Bulgarian Journal of Agricultural Science, 22 (No 1) 2016, 21-25
Agricultural Academy

REGOSOLS IN „CENTRAL BALKAN" NATIONAL PARK

L. MALINOVA
University of Forestry, 1756 - Sofia, Bulgaria

Abstract

MALINOVA, L., 2016. *Regosols* in „Central Balkan" National Park. *Bulg. J. Agric. Sci.*, 22: 21–25

Research of soils on the territory of the "Central Balkan" National Park has been performed as required by the Manual of Cools et al., (2010 pp. 14-17). Presence of *Regosols* has been recognized in areas known for the spread of *Umbrisols* and *Cambisols.* High content of organic carbon, total nitrogen and phosphorus in *Regosols* is defined. In two of the sample plots – Shopov Egrek and Rozinska Mandra, soils are enriched with cadmium from parent materials (2.1-2.4 $mg.kg^{-1}$). The contents of zinc (40 $mg.kg^{-1}$), copper (17 $mg.kg^{-1}$) and lead (21 $mg.kg^{-1}$) in the litter are characterized by increased values in comparison with the values determined for the regions of the European forests. The *Regosols*, developed on weathering materials of gneiss and granite are classified as *Eutric,* and those developed on white in colour gneiss and schists - as *Dystric.* For assessment of areas, occupied by *Regosols* on the territory of "Central Balkan" NP mapping is definitely needed and it will contribute to better planning of the measures for protection of the grassland in the park.

Keywords: grassland, forest, Cu, Pb, As, Cd

Abbreviations: sample plot (SP); national park (NP); management plan (MP)

Introduction

The information of the soils on the territory of "Central Balkan" NP is limited and centered on precisely defined problems and in its essential part it is concentrated on Beklemeto area. Representative of this region data were published in the Atlas of Soils in Bulgaria (1998 pp. 271-276) and in a monograph by Teoharov et al. (2009 pp. 240-243). The organic C stock in soils of different types of land use and different tree stands has been investigated (Zhiyansky et al., 2008a, 2008b). Due to the lack of specified coordinates in the above publications it is impossible to estimate whether some of the research in the area of Beklemeto does not fall outside the boundaries of the Park.

The research of Ganev on the physicochemical properties of soils in the Boatin reserve (1992 p. 36), the one of soil contamination - Bezlova et al. (2001), (Mihova et al., 1997 pp. 33-37), the Bulgarian-Swiss project on the condition of soils in grassland (MP, 2014-2023 pp. 114-115) can be certainly pointed out as having been performed on the territory of the "Central Balkan" NP. In the last years serious attention has been paid to the control of erosion processes (Ilieva et al., 2014; Malinov et al., 2015).

At this stage the soil units on the territory of the Park have not been sufficiently examined and classified. It is considered that *Cambisoils* occupy 96.9% of the forest territory and 2.1% of it is presented by *Luvisols* and 1% - by *Cambic Umbrisols.* Around 55% of the Park is occupied by *Umbrisols*. *Rendzic Lepthosols* have an insufficient presence (MP, 2001-2010 pp. 21-24; MP, 2014-2023 pp. 29-30). The analysis of the soil map of the "Central Balkan" (NP, 2014-2023 pp. 48) shows that *Umbrisols* are spread almost entirely in the territories of grassland and *Cambisoils* – in the territories of forests. It is established that the their distribution presented above is related to altitudes which are not typical of *Umbrisols* - 1000-1200 m, for instance in the area of the western boundary of the park, the territories near the village of Iganovo, the town of V. Levski, etc. According to data by Karatoteva (2014 pp.41) in the territory of the park the largest part of meadow landscapes are located in the middle mountain belt and substantially smaller part – in the upper mountain belt. If we accept the concept of the basic classification of soils in the country (Penkov et al., 1992 pp.69), namely that *Umbrisols* are found in the subalpine and alpine subzones of the upper mountain belt and *Cambisoils* in the medium mountain zone, it can be

E-mail: ludmila_malinova@yahoo.com

assumed that in the meadows and grassland of the middle mountain belt apart from *Cambisoil* there are large areas of other soil units.

Terrain research performed in 2014 in relation to the implementation of the project "Determination of Erosion Control Measures on the Territory of "Central Balkan" NP" (Rashid et al., 2014-2015) displays the presence of *Regosols* and *Fluvisols,* the areas of which are too large to be included in other soil units. They are a product of erosion and fluvic processes, which are inevitable on steep terrains in the park territories.

The aim of the research is defining the presence of *Regosols* on the territory of "Central Balkan" NP, evaluating the content of important macro- and micro-elements in them, as well as their physicochemical characteristics.

Materials and Methods

Subject and Sampling Sites

The object of research are *Regosols* on the territory of "Central Balkan" NP. Terrains of water erosion, exhibited in the past, have been selected during the terrain research, the erosion being a prerequisite for their formation. Four soil profiles have been investigated with different types of land use – forests (stand of *Fagus sylvatica* L.) in the area of Danovska livada and the grassland in the areas of Danovska livada, Shopov egrek and Rozinska mandra.

For analysis mixed samples of layers of 0-10 cm and 10-20 cm have been taken, according to the requirements of the Manual of Cools et al. (2010 pp. 14-17). Each mixed sample consists of 9 single soil samples, taken in a circle of radius of 5 m. In the stand of *Fagus sylvatica* samples of forest litter, layers *OL* and *OFH* have been taken. The sampling sites were coordinated by GPS. The samples were taken in the end of November 2014.

Analytical Methods

Analyses have been performed for determination of the bulk density (ISO 11272); weight of the litter; skeleton amount (SO 11464); $pH_{(H2O)}$ and $pH_{(CaCl2)}$ (ISO 10390); total nitrogen – method of Kjeldahl; organic carbon – modified method of Turin (Kononova, 1963; Filcheva E., C. Tsadilas, 2002); exchangeable cations (ISO 11260 & ISO 14254) - determination with AAS in 0.1 mol/l solution of $BaCl_2$), exchangeable acidity – method of Ganev (1980); macro- and micro- elements - P, Zn, Cu, Pb, As и Cd - ISO 11466 (extraction with aqua regia). The results obtained have been recalculated into dry matter.

Results and Discussion

A morphological description of the soil profiles recognizes the soils as *Regosols*. They were developed on weathering products of metamorphic, sedimentary and igneous rocks (Table 1). They are soils with no significant profile developnent - from 15 cm to 25 cm. The surface horizon is located straight on the weathering materials with no developed transitional horizon. The morphological characteristics does not define diagnostic horizons *Cambic* or *Umbric* as required by the IUSS Working Group WRB (2007 pp.16, 36-37; 2014 pp. 22-23, 53-55). The colour of the surface horizon in dry or fresh condition of the field varies from 10YR 3/2 to 10YR 3/4. The dry soil lightens from 10YR 4/3 to 10YR 3/6. No detectable visible or audible effervescence in *A* and *C* horizons. The abundance of roots in the surface horizon of *Regosols* from pastures (SP 2, SP 3 and SP 4) is high.

Forest litter is formed on the surface of the soil investigated in a beech stand (Danovska livada – SP1). Two layers are clearly differentiated in it – *OL* (fresh organic material) and *OFH* (fragmented and partially decomposed organic matter). An independent *OH* layer is not separated. The forest litter is determined as type *moder.*

Table 1
Location of *Regosol,* land use, altitude, slope and parent materials

Sample plots (SP)	Location	Latitude and Longtitude	Land use	Altitude (m)	Slope (%)	Parent materials
SP 1	Danovska livada	42°44'46" N 24°36'54" E	Forest	1272	48	Weathering materials from gneiss
SP 2	Danovska livada	42°44'42" N 24°36'46" E	Grassland	1270	19	Weathering materials from gneiss
SP 3	Shopov egrek	42°41'20" N 25°06'50" E	Grassland	1384	31	Weathering materials from schist
SP 4	Rozinska mandra	42°44'05" N 24°19'11" E	Grassland	1165	38	Weathering materials from granite

The high skeletal characteristics of soils, determined on the field are confirmed analytically, too. In the surface 10 cm soil layer the skeleton reaches for 50% and in the layer below – for 78%. The bulk density is within the limits of 0.70-0.89 $g.cm^{-3}$ d.m.

The contents of essential macro- and microelements in *Regosols* are presented in Table 2. In the soil of the beech stand (Danovska livada – SP 1) it is established that the litter decays fast. A sharp decrease of the amount of organic C is observed – from layer *OL* to layer *OFH* – 2.6 times. This mode of change is not established for the amount of nitrogen. It is low in both layers of the litter. This behavior of nitrogen is typical, its amount can even rise in layer *OFH*, which is due to its retention of complex-formation with polyphenols like lignans, tannins, etc. in the litterfall as well as in the tissues of microorganisms (Brady et al., 1996 pp. 673). The fast decay of the litter becomes clear in the ratio of organic C/total N, which is very high in the *OL* layer – 47 and it decreases 2.4 times in layer *OFH*. The amount of total phosphorus in the litter is medium (by criteria of Vanmechelen, et al., 1997 pp. 247).

As to the amount of Zn, Cu and Pb in the forest litter high values have been established in comparison with the ones determined for the region of the European forests (ICP-Forest and ICP-IM, 2002 pp. 21). Similar results have been obtained for other regions in the country (Malinova, 2014 pp. 348-378), but they are reported as not being due to an anthropogenic contribution, as it is characteristic of the European forests. As a basic reason for the high values of metals a highly acidic reaction of soils is pointed out, which ensures a high amount of element forms, easily absorbable into plants, hence the enrichment of the litter with them.

There is limited information in the country about the arsenic content in the litter. According to data by Malinova (1988 pp. 115-121) arsenic varies within the limits of 0.035-0.067 $mg.kg^{-1}$. The results obtained from the research on the territory of "Central Balkan" NP (Table 2) appear within the limits of the above range.

In regard to the mineral soil (Danovska livada – SP 1) high content of organic C and total N has been established (Table 2) The ratio of the two elements shows a high degree of soil enrichment with nitrogen in the surface soil layer and average for the one below, by criteria of Artinova (2014). Under the influence of an ongoing forest soil-formation process apart from accumulation of organic C and total N there is accumulation of total phosphorus as well as that of some heavy metals – copper and lead. The amounts of heavy metals under research vary within the limits of the background and precaution values (Regulation № 3, 2008).

Regosols from the grassland of Danovska livada (SP 2), Shopov egrek (SP 3) and Rozinska mandra (SP 4) also show the running of accumulative processes in the surface soil layer – now under the influence of a meadow soil-formation process. This refers to the content of organic C, total N and to some extent of total phosphorus. Most of the investigated heavy metals in these soils are within the limits of the background and precaution values. For the area of Rozinska mandra exceeding of the precaution value of Pb by 1.8 times has been established. The trigger value is multiply higher – 90 $mg.kg^{-1}$ and it have not been exceeded.

As for the amount of cadmium in the surface layers of some areas – Shopov egrek and Rozinska mandra, exceeding of the trigger value (2.0 $mg.kg^{-1}$) has been established. Having in mind these are the soils with no significant profile developnent it is accepted that the source of the increased content of cadmium are parent materials. The exceeding is slight - from 1.04 to 1.2 times, but considering the high mobility of cadmium in acid condition and the fact that most of its total amount is in an exchange form we can admit its high accumulation in

Table 2
Macro and microelement contents in в *Regosols*

Sampling plot	Site and land use	Depth	Org.C	Total N	C/N	Total P	Zn	Cu	Pb	As	Cd
		cm	$g.kg^{-1}$			$mg.kg^{-1}$					
SP 1	Danovska livada	OL	358	7.58	47	788	32	13	13	0.64	0.71
		OFH	148	7.00	21	722	40	17	21	1.08	0.26
		0-10	114.8	10.25	11	1110	71	22	44	3.20	1.54
		10-20	47.6	3.92	12	784	55	14	37	4.27	1.55
SP 2	Danovska livada	0-10	73.3	8.05	9	832	67	18	40	4.36	0.99
		10-15	48.4	4.61	11	745	70	13	28	4.00	1.75
SP 3	Shopov egrek	0-10	98.1	12.15	8	1459	86	33	42	5.83	2.08
		10-20	87.3	8.53	10	882	87	35	36	4.45	2.23
SP 4	Розинска мандра	0-10	69.7	6.63	11	879	100	34	74	6.00	2.41
		10-20	60.6	4.83	13	622	98	31	74	4.66	2.13

Table 3
Exchangeable cations, cation exchange capacity (CEC) and base saturation (BS)

Sampling plot	Site	Depth	pH	pH	Exch. Ca	Exch. Mg	Exch. K	Exch. Na	Exchangeable acidity	Exch. Al	Exch. Mn	CEC	BS
		cm	H_2O	$CaCl_2$	cmol(+).kg^{-1}								%
SP 1	Danovska livada	OL	6.0	5.5	28.66	8.85	6.11	0.09	3.48	-	1.62	47	93
		OFH	6.3	5.6	24.73	3.79	1.87	0.08	0.67	-	0.61	31	98
		0-10	6.4	5.7	14.83	4.63	0.81	0.12	0.17	1.33	0.09	20	99
		10-20	5.3	4.5	7.57	1.14	0.36	0.10	4.27	1.33	0.08	13	68
SP 2	Danovska livada	0-10	5.2	4.3	2.90	0.96	0.39	0.08	4.63	0.44	0.03	4	48
		10-15	5.8	4.6	0.26	0.58	0.30	0.08	2.45	0.00	0.01	1.5	33
SP 3	Rozinska mandra	0-10	4.9	4.1	9.78	1.69	0.15	0.06	11.36	4.00	0.05	23	51
		10-20	5.0	4.2	4.79	0.67	0.12	0.09	11.44	4.00	0.01	17	33
SP 4	Rozinska mandra	0-10	5.1	4.3	7.72	1.63	0.28	0.04	7.32	2.67	0.09	17	57
		10-20	5.3	4.4	6.67	1.21	0.19	0.06	6.62	1.78	0.05	15	55

plants. An analysis of the plant mineral nutrition in this grassland is advisable because of a certain competition of cadmium with other ions (Sheila, 1994 pp.76) and the presence of a potential risk of contamination of the pasture grass.

The physicochemical properties of *Regosols* are presented in Table 3. The litter in the beech stand in the area of Danovska livada (SP 1) is a slightly acid. The base cations are of high values in both layers, which is why the litter has a very high cation capacity and is base saturated. The high content of bases of the litter is only partially inherited by the soil. The surface 10 cm layer is base saturated, but in the layer of 10-20 cm the physicochemical parameters abruptly change their characteristics. Under the influence of the intensive decomposition of organic matter in the litter and the surface soil layer the pH in subsurface layer decreased by 1.1 – the amount of base cations is decreased too and the exchange acidity is increased. It can be accepted that the highly steep slope (48%) contributes to the migration processes of the acid products of the decomposition. The value of the cation capacity also falls sharply. The soil profile is 20 cm and for this depth the soil is assessed as *Eutric*.

Regosols in the grassland in the area of Danovska livada (SP 2) substantially duffers from the *Regosols* in the beech forest (SP 1) because of lack of litter, the higher degree of erosion, and last but not least, because of a change of the soil-formation rocks. The white color of the gneiss suggests high participation of quartz and other nutrient-poor minerals. The properties of the two layers - 0-10 cm и 10-15 cm can be pointed out as very different. In the surface layer, rich in roots, the content of skeleton is 26% but at higher depth its content sharply rises to 78%. The soil has a base saturation of less than 50% and it is *Dystric*. The cation exchange capacity turns from low to very low when going deeper.

Regosols in the grassland of Shopov egrek (SP 3) and Rozinska mandra (SP 4) have similar physicochemical characteristics and differ from those of the soil of the area of Danovska livada in the value of cation exchange capacity. The soil in the grassland of Shopov egrek, which is *Dystric*, can be characterized as more acid with pH 4.9 and higher exchange acidity. *Regosols* in the area of Rozinska mandra is *Eutric*.

Conclusions

The presence of *Regosols* on the territories of the "Central Balkan"NP is defined on the basis of the soil profile description. They are located in territories known distribution of *Umbrisols* and *Cambisols*. The assessment of their physicochemical characteristics allows classification of the investigated *Regosols* on the level of soil type. The soils developed on weathering materials of gneiss and granite are *Eutric* and those developed on white gneiss and schist - *Dystric*. The contents of essential macro- and micro-elements, which characterizes *Regosols* with high values for organic C, total N and phosphorus have been assessed. In two of the investigated areas – Shopov egrek and Rozinska mandra the soils are enriched with cadmium. An analysis of the mineral nutrition of the plants on these grassland is advisable. Mapping is absolutely necessary for the assessment of areas occupied by *Regosols* on the territories of the "Central Balkan" NP. It will contribute to better planning of the measures for the protection of the grassland on the territory of the park.

Acknowledgements

The present investigation was supported by the project of Rashid et al., (2014): "Assessment of the Condition of the Components of Environment on the Territory of the "Central

Balkan" NP. In: "Restoration, Protection and Maintenance of the Natural Habitats in the "Central Balkan" NP. Project DIR 5113325-12-109 "Central Balkan – Park for All", financed by the Environment OP 2007-2013.

References

Artinova, N., 2414. Humus State of Soils in Bulgaria. Soil Organic Matter and Soil Fertility in the Bulgaria. *Bulgarian Humic Substances Society*, Sofia, pp. 29-74 (Bg).

Atlas of Soils in Bulgaria, 1998. *Zemizdat*. Sofia, pp.159 (Bg).

Bezlova, D., M. Doncheva and L. Malinova, 2001. Influence of UM Pirdop Copper Smelter plant on Central Balkan National Park. *Environmental Protection and Ecology*, (2): 125-129. http://www.jepe-journal.info/vol-2-no-1

Brady, C. and R. Weil. 1996. The Nature and Properties of Soil. *Prentice Hall*, New Jersey, 11th ed., pp. 740.

Cools, N. and B. De Vos, 2010. Sampling and analysis of soil. Manual Part X. In: Manual on Methods and Criteria for Harmonized Sampling, Assessment, Monitoring and Analysis of the Effects of Air Pollution on Forests, UNECE, *ICP Forests*, Hamburg, pp.14-17. http://www.icp-forests.org/Manual.htm

Filcheva, E. and C. Tsadilas, 2002. Influence of Cliniptilolite and Compost on Soil Properties. *Commun. of Soil Sci. and Plant Analysis*., (33): 595-607.

Ganev. St., 1992. Physical Chemistry and soil acidity state in the Bulgaria. *Bulgarian Chemical Company*, Section "Soil chemistry". Sofia, pp.49 (Bg).

ICP Forests and ICP Integrated Monitoring, 2002. Joint report, Cause-effect Relationships of Forest Ecosystems. Federal Research Centre for Forestry and Forest Product. *Finnish Environment Institute*. 46 pp.

Ilieva, D. and I. Malinov, 2014. Mapping soil erosion factors and potential erosion risk for the National Park „Central Balkan". http://presentations.copernicus.org/EGU2014-859_presentation.pdf

IUSS Working Group WRB, 2006. World Reference Base for Soil Resources 2006, World Soil Resources Report, № 103, *FAO,* Rome, 115 pp.

IUSS Working Group WRB, 2014. World Reference Base for Soil Resources 2014, World Soil Resources Reports No. 106. *FAO*, Rome,191 pp.

Karatoteva, D., 2014. Abiota. In: Management Plan of NP "Central Balkan 2014-2023-Project". *Operational Programme Environment* 2007-2013, Sofia, pp. 117 (Bg). www.ope.moew.government.bg

Kononova, M., 1963. Soil Organic Matter. His Nature, Properties, and Methods of Studying. *Academy of Science of Soviet Union*, *Moskva*, pp. 314 (Ru).

Malinov, I. and D. Ilieva, 2015. Gully and rill soil erosion in the National Park "Central Balkan" - experimental measurement and soil losses assessment. *Bulgarian Journal of Agricultural Science*. In press.

Malinova, L., 1988. Impact of Industrial Pollution on the Ecological Landscape Units of the Sofia Mountain. *Forestry Institute*. Sofia, p. 158 (Bg).

Malinova, L., 1997. Analysis of the condition of forest soils, Section 7A. In: Environmental Assessment of the Impact of Emissions from Metallurgical Plant - Pirdop on Soils in the Area of Pirdop Zlatitsa, *PHARE* - BG 9310-03-05-02. Sofia, pp. 79 (Bg).

Malinova, L., 2014. Physicochemical and Chemical Soil Parameters from the Forest Ecosystem Monitoring Network. *University of Forestry*, Sofia, pp. 473 (Bg).

Mihova, B., E. Delipavlov and J. Angelov, 1955. Study on the status of the high mountain pastures. In: Management Plan of the High Mountain Woodless Zone of the Central Balkan National Park, Plovdiv, pp. 46 (Bg).

MP, 2001-2010. Management Plan of the Central Balkan National Park. Sofia, pp. 183 (Bg).

MP, 2014-2023. Abiotic factors. In: Management Plan of the Central Balkan National Park. Operational Programme Environment 2007-2013, Sofia, pp. 199 (Bg). www.ope.moew.government.bg

Operational Programme Environment, 2007-2013. Restoration, conservation and maintenance of natural habitats in the Np Central Balkan. In: Project DIR 5113325-12-109 „Central Balkan - park for all", *Operational Programme Environment*, Sofia, pp. 44 (Bg).

Penkov, M., V. Donov, T. Boiadjiev, T. Andonov, N. Ninov, M. Jolevski, G. Antonov and Sv. Gencheva, 1992. Classification and Diagnostic of Soil in Bulgaria in Connection with Land Division. *Zemizdat*, Sofia, pp. 151 (Bg).

Rashid, R., D. Ragyov, L. Malinova, A. Gavrilova, H. Hristov and M. Kircheva, 2014-2015. Assessment of the Status of the Components of the Environment within the Territory of the Central Balkan Mountain National Park (activity 1.2).

Sheila, M. R., 1994. Retention, transformation and mobility of toxic metals in soil. In: Toxic Metals in Soil-Plant System. Dept. of Geography, *University of Bristol*. UK. 139 pp.

Teoharov, M., S. Popandova, T. Atanasova, C. Tzolova, M. Banov, P. Ivanov, E. Filcheva and R. Ilieva, 2009. Reference Data Base for Soils in Bulgaria. Institute of Soil Science "N. Poushkarov", *Agricultural Academy*. Sofia, 413 pp. (Bg).

Vanmechelen, L., R. Groenemans and E. Van Ranst, 1997. Forest Soil Condition in Europe. Forest Soil Co-ordinating Centre. International Co-operative Programme on Assessment and Monitoring of Air Pollution on Forest. *UN-ECE*, 261 pp.

Zhiyansky, M., K. Kolev and M. Sokolovska, 2008 b. Tree species effect on soils in Central Stara planina mountain. *Forest science*, (4): 65-81.

Zhiyansky, M., K. Kolev, A. Hursthouse and M. Sokolovska, 2008 a. Land-use change effects on soil organic carbon and nitrogen contents in ecosystens from Central Balkan Mauntains, Bulgaria. *Balkan Ecology*, (4): 397-411.

Received April, 23, 2015; accepted for printing December, 23, 2015