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ECOLOGICAL CONDITIONS AND SUCCESSIONAL PROCESSES OF THE ABANDONED MOUNTAIN PASTURES IN THE REGION OF MALESH

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ABSTRACT: This paper presents the results of the research of the natural characteristics of the mountain pastures in the region of Malesh and the processes of their overgrowth with forest vegetation. The researches include mountain pastures in the region of Malesh, which are distributed between 1200 and 1932 m above sea level. These mountain pastures until the 1990s were more intensively used for grazing of small and large livestock (sheep and cattle), but after this period there is a noticeable decrease in the livestock, especially sheep, which lead to overgrowing of large areas of these pastures with different shrubs and forest vegetation. The purpose of this paper is to determine the natural succession processes that occur as a result of the afforestation of mountain pastures and the process of their overrun and transformation into young forest plantations. From the results obtained in the research, it was determined that the natural conditions in the Malesh region are favorable for persistence of large areas of mountain pastures on which a substantial number of large and small livestock can be grown. However, the natural conditions in the particular region are also favorable for the development of forest vegetation, due to which a large number of pioneer species are significantly distributed in the pastures on which no livestock is fed. The strong regeneration ability of these species contributes to intensive afforestation of the mountain pastures, whereto a significant part of them lose their function and gradually transform into young forests. This process is assisted by the reduction of livestock in the region and the land use reduction of these areas. Thus, for a period of only 30 years in some parts of these pastures occur intensive overrun processes resulting with a complete transformation of these parts of mountain pastures into young forest plantations

Keywords: site conditions, pasture management, succession.

1 INTRODUCTION

The region of Malesh is situated in the easternmost part of the Republic of Macedonia, bordering the Republic of Bulgaria (Fig. 1). It is characterized by high-developed relief with lowest point at only 660 m a.s.l and highest point at 1932 m a.s.l (Kadiica peak).

The region of Malesh is characterized by very rich hydrographic pattern. There are two bigger catchment areas: Bregalnica and Strumica rivers, which further flow in the Aegean watershed. The catchment area of the river Bregalnica covers mainly the higher mountainous region. The slope of the watershed is steep, where the right side is more developed, i.e. has more tributaries, such as: Ravnica River, Ratevska River, Klepalska River, Zamenichka River, Rusinska River, Kamenichka River, Lenishka River and Zhelevica.



Figure 1: Location of Malesh region

Natural conditions have a major impact on vegetation development at a certain area. Depending on the natural

conditions at the studied area various plant species (wooded and herbaceous) are represented and exist. The existing natural conditions represent optimal values for development of some plant species, but also are limiting factor for development of others. Present plant species have found optimal conditions for their development at the researched area. On the other hand, the altitude is the most limiting factor. The treeline extends up to 1746 m a.s.l. At higher altitudes are developing pasture communities. Plant communities in the high mountains in Macedonia are investigated by Horvat, I. (1933) and Rudski, I. (1938). The forest vegetation in Malesh and Pijanec is explored by Dzekov, S. and Rizovski, R. (1978). At the researched area are present the following forest communities ass. *Quercetum frainetto-cerris*, ass. *Quercetum frainetto-cerris* subass. *pinetosum nigrae*, ass. *Orno-Quercetum petraeae*, ass. *Orno-Quercetum petraeae* subass. *pinetosum nigrae*, ass. *Fago-Pinetum nigrae*, ass. *Festuco heterophyllae-Fagetum*, ass. *Calamintho grandiflorae-Fagetum* and shrublands of common juniper (*Juniperus communis*) [2].

The vegetation of meadows and pastures in Malesh and Pijanec is explored by Micevski, K. (1978.) The pastoral communities at the investigated area belong to the alliances Armerio-Potentillion (ass. *Genisto-Agrostideum byzanthinae*) and Poion violaceae (ass. *Thymo-Poetum violaceae* and *Thymo-poetum violaceae* subass. *chamaespartietosum*) [7]. The possibilities for improving the conditions of pastures, forests, forest land and primary wood processing in Malesh and Pijanec are studied by Rabadziski, B. and Vasilevski, K. (2001).

The management of forest resources in the region of Malesh has a long tradition but mainly done in a traditional manner [1]. Ecological conditions (relief, altitude, inclination, exposure, hydrology, geology, soil and climate features) have major importance for the vegetation on mountain pastures due to their impact on microclimate and mesoclimate conditions at all areas [4].

This region was once known for animal husbandry and majorly sheep farming prevalence due to numerous mountain pastures, favorable natural conditions and good opportunities for animal breeding, activities which had a major role in maintaining mountain pastures. Mountain pastures are zoogenic and anthropogenic areas where changes in vegetation occur constantly [13]. The number of livestock and application of extensive management practices at mountain pastures had an impact on their appearance. Nowadays in the mountainous area of the Malesh region are visible processes of afforestation that lead towards overgrowth of mountain pastures with forest vegetation. Natural regeneration of some indigenous forest tree species at sites without forests in the Malesh region is explored by Velkovski, N. et al. (2008). The vegetation of pastures in Maleshevo is examined by Teofilovski A. (2011).

The period of 1990s caused a massive depopulation of the region leading to drastic reduction of livestock and afforestation of the areas previously pressured intensively by the population and livestock. This phenomenon leads to reduced quality and quantity of the mountain pastures, influenced by the successive processes and allow transformation of the pastures into young forest plantations.

2 METHOD AND RESEARCH OBJECT

The subject of this study are the successional processes of mountain pastures in the region of Malesh distributed between 1200 and 1932 m above sea level and its relation with the ecological conditions at the area. The aim is to determine the influence of the abandonment of pasture management on successional processes in the region of Malesh. Therefore, main task of the research is collecting field data and their analysis to determine successional processes of the vegetation.

In achieving these aims and tasks have been realized numerous activities such as: exploration of anthropogenic and zoogenic influence and its significance regarding the processes of ecological succession, selection of representative areas, setting of 12 experimental plots of 500 m² (25 x 20 m) and demarcation of their borders. The areas for setting experimental plots were chosen according to following criteria: 1. Areas have similar environmental characteristics, 2. Areas have similar floristic composition and 3. Areas are abandoned i.e. no visible signs of anthropologic and zoologic influence.

Each experimental plot is set by firstly positioning the starting point (the south west point), then setting the west border by pointing a compass and prism measuring instrument to north and measuring of the 20 m length to determine the north west point, followed by same approach from both points with 90° turn and measuring 25 m to east to determine the north east and south east points and final control distance measurement between the last two points of 20 m. The starting point and the boundaries of each plot are recorded with a GPS device and referenced in WGS84 coordinate format. Thereby, at all sample plots are determined: altitude, exposure, slope of terrain, soil type, and plot inventory to determine the presence of different forest species and other (accompanying) plant species and number of individuals per sample plot including measuring of their dimensions (height of stem, diameter of crown, diameter at breast height). At precisely defined sub-plots of 50 m² (2 x 25 m), placed in the middle of the 12 main experimental

plots stretching from west to east, is undertaken detailed inventory and measurements of the position and dimensions of the individuals to analyze the succession dynamics. Data from field measurements are recorded in forms, and then mathematically processed. The spatial distribution of the experimental plots is given on the map below (Fig. 2).

The climate characteristics of the area were determined based on obtained data from climate station in Berovo, located at an altitude of 824 m, including: average monthly minimal and maximal air temperatures, monthly sum of precipitation, sum of precipitation over the growing period, annual sums of precipitation and speed and frequencies of the winds.

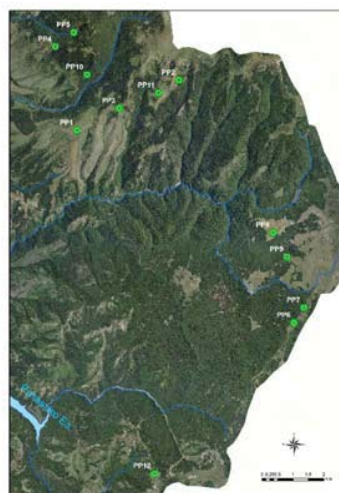


Figure 2: Experimental plots spatial distribution

3 RESULTS AND DISCUSSION

The overall status of the ecological conditions in the region of Malesh and the successional processes of the area is noticed through analysis of the provided data from the climate station in Berovo, comparison of the vegetation data from previous researches and the collected field data and adoption of relationship between site conditions and successional processes.

The relief of the Region of Malesh is quite widespread, intersected with many ravines that rise above the lower and higher sides of the hills and mountains that extend generally from west to the east and northeast.

The altitude has important influence on existence and development of vegetation at the area. The lowest point in the region has an altitude of 660 m, while the highest point of 1932 m (Kadiica peak). The forest line extends up to 1746 m a.s.l. At higher altitudes are developing pasture communities. It is the most limiting factor. Increase of the altitude changes climate characteristics adequately.

Exposure or aspect generally refers to the horizontal direction to which a mountain slope face. It has an impact on other environmental factors, as well as the occurrence of various types of forest in a certain area. Various types of aspects are met at the studied area and presented in Table I.

The slope (inclination) of the terrain is tilted at an angle on which all other natural conditions in a given

environment largely depend. The rising slope of the terrain increases the risk of erosion, increases the intensity of leakage of surface and ground waters, so the amount of moisture in the soil decreases and the soil depth and layers are reduced. Natural conditions that are influenced by the slope are very important for determining the silviculture measures. Analysis of the available data indicate that the terrain of Malesh region has moderately steep slopes up to steep and very steep slopes, which combined with the higher altitude at the research area provide favorable natural preconditions for development of pastoral communities' at large areas. In Table I are shown the slopes of every experimental plot

Table I: Experimental plots aspect and slope

Experimental Plot	Aspect	Slope (%)
EP1	SW	10,4
EP2	SE	37,9
EP3	SW	20,9
EP4	W	25,4
EP5	W	46,7
EP6	N	12,0
EP7	NW	1,6
EP8	SW	9,0
EP9	W	11,3
EP10	SW	36,4
EP11	W	21,4
EP12	NW	15,5

Soil conditions in the region of Malesh are represented by five soil types including: Regosol, Chromic Luvisol on saprolite, Complex of Humic Eutric and Umbric Regosol, Cambisol and Lithic Leptosol. Pastoral succession currently occurs at Regosoles or Complex of Humic Eutric and Umbric Regosol (Fig. 3).

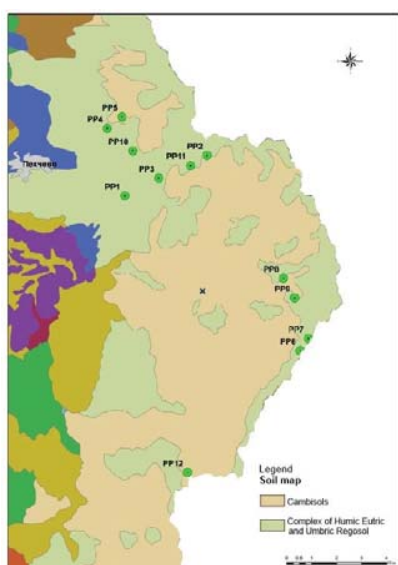


Figure 3: Soil types at the researched area

Climate data are obtained from meteorological station in Berovo, located at an altitude of 824 meters. The processed data for average monthly temperatures and monthly amounts of rainfalls for the period 2001 to 2010

are used for preparation of Walter's climate diagram for Malesh region (Fig. 4). The mean annual temperature for the period from 2001 to 2010 is 9,3°C, while the average amount of rainfall is 699,4 mm.

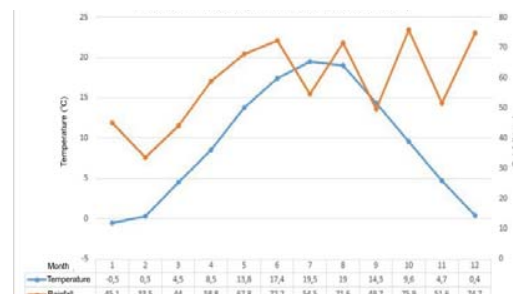


Fig. 4: Walter's climate diagram for Malesh region

Close relationship is revealed between successional processes of abandoned pastures in the region of Malesh and the relevance of anthropogenic and zoogenic factors at the region. Data on demography and mitigation processes provided by the State Statistical Office (SSO) indicate constant declining population trend line (Table II and Fig. 5).

Table II: Population in Malesh region

Year	Urban	Rural	Total
1948	5 306	13 711	19 017
1948 (%)	27,9	72,1	
1953	5 926	14 512	20 438
1953 (%)	29,0	71,0	
1961	6 116	13 932	20 048
1961 (%)	30,5	69,5	
1971	6 974	12 987	19 961
1971 (%)	34,9	65,1	
2013	9 442	10 016	19 458
2013 (%)	48,5	51,5	

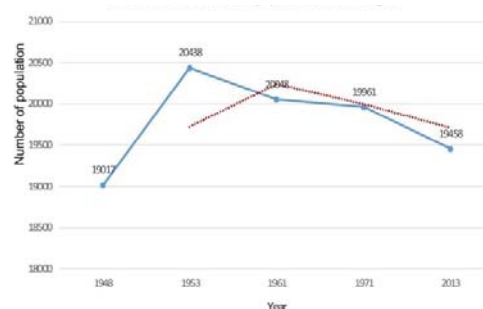


Figure 5: Trendline of population in Malesh region

This phenomenon is caused by the migration of the population from rural to urban areas as well as permanent emigration from the region. It also contributed in land use change. Data on land use indicate process of returning of the forest vegetation at areas formerly pressured by various human activities (Table III). Identified arising issue is human induced afforestation in the high mountain areas with various monocultures (e.g. pines) and providing solid ground for fast advancement of pioneering forest species (mainly coniferous).

Table III: Land use in the region of Malesh

	Total agricultural land (ha)	Arable area (ha)	Pastures (ha)	Forests (ha)
1976	68 218	36 006	32 212	49 613
2011	75 019	32 950	42 068	63 863
Difference	6 801	-3 056	9 856	14 250

Table IV: Number of sheep and cattle in the region of Malesh

	Cattle 2014	Cattle 2007	Cattle 1976	Difference 1976-2014	Sheep 2014	Sheep 2007	Sheep 1976	Difference 1976-2014
Berovo	2 214	2 290	8 240	-4 019	21 771	26 226	47 601	-16 513
Pehcevo	2 007	1 839			9 317	10 647		

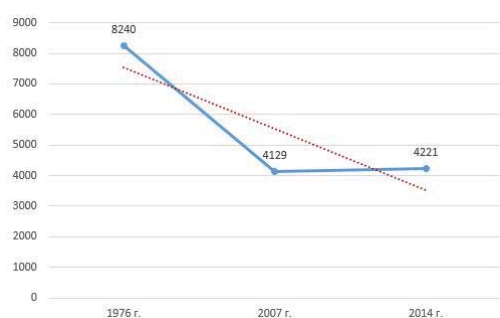


Figure 6: Trendline of cattle in Malesh region

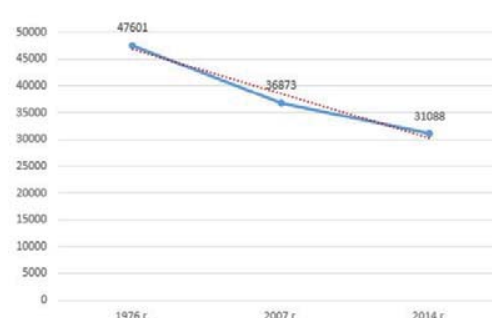


Figure 7: Trendline of sheep in Malesh region

Table V: Summary of the experimental plots data

Category	Experimental plot	Altitude (m)	Number of individuals	Number of taxa	Stage of Succession	Restoration measures
1 - 10 years	EP1	1297	82	5	Initial	Mowing, Firing
	EP8	1492	184	6	Initial	Mowing, Firing
	EP9	1517	253	3	Initial	Mowing, Firing
11 - 20 years	EP3	1426	130	6	Progressive	Mowing, Firing Removal
	EP6	1550	284	12	Progressive	Mowing, Firing Removal
	EP7	1557	208	8	Progressive	Mowing, Firing Removal
21- 30 years	EP2	1575	236	10	Intensive	Mowing, Firing Removal
	EP11	1533	55	5	Progressive	Mowing, Firing Removal
	EP12	1362	80	8	Intensive	Mowing, Firing Removal
Over 30 years	EP4	1408	223	7	Forest	Not applicable
	EP5	1483	100	7	Forest	Not applicable
	EP10	1387	88	8	Forest	Not applicable

Decreased population and livestock in the region lead to decreased livestock pressure over the mountain pastures, allowing space for easier emergence of certain plant species with strong regeneration capability and relatively quickly inhabit places such as abandoned mountain pastures. Such phenomenon contributed in acceleration of succession processes at different stages and emergence of forest vegetation on some pastures, strongly expressed in areas where mountain pastures have been abandoned for long periods.

Up to 10 years of abandonment of the pastures initial-

ly appear pioneering, heliophylous, ruderal and invasive mainly annual and perennial herbaceous plants, with appearance of individual shrubby species of the type of low bushes.

Later, between 11 and 20 years of abandonment, increases the number of individuals and taxa of woody shrubs, as well as their size and coverage. Sometimes in this period, and almost regularly during the period between 21 and 30 years of abandonment, occurs a stratification of the bushes.

After 30 years of abandonment at the area of the

former pasture begins to establish the stratum of the trees (with height over 5m), and in the stratum of the bushes are found species that can thrive in shade.

Main forest woody species that colonize the abandoned pastures are: *Juniperus communis*, *Pinus nigra* and *Pinus sylvestris*. Associated species are: *Chamaecytisus absinthioides*, *Rosa canina*, *Prunus cerasifera*, *Prunus spinosa*, *Crataegus monogyna*, *Coryllus avellana*, *Sorbus aucuparia*, *Mallus sylvestris*, *Rubus fruticosus*, *Rubus idaeus*, *Epilobium* spp., *Carlina acaulis*, *Onopordon acanthium*, *Eringium campestre*, *Verbascum* spp. and *Pteridium aquilinum*.

3 CONCLUSIONS

The rapid and intense successional processes of mountain pastures in the region of Malesh despite the reduction of livestock, the decrease of their utilization and their abandonment, are also influenced by the favorable site conditions for occurrence of forest vegetation as well as numerous pioneering species that have strong regeneration ability to inhabit the abandoned mountain pastures and other similar grounds.

Main factor for successional processes on pastures in the region of Malesh is the declining anthropogenic and zoogenic impact on the area by continuous reducing of the population and livestock in the region of Malesh. Data on land use indicate process of reoccurrence of the forest vegetation at areas formerly pressured by various human activities.

Ecological characteristics at the researched area, in absence of anthropogenic and zoogenic pressure, provide favorable conditions for advancement of numerous pioneering forest trees and shrubs. Data points out rapid and intensive afforestation of the pastures in the region of Malesh and their transformation into areas with forest vegetation due to the favorable ecological conditions. This is especially typical for areas up to 1550 m altitude. At higher altitudes successional intensity is lower due to severe micro climate conditions and emergence of numerous shrub species.

The vegetation change of the high mountain pastures and decrease of their area is negative phenomenon that endangers the fulfillment of their functions, but also reduces the diversity and values of the landscape.

Restoration measures for reclamation of the pastures abandoned up to 20 years are necessary! Otherwise, after about 30 years, forest vegetation will prevail at the areas with pastures. That might cause loss of significant part of overall biodiversity. Former pasture areas, abandoned over 30 years, can be considered as irreversibly afforested by typical forest vegetation. In such case, restoration measures for reclamation of such areas in their previous state are economically and biologically unreasonable.

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