

Soil characteristics in the region of Sarnena Sredna Gora Mountains (Southern Bulgaria)

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Abstract. The present paper is focused on the soil characteristics of the Sarnena Sredna Gora Mts. In the lower altitude zone, with warmer and drier climate, deciduous (mostly oak) vegetation and heterogeneous rock composition, mainly Cinnamon forest soils are developed. The taller, relatively wetter and colder altitude zone, with beech forests and non-carbonate rocks, is dominated by Brown forest soils. In the highest parts of Sarnena Sredna Gora Mts, with well-developed grasslands, there are Mountain meadow soils. In the lower parts of the relief, made up of upper Cretaceous volcanics and pyroclastites, there is a localized development of Smolnitsa, and in the valleys of the rivers and depressions with low alluvial-proluvial deposits - Alluvial and Alluvial-meadow soils.

Key words: Vertisols, Umbrisols, Cambisols, Fluvisols, Rendzic Leptosols, Luvisol.

Introduction

The Sredna Gora Mts is situated in the central part of Bulgaria, bounded on the north by the Sub-Balkan Plains and on the south the Upper Thracian Lowland. The mountain is bordered by the Iskar River to the west and Tundzha River to the east. The Sredna Gora Mts is some 285 km long and about 50 km wide with highest peak Bogdan 1603 m a.s.l. Its area is approximately 6000 km², which is about 6% of the country's territory. Sredna Gora Mts is divided to three parts: Ihtimanska Sredna Gora (western part), Sashtinska Sredna Gora (central part) and Sarnena Sredna Gora (eastern part) (Michev *et al.* 1980, Petrova 2020).

Sarnena Sredna Gora has a distinct "chain" character, parallel to the main chain of Stara Planina Mts. It extends east from the Pesnopoy Gorge of the Stryama River, developed between the Karlovo Field and the Upper Thracian Lowland to the turn of the Tundzha River north of the town of Yambol, where is located its last hill - Zaichy Peak (Fig. 1). To the north it borders with the valleys of Kazanlak, Tvarditsa and Sliven, and to the south – with the Upper Thracian Lowland, and it wedges into this valley through the Chirpanski Vazvisheniya Hights (Fig. 1).

The length of the Sarnena Sredna Gora Mts is 135 km (half of the total length of the Sredna Gora Mts), the average width is about 20 km, at Chirpanski Vazvisheniya Heights it is just over 40 km, and to the east it is only 1-2 km. Its highest peak Bratan (1236 m a.s.l.) rises in the western part. Sarnena Sredna Gora Mts is made up of granites, gneisses, andesite, tuffs and various sedimentary rocks. In general, the relief can be defined as mountain-hilly.

The climate is mainly transcontinental, but around the region of Bratan Peak is mountainous. The middle winter temperatures rising from -4°C to 1°C, and the middle summer ones from 18°C to 23°C. The rainfalls are from 550 to 700 mm per year (Dobrev 1979, Georgiev 2005).

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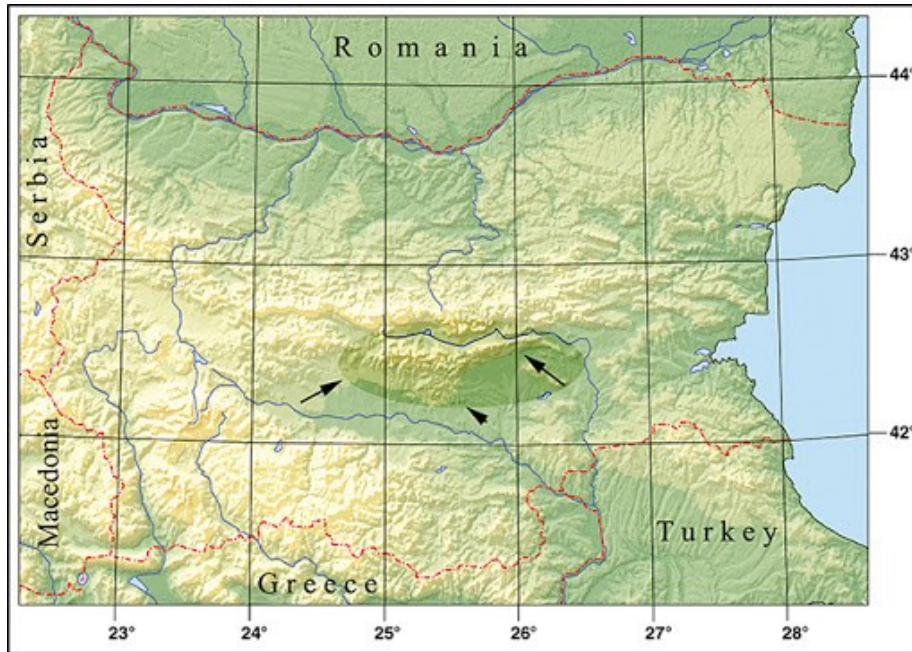


Fig. 1. Location of Sarnena Sredna Gora Mts.

Results

Soils and pedoclimatic zones of Bulgaria

Soils of Bulgaria are developed in different climatic conditions. The country lies between the strongly contrasting Temperate continental and Mediterranean climatic zones (Fig. 2). Bulgarian mountains and valleys act as barriers or channels for air masses, causing sharp contrasts in weather over relatively short distances. The climate is one of the major driving force of soil formation (Constatini *et al.* 2013). Soil climate regimes, expressed via soil moisture and soil temperature regimes, are important in a wide range of applications as soil quality, farming, and ecosystem management. Soils themselves may respond to climate change, leading to both positive and negative effects (Hristov & Filcheva 2017).

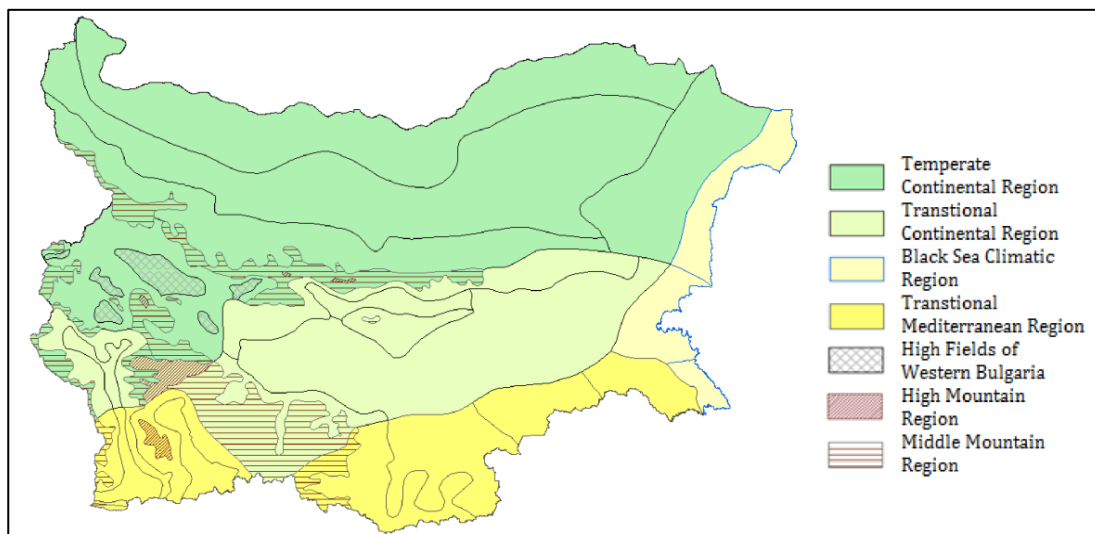


Fig. 2. Climatic map of Bulgaria (Subev *et al.* (1963) digitized by Dimitrov (2014), after Hristov & Filcheva 2017).

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Five climatic regions are typical for the territory of Bulgaria (Fig. 2) – Temperate continental, Transitional continental, Transitional Mediterranean, Black Sea coast, and Mountainous (Subev *et al.* 1963, Dimitrov 2014, Hristov & Filcheva 2017). All these climatic regions have influence over soil temperature and moisture regimes as defined in Soil Taxonomy (Soil Survey Staff, 1999, 2010; FAO, 2006). Boyadjiev (1989) applied the model of Newhall (1972) and identified six different combinations of temperature and moisture regimes over the territory of Bulgaria (Fig. 3): Thermic-Xeric, Mesic-Xeric, Mesic-Ustic, Mesic-Udic, Cryic-Udic and Pergelic-Udic (after Hristov and Filcheva, 2017). The last one Pergelic - Udic is too small and it is united with Cryic - Udic zone, which is spread mainly on mountainous area of Bulgaria. The Mesic - Udic zone is cover the area of fore-mountains, high fields of central and western Bulgaria and the region of “Ludogorie” of North-East Bulgaria. Soils with Mesic - Ustic regime cover also some regions with lower hilly-mountain relief in South and West Bulgaria. Mesic - Xeric and Thermic - Xeric zones are spread over the lowest and driest places of Bulgaria, the first one covers northern parts the second one is in the south parts of Bulgaria (Hristov & Filcheva 2017).

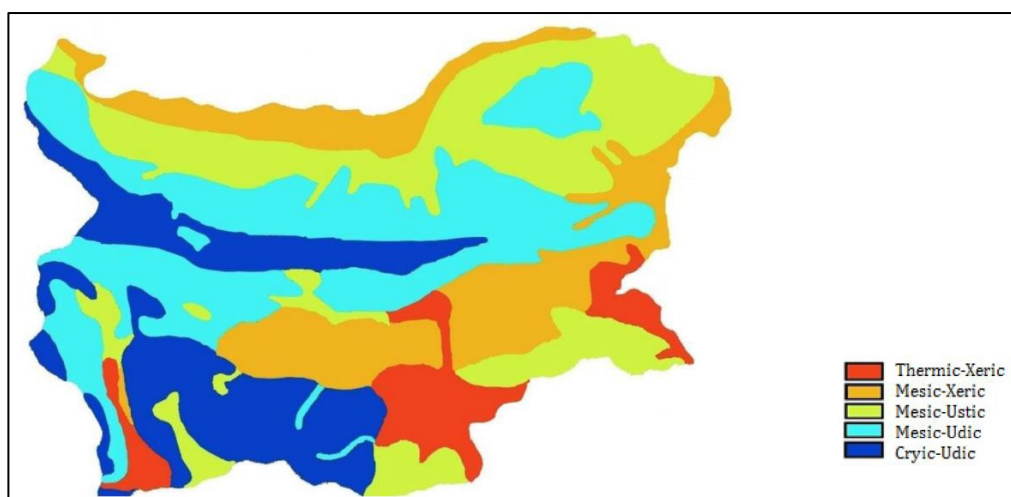


Fig. 3. Temperature and moisture regimes of Bulgarian soils (Boyadjiev 1989, after Hristov & Filcheva 2017).

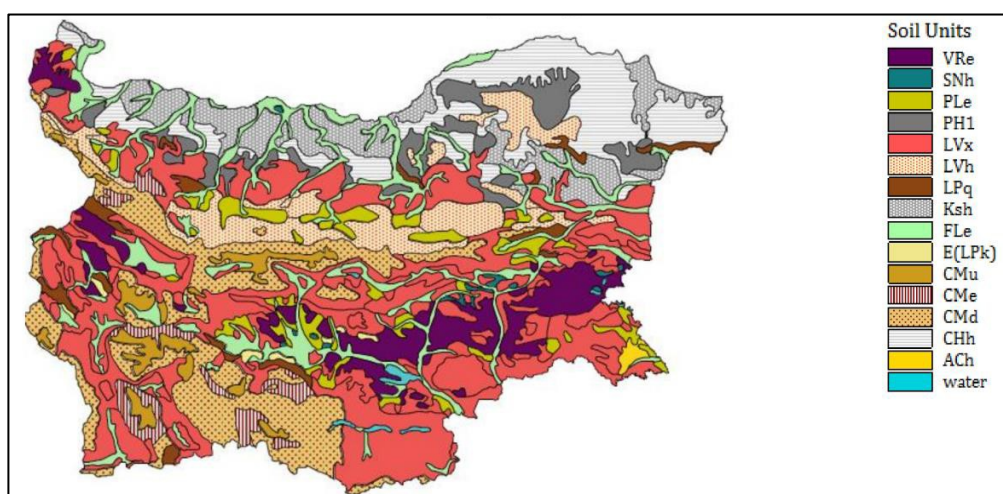


Fig. 4. Soil map of Bulgaria (Kolchakov 1994, after Hristov & Filcheva 2017).

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Legend (from Fig. 4): Soil Units: VRe - Eutric Vertisols; SNh - Haplic Solonetz; PLe - Eutric Planosols; PHl - Luvic Phaeozems; LVx - Chromic Luvisols; LVh - Haplic Luvisols; LPq - Lithic Leptosols; KSh - Haplic Kastanozems; FLe - Eutric Fluvisols ; LPk - Rendzic Leptosols ; CMu - Humic Cambisols; CMe – Eutric.

The soil map of Bulgaria was made on the basis of typical soil profiles data and presented according to specific soil group of WRB (2014) (Fig. 4) (Kolchakov 1994, after Hristov & Filcheva 2017).

Soils in the region of Sarnena Sredna gora Mts

Sredna Gora Mts soil cover is closely dependent on geological structure, relief, vertical zoning of bioclimatic conditions, etc.

According to data from Hristov & Filcheva (2017) and Jordanova (2017), among the most common soils in the Sarnena Sredna Gora Mts are: Cinnamon forest soils (Luvisol), Brown forest soils (Cambisols), Smolnitsa (Vertisols), Alluvial soils (Fluvisols), Mountain meadow soils (Umbrisols), Rendzini (Rendzic Leptosols), etc.

Cinnamon forest soils (Luvisol): Both varieties are common - typical and podzolic. They occupy the low parts of hills, usually up to 800 m a.s.l., characterized by warmer and drier climate, with deciduous (mostly oak) vegetation and heterogeneous rock composition.

Brown forest soils (Cambisols): They are widespread in the mountain slopes with altitudes from 800 to 1600-1700 m a.s.l., relatively wetter and colder climate, with beech forests and non-carbonate rocks.

Smolnitsa (Vertisols): They have little distribution in the lower parts of the relief. They are mainly developed in the valley bottoms and made up of upper Cretaceous volcanic rocks and pyroclastites, tuffs and tuffites.

Mountain meadow soils (Umbrisols): They are limited only in the highest mountain parts, with well-developed grassland (around Bratan Peak).

Alluvial and alluvial-meadow soils (Fluvisols): They have limited distribution in the valleys of rivers and in the valleys and depressions, filled with young alluvial-proluvial deposits.

Rendzini (Rendzic Leptosols): These are soils distributed on calcareous (calcareous) terrains. They are characteristic of the Chirpanski Vazvisheniya Hights.

An attempt for agro-ecological zoning of soil and climate conditions in the watershed of Tundzha River with respect to the main agricultural crops is made by Pankov (2014) as presented below.

In the region of Karlovo, Kazanlak and Sliven fields, as well as part of the fence slopes of Sarnena Sredna Gora, the soil cover dominates Deluvial, Alluvial-meadow and Cinnamon forest soils. The region has a specific climate, which is due to its valley character and its protection by the north. The average annual temperature is about 10.5°C. The temperature sum for the growing season in agriculture, which starts on average around the 10th March, is about 3800°C. Rainfall is 660 mm. The balance of atmospheric humidity for the growing season is represented by a deficit of about -200 mm (Pankov 2014).

In the region around the town of Yambol the relief is relatively flat, however, affected by tectonic movements with predominant subsidence. The soil cover is composed mainly of Smolnitsa, Leached Cinnamon forest soils and Alluvial-meadow soils. In terms of climate, this region is characterized by relatively mild winters and hot summers. The average annual temperature is 12°C. The vegetation period has very good thermal insulation - a temperature sum of about 4250°C. There is too little humidity - 600 mm of rainfall here annually, with high evaporation. The deficit in

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the atmospheric humidity balance for the growing season is about -380 mm (Pankov 2014).

In the northwest direction of the town of Yambol (northeast part of the Stara Zagora Field), the soil cover is made up of Leached Cinnamon forest soils, Pseudopodzolic forest soils, Smolnitsa, Rendzini, Alluvial-meadow and Deluvial-meadow soils. The territory falls in the climatic region of Eastern Central Bulgaria, which is distinguished by its transitional continental character. The average annual temperature is high - about 12°C. The heat supply of the area is very good and allows the development of many thermophilic crops. The temperature sum for the growing season is about 4200°C. Annual rainfalls here averages 600 mm, of which 320 mm fall during the growing season. The balance of the atmospheric humidity is with very large deficit - about -450 mm as the area is quite arid (Pankov, 2014).

In the region of the southern foothills of Sarnena Sredna Gora Mts, the terrain is rugged, low mountainous, with extensive flattening, with thick and deeply incised hydrographic network and strongly expressed conditions for the erosion processes. The soil cover is variegated, but the Leached Cinnamon forest soils, Pseudopodzolic forest soils and undeveloped soils are more prevalent. The geographical location determines the climatic characteristics. The average annual temperature for the higher parts is about 10°C and for the lower is 12°C. Temperature amounts during the growing season reach 3500-4000°C. The amount of precipitation is about 600 mm. The deficit in the atmospheric humidity balance, depending on the orographic features, varies in wide limits from -100 mm to -480 mm.

Description of some soil profiles from the region of Sarnena Sredna Gora Mts

Description of soil profile of typical Cinnamon forest soil (Haplic Luvisol, Chromic) near the Chirpanski Vazvisheniya Hights (at 274 m a.s.l.) was made by Jordanova (2017):



Ak horizon: 0–10 cm, humic horizon, brown-red color, dense, clayey, presence of rock fragments, vegetation roots and carbonate concretions

Btk1 horizon: 10–38 cm, illuvial horizon, red-brown color, heavy clayey, dense, presence of rock fragments, vegetation roots and carbonate concretions

Btk2 horizon: 38–60 cm, illuvial horizon, light brown color, clayey, carbonate concretions and rock fragments present, transition with Btk1—sharp

BCk horizon: 60–78 cm, transitional horizon, beige color with orange and grayish-green mottles, loose texture, abundant rock fragments

Ck horizon: C horizon, light beige color, mottled, abundant rock fragments

Parent rock: marls with chert.

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Description of soil profile of Brown forest soil in the central part of Sredna Gora Mts was made by Shishkov *et al.* (2016):



Ah 0-7 cm, color 10YR 4/3 (dry) and 10YR 3/3 (moist), very friable fine granular structure 1-2 mm size, weak ped development, many fine roots and residiums

A 7-27 cm, color 10YR 5/3 (dry) and 10YR 4/2 (moist), friable medium granular structure 2-5 mm size, moderate ped development, some fine roots

AB 27-60 cm, color 10YR 6/3 (dry) and 10YR 4/3 (moist), firm coarse granular structure 5-10 mm, strong ped development, few roots 1-2 mm diameter

Bw 60-120 cm, color 10YR 6/4 (dry) and 10YR 4/4 (moist)), friable fine 5-10 mm subangular blocky structure, strong ped development

BC 120-170 cm, color 10YR 6/6 (dry) and 10YR 5/8 (moist), friable single grain structure and massive.

Description of soil profile of Vertisols near the town of Chirpan (at 160 m a.s.l.) was made by Jordanova (2017):



0-6 cm: humic (A1) horizon, dark gray, sandy-clayey, no carbonates

6-40 cm: humic (A2) horizon, black-gray, heavy clayey, dense, slickensides present

40-100 cm: humic (A3) horizon, tarry black, no carbonates, heavy clayey, slickensides present

100-140 cm: transitional AB horizon, dark brown, dense, carbonate and Fe-Mn concretions

140-155 cm: illuvial (Bk) horizon, gray-brown, clayey, carbonate concretions, Fe-Mn concretions present

155-183 cm: transitional (Bck) horizon, light brown, carbonates and carbonate concretions present

183-240 cm: Ck horizon, light brown-beige, sandy

Parent rock: Pliocene clays

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Conclusion

The soil cover of Sarnena Sredna Gora Mts is closely dependent on geological structure, relief, vertical zoning of bioclimatic conditions, etc. In the lower altitude zone, with warmer and drier climate, deciduous (mostly oak) vegetation and heterogeneous rock composition, mainly Cinnamon forest soils are developed. The taller, relatively wetter and colder altitude zone, with beech forests and non-carbonate rocks, is dominated by Brown forest soils. In the highest parts of Sarnena Sredna Gora Mts, with well-developed grasslands, there are Mountain meadow soils. In the lower parts of the relief, made up of upper Cretaceous volcanics and pyroclastites, there is a localized development of Smolnitsa, and in the valleys of the rivers and depressions with low alluvial-proluvial deposits - Alluvial and Alluvial-meadow soils.

Vegetation is closely dependent on physical and geographical conditions, but is also influenced by human economic activity. Alluvial soils are accompanied by hydrophilic grass and forest vegetation - alder, willow, poplar. Areas with the distribution of Cinnamon forest soils and Smolnitsa constitute arable land, and in the higher parts there are oak, hornbeam and oak-hornbeam forests. Significant areas of the forest fund have been artificially replaced by coniferous forest plantations, mainly pine.

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