Statistical Assessment of Fluvisols in "Gladino" Gravel Quarry, Chelopechene, Bulgaria

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Abstract

The paper presents results of an investigation on Fluvisols. The soils are located in "Gladino" gravel quarry, Chepintsy district, Bulgaria, on an area of 1.043 km^2. Soil samples were taken from fifteen soil profiles at a depth of 0-100 cm. The factors of soil formation were characterized and it`s physicochemical properties were studied. The changes in physicochemical properties were investigated at different soil depths and the relationships between different soil characteristics were tested by correlation analysis. The results reveal that some soil characteristics, such as the content of clay, sand, organic matter, and the soil porosity have strong positive or negative correlation with the soil depth. The soil characteristics such as acidity or alkalinity of soil (pH), the content of loam, bulk density, Total Kjeldal Nitrogen (TKN), mobile phosphorus and potassium demonstrated an insignificant or weak relationship with the soil depth. There are significant correlations between the physicochemical soil properties in 28 out of 78 cases. All results are discussed in relation to soil formation processes in the studied region.

Keywords: Fluvisols, Physicochemical properties, statistical assessment, gravel quarry.

Introduction

The sustainable development and productivity of suburban green areas depend to a great extent on the soil properties. Soil characteristics determine the existence and normal functioning of ecosystems. The studies on the soil composition and properties allow suitable planned activities to ensure efficiently and environmentally use.

Fluvisols are intrazonal and occur in the riverside environment (Donov, 1993). These soils are relatively poor in nutrients, especially in tropical areas (Edelman & Van der Voorde, 1963), and are sometimes represented by completely infertile gravels and sands. They are characterized by variable physicochemical properties (Dengiz, 2010; Woźniak & Kud, 2005), but have a favourable water regime (Duchaufour, 1965; Donov, 1993) and good bulk density indicators (Kaczmarek et al., 2015). There is a textural variation in the soil profile (Valentin, 1991). The chemical properties of these soils are directly related to their distance from the riverbed (Amossé et al., 2015). They are characterized by acid, neutral or alkaline reaction in relation to river basins. Soil organic matter (SOM) is average or low, but varies strongly

(Woźniak & Kud, 2005) and may reach up to 2% in the surface horizon (Mitkova & Mitrikeski, 2005). The nitrogen content is high or average (Yigini et al., 2013). Fluvisols may be suitable for some forest species - willows, elms, ashes (Donov, 1993), as well as for tree fruit species such as apple, plum, pear, peach (Kalala et al., 2017) and quince (Shishkov & Kolev, 2014). Favorable water, air, and soil thermal properties indicate that these soils have been used for agriculture since ancient times. The soils are characterized by a low store of nutrient elements. Low content of organic colloids and coarse texture characterize the soils as such with low Cation Exchange Capacity (CEC) 10–15 meq/100 g and low buffer properties (Shishkov & Kolev, 2014). These soils can be used for the growing of high yield cultures if fertilized properly (Donov, 1993; Kalala et al., 2017).

Fluvisols are found between Chernozems and Gray forest soils in Northern Bulgaria, along with the rivers - Danube, Lom, Ogosta, Iskar, Osam, Yantra, Rositsa and Kamchia (Teoharov et al., 2015; Hristov, 2009). In Southern Bulgaria, they are situated between Vertisols and Cinnamonic Forest soils, along with the rivers Maritsa, Tundzha, Arda, Mesta, Struma, Iskar, and Erma (Antipov-Karataev et al., 1959; Donov, 1993) (Fig. 1). A main soil-forming factor is the nature of the alluvial deposit (Aubert & Boulaine, 1972), which differs depending on the adjacent water basin that has carried the deposits, on the location along the river, and on the distance from the water. The weather conditions are determined by the climate zone of the respective river valley, or where the hollow is located (Donov, 1993).

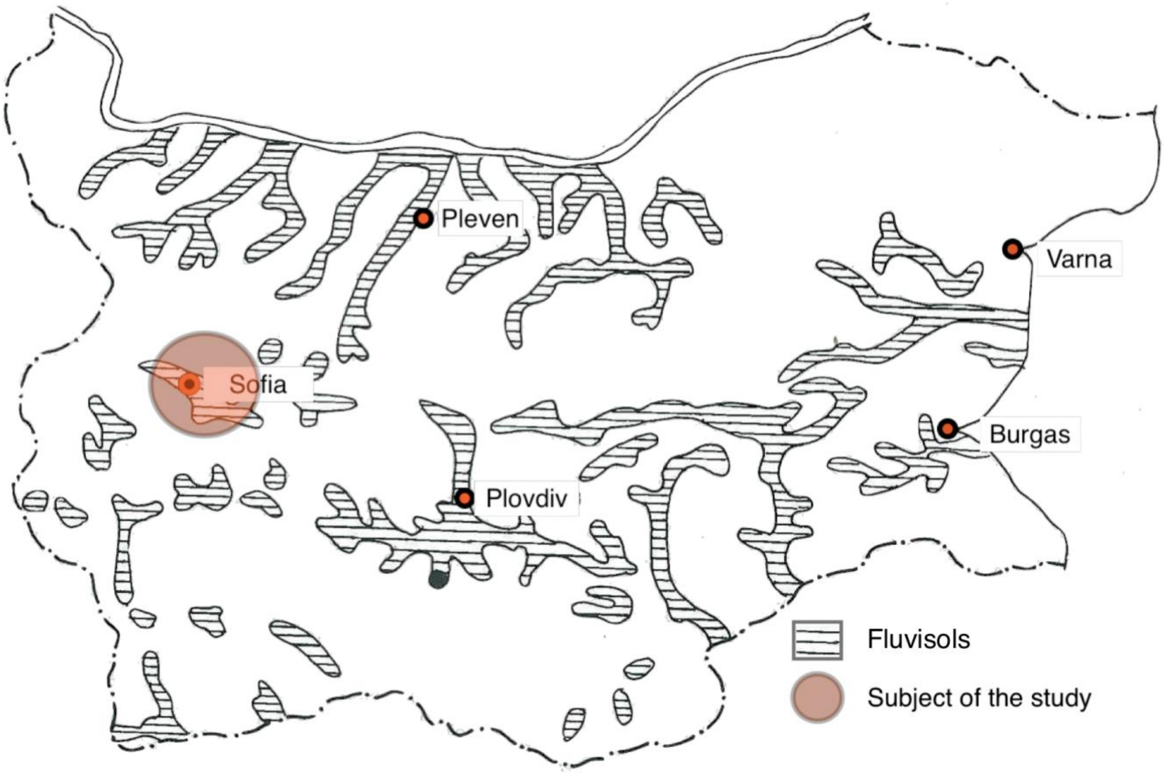

Fig. 1. *Distribution of Fluvisols and subject of the study (Koynov et al., 1998)*

The purpose of the study was to analyze the key properties of Fluvisols in relation to soil-forming materials and soil formation. Analyzing these processes and properties could help the effective landscape planning and increasing the productivity of suburban ecosystems.

Materials and Methods

The object

Fluvisols (WRB, 2014) occurring on the territory of “Gladino” sand and gravel quarry, located 1 km west of the village of Chelopechene, Bulgaria was the object of the study. This soil type is usually found in the Lower forest vegetation zone (0 - 600 m a. s. l.) of the Moesian forest vegetation area of Bulgaria (Zahariev et al., 1979). The studied area covers 1.043 km^2 (Fig.1).

Methods of study

Fifteen soil profiles at a depth of 0-100 cm were done at representative plots. A systematic sampling design was used (Petersen & Calvin, 1996). The samples were taken at depths of 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm, and 80-100 cm.

The following soil characteristic was analyzed by using the respective methods:

- Soil Organic Matter (SOM, %) by the Turin method (Donov et al., 1974);
- Total Kjeldahl Nitrogen (TKN, %) content, with a modified version of the classic Kjeldahl method (Tecator 1030);
- P_2O_5 ($mg.100g^{-1}$) – extraction with Ammonium Acetate and Calcium Lactate-pH 4.2 (UV-VIS spectrophotometer Perkin Elmer Lambda 5) (Ivanov, 1984);
- K_2O ($mg.100g^{-1}$) – extraction with Ammonium Acetate and Calcium Lactate-pH 4.2 (Flame photometer Jenway php 7) (Ivanov, 1984);
- Soil acidity (pH in water extraction and $CaCl_2$ extraction 1:5 w/v) – measured potentiometrically (WTW 720 pH meter);
- $CaCO_3$ (%) by Shaibler’s method (Eijkelkamp 08.53 calciummeter) (NEN-ISO 10693);
- Soil texture (Sand - 2 mm - 63 μm, %; Silt - 63 μm - 2 μm, %; Clay < 2 μm, %), using the sedimentation method (ISO 11277);
- Bulk density (BD, $g.cm^{-3}$), according to the Kachinsky method (Donov et al., 1974, Cools & De Vos, 2016, DIN ISO 11272:1998, 2001);
- Total porosity (TP, %) by calculation of bulk density and relative density (Donov et al., 1974);
- Plant available water capacity (PAWC, mm), by a laboratory method, with the calculation of field capacity and permanent wilting point (Donov et al., 1974);

Data analysis

Descriptive statistics were applied using Numbers and Excel in Mac and PC, respectively. Percentage data were arcsine-square root transformed before the analysis (Compton, 1994). The relationships among the soil characteristics studied were tested by using Pearson's product-moment correlation. Pairwise correlation coefficients were calculated by using SPSS for Windows, version 16.0. Their statistical significance (the significant difference from zero) was tested at $\alpha=0.05$. Linear regression analysis was applied for additional testing for a functional relationship between the soil depth and the other characteristics. Corrected variants of regression coefficients (R^2) were calculated and the statistical significance of the relationship was tested at $\alpha=0.05$.

Results and Discussion

Soil characteristics

Soil physical parameters change slightly in the soil depth. The soil texture at a depth of 0-20 cm is almost equally distributed as sandy clay loam. At a depth of 20-40, 40-60, 60-80 cm it falls into the sandy loam texture group. The samples taken at a depth of 80-100 cm fall mainly into the loam sand group (Fig. 2). The soil texture variability is consistent with a study carried out by Singh et al. (2000).

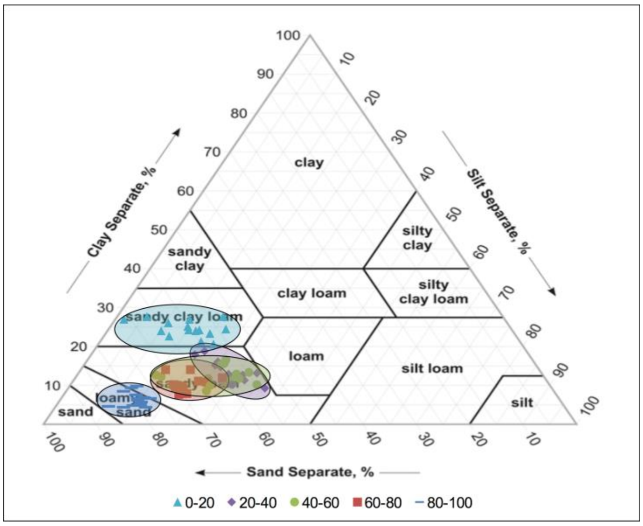

Fig. *2. Soil texture (according to Soil Survey Staff, 1975).*

Texture variability of the studied soils is mainly due to the decrease in the content of the clay fraction and the increase in the content of the sand fraction with depth. The silt fraction decreases gradually with depth, except in the first layer at a depth of 0-20 cm, where this fraction has the lowest average value, whereas the clay fraction has the highest content percentage (Fig. 3). The variation of soil texture with depth is characterized by a negative linear relationship with high statistical significance for the clay fraction (R^2=0.754, p<0.001) and sand fraction (R^2=0.609, p<0.001). No statistically significant relationship was found between depth and silt fraction (R^2=0.022, p=0.278) (Fig. 4) (Table 1).

The bulk density values are between 1.23 and 1.61 g.cm^{-3} in the upper (0-20 cm) layer, varies between 1.23 and 1.61 g.cm^{-3} in the 20-40 cm layer, between 1.15 and 1.72 g.cm^{-3} in the 40-60 cm layer, between 1.02 and 1.86 g.cm^{-3} in the 60-80 cm layer and 1.12 and 1.84 g.cm^{-3} in the lower (80-100 cm) layer. Despite the weak upward trend of the maximum bulk density values with depth, there is no significant relationship between the depth and the bulk density (R^2=0.007, p=0.458).

The study of the Fluvisols showed that there is a clear downward trend in porosity with depth (R^2 =0.752, p<0.001) (Fig. 5), varying from medium to low (according to Blume's classification, 1992).

Table 1. *The matrix of the correlation coefficients among the soil characteristics studied.*

	Sand	Silt	Clay	BD	TP	PAWC	pH (H_2O)	pH ($CaCl_2$)	$CaCO_3$	SOM	TKN	P_2O_5
Silt	**-0.658**											
Clay	**-0.635**	-0.158										
BD	0.118	-0.071	-0.086									
TP	**-0.549**	-0.127	**0.838**	0.007								
PAWC	-0.008	0.092	-0.097	-0.115	-0.009							
pH (H_2O)	-0.118	-0.071	**0.230**	-0.006	**0.326**	0.120						
pH ($CaCl_2$)	**0.246**	-0.272	-0.037	0.058	0.065	0.026	**0.458**					
$CaCO_3$	-0.106	0.000	0.120	-0.011	0.069	0.044	0.080	0.100				
SOM	**-0.704**	**0.222**	**0.697**	-0.176	**0.589**	-0.065	0.166	-0.120	0.127			
TKN	**-0.269**	0.066	**0.313**	-0.020	**0.282**	-0.188	0.186	0.182	0.074	**0.304**		
P_2O_5	**-0.301**	-0.083	**0.467**	-0.068	**0.471**	0.020	**0.258**	-0.032	0.117	**0.249**	**0.323**	
K_2O	-0.175	-0.079	**0.313**	0.157	**0.324**	-0.083	**0.290**	0.131	**0.228**	0.195	**0.260**	**0.265**

Legend: The values in Bold indicate statistically significant correlation at p≤0.05. For abbreviations of the names of soil characteristics, see part "Material and Methods"

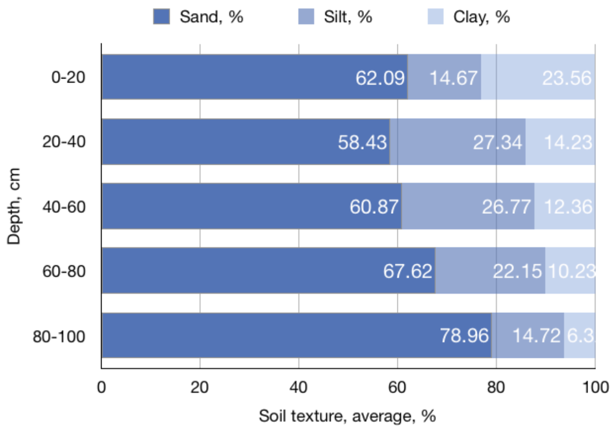

Fig. 3. *Soil texture (average data) in depth.*

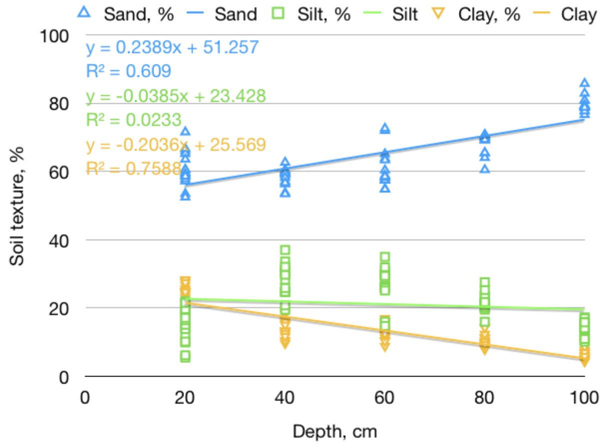

Fig. 4. *The relationship between depth and soil texture characteristics.*

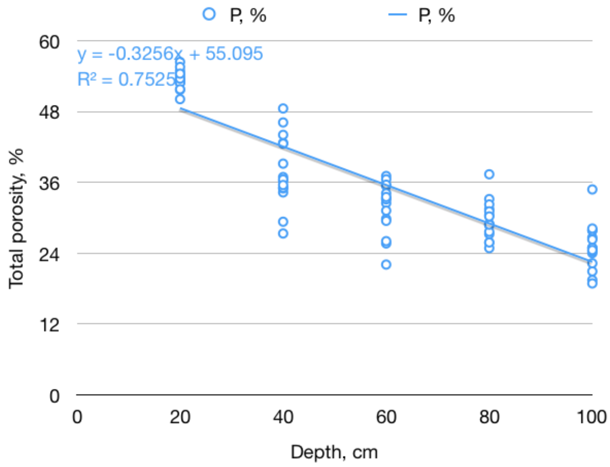

Fig. 5. *The relationship between soil depth and porosity.*

Pearson's product-moment correlation coefficients express the relationships among the soil characteristics (Table 1). It can be seen that roughly one-third of the correlation coefficients (28 of 78) are significantly different from zero. In other words, there are significant relationships among different soil characteristics. There are six negative correlations and all they are related to sand content. It correlates negatively with silt, clay, porosity, SOM, TKN and P_2O_5. There is a highly significant positive correlation between the clay fraction and porosity (r=0.838) and a negative one between the sand fraction and porosity (r=- 0.549), while there is no relationship between the silt fraction and porosity. Clay content correlates significantly with porosity, pH (H_2O), SOM, TKN, P_2O_5 and K_2O (positively) and with sand content (negatively). Interestingly enough, PAWC does not correlate significantly with any of the other characteristics (Table 1).

PAWC in the studied soils varies from 128.79 mm to 164.51 mm (Mean=146.03) and shows a fluctuation around the values of fresh soils (Coeff. of variation= 6.08%) (Fig. 6).

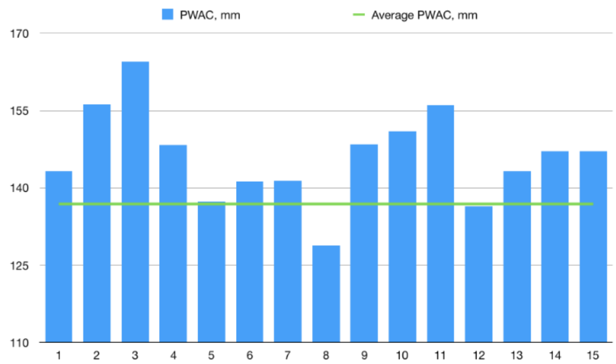

Fig. *6. PAWC variation.*

The reaction of the H_2O extract of the studied soils varies from slightly acidic to slightly neutral, which is consistent with data provided by Walker et al. (2003) and Hartemink (1998) on the pH variation within the range of 5.2-7.1. The pH values in the H_2O extract are between 6.36 and 7.23 in the upper (0-20 cm) layer, pH varies between 5.88 and 7.37 in the 20-40 cm layer, between 5.74 and 6.76 in the 40-60 cm layer, between 5.76 and 7.06 in the 60-80 cm layer and between 5.76 and 7.04 the lower (80-100 cm) layer. The pH values in the $CaCl_2$ extract are between 6.09 and 7.18 in the upper (0-20 cm) layer, pH varies between 5.29 and 6.82 in the 20-40 cm layer, between 5.65 and 6.53 in the 40-60 cm layer, between 5.85 and 6.85 in the 60-80 cm layer and between 6.00 and 7.1 in the lower (80-100 cm) layer. This indicates that the exchangeable acidity, which is an indicator for degradation processes, is small (Ignatova & Damyanova, 2010). There is weakly expressed the linear relationship between the soil reaction in H_2O and soil depth (R^2=0.05, p=0.029) and no relationship between the soil reaction in $CaCl_2$ and soil depth (R^2=0.004, p=0.561).

The values of the carbonate content are relatively low, which is expected based on the pH data. There is no significant linear relationship between $CaCO_3$ and depth (R^2=0.027, p=0.256). The studied soils are generally characterized by low SOM and TKN values, which is consistent with Donov (1993) and Singh et al. (2000). The SOM and TKN are between 1.13 and 2.18%, 0.001 and 0.020% in the upper (0-20 cm) layer, between 0.87 and 1.91%, 0.002 and 0.012% at 20-40 cm, 0.88-1.88% and 0.001-0.012% at 40-60 cm depth, between 0.20 and 1.07%, 0.001 and 0.011%, at 60-80 cm and between 0.08 and 0.96%, 0.001 and 0.010% respectively in the lower (80-100 cm) layer. There is a strong linear negative relationship between SOM and the depth (R^2=0.603, p<0.001), and a weaker one, although statistically significant, between TKN and the depth (R^2=0.13, p=0.004) (figures 7 and 8)

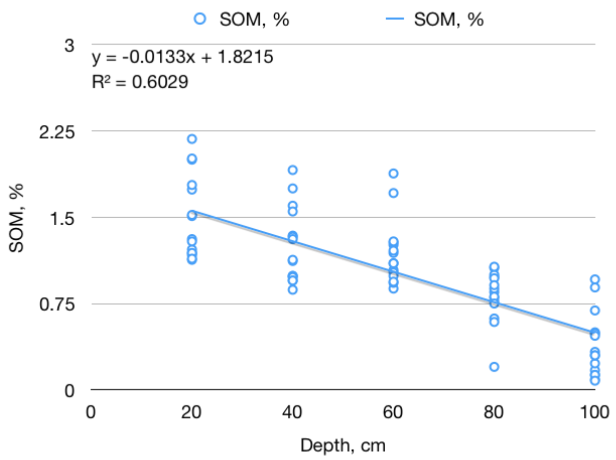

Fig. 7. *The relationship between depth and SOM.*

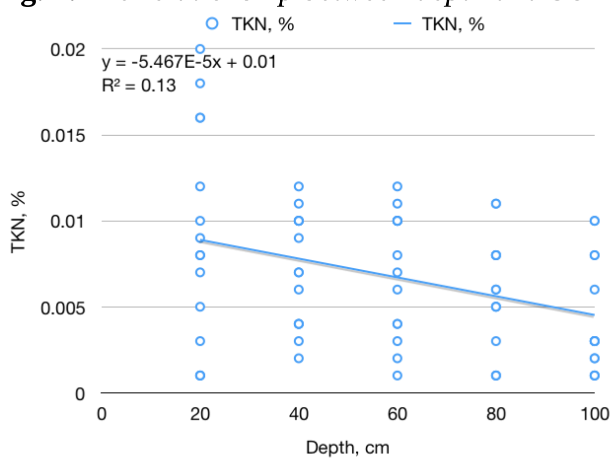

Fig. 8. *The relationship between depth and TKN.*

The studied soils are characterized by a very low availability of P_2O_5 and an average of the very good availability of K_2O. The P_2O_5 and K_2O are between 0.06 and 0.43 mg.100g^{-1}, 0.75 and 56.25 mg.100g^{-1} in the upper (0-20 cm) layer, between 0.04 and 0.2 mg.100g^{-1}, 1.37 and 14.81 mg.100g^{-1} at 20-40 cm, 0.09-0.17 mg.100g^{-1} and 0.09-14.05 mg.100g^{-1} at 40-60 cm depth, between 0.20 and 0.13 mg.100g^{-1}, 0.43 and 11.74 mg.100g^{-1}, at 60-80 cm and between 0.03 and 0.16 mg.100g^{-1}, 0.16 and 15.56 mg.100g^{-1} respectively in the lower (80-1000 cm) layer. There are low linear negative relationships between P_2O_5 and depth (R^2=0.264, p<0.001), and between K_2O and depth (R^2=0.161, p=0.006). The relatively low level of relationship, as illustrated by the coefficient of determination (R^2), are due to the high variation of P_2O_5 in the first layer, which decreases downward to the 60-80 cm layer, and the high variation of K_2O in the first layer, followed by an almost similar variation in the next layers (figures 9 and 10).

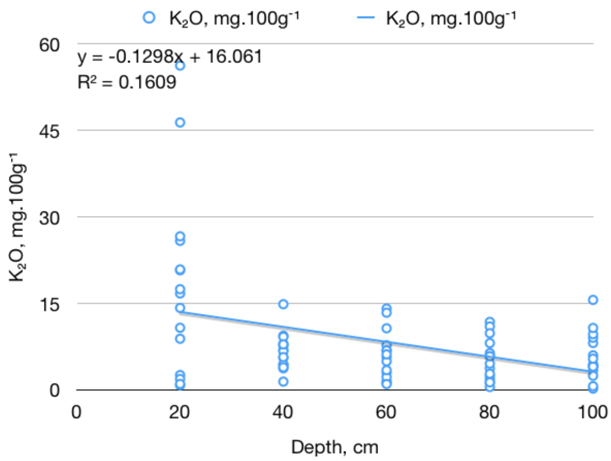

Fig. 9. *The relationship between soil depth and P_2O_5 content.*

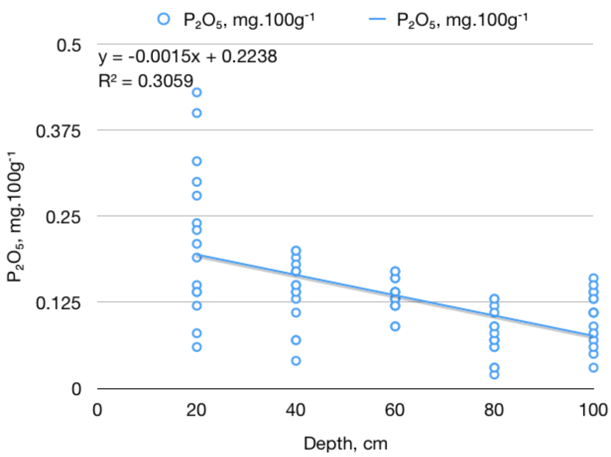

Fig. 10. *Relationship between soil depth and K_2O content*

Plant cover

As a result of the field studies carried out, 28 species of higher plants were identified in the studied territory. It should be emphasized immediately that this composition represents only part of the plant species on the site. By the time the study was carried out, spring species (ephemeres and ephemeroids) had completed their vegetation period and could only be encountered incidentally. A cereal grass turf had formed on all observation sites and the projection coverage is about 80%. Couch-grass (*Cynodon dactylon* L.) predominates with a projective coverage of about 70%. *Poa pratensis* L. and *Arrhenatherum elatius* (L.) P. Beauv. Ex J. & C. Presl of the cereals account for several percents (up to 5), and in certain areas, up to 1-2% of the cover consists of large-sized species such as *Dipsacus fullonum* L.

Table 2. *List of identified species*

Species	Family	Geo element	Biological type
Achillea millefolium L.	Asteraceae	Eur-Sib	P
Agrimonia eupatoria L.	Asteraceae	Eur-Med	P
Arrhenatherum elatius (L.) P. Beauv. ex J. & C. Presl	Poaceae	Eur-As	P
Artemisia absinthium L.	Asteraceae	Pont-Med	P
Artemisia vulgaris L.	Asteraceae	subBoreal	P
Berteroa incana (L.) DC.	Brassicaceae	SPont	P
Chenopodium album L.	Chenopodiaceae	Kos	A
Chondrilla juncea L.	Asteraceae	Eur-Sib	P
Cichorium intybus L.	Asteraceae	Eur-Sib	P
Cirsium arvense (L.) Scop.	Asteraceae	Eur-As	A
Convolvulus arvensis L.	Convolvulaceae	Kos	A
Conyza canadensis (L.) Cronquist	Asteraceae	Adv	A
Cynodon dactylon (L.) Pers.	Poaceae	Kos	P
Dactylis glomerata L.	Poaceae	Eur-As	P
Daucus carota L.	Apiaceae	Eur-As	B
Dipsacus fullonum L.	Dipsacaceae	Eur-OT	B-P
Echium vulgare L.	Boraginaceae	Eur-As	B-P
Elymus repens (L.) Gould.	Poaceae	Boreal	P
Euphorbia cyparissias L.	Euphorbiaceae	Eur	P
Galium verum L.	Rubiaceae	Eur-As	P
Linaria genistifolia (L.) Mill.	Scrophulariaceae	Pont-Sib	P
Persicaria maculata (Raf.) Gray	Polygonaceae	Eur-As	A
Poa pratensis L.	Poaceae	Kos	P
Prunus cerasifera Ehrh.	Rosaceae	Eur-As	T
Rumex patientia L.	Polygonaceae	Eur-As	P
Saponaria officinalis L.	Caryophyllaceae	Eur-Sib	P
Scabiosa argentea L.	Dipsacaceae	Bal-Anat	B-P
Taraxacum officinale Webb	Asteraceae	Eur-Med	P

Legend: For the designation of the geo elements – see Assyov and Petrova, eds. (2012). For biological type: A – annual plant, B – biennial plant, B-P – biennial to perennial plant, P – perennial plant, and T – tree.

The grass mixture consists of single specimen or small groups of other species, the most common of which are *Berteroa incana* (L.) DC., *Chondrilla juncea* L., *Achillea* *millefolium* L. and *Galium verum* L. The other species are of a more limited occurrence and have been encountered on one or two observation sites. A list of the species has been provided below in Table 2.

The Asteraceae family is the most numerous, represented by 9 species, followed by the Poaceae family – 5 species. Dipsacaceae and Polygonaceae are represented by two species and 10 families are represented by one species.

According to the biological type, 5 species are annual herbaceous plants, 1 species is a biennial herbaceous plant, 3 species are biennial to perennial herbaceous plants, 18 species are perennial herbaceous plants, and one species is a tree, which is, however, represented by a small specimen hardly distinguishable in the grass community.

According to the geographical origin of the species, 13 types were identified. The most numerous are the Euro-Asian elements (Eur-As) – 9 species, followed by Euro-Siberian (Eur-Sib) and Cosmopolitan (Kos) geo elements – 4 species each. The Euro-Mediterranean elements (Eur-Med) are represented by two species, and the other geo elements are represented by one species each (Fig. 11).

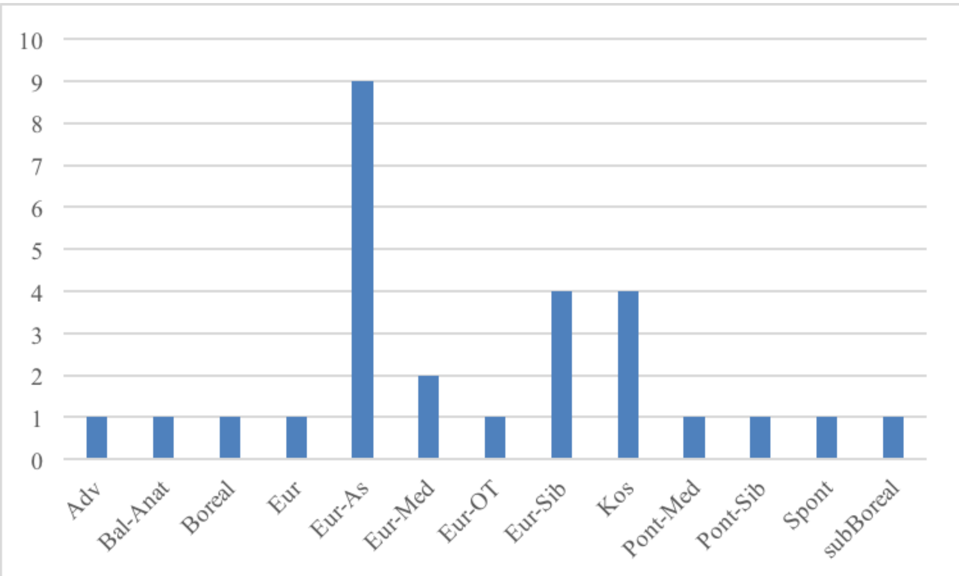

Fig. 11. *Geoelements in the studied territory (according to Assyov and Petrova, eds., 2012).*

Soil formation process

The soil forming factors influence the nature, direction and speed of soil forming processes (Donov, 1993). The key factors are climate, biota, topography, and parent material. *The climate* has a direct influence on the temperature and moisture of the soil, and an indirect one on the biota. In terms of climate, the subject of study falls within the European continental climatic region, temperate continental sub-region, the climatic region of the high fields of Mid-Western Bulgaria (Troeva, 2009). The retention and additional radiative cooling of air masses are typical of the territories around Sofia, and this results in temperatures as low as -25 °C. The average temperatures in January are about 4–5 °C, and the average temperatures in June are 20–21 °C. The relative air humidity is 70%. The average annual temperature of the studied area varies around 11.5°C, the average annual rainfall varies around 837 mm, with a peak rainfall in May and a minimum in July. The winter is cold and relatively dry with an average temperature in January of 2.6 °C. There is a small amount of rain (102 mm). The summer is relatively warm with an average temperature in July~23.8°C. There is significantly more rainfall in the fall than in the spring. This is due to the basic features of this region (Troeva, 2009). Small amounts of precipitation fall in July, August and September (Fig. 2). Climate is continental, with highest mean monthly temperature in July and the lowest – in January, and with highest precipitation amount in May and lowest – in September (Fig. 12).

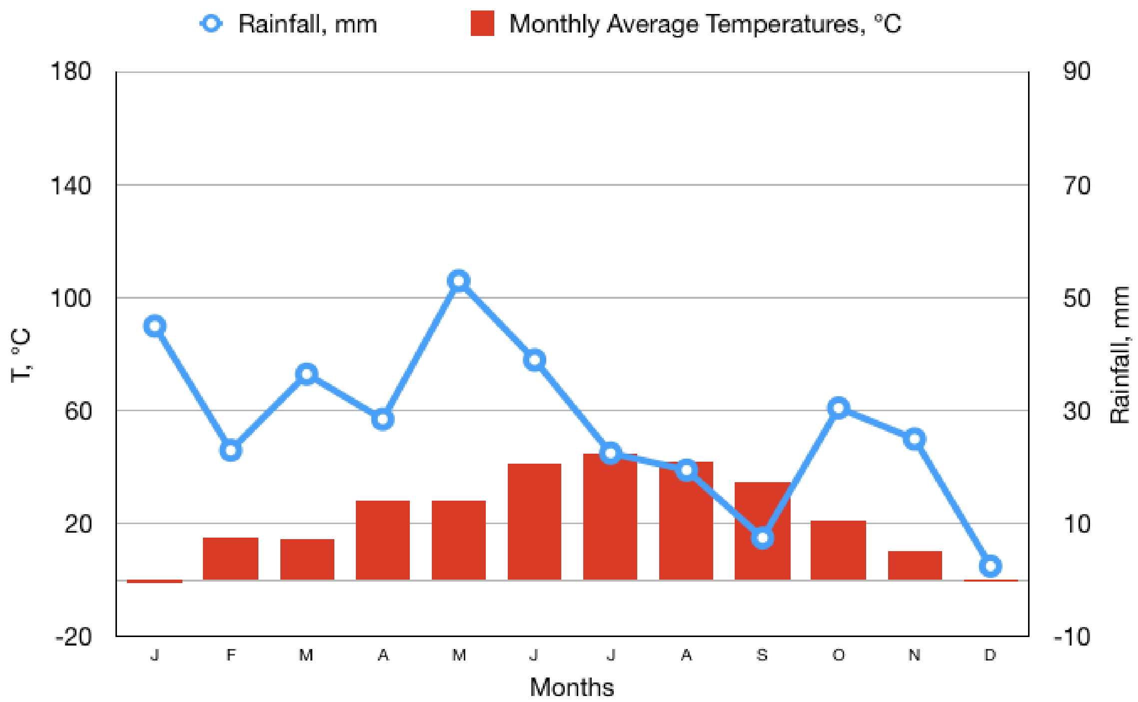

Fig. 12. *Climate diagram 2016 of the region of study (NIMH, BAS, 2016).*

Higher plants are the most significant *biotic* factors that shape the formation of soils, microclimate, supply the soil with organic matter and influence its composition and properties (Donov, 1979). A number of plant species are closely related to the soil properties by influencing plant development, or by indicating changes in the soil substrate (Bogdanov & Glogov, 2006; Bogdanov, 2013, 2014; Bogdanov et al., 2015). The soils have been formed under poorly developed meadow vegetation (Stransky, 1935; Georgiev, 1959; Donov, 1979). Forests develop less frequently on such soils (Stransky, 1935), but if they do, in Bulgaria they form riparian ecosystems dominated by poplars (*Populus* spp.) and willows *Salix* spp., and less frequently – by Common oak (*Quercus robur* L.) and Ashes (*Fraxinus* spp.) (Bondev, 1991). In more northern conditions they may be composed of *Picea* spp., *Larix* spp., *Betula* spp., *Ulmus* spp. (Zelikov, 1981). Meadow-marsh vegetation and more rarely, salt-tolerant vegetation develop in lower regions (Stransky, 1935). The study on Fluvisols in the Sofia hollow showed that the most numerous families are Asteraceae, Poaceae and Rosaceae. Many families are represented by a single species. Euro-Asiatic floristic elements form the most numerous group of species phytogeographic origin, followed by cosmopolitan elements. European and Euro-Mediterranean elements come next by low representation. The adventive species are fewer than 10%. Four groups are represented by a single species, which makes a percentage ratio of 1.25% (Ilinkin et al., 2014).

The parent material is a river deposit, mostly sandy, which becomes finer and finer as the river flows from its source to its mouth. It is layered due to its periodic precipitation when rivers burst their banks (Georgiev, 1959; Donov, 1993). These soils are young, at an early stage of development. Their periodic flushing by fast-flowing rivers during flooding and the precipitation of new sediments prevent the occurrence of permanent vegetation and soil formation (Georgiev, 1959; Donov, 1993). Over the short period of their existence, no genetic horizons have formed. There are only separate layers, or a poorly developed primordial humus horizon (Donov, 1993) 1-10 (30) cm thick (Zelikov, 1981), followed by different sediment layers. The soils located downstream are characterized by basic soil processes of humus formation and humus accumulation (Zelikov, 1981; Donov, 1993). Depending on the strength of the water current, a big or a small amount of large or tiny particle material is deposited all at once, which forms thicker or thinner soil layers. Alluvial embankments form soil layers that do not have a genetic link. The soil profile is of type I, II, III, IV, V, etc., $AC_1C_2C_3C_4C_5$, or AI II III IV V, etc. with a well-developed humus-cumulative horizon (Donov 1979; Donov, 1993).

Conclusion

The complex influence of soil formation factors (as periodical deposing of parent material) determines a variation of different soil characteristics (such as bulk density, pH, etc) and because of this, there are weak relationships between different soil characteristics and soil depth. There are moderate to high relationships between some soil characteristic such as clay, sand, porosity and soil organic matter and soil depth and weak and insignificant relationships between the other characteristics and soil depth. There are significant correlations among the physical and chemical soil properties in one-third of all possible cases and this is a result of the fact that many characteristics depend on the same factors and are the result of similar processes.

The studied soils are characterized by some favourable physical properties, e.g. porosity (in upper layers) and PAWC. The soil texture variation from loamy sand to sandy clay loam determined the soils as light by texture and favourable for a wide set of species (and varieties) for a restoration of the environment. Some examples – Indigenous arboreal species: *Pinus nigra* Arnold, *Alnus glutinosa* (L.) Gaertn., *Carpinus betulus* L., *Populus alba* L., *Salix alba* L., *Salix fragilis* L., *Cornus sanguinea* L., *Frangula alnus* Mill.; Exotic arboreal species: *Picea pungens* Engelm., *Taxodium distichum* (L.) Rich., *Cupressus arizonica* Greene, *Salix babylonica* L., *Salix viminalis* L., *Liquidambar styraciflua* L., *Berberis thunbergii* DC. Herbaceous species: *Elymus repens* (L.) Gould., *Poa trivialis* L., *Arrhenatherum elatius* (L.) P. Beauv. ex J. & C. Presl., *Lolium perenne* L., and some appropriate grass mixtures for the establishment of a meadow-like environment.

The SOM, TKN and P_2O_5 are in low (but normal for this soil type) contents. The variation of soil pH between 6.0-70 reduces the availability of some elements (Gorbanov et al., 2005), which can reduce the plant nutrition of P_2O_5. The K_2O content is high.

Activities for the restoration and productivity increase of the suburban ecosystems in the region should be planned in accordance with soil characteristics and particularly with its specific chemical composition.

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