Study of Forest Landscape on the Territory of Pirin National Park in Relation to Soil Health

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Abstract

An analysis of the forest territory of the Pirin National Park was carried out to study forest landscapes, such as the variety of soil-forming rocks and the morphometric characteristics of the relief-altitude, slope, and exposure in relation to soil health status. Based on the landscape-ecological approach, a total of 54 relatively homogeneous landscape units were obtained. We established that these units have a fragmented horizontal structure, and they are presented in a map. The landscape units are highly informative and comparable and can be used as a basis for further scientific studies. The results obtained show that acidic silicate rocks and steep terrain, predominate, which are occupied in a larger part by coniferous forests. The soil units are mainly Dystric/Eutric Cambisols and Umbrisols.

Keywords: forest soils, parent material, landscape classification, landscape units

Introduction

The soil is defined as a dynamic living system, the health of which underlies its productivity and ecological functions (Doran et al., 1996; Lehmann et al., 2020). Its main functions are directly related to ensuring plant growth, regulating the movement and purification of water, transforming organic matter and transporting nutrients (Lal, 2016). According to ITPS (2020), soil health is defined as the ability of the soil to provide ecosystem services and fulfill its ecological functions. Tree species, climate, bedrock and relief have a significant impact on soil formation and its health status in forest areas of temperate climate regions (Binkley and Fisher, 2012). The main tree species in forest communities directly affect the chemical parameters of the soil (e.g. pH), the biological component (decomposition rate of aboveground litterfall and depth of the root system) and the amount of available moisture in the soil (Adams et al., 2019). Forest landscapes and their main components play a major role in the health status of the soils in the country.

In Western Bulgaria, one of the most diverse in terms of landscapes is the territory of the Pirin National Park. Several authors focused their research on individual landscape components on the territory of the park. In the management plan of Pirin National Park (2004-2014) are pointed out the main characteristics of the landscapes and their components. In terms of soil health status of soil units on the territory of the park in the study of Tzvetkova et. al., (2016) have been found increased concentration of cadmium in the soil. According to Kitev (2017), landscapes with conservation value show high compactness and low fragmentation of habitats in Southern Pirin. In Petrov's (1997) research, the territory of Pirin National Park was divided into relatively homogeneous, territorially complete and genetically related physical and geographical landscape complexes. They are combined within the borderline of the Pirin landscape region, which is a part of the Rila-Pirin landscape sub region of the Osogovo-Rhodope region. According to the typological landscape classification (Petrov, 1997), the territory of the park is divided into 7 landscape groups. The scale of the classifications (M1:400000) does not provide more detailed information about the landscape units, the landscape-ecological approach was applied. Such an approach has been applied to landscape classifications in the Bulgarka Nature Park (Malinova, 2007; Malinova, 2008a; Malinova, 2008b), in the Central Balkan National Park (Karatoteva, 2016a), Vitosha Nature Park (Karatoteva, 2016b; Karatoteva, 2016c), as well as for other studies related to the Plana Mountain (Dobrinova, 1989), the Sofia Mountain (Malinova, 1988), the Melnik Pyramids Region (Zakova- Aleksandrova, 2014), etc. The application of this approach aims to a more detailed study of the landscape structure of the territories occupied by forests in the Pirin National Park.

Materials and Methods

The subject of the present study is a forest landscape from the territory of Pirin National Park. For this purpose, a classification system was chosen for dividing the forest landscape into lower taxonomic levels with the leading component being soil-forming rocks. They were chosen as a stable and easily recognizable component of the terrain. The rocks are identified depending on their origin and method of formation. It is well known that silicate igneous rocks lead to formation of soils with an acidic reaction, which has a negative effect on soil health (Shaaban, 2024). Igneous (massive) rocks are divided into effusive and intrusive, and sedimentary and metamorphic rocks into silicate and carbonate. Morphometric characteristics of the relief are used to divide the forest landscapes at the second taxonomic level. The relief plays the role of the main redistributor of the other components in the landscape. To determine its indicators, the Instruction for the establishment and mapping of forest habitat types (FEA, 2011) was used. The forest vegetation regions and forest vegetation belts correspond to the forest vegetation zoning of the country. At the next taxonomic level, within the borderlines of the altitude zones, landscapes of flat (0°-4°), sloping (5°-10°), sloping (11°-20°), steep (21°-30°) and very steep terrains (>31°) were distinguished. For the last taxonomic level, the expositions were used, which were combined in two groups - shady (north, northeast, northwest and east) and sunny (south, southeast, southwest and west). A geographic information system (GIS) was used to divide landscape units.

Results and Discussion

The territory of Pirin National Park falls into the Southern Border Forest Vegetation Area and encompasses two altitude belts – the Middle Belt of Beech and Conifers and the High Mountain Belt. With the combinations of the diversity of soil-forming rocks and the morphometric characteristics of the relief, a total of 54 relatively homogeneous landscape units were obtained (Fig. 1). These units have a fragmented horizontal structure.

The map presented on Fig.1 show that landscape type “rocky massive intrusive” occupies the largest territory of Pirin National Park. Its total area is 5775.8 ha. The bedrock is granite and the predominant part - 5317.61 ha is distributed in the Middle Belt of Beech and Conifers (middle belt) in the range of 900-2200 m a.s.l. In terms of slope and exposition, the steep shady terrains with the largest area here are 1552.3 ha.The visual appearance of these landscapes is mainly determined by coniferous seed stands of *Pinus peuce* Griseb. and *Pinus heldreichii* Christ. (total area of 614.72 ha) and *Picea abies* L. Karst (356.82 ha) developed mainly on Dystric/Eutric Cambisols and Dystric Umbrisols soil units (WRB, 2006). The structure of these landscapes also includes species such as *Pinus sylvestris* L., *Pinus mugo* Turra, *Pinus nigra* Arn., *Fagus sylvatica* L., *Abies alba* Mill., etc.. The second largest area in this belt of steep terrains are the sunny slopes with an area of 1412.78 ha. Their appearance is dominated entirely by coniferous stands of *Pinus sylvestris* L. (699.48 ha) and species of the genus *Pinus* (381.9) developed on dark-colored forest soils Cambisols and Umbrisols. The next landscape units in the middle belt are these on very steep terrains, respectively on shady (973.44 ha) and on sunny (661 ha) areas. Their visual appearance is dominated by coniferous species of the genus *Pinus* (659.06 ha) and stands of *Pinus sylvestris* L. (244.49 ha). In this belt there are also inclined shady (363.81 ha) and sunny (330.42 ha), sloping shady (8.86 ha) and sunny (14.9 ha) areas, as well as flat shady (with an area of 0.1 ha).

The remaining part of the landscape type "rocky massive intrusive" falls into the high mountain belt - 458.19 ha. The predominant part of it is located on very steep terrain with shady terrains (215.39 ha) and sunny areas (141.9 ha). Here the visual appearance is completely dominated by *Pinus mugo* Turra and mountain-meadow soils. There are also steep (90.33 ha) and sloping (10.56 ha) terrains, both on shady and sunny expositions.

The second most widespread landscape type is the "rock metamorphic silicate" landscape, which occupies an area of 2513.03 ha, and in which the bedrock is granite. This landscape type is located mainly in the middle belt but is also found in the High Mountain belt. The Middle belt is dominated by very steep terrains - 1193.87 ha, in which the shady areas cover an area of 781.1 ha. Its structure includes stands of mulberry trees (205.6 ha) and stands of *Fagus sylvatica L.* (141.5 ha) with Cambisols and Umbrisols. This type of stands is characterized by high aesthetic value and seasonal dynamics caused by the visual differences between coniferous and deciduous species. Steep shady terrains are next in line - 726.87 ha. Their visual appearance is determined by both coniferous and deciduous forests. Among the conifers, species of the genus Pinus are dominant such as *Pinus heldreichii* Christ. and *Pinus peuce* Griseb. (205.61 ha) and *Pinus sylvestris* L. (103.32 ha) located on dark-colored forest soils such as Cambisols and Umbrisols dominate, and among the broadleaf seed stands are these of *Fagus sylvatica* L. (141.5 ha) growing entirely on Cambisols. On the third place of this altitude belt are very steep sunny terrains – 412.14 ha. Their structure mainly includes

species of the genus Pinus (*Pinus sylvestris* L., *Pinus heldreichii* Christ. and *Pinus peuce* Griseb.), as well as *Fagus sylvatica* L., growing on Cambisols and Umbrisols.



Legend

- Number form Forest management plan
- Glade
- Ski run
- Ski road
- Road
- Other
- Forest landscape on metamorphic silicate rocks in middle belt on steep shady terrians
- Forest landscape on sedimentary silicate in middle belt on steep sunny terrains
- Forest landscape on metamorphic silicate rocks in middle belt on steep shady terrains
- Forest landscape on metamorphic carbonate rocks in middle belt very steep shady terrains
- Forest landscape on metamorphic carbonate rocks in middle belt very steep sunny terrains
- Forest landscape on sedimentary silicate in middle belt on middle belt on moderate steep shady terrains
- Forest landscape on sedimentary silicate in middle belt on steep sunny terrains

Fig. 1. *Landscape units in Pirin National park*

In the High Mountain belt, very steep sunny terrains prevail (25.86 ha) followed by very steep shady terrains (13.74 ha). In this altitude belt, there are also sloping shady – 16.6 ha, steep (9.1 ha) shady and sunny terrains, as well as very steep sunny (225.86 ha) areas.

On the third and fourth place are the landscapes “rock sedimentary silicate” and “rock metamorphic carbonate”, which are almost equal in area of distribution, respectively 1703.76 ha and 1626.80 ha.

The rock foundation in these landscape units is made of gravel. In the middle belt, steep shady expositions dominate – 550.09 ha. Their visual appearance is determined by stands of mulberry trees – 188.34 ha and *Picea abies* L. Karst., developed on Cambisols and Umbrisols, as well as stands of *Fagus sylvatica* L. (119 ha) developed on Cambisols. The next landscapes are steep sunny expositions with an area of 220.76 ha. In this landscape *Pinus sylvestris* L. stands (149 ha) predominate. There are also many steep (436.7 ha), sloping (340.23 ha) and incline (83.71 ha), both on shady and sunny expositions. Flat slopes in this altitude zone are found only on shady expositions – 30.6 ha.

In the high mountain belt, only steep shady with 21.94 ha, as well as very steep sunny (15.36 ha) and shady (2.1 ha) expositions are found. The rock foundation in the landscape "rock metamorphic carbonate" is represented by marbles. It mainly occupies the middle altitude belt of steep shady terrains - 684.43 ha. Its visual appearance is determined by pure and mixed forest stands with the participation of coniferous species of the genus Picea - mainly Norway spruce (205.6 ha) and Austrian pine (103 ha) and broad-leaved forests of common beech (141.4 ha). In this altitude zone, there are also steep shady - 378.73 ha, very steep sunny - 245.42 ha, steep sunny - 120.17 ha, sloping (139.79 ha) on shady and sunny areas, and incline (6.8 ha) and flat terrains (0.7 ha) only on shady areas. In the high mountain zone, only steep (29.31 ha) on sunny and shady areas, sloping shady - 10.9 ha and very steep shady - 10.55 ha are found.

Conclusions

Analysis of the main components of the landscape on the territory of Pirin National Park showed a wide variety of soil-forming rocks - massive intrusive (granites), sedimentary silicate (gravels) and metamorphic silicate (gneisses) and carbonate (marbles). This rock composition and the diverse combinations of the morphometric characteristics of relief allowed the identification of a total of 54 relatively homogeneous landscape units. They are shown on a map and represent relatively uniform spatially distinct territorial units that are highly informative. The landscape units thus obtained are comparable and can be used for the purposes of further scientific research.

According to the results obtained, it is established that on the territory of Pirin National Park territories with acidic silicate rocks predominate. This is a prerequisite for developing acidic soils with soil texture in which sand and silt predominate. The high percentage of steep slopes also negatively affects the soil formation process. The large area occupied by coniferous species on the territory of Pirin National Park has a significant impact on soil health by introducing organic matter into the soil with acidic reaction. These soil forming factors can be a prerequisite for the occurrence of degradation processes and therefore soil health decline.

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