a low-cost method to analyze the human-induced deterioration of soil.

Our result regarding the pastoral value have indicated that there is a strong connection between the pasture quality and the anthropogenic pressures. Pastoral value analysis reveal high number of non-consumable or low-consumption species, toxic and harmful species for the vegetation cover (more than 50% for all four pastures), which has consequences in the products provided by the livestock grazing in those pastures. The pastoral value of the species identified in-situ is the same as in the Romanian regulation and is also used by Marușca et al. (2014). This method is used in establishing pastoral quality in Romania. Păcurar and Rotar (2014), consider that this method is properly used when the species density is high and for aiming to emphasize the economic value of the pasture.

Another challenge for the grazing areas is represented by the effect of climate change, which can be reflected in all the environmental components. Climate regulates the existence of species in a habitat, whether we are talking about air temperature, soil or air humidity. Some species have a high vulnerability and low resilience towards microclimate changes and even small discrepancies can eliminate them from specific ecosystems. Because plant species are at the bottom of the trophic chain, all the superior levels depends on their health conditions. Thus, it is necessary to analyze the effects of climate change on grazing areas, to ensure habitat equilibrium and high-quality ecosystem services.

4.1.2. Land use dynamics

Land use analysis that we have conducted had shown how the landscape changed for our case studies in the last decade. In this way we have established the driving forces of pasture quality degradation. Therefore, the land use dynamics analysis backed our results in regard of the pasture quality.

Land use and land cover analysis are commonly used to determine the degradation level of certain habitats or ecosystems, and usually are used to emphasize fragmentation patterns or amplitude. Similar techniques are used by Kuemmerle et al. (2008) to assess the land use changes induced by a shift of policy in Romania. The use of landscape metrics for quantitative analysis of the land use change phenomenon is widely used by many researchers. Whether these metrics are used for riparian ecosystems (Kumar et al, 2018), woodlands (del Castillo et al, 2015) or urban areas (Gavrilidis et al, 2015) the projecting results are representative to establish the causes and effects determined by landscape changes. The use of landscape metrics in our study helped us determine the fragmentation degree of the analyzed pastures supporting the ecological analysis results.

4.2. Conclusions

The use of the presented techniques for evaluating the pastures' quality helped us reached the aims of the study. However, further analysis must include an undisturbed pasture plot to further enhance the amount of pasture degradation. This task is however hard as most of the Romanian pastures are overgrazed or with a scarce management, making impossible the establishment of this plot. The methods presented in this paper can be easily used in any preliminary assessment regarding pasture quality. An important flaw in assessing pasture quality in Romania, is the lack of information and data regarding the past phytocoenosis quality of the pastures, therefore the present results cannot be compared with prior ones, thus it's hard to establish whether the pasture quality has decreased or increased throughout the years.

If we think about solutions towards improving the grazing areas quality, geo-informational solutions can be useful. One example may be to introduce a National catalogue of the pastures, in a platform (like ArcGIS Online), in the form of an interactive map, where the

Ministries for Agriculture or Environment, can keep track of the quality of the pastures at national level. The interactive map could include all the pastures as polygons, and each of them will have an attribute table (Table 6), available with a click, with information reported by the owners. In this way the authorities could supervise the users of the pasturelands (to avoid overgrazing) and also information could be available to the worldwide public.

Table 6. Example of an attribute table used in the interactive map

VARIABLE	DESCRIPTION OF THE VARIABLE
LEGAL STATUS	Private/Public
SURFACE	Hectares
EXISTENCE OF PASTORAL	Yes/No
MANAGEMENT STUDY	Period of implementation
HABITAT TYPE	Name and small description
SPECIES INVENTORY	List of species identified in-situ
PRODUCTIVITY	tones/hectares
REQUIRED IMPROVEMENT	Waste collecting/Ground leveling/ Rocks collecting/Fertilization
ACTIVITIES	required (type, quantity)
PROTECTED ENVIRONMENT	Natura 2000 site/Natural Reserve/Natural or National Park

Without a strong strategy endorsed by national and local regulation the quality of Romanian pastures will continue its descending trend, affecting the amount of livestock and the prices of derived products, ultimately influencing the quality of life levels.

REFERENCES

Abhay, R. K., & Patra, P. (2018). Measuring Resilience Of Land Against Degradation From A Farmer’s Perspective Approach In Kendujhar Plateau, Odisha (India). *European Journal of Geography*. 9 (1): 23-37.

Beller, E., E., Spotswood E. N., Robinson, A., H,, Anderson,M., G., Higgs, E., S., Hobbs, R., J., Suding,K., N., Zavaleta,E. S., Grenier,J., L., & Grossinger, R., M. (2018). Building Ecological Resilience in Highly Modified Landscapes. *BioScience*. XX:1-13. https://doi.org/10.1093/biosci/biy117.

Bičík, I., Jeleček, L., & Štěpánek, V. (2001). Land-use changes and their social driving forces in Czechia in the 19th and 20th centuries. *Land use policy*. 18 (1): 65-73.

Bieling, C., & Plieninger, T. (2013). Recording manifestations of cultural ecosystem services in the landscape. *Landscape Research*. 38 (5):649-667.

Chmura, D., Żarnowiec,J., & Staniaszek-Kik, M. (2017). Do Ellenberg’s Indicator Values Apply to the Vascular Plants Colonizing Decaying Logs in Mountain Forests?. *Flora: Morphology, Distribution, Functional Ecology of Plants*. 234: 15–23. https://doi.org/10.1016/j.flora.2017.06.008.

Cosgrove, D.; Underdander, D.; Cropper, J. (2001). Guide to Pasture Condition Scoring. Grazing Lands Technology Institute.

Cumming, G. S. (2011). Spatial resilience: integrating landscape ecology, resilience, and sustainability. *Landscape ecology*. 26 (7): 899-909.

Del Castillo, E. M., García-Martin, A., Aladrén, L. A. L., & de Luis, M. (2015). Evaluation of forest cover change using remote sensing techniques and landscape metrics in Moncayo Natural Park (Spain). *Applied Geography*. 62: 247-255.

Doblas-Miranda, E., Alonso, R., Arnan, X., Bermejo, V., Brotons, L., de Las Heras, J., & López-Serrano, F. R. (2017). A review of the combination among global change factors in forests, shrublands and pastures of the Mediterranean Region: Beyond drought effects. *Global and Planetary Change*. 148: 42-54.

Doniţă, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, S., & Biriş, I. A. (2005). Habitatele din România. Ed. Tehnică Silvică.

Durău, C., Moisuc, A., & Sărăţeanu, V. (2010). Approaches on floristic composition and pastoral value of some permanent pastures in Hăuzeşti area (Western Romania). *Research Journal of Agricultural Science*. 42 (1): 427-430.

Ellenberg, H., Weber, T.H.E., Dull, R., With, V., Werner and W., Paulisen, D. (1992). Indicator values of plants in Central Europe. *Gottingen: Scripta Geobotanica*. 18:7-97

Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual review of ecology, evolution, and systematics*. 34 (1): 487-515.

Fischer, J., Lindenmayer, D. B., & Manning, A. D. (2006). Biodiversity, ecosystem function, and resilience: ten guiding principles for commodity production landscapes. *Frontiers in Ecology and the Environment*. 4 (2): 80-86.

Gafta, D., & Mountford, J. O. (2008). Manual de interpretare a habitatelor Natura 2000 din Romania [Romanian Manual for Interpretation of EU Habitats]. Cluj-Napoca. Ed. Risoprint.

Gavrilidis, A. A., Grădinaru, S. R., Iojă, I. C., Cârstea, E. M., & Pătru-Stupariu, I. (2015). Land use and land cover dynamics in the periurban area of an industrialized East-European city. An overview of the last 100 years. *Carpathian Journal of Earth and Environmental Sciences.* 10 (4): 29-38.

González, M. J. G. (2017). Planning, urban sprawl and spatial thinking. *European Journal of Geography*. 7 (5): 32-43.

Government Emergency Ordinance no. 34/2013 regarding the organization, management and exploitation of permanent meadows

Grădinaru, S. R., Ioja C. I., Onose D. A., Gavrilidis A. A., Pătru-Stupariu I., Kienast F. & Hersperger A. M. (2015). Land Abandonment as a Precursor of Built-up Development at the Sprawling Periphery of Former Socialist Cities. *Ecological Indicators*. 57: 305–13. https://doi.org/10.1016/j.ecolind.2015.05.009.

Hennig, E. I., Soukup, T., Orlitova, E., Schwick, C., Kienast, F., & Jaeger, J. A. G. (2016). Urban Sprawl in Europe. Joint EEA-FOEN report. *EEA Report*. No. 11: 1-5.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual review of ecology and systematics*. 4 (1): 1-23.https://doi.org/10.1007/s10021-008-9146-z.

Inostroza, L., Hamstead, Z., Spyra, M., & Qhreshi, S. (2019). Beyond urban–rural dichotomies: Measuring urbanisation degrees in central European landscapes using the technomass as an explicit indicator. *Ecological Indicators*. 96: 466-476.

Krahulec, F., Skálová, H., Herben, T., Hadincová, V., Wildová, R., & Pecháčková, S. (2001). Vegetation changes following sheep grazing in abandoned mountain meadows. *Applied Vegetation Science*. 4 (1): 97-102.

Kuemmerle, T., Patrick H., Volker, C R., van der Linden, S., Perzanowski, K., & Kruhlov, I.. (2008). Cross-Border Comparison of Post-Socialist Farmland Abandonment in the Carpathians. *Ecosystems*. 11 (4): 614–28.

Lade, S. J., Haider, L. J., Engström, G., & Schlüter, M. (2017). Resilience offers escape from trapped thinking on poverty alleviation. *Science Advances*. 3(5).

Law no. 231/2018 for the modification and completion of the Land Fund Law no. 18/1991

Law no. 44/2018 on the modification and completion of Government Emergency Ordinance no. 34/2013 regarding the organization, management and exploitation of permanent meadows and amending and supplementing the Land Fund Law no. 18/1991

Lucash, Melissa S, Robert M Scheller, Eric J Gustafson, and Brian R Sturtevant. (2017). Spatial Resilience of Forested Landscapes under Climate Change and Management. *Landscape Ecology*. 32 (5): 953–69. https://doi.org/10.1007/s10980-017-0501-3.

Maruşca, T., Mocanu, V., Has, E.C., Tod, M.A., Andreoiu, A.C., Dragoş, M.M., Blaj, V. A., Ene, T.A., Silistru, D., Ichim, E., Zevedei, P.M., Constantinescu, C.S. and Tod, S.V. (2014) Ghid de întocmire a amenajamentelor pastorale. Braşov. Ed. Capolavoro

McGarigal, K. & Marks, B.J., (1995). FRAGSTATS: Spatial Pattern Analysis Program for Quantifying Landscape Structure. *General Technical Report PNW-GTR-351*. USDA Forest Service, Pacific Northwest Research Station, Portland.

Mokarram, Marzieh, Ali Darvishi Boloorani, & Majid Hojati. (2016). Relationship Between Land Cover And Vegetation Indices. Case Study: Eghlid Plain, Fars Province, Iran. *European Journal of Geography*. 7 (2): 48–60.

Müller, F., Bergmann, M., Dannowski, R., Dippner, J. W., Gnauck, A., Haase, P. & Küster, M. (2016). Assessing resilience in long-term ecological data sets. *Ecological indicators*. 65:10-43.

National Institute of Statistics, (2014); AGR101B - Suprafata fondului funciar dupa modul de folosinta, pe judete si localitati; National Institute of Statistics; 19.01.2019. http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Păcurar, F., & Rotar, I. (2014). Metode de studiu şi interpretare a vegetaţiei pajiştilor. Cluj-Napoca. Ed. Risoprint.

Pătru-Stupariu, I, Tudor, C. A., Stupariu, M. S., Buttler, A. & Peringer, A., (2015). Landscape persistence and stakeholder perspective: The case of Romania’s Carpathians. *Applied Geography*. XXX:1-12

Pătru-Stupariu, I., Stupariu, M. S., Cuculici, R., & Huzui, A., (2011). Understanding landscape change using historical maps. Case study Sinaia, Romania. *Journal of Maps*. 206-220.

Pătru-Stupariu, I., Stupariu, M. S., Tudor, C. A., Grădinaru, S. R., Gavrilidis, A.A., Kienast, F., & Hersperger, A. M. (2015). Landscape fragmentation in Romania's Southern Carpathians: Testing a European assessment with local data. *Landscape and Urban Planning*. 143:1-8.

Peringer, A., Gillet, F., Rosenthal, G., Stoicescu, I., Pătru-Stupariu, I., Stupariu, M. S.& Buttler, A. (2016). Landscape-scale simulation experiments test Romanian and Swiss management guidelines for mountain pasture-woodland habitat diversity. *Ecological Modelling*. 330:41-49.

Sârbu, I., Ştefan, N. & Oprea, A., (2013). Plante vasculare din România, Determinator ilustrat de teren, Editura VictorBVictor.

Schmitt, T., & Rákosy, L. (2007). Changes of traditional agrarian landscapes and their conservation implications: a case study of butterflies in Romania. *Diversity and distributions*. 13(6): 855-862.;

Suditu, B., Nae, M., Neguț & S., Gheorghilaș, A., (2014). Responsibilities and Limits of Local Government Actions against Users of Public Services of Planning and Sustainable Territorial Development in Romania. *Amfiteatru Economic Journal*. 16. (35): 154-170.

Szymura, T. H., Szymura, M., & Macioł, A. (2014). Bioindication with Ellenberg's indicator values: A comparison with measured parameters in Central European oak forests. *Ecological indicators*. 46: 495-503.

Valjavec, M. B., Zorn, M., & Čarni, A. (2018). Bioindication of human-induced soil degradation in enclosed karst depressions (dolines) using Ellenberg indicator values (Classical Karst, Slovenia). *Science of The Total Environment*. 640: 117-126.

Wittig, R., Becker, U., & Nawrath, S. (2010). Grassland loss in the vicinity of a highly prospering metropolitan area from 1867/68 to 2000—The example of the Taunus (Hesse, Germany) and its Vorland. *Landscape and Urban Planning*. 95(4): 175-180.

Zeng, H., & Wu. B., (2005). Utilities of Edge-Based Metrics for Studying Landscape Fragmentation. *Computers, Environment and Urban Systems*. 29 (2): 159–78. https://doi.org/10.1016/j.compenvurbsys.2003.09.002.