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EVALUATION OF CARBON STORAGE AS AN ECOSYSTEM/LANDSCAPE SERVICE IN *eutric Cambisols, CMe, albic Luvisols, LVa* AND *rendzic Leptosols, LPk* IN MALA PLANINA

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ABSTRACT— *The aim of the current investigation is to identify and quantify organic carbon as a supporting ecosystem/landscape service of the following soil subtypes: eutric Cambisols, CMe, albic Luvisols, LVa and rendzic Leptosols, LPk in Mala Planina. Nine soil samples were collected from typical landscapes in the mountain. Each sample weighs 500 grams, which is a necessary weight for the conduction of chemical analyses in a laboratory. The value of carbon per ton in the investigated soils in Mala Planina, equated to the carbon emissions, is determined and displayed as monetary value in EUR to indicate the value of "carbon stock" as a supporting ecosystem/landscape service of eutric Cambisols, CMe, albic Luvisols, LVa and rendzic Leptosols, LPk. The results are comparable to other investigations and fall within the range of the average values for Bulgaria.*

Keywords*:* ecosystem/landscape services, organic carbon, Mala Planina

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1. INTRODUCTION

Ecosystems have a great deal of functions and some of the most essential of them are storage and sequestration of greenhouse gases, removal of carbon dioxide (CO_2) from the atmosphere and improvement of their own capacity to adapt to the effects of climate change (Maes et al., 2013). During the process of photosynthesis vegetation absorbs CO_2. After a great deal of biochemical processes, a part of the carbon is released during respiration and another portion is turned into biomass in the form of leaves, stems and roots. When vegetation's life cycle comes to an end, carbon sinks into soils and starts building up. The current study's foundation lies in this process. It is based on the classification of ecosystem/landscape goods and services, following the Millennium Ecosystem Assessment report of 2005. A main aim is to identify the quantity of organic carbon (C), as a supporting ecosystem/landscape service in distinguishable soils in the area of the research. The study presents an evaluation of ecosystem services as a capability of absorbing and preserving carbon by the soil subtypes *eutric Cambisols, CMe, albic Luvisols, Lva* and *rendzic Leptosols, LPk*. A similar soil research in Bulgaria was conducted of *Umbrosols (UM)* in the municipalities of Gorna Malina, Mirkovo, Chelopech, Zlatitsa, Pirdon and Anton (Assenov et al., 2016).

Ecosystem studies and their investigation in Bulgaria is not a new event in the scientific literature of the country, as the studies of Nedkov & Burkhard (2012) and Assenov & Borissova (2014) mark.

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2. MATERIALS AND METHODS

The area of the current investigation is Mala Planina, which is located in the western part of the country in a very close proximity to the capital city of Sofia. To the north are the mountains of Chepun and Ponor, to the south is Sofia valley, to the east are the mountains of Golema Planina and Sofiiska Planina. The collection of soil samples in the studied object was completed during terrain research in the summer of 2016. Nine morphological descriptions in typical landscapes were carried out (Fig. 1). Each description contained a soil sample, weighing 500 grams, which was taken for laboratory tests.

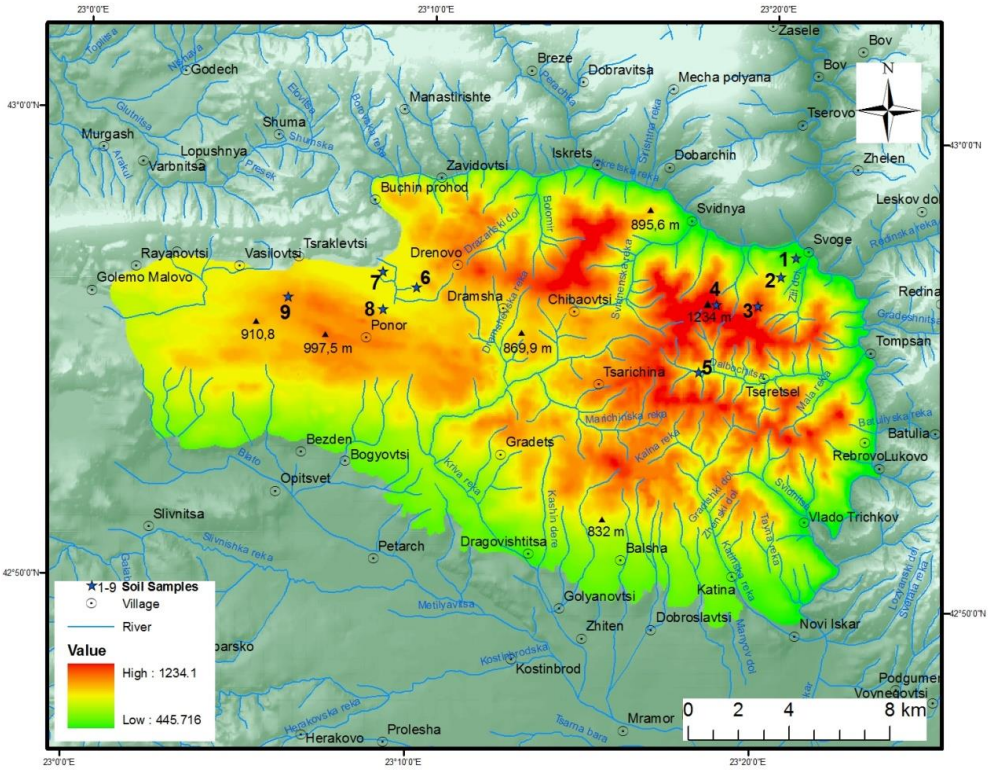

Figure 1. Map of the location of the soil samples in Mala Planina

If we look closely into the map, we will find out the specific areas, chosen for soil trials. Soil samples, numbered 1, 2, 3, 4 are from the soil subtype *eutric Cambisols, CMe*, sample number 5 is collected from *albic Luvisols, LVa* and samples from number 6 till number 9 are picked up from r*endzic Leptosols, LPk*. Samples 1-4 are collected from a representative profiles, advocating for the broadest denivelation difference in Mala Planina – from the town of Svoge, including Kosmatitsa neighborhood to the highest peak in the mountain (Tseria – 1234,1 m). The authors assume the average value of organic carbon in these four samples, as being representative for *eutric Cambisols, CMe* in Mala Planina. Sample number 5 adds more value to the investigation, representing a different soil subtype and it was collected at a slope along the mountainous road, located western of Tseretsel village. The average value of organic carbon in samples 6 to 9 - the rendzinas (*rendzic Leptosols, LPk*) is acknowledged for being representative for this soil subtype of the soil richness in the karst Kamuka Ridge. They were collected in the area of Ranislavtsi Field: sample 8 – near a pot-hole in the northern part of Kamuka Ridge and sample 9 – from the area of the former military polygon, several kilometers western of Ponor village.

Laboratory tests, concerning the quantity of organic substance – humus, were carried

out in the "Geochemistry" laboratory of the University of Mining and Geology "St. Ivan Rilski", which is certified with an accreditation, registration № 113 /16.01.2015, valid until 16.01.2019. The samples were tested under Protocol № 185-I/14.11.2016 by a standard test method BSS 11302:1973, which represents the modified method of Turin. The testing period was 31.10.2016 – 14.11.2016.

3. RESULTS AND DISCUSSION

The complete results are presented on Table 1, where apart from the values of organic substance (humus), shown in column number 6, we can see also do values of organic carbon in column number 7, while at the same time, in column 9 are presented the exact geographic coordinates of the soil samples.

It can be deduced that the overall values of organic carbon are falling within the average range for the country (Filcheva, 2014). There are some high values between 10 and 13 % in *eutric Cambisols, CMe* and even 16.83 %, which is in sample number 6 (*rendzic Leptosols, LPk*), collected in the area around Ranislavtsi Field. This particular sample stands out because it does not fall within the average values for the country, having higher humus content. A possible explanation for this matter may be found in the presence of natural forest vegetation, dominated by *Quercus sp.* The rest selected *rendzic Leptosols, LPk* sites in Kamuka Ridge show a lack of this type of vegetation and the values of samples 7 and 8 present a proof of this. Their values are 3.28% and 5.61%, respectively and they fall within the country's average. The lowest value for humus content is 2.35% and the explanation for this is the higher degree of leaching.

Later on the content of carbon in the soils samples weighing 0,500 kg was multiplied by two in order to determine the content of carbon in a layer with a depth of 10 cm, multiplied by ten for 1 square meter (m²) and these actions were repeated for the soil depths of 25 cm, 27.5 cm, 30 cm, 40 cm and 50 cm in order to determine the total volume of carbon in the respective profiles in cubic meters (m³).

Table 1. Humus content and organic carbon

№	Indicator name	Unit	Standardized, validated laboratory methods	Register № of the sample	Test results	Organic carbon %	Test conditions	Coordinates
1	2	3	4	5	6	7	8	9
1	Organic substance - humus	%	BSS 11302:1973	**185-1**	12.09 ± 0.07	7,03	t 20.9±0.1ºC w 32.0±1.0%	N 42º57'25" E 23º20'17"
2		%	BSS 11302:1973	**185-2**	10.86 ± 0.09	6,31		N 42º57'07" E 23º20'09"
3		%	BSS 11302:1973	**185-3**	10.40 ± 0.08	6,05		N 42º56'15" E 23º19'24"
4		%	BSS 11302:1973	**185-4**	12.62 ± 0.14	7,34		N 42º56'15" E 23º18'35"
5		%	BSS 11302:1973	**185-5**	2.35 ± 0.08	1,37		N 42º54'52" E 23º16'26"
6		%	BSS 11302:1973	**185-6**	16.83 ± 0.14	9.78		N 42º56'55" E 23º09'51"
7		%	BSS	**185-7**	3.28 ±	1,91		N 42º57'13"

			11302:1973		0.11			E 23º09'17"
8		%	BSS 11302:1973	**185-8**	5.61 ± 0.11	3,26		N 42º56'22" E 23º09'22"
9		%	BSS 11302:1973	**185-9**	11.47 ± 0.11	6,67		N 42º56'02" E 23º06'23"

The calculated value is assumed to be an average for the respective area in Mala Planina. Values for a volume of 1,2 g/cm³, showing the mass of a volume unit of a dry soil in the environment, are taken in mind, during the calculation of the total quantity of organic carbon. Table 2 displays the average carbon content (t) in Mala Planina's soils, taking in mind the area they cover.

Table 2. Average content of carbon (t) in Mala Planina's soils

Area of Mala Planina (km²)	**Area of soils in Mala Planina (km²)**	**Average carbon content (t)**
351,3 km²	*eutric Cambisols, CMe* - 59,4 km²	31 566.6
	albic Luvisols, LVa - 106,4 km²	24 522.4
	rendzic Leptosols, LPk - 106,7 km²	82 026.7

Indication results, concerning the carbon content, are presented in EEA's report about Bulgaria (2013). Apart from this, Boyadgiev et al. (1994) calculate that the total quantity of organic carbon in Bulgarian soils, which reaches 1.4 Gt. The content of organic carbon is calculated in petagrams. One petagram is equal to one gigaton C (1 PgC = 1 GtC). The value of carbon per ton is 1 t C = 3.67 t CO_2. When calculated, it turns out that it is highest within *rendzic Leptosols, LPk*) - 301 037.9 (Table 3).

The price and evaluation of organic carbon in the selected soils in Mala Planina is based on carbon emissions quotas, presented in the European Market (2017) where the price in EUR/tCO_2 as of 01.08.2017, 16:00 is 5.27 EUR/t. The price is displayed at table 3 and the sums represent the total price of the supporting ecosystem/landscape service "carbon storage" for these soil subtypes in the area of the mountain. If we compare the current price with the one, discussed in the already mentioned study by Assenov et al. (2016) we observe a drop by 1.38 EUR/t and this is a matter that shouldn't be underestimated, considering the possibility of buying more CO_2 emissions for less money, inevitably leading to a more environmental pressure.

Table 3. Average carbon content (t), equaled to CO_2 emissions and market value

Soils	**Average carbon content (t)**	**Carbon value (t) in terms of CO^2 emissions (X 3,67 CO_2)**	**Market value of CO_2 emissions at the price of 5.27 €/t (EUR)**
eutric Cambisols, CMe	31 566.6	115 849.4	337 010
albic Luvisols, LVa	24 522.4	89 997.2	261 211.9
rendzic Leptosols, LPk	82 026.7	301 037.9	875 759.4

4. CONCLUSIONS

The current investigation deals with nine samples of the soil subtypes *eutric Cambisols, CMe, albic Luvisols, LVa* and *rendzic Leptosols, LPk* from the territory of Mala Planina and each sample weighs 0,500 kg. This study represents an opportunity to discuss the ecosystem/landscape goods and services, which the mountain provides, from a different perspective. A main subject of the tests in the laboratory of "Geochemistry" in the University of Mining and Geology "St. Ivan Rilski" was the investigation of the quantity of organic substance – humus, which is indivisibly connected with soil composition, especially when it comes to the organic carbon. The collected samples allowed the authors to sum the average content of C (t), carbon value (t) when it comes to CO_2 emissions, as well as the market value of the CO_2 emissions at the price of 5.27 EUR/t. The highest results are bound with *rendzic Leptosols, LPk*, which show their essential and specific place, when it comes to the functional biodiversity of Mala Planina.

The successful outcomes of this study may be implemented in the broader context of Western Stara Planina, which will give us a wider picture of the investigated issue.

5. REFERENCES

Maes, J., Teller, A., Erhard, M. et al. (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. 1st MARS report. Publications office of the European Union, Luxembourg.

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Assenov, A., Sarafov, A., Bozhkov, P. (2016). Ecosystem/landscape services provided by Umbrosols (UM) in selected mountainous municipalities of Sofia District. Comptes rendus de l'Academie bulgare des Sciences, Geologie, 69, 3.

Nedkov, S., Burkhard, B. (2012). Flood regulating ecosystem services – Mapping supply and demand in the Etropole municipality, Bulgaria. Ecological Indicators, 21, 67-79.

Assenov A., Borissova, B. (2014). Value of the ecosystem/landscape services in the areas of the towns Apriltsi, Kalofer and Smolyan. Sofia University Yearbook, Faculty of Geology and Geography, 2, 107.

Filcheva, E. (2014). Humus formation, composition of organic matter and soil organic carbon stocks according to soil groups. In: Soil Organic Matter and Fertility of Soils in Bulgaria (eds Krastanov et al.), Bulgarian Humic Substances Society, ISBN 978-619-90189-1-0, 88{106 (in Bulgarian).

National Report on the Status and Protection of the Environment in Bulgaria in 2011 (edition 2013, in Bulgarian); http://eea.government.bg/bg/soer/2011/land-use/sastoyanie-na-pochvite.

Boyadgiev, T., Filcheva, E., Petrova, L. (1994). The organic carbon reserve of Bulgarian soils. In: Soil Processes and Green House Effect (eds R. Lal, J. Kimble, E. Levine), Advance in Soil Science, III, 19-23.

The European Energy Exchange (EEX), European Emission Allowances (EUA); https://www.eex.com/en/market-data/environmental-markets/spot-market/european-emission-allowances#!/2017/08/01.