THE ANALYSIS OF SOIL PROPERTIES AND QUALITY IN JIJIA'S UPPER BASIN

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Abstract

The study of soil properties, according to the distribution of soilscapes and of soil forming factors and processes, is essential for the modern spatial analysis of the soil cover and for its integration in the soil mapping process. Thus, soil forming and soil evolution processes, determined by the complex of factors and by the physical and chemical characteristics of soils (expressed by soil reaction, organic matter, contents of carbonates, nitrogen, phosphorous, potassium), represent the criteria in establishing diagnoses and classifying soils from the Jijia upper basin. On the territory of Hilişeu township have been identified 49 soil units, belonging to Protisols, Chernisols, Luvisols, Hidrisols and Anthrisols. Chernisols dominate this repartition, with over 40%, being followed by Luvisols. Gleysols are also well represented, being developed in the floodplains of Jijia and its tributaries. A general characteristic of soils from the studied territory is the high clay content, even from the soil surface, as well as the low humus reserve in the upper horizons. The present paper approached the identification of soils' qualitative aspects in the area, as well as the correlation with the morphometric or land use parameters, having in view the strong conditioning of the soil properties by the landscape of the region. In what regards soil quality, the area is dominated by the 2nd and 3rd quality classes, each with about 40% and 37%, being followed by the 4th (19%) and 5th (4%) classes. The lower quality of these soils is given mainly by erosion and by the gleyzation-stagnogleyzation processes.

Key words: soil quality, physical and chemical indicators, Hilişeu

The dynamic of morphometric and land use aspects from the Hilişeu-Horia township, which is referred in this paper, situated in Jijia's upper basin, involves correlation with the qualitative elements of the soil cover, presenting also the developed interference between soil features and local relief. In the ecosystem, the soil works at the highest parameters as long as its physical, chemical and biological properties evolve in an ambient that allows preserving its natural functions for long term. In this way, the quality analysis of soil cover was first based on the characterization of the physical and chemical features, without implying the biological parameters, which imply relatively difficult analytical methods (Cârstea S., 2001). Hereby, the indicators that correspond to soil quality evaluation should present not only variable features to the system, but also sustainable actions in relation to certain factors that are not included in the decision framework (Vasiliniuc I., 2009). Establishing quality classes and classifying soils according to these clearly indicates the favorability for a certain type of land use, and also the intensity of the essential properties displayed, that makes soil a different layer, apart from parent material and underlying rocks, respectively fertility. Since nutrients are assured and redistributed only by the soil cover, the ability of the soil to accumulate, store and supply water and nutrients for the topsoil, represents the resultant of all physical, chemical and biological features (Rusu C., 1998).

The correlation of soil characteristics with current geomorphologic processes justifies for a lesser extent, the lower quality for few sections of the soil units, due to erosion or gleyzation and stagnogleyzation processes.

MATERIAL AND METHOD

The data used in the soil quality evaluation are made up of the soil map (1:10000) realized according to the studies conducted by O.S.P.A. Botoşani for the Hilişeu township. On the process of database validation was introduced, beside the use of thematic literature, also the field study.

The research method involved, after the digitization of the topographic maps at scale 1:25.000 in Stereo 70 projection and creating the digital elevation model, the spatial morphometric analysis and the computation of other geomorphometric parameters. The knowing of the character of these indicators (especially altitude and slope) is necessary in increasing the specificity

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of the geomorphological processes in the field area. The relief's aspect is generated by the rocks, which represent for the soil the material from which results the mineral section. The chemical and structural composition of the rocks influences the evolution process and also the characters of the soils.

In order to determine the qualitative features of the soil cover we used different physical parameters, the most important of all being the texture, bulk density, porosity, and the degree of compaction. Among the chemical features we introduced in the analytical process the soil reaction, humus content, the presence of N, P, K elements and their quantity.

RESULTS AND DISCUSSIONS

The study area is situated at the transition of three geographical subunits, Bour - Mare-Hârlău Hill, Ibăneşti Hill and Jijia - Başeu Plain, position that influences the character of the soil and geomorphological conditions (Băcăuanu V., 1980). Based on the soil diagnosis and taxonomy, were identified 49 soil units on a total agricultural surface of 3257.53 ha, that belong to: Protisols - 819.06 ha (25.14%); Chernisols - 1450.61 ha (4.53%); Luvisols - 565.57 ha (17.36%); Vertisols - 60.81 ha (1.87%); Hydrisols - 130.44 ha (4%); Anthrisols - 230.86 ha (7.09%) (fig. 2).

The distribution of the soil units is correlated with the morphometric variable. The Chernisols are representative for the soilscape in the central-eastern part, more exactly displayed on the reverse slopes of ~250 m altitude, area dominated by Haplic Chernozems (*fig. 1*).

The soil cover developed at the highest altitude values of the region is represented by the Luvisols, type Haplic Luvisols.

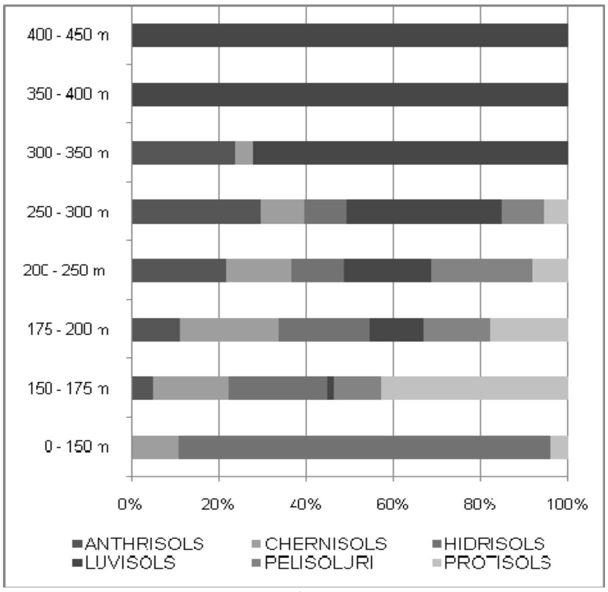
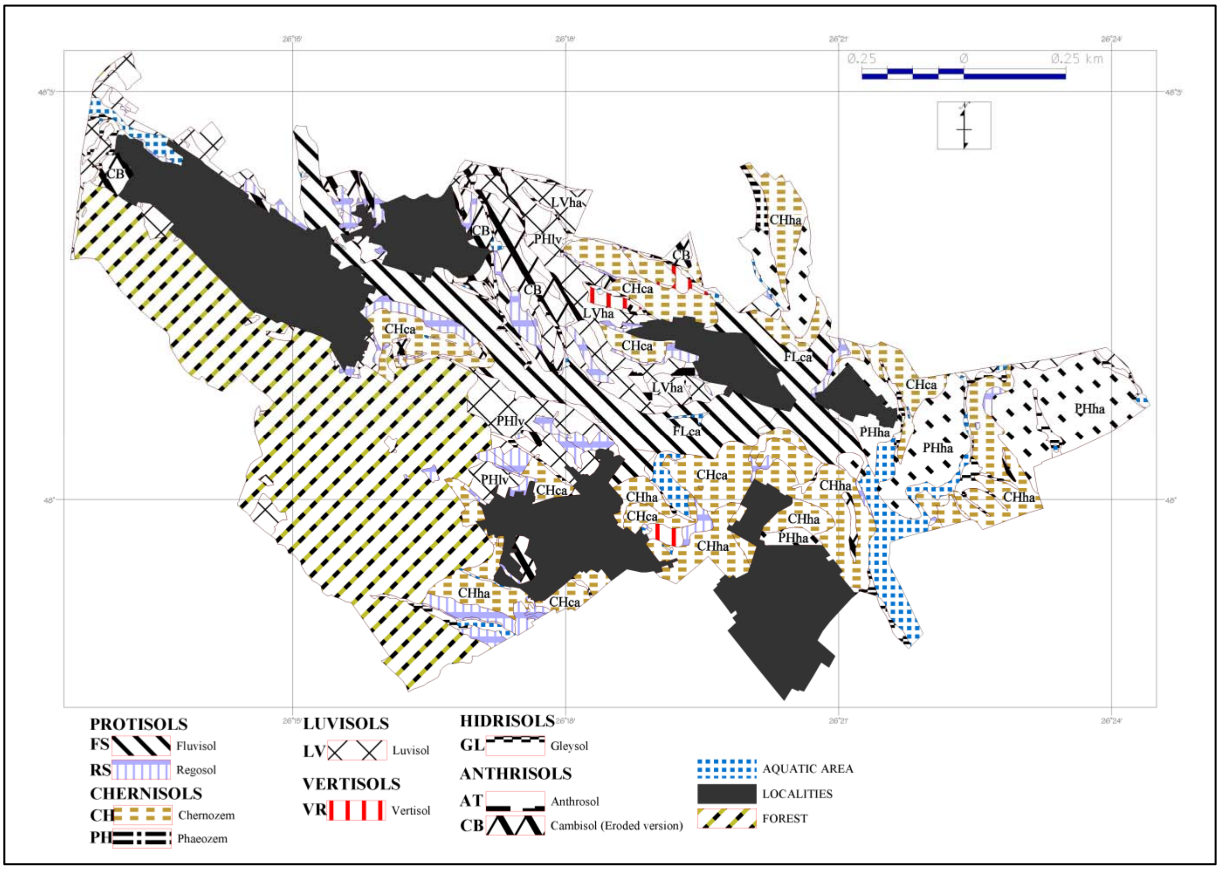


Figure 1 **The percent of soil classes on altitude classes**

Figure 2 **Soil types in the area of Hilişeu (after O.S.P.A. Botoşani)**



In the elevation span between 0-175 m, the highest percents are assigned to Protisols, respectively Calcaric Fluvisols from Jijia valley and its tributaries. For the interval 200-250 m, each soil class presents values over 20%, the highest being set for Anthrisols (53.12%) and Vertisols (56.75%).

With respect to slope distribution, the highest values are found for 15-25° interval. In this case, the hillsides soil cover is affected by erosion processes and landslides, and the soils dominant on this interval are the Cambisols (49.67%).

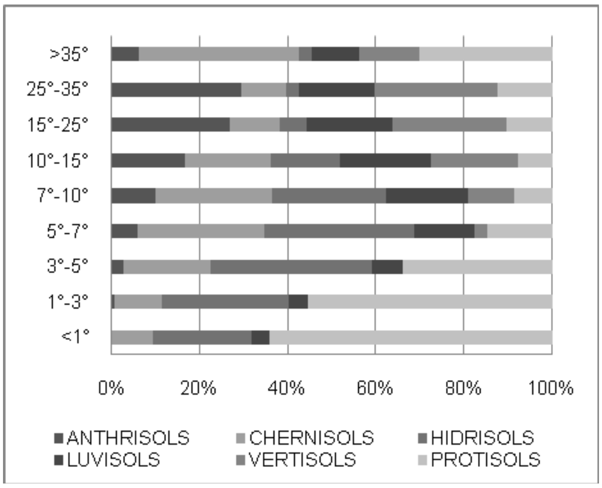


Figure 3 **The percent of soil classes on the slope intervals**

Considering the extreme values for the hillsides slopes displayed in the chart above (*fig.3*), while the Fluvisols are found on lower slopes up to 7°, the Chernozems and Calcaric Regosols are identified on hillsides with slopes higher than 35°.

Regarding the physical and mechanical parameters of soil quality, it can be stated that soil properties involve differentiated actions, depending on the soil texture and aggregation phase (Canarache A., 1990).

Thus the first physical indicator included in the present study is texture, represented by two main categories of medium and fine textured classes. In terms of surface distribution, the highest values are typical for the fine textured class, subclass of clayey loam (47.6%).

The dominance of medium-fine textured subclasses is determined by the lithologic layer, which is represented by loess-like deposits and deposits derived from marls and clays. After the clayey loam subclass (47.6%), follows at a considerable distance the loam subclass (18.6%) and clayey-silty loam (16.9%) (fig. 4). Lower percents can be found for fine textures (silty clay - 0.26%; clay - 1%) that correspond to Cambisols and Calcaric Regosols.

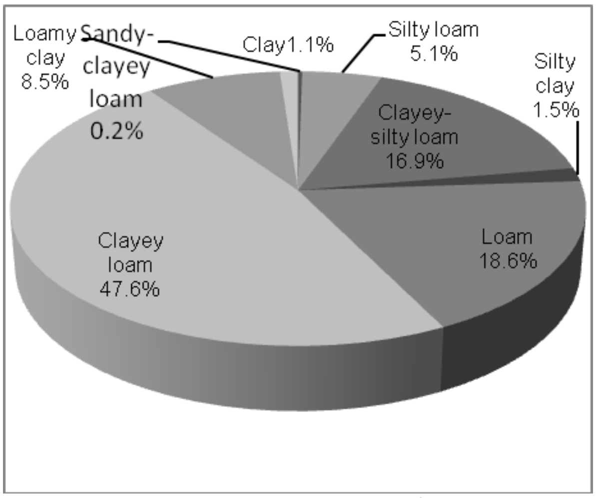


Figure 4 **Textural classes percents for the upper horizons**

The presence of fine textured classes in this area is justified by the clays and marls from the surface deposits. The fine textured classes assures a constant fertility, due to high capacity of water retain and high content of colloids (Rusu C., 1998). In geomorphological terms, the clay textured soils involve initiation of certain processes, such as landslides.

Another physical parameter is represented by the textural differentiation index (Tdi), determined by the clay content ratio of B and A horizons.

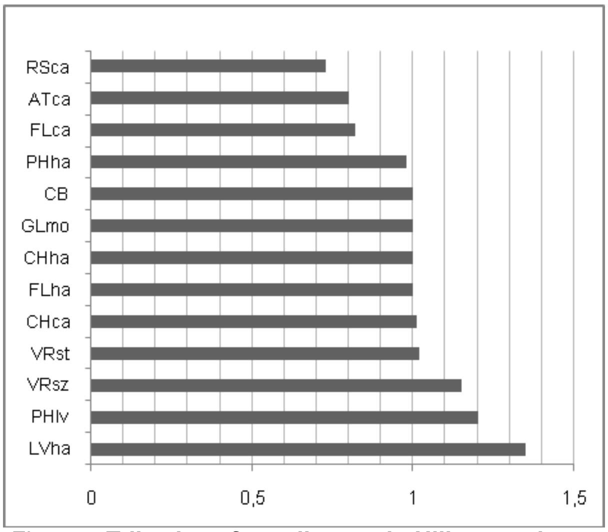


Figure 5 **Tdi values for soils type in Hilişeu region**

According to *fig. 5*, high values for textural differentiation index are recorded for salic Vertisols, but mostly for soils characterized by intensive development of eluviation processes, respectively haplic Luvisols and luvic Phaeozems.

Lower values of this indicator can be found for Calcaric Anthrisols (0.8) which are affected by mixing processes of the materials in the horizons, Calcaric Fluvisols (0.82) with a relative uniform sedimentation and Calcaric Regosols (0.73) characterized by a low content of clay and by the erosion process on surface, that contributes to the homogenization of the upper section of the profile.

In association with textural level specific to the region's soils, it rises the interest for the physical indicators that assure high qualitative properties for medium and fine textured soils, like bulk density, total porosity and degree of compaction.

Bulk density values are influenced by the particle size composition and organic matter content of the soil, ranging in the interval 1-1.6 g/m^3. It is accepted the connection between the optimal values of density and grain size distribution, indicating a range between 1 to 1.3 g/m^3 (Lupaşcu G. şi colab., 1998). This interval is representative for Haplic Chernozems, Luvic Phaeozems and Calcaric Regosols. The high values of the bulk density are found for Vertisols (1.45 g/m^3), due to the high content of clay; also for Mollic Gleysols (1.49 g/m^3) whose high values are determined by the clay destruction and their natural compaction, but also in the case of Cambisols (1.54 g/m^3) for which are identified higher values caused by bringing to surface from B horizon the clayey materials. The occurrence of compaction processes, that threaten the qualitative level of soils, may be observed for fine textured soil units, such as Calcaric Chernozems, Cambisols and Haplic Phaeozems, for which were revealed values ranging from 1.44 to 1.50 g/m^3.

Regarding the total porosity (PT), it is influenced by the grain size distribution that causes a smaller pore volume for fine textured soils, respectively Gleysols, Luvic Phaeozems, Chernozems, Fluvisols. Also, total porosity values depend on those of density and bulk density, being pointed out this way the differences between the main textural classes.

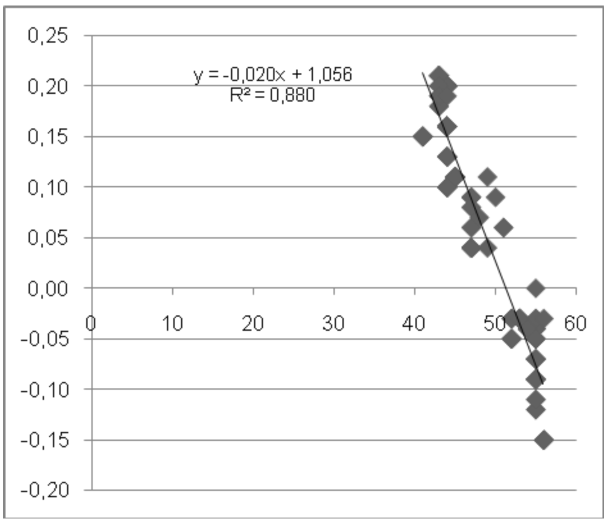


Figure 6 **Correlation between PT (%) and GT (%)**

The qualitative aspect of the total porosity is diminished for clay textured soils, with values lower than 45%, these being correlated directly to the degree of compaction and soil permeability, respectively to hydrophysical coefficient values (fig. 6).

Moreover, the Anthrisols, Hidrisols, Luvisols and Vertisols present percentage values of total porosity between 41-44%.

The degree of compaction characteristic for soils from the study area varies from -1 to +1%, causing the weak compacted character for the majority of the soils with positive values, respectively lack of compaction for Chernisols (Calcaric Chernozems) and Protisols (Calcaric Fluvisols).

The analysis of chemical parameters for soil quality confirms the structural and functional sustainability of the soil cover (Vasiliniuc I., 2009). The variables included in the present research are: soil reaction, humus content, total nitrogen, mobile potassium and phosphorus content.

With respect to soil reaction, in the region become differentiated the following features: soil reaction in the upper horizon of Protisols varies from neutral (pH=7.12) to moderately alkaline; for Chernisols the values are included in the interval 6.55-8.55, causing the changing from a weak acid reaction to a moderately alkaline one; for Luvisols were registered values of pH included between 5.95-6.71, showing a weak acid reaction; the Vertisols present a weak alkaline reaction, having values between 7.75-8.09; for Hidrisols, the soil reaction in the upper horizon is moderately alkaline, with a pH of 8.85; the soil reaction for the Anthrisols level in the upper horizon is low alkaline, with a pH of 7.58. Thereby, the weak acid character characteristic for some of the soils in the region is caused by the higher quantities of precipitations, factor which determines an emphasized eluviation, so the loss of bases by the soil profiles.

The soil reaction conditions the nutrients' regime, taking part in their solubilization and accessibility. In this case, it can be mentioned that soil with improper reaction (6.6%) involves a diminished production, therefore an unsatisfactory qualitative level.

The humus content that corresponds to the soils from this region varies from extremely low values (0.96% for Haplic Luvisols) up to values of 5.99% in the upper horizon of Vertisols, causing a range of 2.35% that shows a good qualitative state of the soils for this parameter.

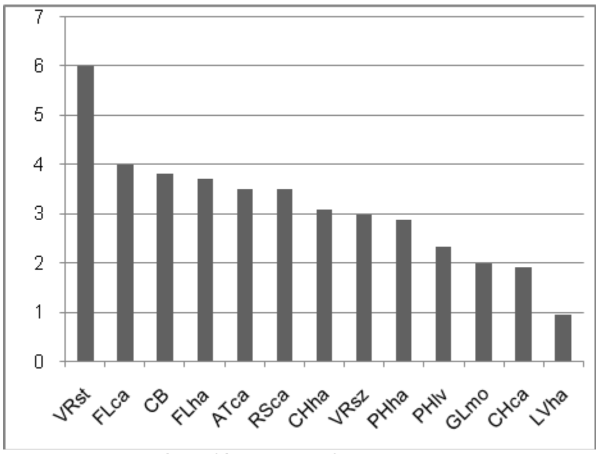


Figure7 **The OM (%) values for the most important types of the region**

The medium values are registered for Fluvisols, Cambisols, Anthrosols, Regosols, Chernozems, placed in the interval 3.08-3.99% (fig. 7).

In what regards the elements content, the limits of total nitrogen for the territory are integrated into a large interval, between 0.1-0.7%, the higher values being assigned for Haplic Chernozems, followed by Salic and Stagnic Vertisols with its total nitrogen ratio between 0.33-0.22% (tab. 1).

The mobile phosphorus content represents another parameter for soil quality evaluation, and in this field area, the content varies in a very large spectrum, from 8 up to 180 ppm. Thus the soils from the Hilişeu township are from very poor to very well provided with mobile phosphorus.

Table 1

N tot, K, P values for the soil types - Hilişeu township (O.S.P.A. Botoşani)

	N (%)	K(ppm)	P(ppm)
RSca	0.13	248	27
FLca	0.2	285	48
FLha	0.2	320	34
CHca	0.16	236	26
CHha	0.76	296	40
PHha	0.15	198	82
LVha	0.12	169	8.5
PHlv	0.14	175	12
VRst	0.33	12	180
VRsz	0.22	18	500
GLmo	0.1	195	10
CB	0.15	188	9.5
ATca	0.2	320	8

This diversity can also be noticed for the soil classes. While the values for Phaeozems are expressed by a very high degree of assurance, the Chernozems subclass presents medium values. In general, the insufficient provision of soils in phosphorus is one of the causes that lead to poor and fluctuating harvests every year. Also, the insufficient assurance in mobile phosphorus widely limits the effect of nitrogen fertilizers (Florea N. şi colab, 1987).

The content analysis of mobile potassium reveals values ranged from 18 to 320 ppm, showing that the region's soils may have a state of assurance ranging from very low to very high, fact that indicates the best qualitative parameters for Fluvisols. The role of potassium fertilizers in realizing planned agricultural production at a certain quantity and quality level becomes more important in periods with adverse weather variations, when plants are subjected to soil and climatic stress, especially with poor chemical features (Canarache A., 1990).

According to physical and chemical parameters the analyzed soils had been integrated in quality classes, ranging from II up to V.

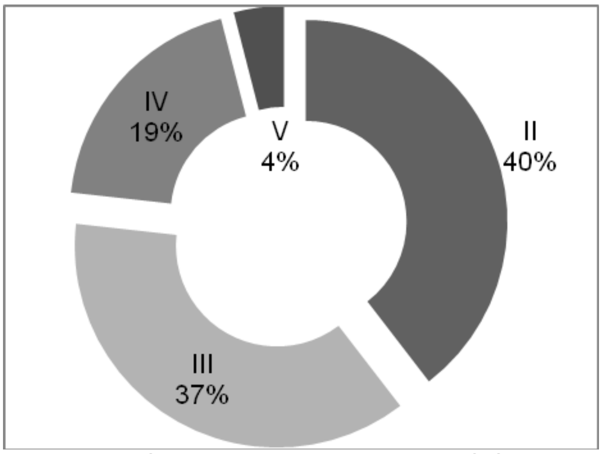


Figure 8 **Quality classes percentage (O.S.P.A. Botoşani)**

The synthesis of grouping the agricultural terrains in quality classes includes in the 2nd class the highest value related to surface, characterized by land use in arable, pasture and orchards, but a value close to the 2nd class it is shown for the 3rd quality class, which also includes vineyards (*fig. 8*). Regarding the types of soils that belong to the 5th quality class (Mollic Gleysols) and those from the 4th class (Salic and Stagnic Vertisols), these are appreciated with a lower level of quality due to gleyzation and stagnogleyzation processes that influence soil characteristics.

The hydromorfism processes that are activated not only in depth, but also at surface due to moisture excess coming from precipitations, affect mineral and organic complex, inhibit the nitrification process by amonium formation and cause the increasing of clay formation process.

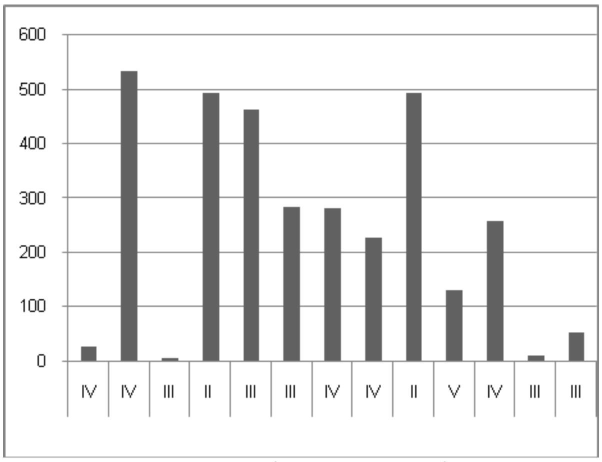


Figure 8 **Distribution of soil types surfaces (ha) on quality classes**

While the 2nd class presents the highest value (40%), including soils that have a stable quality level, respectively Haplic Chernozems and Haplic Phaeozems, in the 3rd quality class, which displays also a high percentage (37%), are integrated Calcaric Anthrisols, Salic Vertisols, Calcaric Chernozems and Luvic Phaeozems.

CONCLUSIONS

The parameters used with the aim of identifying the soil quality level have been separated according to their type: physical and chemical.

The most relevant physical indicator is the soil texture, and on its basis it was identified that Chernisols are the ones with a high quality level above other soil units. Subsequently, on the basis of bulk density and minimum required porosity, was computed the total porosity and the degree of compaction, whose values confirm the inverse ratio to the clayey texture of the soil. Regarding the chemical indicators, soil reaction varies between low acid and low alkaline, while the humus, that represents the soil element with role in storing the nutrients, decreases the high cohesion of clayey soils.

All in all, the evaluated soils have been included in different evaluation classes. The dominant quality class is the second one, that corresponds to 40% of the area (1288.36 ha). Close to the Haplic Chernozems and Haplic Phaeozems, high quality values of the 3rd class show the Vertisols, but also Calcaric Chernozems and Haplic Luvisols (37%).

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