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Agroecological potential and geographic information systems (GIS) mapping in the region of Stara Zagora, Bulgaria (Part I). Characteristics of the ecological factors

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Abstract

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Relief, climate and soils in the lands of the villages of Edrevo and Panicherevo, Stara Zagora region, Bulgaria were examined. A geographic information system (GIS), including the collected information, and spatial visualization of soil data and main soil characteristics was carried out in the form of a soil map and thematic maps of soil texture (physical clay content in %), humus content (%) and soil acidity (pH). A greater part of the agricultural land is occupied by Cinnamon forest soils, a total of 1720.56 ha, of which 1012.43 ha are strongly leached to slightly podzolized with varying degrees of erosion and 708.12 ha are undeveloped and shallow soils. The rest of the agricultural lands are from Alluvial (Deluvial) – meadow soils – 930.29 ha. The detailed description of the soil-climatic conditions was applied in determining the credit rating and category of the lands in the investigated lands (part II).

Keywords: geographic information systems (GIS); agro-ecological potential; relief, climate; soils

Introduction

Sustainable agricultural land use can be achieved through agroecological approach, whereby the group of crops or individual crop can be optimally cultivated in the regions with homogeneous climate and soil based on land suitability and capability (Altieri, 1992).

Economic activity in the past can be summarized as positive (suitabletillage, fertilizing, crop rotation, afforestation, etc.) aimed at protecting soil, preserving and increasing its fertility, and negative, i.e. deforestation, improper tillage, etc., which ultimately leads to strengthening of erosion processes, which – affectes the soil humus horizon.

Under contemporary conditions with the intensification of agriculture, the wide application of a number of amelioration activities such as chemical fertilization, unsustainable tillage systems, etc. even unfavorable changes in soil properties are expected. This, in turn, greatly affects the quality and quantity of yields of a number of agricultural crops and does not allow the optimal use of soil resources.

The main objective of the research study is on the basis of data from the study presented, to characterize the main ecological elements (relief, climate and soils) relevant to the agricultural lands evaluation. To develop a GIS-based model to geospatial interpretation and visualization of the soil resources and their main characteristics in the studied area.

Materials and Methods

For the characterization of the main agroecological characteristics (relief, climate, soils), data from the large-scale soil survey of the lands in the villages of Edrevo and Panicherevo were used "Soil characteristics of the lands of Agricultural and industrial complex Gurkovo", archive of ISSAPPNP "Nikola Poushkarov" (Spirov, 1987), officially published climate data summarized for a minimum 25–30 year period (Koleva & Peneva, 1990; Kyuchukova, 1979, 1983; Hershkovich, 1984).

ArcGIS Desktop 10.8 software was used to develop the geographic information system and geospatial data interpretation.

Results and Discussion

The lands of the villages of Edrevo and Panicherevo are located in the South Central region of the country in the Stara Zagora district (Figure 1). The altitude of Edrevo village is 328 m and the total area of the land is 1542.05 ha. To the east, it borders the village of Panicherevo, which is located in the immediate vicinity of the Zhrebchevo dam. The altitude of Panicherevo village is 278 m and the land area is 4136.14 ha. The main soil types in the territory of the two studied lands are the Cinnamonic forest soils and Alluvial (Delluvial) meadow soils.

Morphologically, the two lands are located in the Srednogorce-sub-Balkan sub-region of the transition zone, more precisely in the Kazanlak valley between the ridge of Sarnena Sredna gora and the Debelec ridge of the main Staroplaninska chain. The Kazanlak valley is located between the Triglav, Shipchenska and Trevnenska mountains (parts of Stara Planina) in the North and Sarnena Sredna gora in the South. To the west, the Strazhata mountain threshold (Krastets, 610 m) separates it from the Karlovo valley, and to the east, the Yamurdzha hill and the Mezhdenik ridge separate it from the Tvardishka valley. The villages of Edrevo and Panicherevo are surrounded by low hills, branches of Sredna Gora. To the east is "Goliyat Bair" hill, to the south of the village of Panicherevo is „Kerezlikut", and on its western side is a third hill called Turkmyanska Koria. To the north is Yamurdzha hill.

The Kazanlak basin is a tectonic depression, subject to subsidence during the Neogene and Quaternary. It consists of two crests,Sheynovskiy in the west and Kazanlashki in the east, separated by a low transverse sill with a north-south direction. The western part (Sheinovski crest), where the studied lands of the villages of Edrevo and Panicherevo are located, is narrower and has a rather hilly surface with nu-

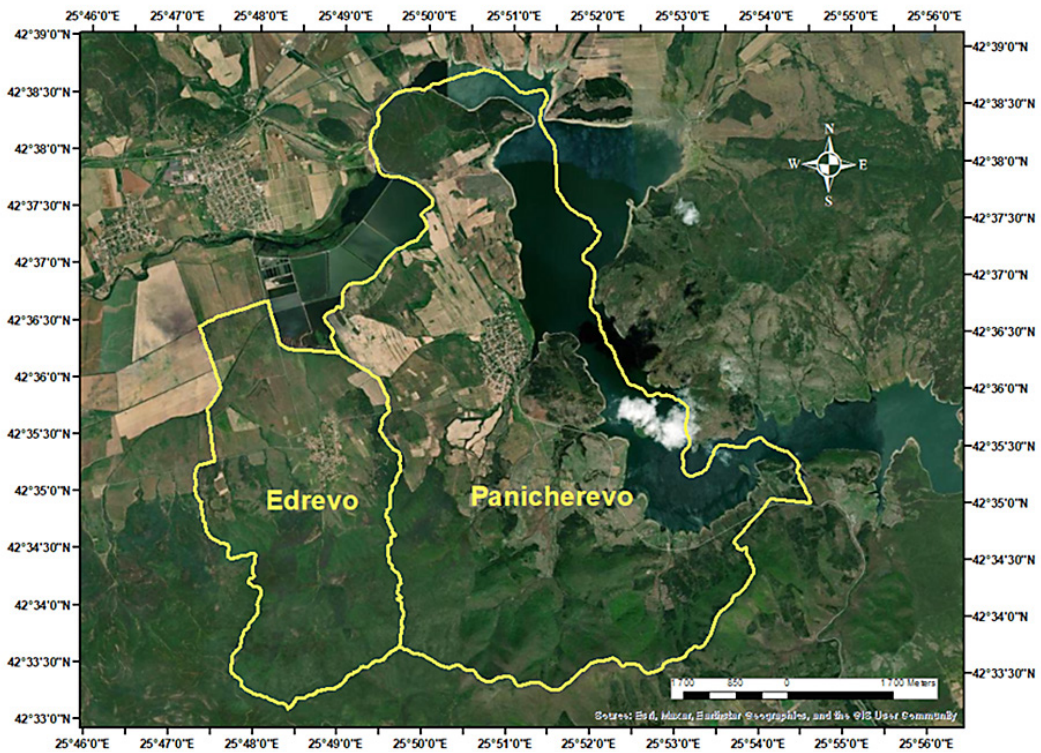

Fig. 1. Localization of the lands of the villages of Edrevo and Panicherevo, region Stara Zagora

merous alluvial cones formed by the Old Mountain rivers. The altitude here reaches 400–500 m. The area of the Sheynovsky Crest began its formation in the Pliocene. Subjected to epirogenetic subsidence until contemporary times, it has outlined the boundary of the alluvial plain of the Tundzha River with the numerous remnants of river terraces. The higher parts of the relief are well drained, but in the Tundzha alluvial valley area, the groundwater level varies from 1.50 to 2.50 m depending on the season and the amount of rainfall.

A large part of the cultivated areas in the flat parts of the relief are located on thick Quaternary deposits. These are delluvial deposits with a heterogeneous lithological composition and alluvial cones at the border of the plains and the mountain areas. Sredna Gora is formed of Sredna Gora granites, surrounded by gneisses and amphibolites. These rocks are soil-forming in this area.

The rugged relief of the Debelec ridge reveals sedimentary flysch materials, made up of large pieces of diabase, granitoids and granites.

According to their geographical location, the two villages fall into the Transitional-Continental climatic sub-region of Bulgaria and more precisely in the Climatic region of the Eastern Trans-Balkan Fields.

There is a noticeably mild winter, due to the protective influence of Stara planina from cold invasions. Again, under the influence of the mountains, the summer is cooler and with more precipitation than the Thracian lowland.

The rainfall regime has a continental character – with a summer maximum and a winter minimum, but the difference between the summer and winter precipitation is small, on average about 6-8% of their annual amount (Table 1).

The amount and seasonal distribution of natural rainfall are critical to agriculture. This is of particular importance when irrigation conditions are lacking.

The dynamics of the measured average monthly values of the relative air humidity in the study area is shown in Table 2. They range between 55–78%. Relative humidity is lowest in the months of August and September, and highest in winter (November, December, January). The average annual value is 66%.

The air temperature is also of crucial importance for the implementation of agricultural activities in the field of crop production. This necessitates the need to consider several important temperature characteristics: average monthly and average annual air temperature, number of days with average daily air temperatures above 0, 5, 10, 15°.

The average annual temperature for the area is 12.4°. The warmest months of the year are July and August. The average monthly temperatures in January remained positive (although it was recorded as the coldest), which suggests protection of winter crops from frost (Table 3).

The number of days with average daily air temperatures above certain temperature (0, 5, 10, 15°) (Table 4) are the so-called „vegetation" temperatures determining the limits of the active vegetation of different agricultural cultures. Very often in agriculture, the limit of 10°C is important. This characteristic feature should be considered in parallel with the temperature sums for the periods with average daily air temperatures above 0, 5, 10 and 15° (Table 5). If the sum of the average daily air temperatures is less than 1900° for the periods with average daily air temperatures above 10°, the area is considered to be temperature unsecured.

In the studied area, the temperature sums of the average daily air temperatures above 10° are sufficient (3865°), which

Table 4. Number of days with average daily air temperatures above 0, 5, 10, 15° in the study area

Average daily air temperatures	> 0°	> 5°	>10°	>15°
Number of days	365	274	210	155

Table 5. Temperature sums (ΣT°) for the periods with average daily air temperatures above 0, 5, 10 and 15° in the study area

Average daily air temperatures	> 0°	> 5°	>10°	>15°
Σ T °	4560	4340	3865	3140

Table 1. Average monthly and average annual precipitation amounts (P, mm/m²) in the study area

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Σ_{I-XII}	Winter	Spring	Summer	Autumn
P, m/m²	46	41	31	50	67	66	54	37	32	43	61	59	587	145	148	157	136

Table 2. Average monthly and average annual relative air humidity (RH, %) in the study area

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average Year
RH (%)	77	73	68	64	62	60	56	55	59	68	76	78	66

Table 3. Average monthly and average annual air temperature (T°) in the study area

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average Year
T^0	1.2	2.8	5.9	11.6	16.6	20.6	23.2	22.9	18.8	13.4	8.2	3.5	12.4

Table 6. Average and final date of last spring and first autumn frost, frost-free days and monthly number of frost days in the study area

Last frost		First frost		Average duration of frost-free days	Number of frost days			
Average date	Latest date	Average date	Earliest data		IV	V	IX	X
26.III	8.V	12.XI	1.X	230	0.7	0.1	0.0	0.6

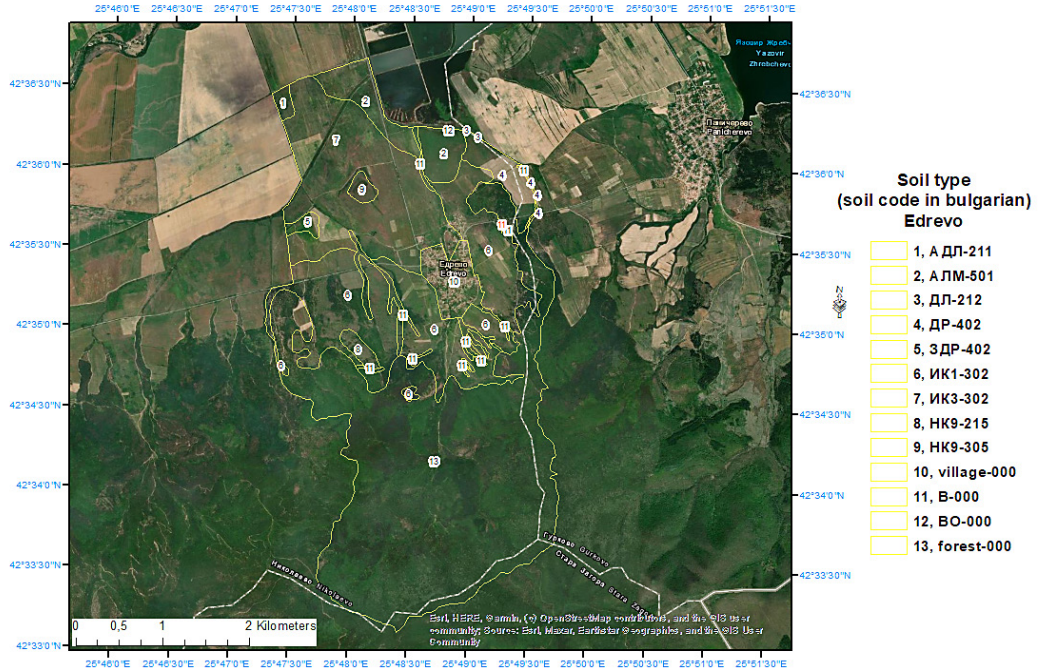

Fig. 2. Soil map of the land of the village of Edrevo, area. Nikolaevo, region Stara Zagora

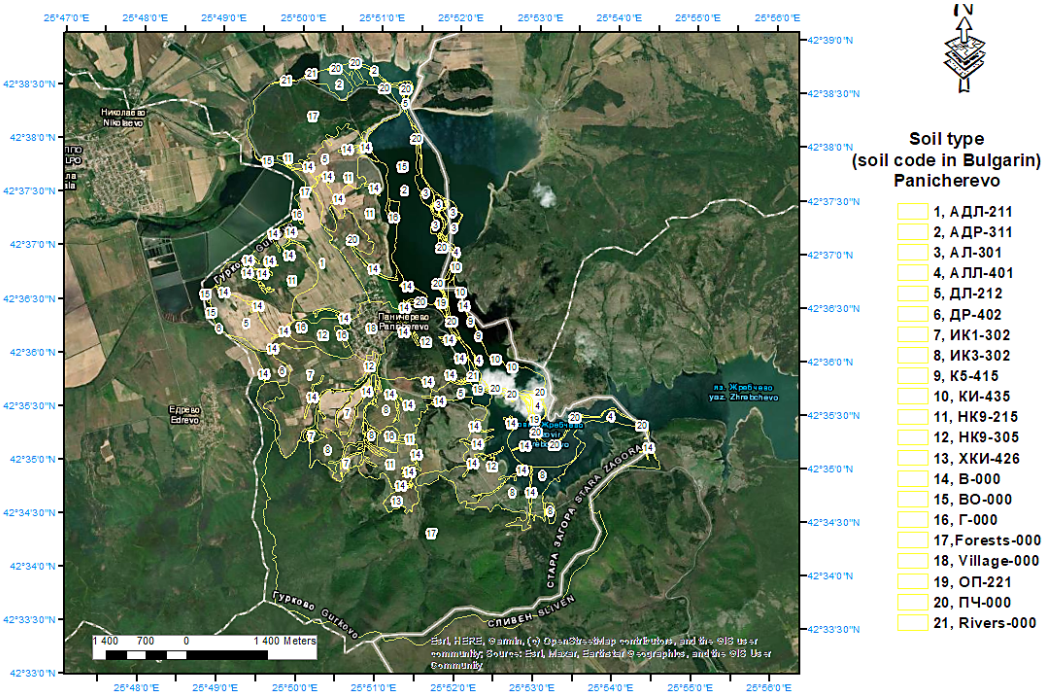

Fig. 3. Soil map of the land of the village of Panicherevo, municipality Gurkovo, region Stara Zagora

Table 7. Legend of the soil types in the village of Edrevo, municipality Nikolaevo, region Stara Zagora

№	Bulgarian soil code	Code soil texture	Code stony	Code soil forming rock	Soil	Soil texture	Stony	Soil forming rock
1	АДЛ-211	2	1	1	Alluvial – deluvial, weakly powerful	clay-sandy	slightly stony	alluvial deposits
2	АЛМ-501	5	0	1	Alluvial – meadow, powerful	heavy sandy-clay	missing	alluvial deposits
3	ДЛ-212	2	1	2	Deluvial, weakly powerful	clay-sandy	slightly stony	deluvial deposits
4	ДР-402	4	0	2	Deluvial, moderately powerful	medium sandy-clay	missing	deluvial deposits
5	ЗДР-402	4	0	2	Deluvial-meadow, moderately powerful, slightly swampy	medium sandy-clay	missing	deluvial deposits
6	ИК1-302	3	0	2	Strongly leached to weakly podzolized Cinnamonic forest soils, uneroded and slightly eroded	slightly sandy-clay	missing	deluvial deposits
7	ИК2-302	3	0	2	Strongly leached to weakly podzolized Cinnamonic forest soils, slightly and moderately eroded	slightly sandy-clay	missing	deluvial deposits
8	НК9-215	2	1	5	Undeveloped and shallow Cinnamonic forest soils, slightly and moderately eroded	clay-sandy	slightly stony	Non-carbonate sandy-clay and clay deposits
9	НК9-305	3	0	5	Undeveloped and shallow Cinnamonic forest soils, slightly and moderately eroded	slightly sandy-clay	missing	Non-carbonate sandy-clay and clay deposits
10	Village-000*	0	0	0	Village			
11	В-000*	0	0	0	Gully s			
12	ВО-000*	0	0	0	Water areas			
13	Forest*	0	0	0	Forest			

* not subject to the soil survey

suggests that the area meets the conditions, which makes it suitable for late and early crop varieties and hybrids.

Frost damage to crops causes huge losses to farmers. The average and final date of the last spring frost are 26 March and 8 of May, respectively. The first autumn frost occurs at the earliest on 1 October, and the average date is 12 of November (Table 6).

In the past, the natural vegetation of the flat part of the area was mainly meadow. Today it has been replaced by cultivated vegetation and only in some depressions, where cultivation is impossible, the meadow vegetation has been preserved. The forest vegetation on the slopes of the mountain Stara Planina and the mountain Sarnena Gora is mainly represented by oak and rarely by elm. Some of the deforested slopes are forested with coniferous forests. The southern slopes of the Stara Planina with an altitude of over 800 m are mostly under beech forests, and as an undergrowth there are hornbeam, hazel, rosehip, dogwood, etc.

During the large-scale soil surveys of the studied area („Soil characteristics of the lands of the APC, Gurkovo, Starozagorski district", 1987 – archive of ISSAPP „N. Pushkarov"), the following soil types were established in the lands of the villages of Edrevo and Panicherevo: Cinnamonic forest soils; Alluvial and Deluvial including Alluviall-meadow, Deluvial-meadow and Alluvial-deluvial meadow; Rendzinas (Humic-carbonate). The soil types are visualized in Figures 2 and 3, Tables 7 and 8.

In the village of Edrevo, the agricultural lands occupy 719.28 ha, and 822.76 ha are other territories (valleys, ravines, reservoirs, forests and a village). The predominant soil type is Cinnamonic forest soils (600.75 ha or 38.96% of the total land area), of which 583.19 ha are highly leached to slightly podzolized Cinnamonic forest soils with varying degrees of erosion and 17.55 ha are undeveloped and shallow Cinnamonic forest soils. Alluvial soils in the land occupy 70.48 ha or 4.57% of the total area, and Deluvial soils,41.55 ha. Alluvial-deluvial meadow soils have a small distribution, 6.43 ha.

In the village of Panicherevo, a total of 2049.09 ha are agricultural lands and 2087.05 ha are other territories (val-

Table 8. Legend of the soil types in the village of Panicherevo, municipality Gurkovo, region Stara Zagora

№	Bulgarin s oil code	Code soil texture	Code stony	Code soil forming rock	Soil	Soil texture	Stony	Soil forming rock
1	АДЛ-211	2	1	1	Alluvial – deluvial, weakly powerful	clay-sandy	slightly stony	alluvial deposits
2	АДР-311	3	1	1	Alluvial – deluvial, moderately powerful	slightly sandy-clay	slightly stony	alluvial deposits
3	АЛ-301	3	0	1	Alluvial, weakly powerful	slightly sandy-clay	missing	alluvial deposits
4	АЛЛ-401	4	0	1	Alluvial – meadow, weakly powerful	medium sandy-clay	missing	alluvial deposits
5	ДЛ-212	2	1	2	Deluvial, weakly powerful	clay-sandy	slightly stony	deluvial deposits
6	ДР-402	4	0	2	Deluvial, moderately powerful	medium sandy-clay	missing	deluvial deposits
7	НК1-302	3	0	2	Strongly leached to weakly podzolized Cinnamonic forest soils, uneroded and slightly eroded	slightly sandy-clay	missing	deluvial deposits
8	НК3-302	3	0	2	Strongly leached to weakly podzolized Cinnamonic forest soils, slightly and moderately eroded	slightly sandy-clay	missing	deluvial deposits
9	К5-415	4	1	5	Cinnamonic forest soils, moderately and heavily eroded	medium sandy-clay	slightly stony	Non-carbonate sandy-clay and clay deposits
10	КИ-435	4	3	5	Undeveloped and shallow Cinnamonic forest soils, moderately and heavily eroded	medium sandy-clay	highly stony	Non-carbonate sandy-clay and clay deposits
11	НК9-215	2	1	5	Undeveloped and shallow Cinnamonic forest soils, slightly and moderately eroded	clay-sandy	slightly stony	Non-carbonate sandy-clay and clay deposits
12	НК9-305	3	0	5	Undeveloped and shallow Cinnamonic forest soils, slightly and moderately eroded	slightly sandy-clay	missing	Non-carbonate sandy-clay and clay deposits
13	ХКИ-426	4	2	6	Humus -carbonate soils (Rendzini), shallow, moderately and heavily eroded	medium sandy-clay	medium stony	carbonate rocks
14	В-000*	0	0	0	Gullys			
15	ВО-000*	0	0	0	Water areas			
16	Rocks -000*	0	0	0	Rocks			
17	Forests-000*	0	0	0	Forests			
18	Village-000*	0	0	0	Village			
19	ОП-221	2	2	1	Cultured sands	clay-sandy	medium stony	alluvial deposits
20	ПЧ-000*	0	0	0	Sand and gravel			
21	Rivers-000*	0	0	0	Rivers			

* not subject to the soil survey

leys and ravines, water areas, rivers, rocks, forests, sand and gravel and a village). The predominant soil type is also Cinnamonic forest soils – 1119.81 ha or 72.62% of the total area. The majority of Cinnamonic forest soils are undeveloped and shallow – 690.57 ha and 429.24 ha are highly leached to slightly podzolic Cinnamonic forest soils with varying degrees of erosion. The Alluvial and Deluvial soils have a total area of 811.78 ha.

The Cinnamonic forest soils are more or less clayey, red-brown colored forest soils with well-defined textural differentiation. Strongly leached to weakly podzolized Cinnamonic forest soils, uneroded and slightly eroded, occupy lower slopes, and slightly and moderately eroded higher slopes and were formed on deluvial materials. They are distinguished by a humus-eluvial horizon of varying thickness (about 25–28 cm) with slightly sandy-clay soil texture. The average values for the content of particles < 0.01mm vary from 23.0 to 28.2% in the two studied regions. The undeveloped, shallow Cinnamonic forest soils have a clay-sand and slightly sandy-clay soil texture (16.0–23.2%). Only a very small part (1.41 ha) in Panicherevo region has a moderately sandy-clay soil texture – 35.8% (Figures 4 and 7).

The content of humus in the Cinnamonic forest soils is from very low (0.59–0.82%) to low (1.2%) in the two studied regions. In the Panicherevo region, a very small part of the shallow Cinnamonic forest soils have a high humus content – 3.4%, but this is due to the presence of a humus horizon (development of meadow vegetation) (Figures 5 and 8). The soil reaction ($pH_{/KCl/}$) of these soils is acidic. In the land of the village of Edrevo from highly to moderately acidic – $pH_{/KCl/}$ 4.02–4.55, and in Panicherevo region from highly to slightly acidic ($pH_{/KCl/}$ 4.02–5.33) (Figures 6 and 9).

The diversity of soil-forming conditions and mainly of the parent rocks determine a number of differences in the texture, properties and fertility of the Cinnamonic forest soils. Highly leached to slightly podzolic Cinnamonic forest soils are characterized by lower fertility. The acidified reaction, the deteriorated texture, the unfavorable nutritional regime, and the problematic physical and mechanical characteristics worsen the fertility of these soils. In the case of undeveloped and shallow varieties, a limiting factor is the small thickness of both the humus horizon and the profile, as a whole. Cinnamonic forest soils occupy more or less sloping terrain and are subject to varying degrees of erosion. That is why all activities for the selection of these soils should be primarily related to combat erosion and increase the depth active root development layer, improve the structural condition, nutritional and water-air regime

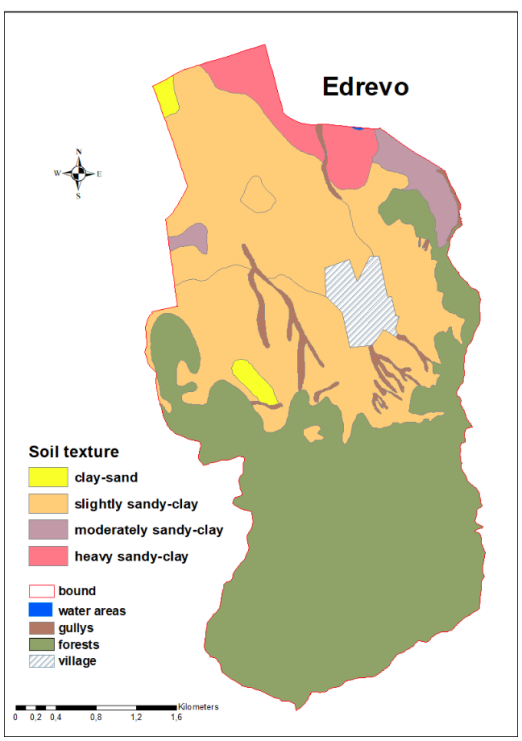

Fig. 4. Soil texture in the land of the village of Edrevo, region Stara Zagora

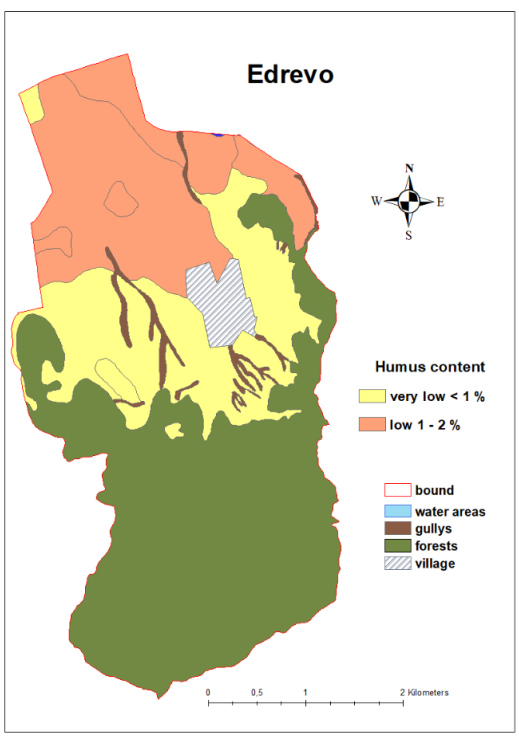

Fig. 5. Humus content of the soils in the land of the village of Edrevo, region Stara Zagora

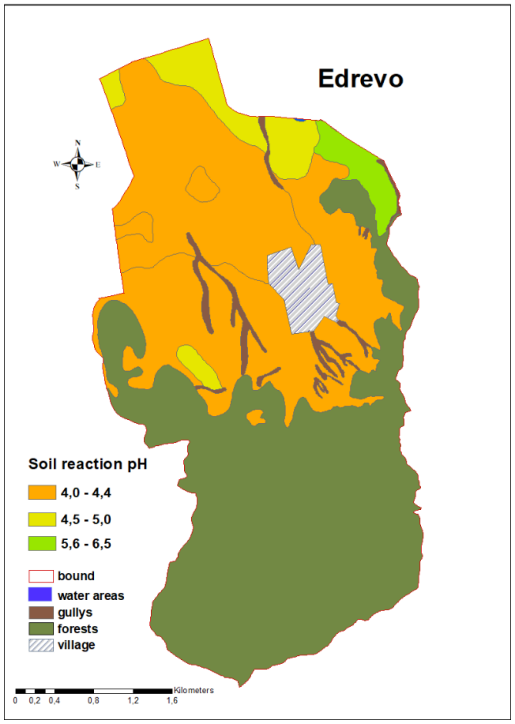

Fig. 6. Soil reaction ($pH_{/KCl/}$) of the soils in the land Edrevo village, region Stara Zagora

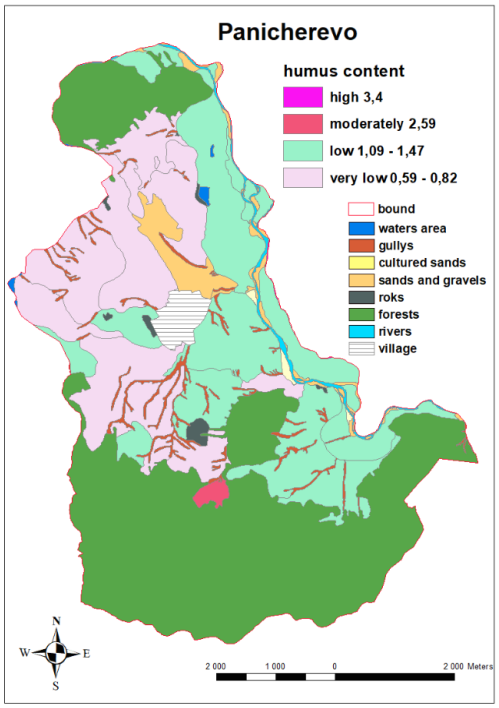

Fig. 8. Humus content of the soils in the land of Panicherevo village, region Stara Zagora

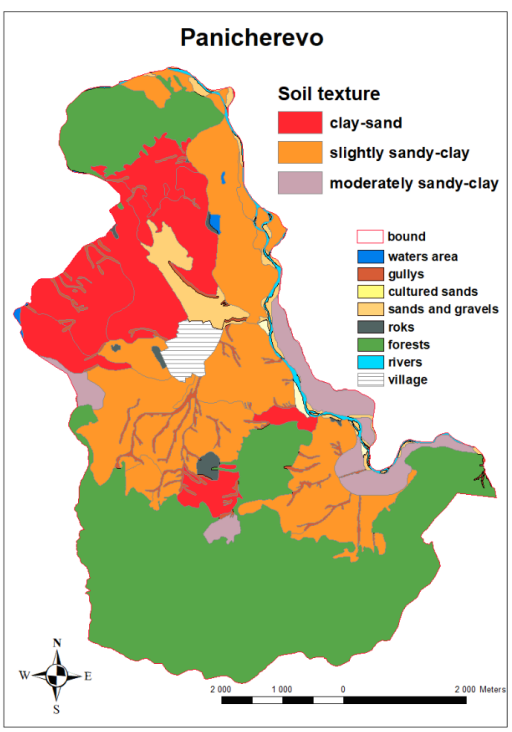

Fig. 7. Soil texture in the land of Panicherevo village, region Stara Zagora

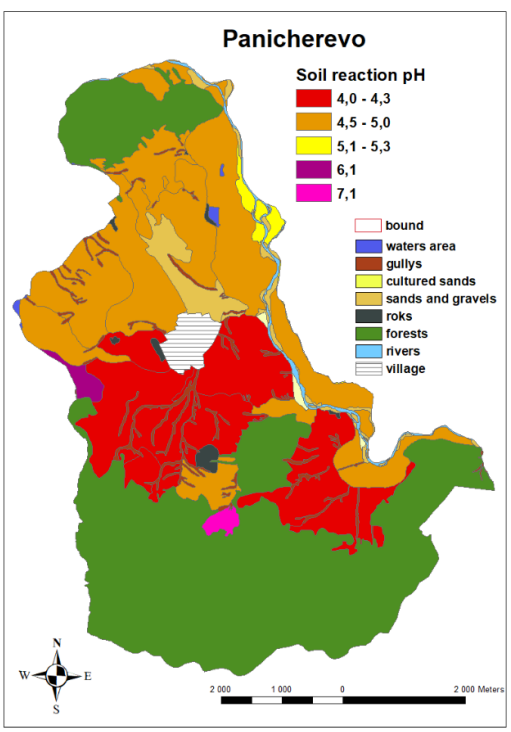

Fig. 9. Soil reaction ($pH_{/KCl/}$) of the soils in the land of Panicherevo village, region Stara Zagora

and enrich the soil with more organic substances. One of the most important tasks is the proper organization of land use territory and the selection of suitable crop rotations, in order to preserve these soils from erosion. Special anti-erosion crop rotations should be used in hilly and mountaineous areas that are more at risk of erosion.

In connection with the unfavorable physical and physicochemical properties, a particularly important aspect of management of these soils should be the selection of the most appropriate optimal humidity, at which the manifestation of the negative properties will be minimized. Due to the small reserves of organic matter and nutrients, fertilization is very important for improving the fertility of these soils. In general, the regime of nitrogen fertilization can be evaluated as unfavorable and scarce, due to the small reserves of organic nitrogentherefore the need for nitrogen fertilization, especially in the highly leached to slightly podzolized Cinnamonic forest soils. The phosphorus regime is also unsatisfactory,because a large part of the available phosphorus is found in the form of iron and aluminum phosphates, which are difficult to dissolve and provide available phosphorous for plants, especially in the highly leached to slightly podzolic soils, where the reaction is very acidic. In order to enhance the microbiological activity and improve the chemical conditions for plant nutrition, it is necessary to ameliorate soil acidity by liming, especially in the heavily leached to slightly podzolic soils.

An important measure for improving the water regime and increasing the fertility of Cinnamonic forest soils is irrigation. However, their specific hydrological properties and especially the small water permeability and relatively high moisture capacity of the deeper compacted illuvial horizons must be taken into account. Especially, in the clay varieties of the highly leached to slightly podzolic Cinnamonic forest soils, these properties create conditions for subsoil and surface waterlogging at higher irrigation rates.

Alluvial (Deluvial) – meadow soils are actually alluvial and deluvial sediments, on which a meadow process of varying duration and intensity has developed. The formation of the profile of these soils, as well as the soil texture, depend on the nature of the sediments deposited to a great extent. The profile of the Alluvial (Deluvial)-meadow soils has a layered character. The thickness of the humic horizon varies from 21 to 48 cm, with an average of about 28 cm. In terms of soil texture, these soils are clay-sandy (14.98 – 16.39% particles < 0.01mm), moderately sandy-clay (30.85 – 36.75%) and heavy sandy-clay (48.9%) in Edrevo region. In the land of the village of Panicherevo – of clay-sandy to moderately sandy-clay (14.98 – 32.75%) (Figures 4 and 7).

The humus content of these soils is very low and low. In the Edrevo region 0.75 – 1.64% humus, and in the land of Panicherevo 0.75 – 1.47% (Figures 5 and 8). The soil reaction of Alluvial (Deluvial) – meadow soils from the studied areas is from acidic to neutral (Figures 6 and 9) – slightly acidic to neutral ($pH_{/KCl/}$ 6.05), moderately acidic (pH_{KCl} 4.55 – 4.99) in both regions, and highly acidic ($pH_{/KCl/}$ 4.22) in the land of Edrevo.

Alluvial (Deluvial)-meadow soils have relatively high effective fertility, related to the light soil texture and favorable water, air and thermal properties. They are loose, airy, do not form a crust. They are suitable for almost all agricultural crops and especially for vegetable production, fruit growing, viticulture and for a number of technical and fodder crops. In the Kazanlak field, they are suitable for rose oil and some essential-oil crops. The low humus content, the low supply of nutrients and the intensive use of these soils, which is associated with the rapid deterioration of the nutritional regime, necessitate to take measures to increase the organic matter and improve the nitrogen and phosphorus regime. Due to the light soil texture and low moisture capacity, these soils often suffer from drought and irrigation is essential to increase their fertility.

The humus-carbonate soils (Rendzina) from the Panicherevo region occupy a small area of 18.46 ha. They were formed on carbonate materials and occupy highly pronounced slopes and narrow ridges (Figure 3). The thickness of the humus horizon is about 20 cm. The total power of the profile matches the power of the humic horizon because below there is a Cd horizon. The soil texture is moderately sandy-clay – the amount of particles < 0.01mm is 40.6% (Figure 7). The average humus content is 2.59% (Figure 8), and the soil reaction is alkaline ($pH_{(KCl)}$ 7.10) (Figure 9). These soils have extremely low fertility and are used as pastures.

Conclusion

A characterization of the main agro-ecological factors (relief, climate and soils) in the area of the lands of Edrevo and Panicherevo villages was performed.

The predominant soil type in both investigated lands is Cinnamonic forest soils – a total of 1720.56 ha, of which 1012.43 ha are strongly leached to slightly podzolized Cinnamonic forest soils with varying degrees of erosion and 708.12 ha are undeveloped and shallow Cinnamonic forest soils.

The rest of the agricultural lands are occupied by Alluvial (Deluvial) meadow soils – 930.29 ha, represented by Alluvial and Alluvial – meadow, Deluvial and Deluvial – meadow, Alluvial – Deluvial soils.

The humus-carbonate soils (Rendzini) have a minimal spread, 18.46 ha or 0.4% of the total area.

A geographic information system (GIS) was developed, including the data on agro-ecological resources in the studied area. Visual interpretations were made with a map generated for the geographical location of the studied land, a soil map, as well as thematic maps for the soils texture (physical clay content in %), humus distribution (%) and soil acidity (pH).

The approach used to manage and process the collected data, namely geographic information systems (GIS), makes it possible to add new information from various sources (paper maps, statistics, field surveys, satellite images, aerial photographs, etc.) in the future, as well as for different visual interpretations.

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References

Altieri, M. A. (1992). Agroecological foundations of alternative agriculture in California. *Agriculture, Ecosystems and Environment, 39*(1-2), 23-53.

Hershkovich, E. (1984). Agro-climatic Resources in Bulgaria. *BAN,* Sofia, 115 (Bg).

Koleva, E. & Peneva, R. (1990). Climate Guide. Rainfall in Bulgaria. *IMH, BAN*, Sofia, 169 (Bg).

Kyuchukova, M. (1979). Climate Guide for NR Bulgaria. Air humidity, fog, horizontal visibility, cloud covor and snow cover. *Sciense and Art,* Sofia, *2,* 811 (Bg).

Kyuchukova, M. (1983). Climate Guide for NR Bulgaria. Air temperature, soil temperature, frost. GUMH, IMH. *Sciense and Art*, Sofia, *3,* 440 (Bg).

Spirov, B. (1987). Soil characteristics of the lands of “Agricultural and industrial complex” Gurkovo. Archive of ISSAPPNP “Nikola Poushkarov” (Bg).

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