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PEDO-GENETICAL FACTORS IMPLICATED IN SOIL DEGRADATION (LOWER TIMIS RIVER BASIN AREA)

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Abstract

This paper is an overview of pedo-genetical factors implicated in soil degradation from lower Timiş River basin area. The microrelief forms, the groundwater depth in soil profile and the nature of parental rocks is some of the principals factors who dictate the process of soil formation and their direction of development. The analysis of the limiting factors refers to their enumeration by synthesizing the ones the land plots for arable, the study and then the analysis of each one in relation to the manifestation at different points of the studied area, respectively. The purpose of this analysis is to provide the beneficiary with a global picture of the phenomena within the elemental unity of the pedological landscape that would result in the overall strategy on a set of sustainable ameliorative or cultural measures. Among the fundamental features of soil that have a relatively more determinant function are: salinisation, sodisation, acidity, humus reserve, $CaCO_3$ content, properties who influenced the growth and birth of plants in direct relation to the mode of manifestation and the intensity of the phenomena.

Key words*: fine texture, compactness, excess moisture.*

INTRODUCTION

As part of the vast Tisza Plain, the low plain of the commune's area has a relatively low lithological evolution over the pleistocene sand and pebble formations pushed by Mureş, Timiş and Bega; in the lacustrum phase there are deposited clay and clay, Strong, occur in various situations, generating a variety of soil types.

To make a characterization of the current envelope, it is absolutely necessary to overcome the natural factors that have contributed to the actual materialization of the soil cover. The area studied as a component of the Pannonian depression was constituted by repeated sediments that occurred over the crystalline foundation.

Based on the field study and the study in the office, 7 types of soils were identified as follows: fluvisols on 18.37% of the surface, entiantrosols on 0.14% of the surface, chernozems on 6.13% of the surface, phaeozems on 11.41% of the area, eutric cambisols on 55.15% of the area, pelosols on 2% of the area, solonetz on 0.08% of the surface and associations of soils on 6.72% of the area.

MATERIALS AND METHODS

For achieve our objectives we were used pedological mapping, morphological descriptiton, expedited determination in the field, laboratory information processing soil like research pedological methods. (Buta, 2009, Mihalache et al., 2013; Radulov et al., 2011; Rusu et al., 2007)

The soil profiles were located in representative areas of the researched area so that we can be describe the most representative soil types and subtypes of soils. Soil samples was collected from pedogenetical horizons of the soils profile in natural settlement (unchanged) and in amended settlement.

Soil samples in natural settlement (unchanged) it was taken in hydro-cylinder from metal of known volume to characterize certain physical characteristics, the momentary soil moisture and in cardboard boxes for characterize its

micromorphology (Blaga et al., 2008; ICPA., 1987).
Sampling the settlement as to characterize physico-chemical and biological part, was made in bags from each genetic horizon.
Agrochemical samples was taked for the determination of specific chemical indices (processing layer). Research ecopedological conditions and morphological description of soil was studied after "the Romanian system of soil taxonomy (2012), completed and/or modified by "Development methodology of soil studies" (volumes I, II, III) writed by ICPA Bucharest in 1987 (ICPA, 1987; ICPA, 2012).
Other determinations and testing were perfor-med in Pedological and Agrochemical Studies Office from Timisoara, and in the laboratory of Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timișoara, according to the national rules and standards approved by the Standards Association of Romania (ASRO).

RESULTS AND DISCUSSIONS

Limitations due to soil chemical characteristics

Salinization according to the pedological study on the studied area, the intensity of chlorinated salinization exceeds 0.6 me/100 g but it does not exceed 5 me/100 g, respectively sulphatic salinization 1.1 m/100 g but does not exceed 7.2 m.e/100 g, consequently we do not have solonchaks, but other types of soils fluvisols, chernozems, eutric cambisols.
Alkalization (saturation) is present in different subtypes of solonetz and several subtypes of fluvisols, chernozems, eutric cambisols, pelosols; In the first case, it is a sodium saturation more than 15% sodium exchangeable in the clay-humic complex of the cation exchange capacity).
In the studied area salinization and sodification affect 9.46% of the area (Figure1).
Acidity in the perimeter under investigation, the presence of acid reaction creates metabolic defects in most cultures with negative consequences in agricultural production, pH 5.2-5.6 (Dodocioiu et al., 2009; Marin et al., 2016).
Acidity in different degrees affects the area surveyed on 30.95% of the agricultural lands from the studied area (Figure 1).
The humus reserve is a crop food crop and, at the same time, a constituent that, through its influence on the physical, chemical, biological soil properties, determines to a large extent the productive level of the land.
Depending on the criteria specific to indicator 144 (MESP, 1987) within the researched perimeter, we encounter 7383.15 ha, representing 88.03% of the territory (Figure 1).
The CaCO3 content exceeds 12% forming a horizon as it appears in the first 100 cm, which has a negative impact on agricultural output. The content of calcium carbonate affects 11.71 ha, 0.14% of the territory (Figure 1).

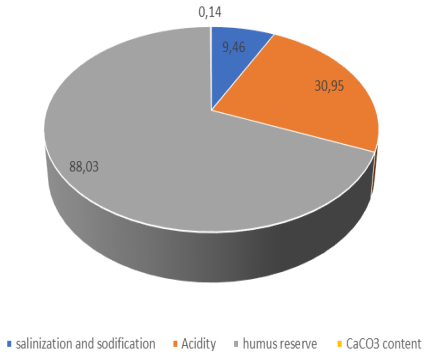

Figure 1. Graphical representation of limitation due to chemical characteristics

Limitations due to physical characteristics of soils

Physical and hydrophysical properties of soils determine the limits in which plants are grown in culture.
Among the physical and hydrophysical features that constitute limiting factors in this area we mention the texture and compactness, the reduced load.
Soil texture or granulometric composition defined by the proportion of particles of different sizes involved in the formation of the general part of the soil and the distribution of different particle sizes in the profile section. It plays an important role in ensuring the necessary conditions for the growth of plants (making different rooting in relation to the texture) as well as other soil characteristics, being correlated with other soil characteristics, enlarging or limiting their production capacity (Mihalache et al., 2013; David et al., 2019; Lațo et al., 2016).

Fine texture - a class group having the following composition: clay <0,002 mm ≥ 33%; Dust 0.002-0.02 mm ≤ 67%; Sand 2-0.02 mm ≤ 67% - affects 1561.84 ha, 18.62% of the area surveyed (Figure 2).

Compactness is the property of the soil to resist forces that tend to mechanically dismantle the particles that make up it. It is related to the granulometric composition, the water content, the humus content and the nature of the adsorbed cations. Tasking through current cultural works occurs when the soils are wet and when the work depth is the same for many years.

Compactness, compaction, total porosity, existing water reserve, microbiological activity and agricultural production are tight links.

Soil compactness is one of the main physico-mechanical properties of greater practical importance in agriculture (besides the other features: consistency, plasticity, compressibility, swelling, contraction, adhesion, cohesion and resistance to soil work). Compaction is expressed by the degree of compaction as the ratio between apparent soil density at one point (g/cm3) and the maximum apparent density of the soil (g/cm^3). It is expressed as a percentage, establishing the soil compactness classes: very loose, loose, low compact, moderately compact, very compact, characteristics closely related to a complex indicator of compaction - the degree of compaction. In the present paper for each TEO (homogeneous ecological territory) the apparent density, the total porosity and the clay content necessary to determine the degree of compaction were calculated. Compactness is also influenced by the water content, humus and the nature of the cations.

Compactness is a phenomenon that occurs either naturally in the studied area to clay and alluvial soils, or due to anthropogenic causes by carrying out agricultural works at the same depth, leading to worsening of water and air permeability and the resistance that the layer of soil compacted to the penetration of the root system on an area of 8281.61 ha, 98.74% of the arable land (Figure 2).

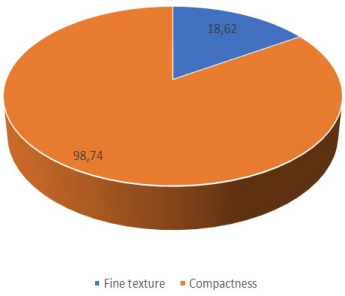

Figure 2. Graphical representation of lands physical limits

Limitations due to moisture excess

Soil moisture excess can be caused by water from rainfall, underground water, or due to poor external and internal drainage.

Water excess is manifested:

- morphologically by the presence of the Gr gley horizon or stagnogley W;
- physically - the water content exceeds the capacity of the field.

Limitations due to groundwater excess

Agricultural crops support the groundwater excess without diminishing production for a short period of time. The expected improvement measures will first aim at removing the causes of excess humidity and then fighting the consequences of water excess on the soil. The excess moisture content of the groundwater affects 34.45% of the area surveyed.

Limitations due to stagnant (surface) humidity excess

Stagnant humidity excess is due to precipitation in years or rainy periods, but also due to a contest of circumstances:

- the presence of a clay soil;
- the existence of micro-depressions;
- the presence of impermeable layers;
- the use of heavy agricultural machinery on poorly landscaped lands.

On an area of 33.36% of the area surveyed.

Limitations due to overflow flooding

The lands with these limitations are situated in the floodable areas of the Timiș River up to the defense and protection dike and cover an area of 4.47% from the surveyed area.

Limitations due to moisture deficiency

Moisture deficiency in the soil is a limiting factor in the normal growth of plants. According to the hydro climatic balance it affects 68.53% of the area surveyed (Figure 3).

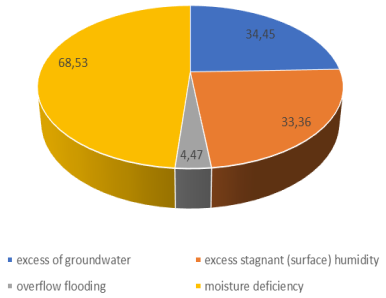

Figure 3. Graphical representation of excess and deficiency of moisture

Limitations due to anthropogenic degradation

The anthropically degraded lands are those limited to the depot (landfills) due to waste deposited and scattered by the wind, in an area of 0.14% from the surveyed area.

Below we present the possible ways to improve the properties of the soils and implicitly the agricultural production and the way of use. From this synthesis also resulted an indicative framework of requirements and improvement measures, the sequence of the approached phenomena is the following:

Salting (salinization and alkalization)

The soil solution becomes harmful to the development of plants from certain limits of soluble salt concentration, as well as to a certain degree of alkalinity. Harmful salts on plants are: NaCl, Na_2SO_4, Na_2CO_3, $MgCl_2$, $MgSO_4$, $CaCl_2$; salts are not harmful: $MgCO_3$, $CaSO_4$, $CaCO_3$. Increasing osmotic pressure reduces the accessibility of water to plants and negatively affects the microbiological activity of the soil. In addition to increasing osmotic pressure, salts harm plants through the toxic effect of ions released by dissociation. In this respect, the Cl- ion is more toxic than SO_4^{2-}, and the most toxic of chlorides is $MgCl_2$.

A high sensitivity to chlorine is shown by fruit trees, followed by grasses, legumes and fodder legumes, and sugar beet supports the Cl ion better than the SO_4 ion.

On solonets the plants suffer not because of the excess of salts, but because of the high alkalinity of the soil, determined by the preponderance of Na and Mg cations in the adsorbent complex, as well as by the presence of Na_2CO_3 - so of soda. Soda, among other novice effects, thus manifests a direct caustic action on plants, with the effect of dissolving plant tissues.

Increasing the content of soluble salts in the soil solution has negative effects not only on cultivated or spontaneous plants, but also on the microbiological activity in the soil. The genesis of saline soils is related to the exudative water regime of the soil, to the slightly depressed areas, with faulty drainage, in which the salinization process predominates over the desalination process. Another plausible cause of salinization characteristic of heavily compacted surfaces, with mineralized groundwater without raising their level, is the increase in the height of capillary rise of water in the soil. This phenomenon is possible by accentuated compaction, by destroying the structure and achieving the capillary continuity of the soil on the entire thickness of the profile, especially on the pastures loaded with too many animals during the wet periods of the year.

Improvement of saline and sodium soils involves a series of complex measures, being in possession of all data related to local factors: the degree of uneven terrain, meso and microrelief shape, soil granulometry, the degree and intensity of salinization and soda, the degree of desiccation and dams and a number of other physical and hydrophysical characteristics of the TEOs in question, land use category, genesis of solonet, saline solonet, respectively of other saline soils (components of the soil cover in the perimeter of Şag commune).

The saline and alkaline soils, in the studied area, the salinized, salinized-sodized soils, the salinized solonets are improved by specific measures:

- solonets, can be proposed for pasture use, possibly floristic reservations;
- the saline-sodium soils require the restoration of the drainage and gypsum amendment system, plus agro-amelioration measures from case to case (leveling, mole drainage, scarification - loosening, resistant plants in the assortment of cultivated ones);
- washing is required only on a drained bottom and only where the salinization is strong, being

a subsequent measure to correct the solidification by gypsum.

Acidity

Acid soils were formed by intense leaching of soluble soils and calcium carbonate in some rocks, destruction of silicates and alteration of other primary minerals with the release of bases and oxides-hydroxides of Si, Al, Fe, Mg, perforation of bases and the accumulation of hydroxides in clay minerals; deep migration of newly formed clay "protected" by fulvic acids and formation of the B argiloiluvial horizon.

The improvement of these acid soils can be achieved by: calcium amendment with different doses of $CaCO_3$ t/ha regulation of the aerohydric regime, through agro-ameliorating measures of ameliorating fertilization and land improvement measures.

Humus reserve

The mapped agricultural area with limitations due to the humus reserve has moderate and low limitations, which entitles us to continue to recommend a rational fertilization, balanced with both organic and chemical fertilizers and the application of agrotechnics adapted to local conditions, creating conditions favorable physical - aerohydric, mechanical, hydrophysical and chemical, the humidification process, the main source of increasing the productive potential and preserving the important characteristics of the soils.

The mineral part of the soil is made up of mineral particles of different sizes.

CONCLUSIONS

A plausible cause of salinization characteristic of heavily soiled surfaces, with groundwater mineralized without raising their level, is the increase of the capillary rise of the water in the soil.

Acidic soils were formed by intense leaching of soluble soils and calcium carbonate in some rocks, destruction of silicates and alteration of other primary minerals with the release of bases and oxides of hydroxides of Si, Al, Fe, Mg, perforation of bases and bringing the hydroxyls into clayey minerals; The in-depth migration of newly formed "protected" clay by fulvic acids and the formation of the argiloiluvial B horizon.

The cartographic agricultural of studied area with limitations due to the humus reserve has moderate limits and limited limits, which justifies us to recommend a rational fertilization, balanced with both organic and chemical fertilizers, and the application of an agrotechnics adapted to local conditions, creating conditions favorable physical - aerohydraulic, mechanical, hydrophysical and chemical processes, humification process, the main source for increasing the productive potential and preserving the important soil characteristics.

The degree of compaction is expressed quantitatively by apparent density, through porosity and penetration. We have a natural compaction caused by volume variations, temperature variations, accompanied by so-called "self-sacrifice" at the surface of the ground, and the most widespread anthropogenic compaction dangerous due to the mechanical work at proper humidity, the large number of passes on the ground with heavy machinery and equipment.

Excess wetlands from rainfall are generally depressed, stagno-gleyc formed on fine textured materials.

Grounds with humidity excess from the groundwater are influenced by humidity due to the presence of the groundwater at low depth (critical).

Within the studied territory, soil moisture can decrease in some years to the root casting coefficient for periods that may exceed 5-15 days. In these years, many crops suffer from the lack of water with low crop yields. Irrigation is necessary for very intensive agriculture.

REFERENCES

Blaga, Gh., Filipov, F., Paulette, L., Rusu, I., Udrescu, S., Vasile, D., (2008). *Soil Science, Academic Publishing Mega, Cluj - Napoca,*

Buta, M. (2009). *Research on quality evaluation of soils in hills Cojocna-Sic, subunit of the Transylvania Plain, Doctoral Thesis, UASVM Cluj-Napoca,*

David, G., Ţărău, D., Sandor, C., Niţă, L. (2018). Soil and climate factors that define land productivity in the lower plain of Banat. *International Multidisciplinary Scientific GeoConference: SGEM, 18*(3.2), 465–472.

Dodocioiu, A. M., Mocanu, R., Susinski, M., 2009. The changing of the soil reaction as a result of applying several fertilizer types, *Lucrari Stiintifice USAMV Ion Ionescu de la Brad Iasi, Seria Agronomie, 52*(1), 341–344.

Ilie, L., Mihalache, M., Marin, D.I., Scăețeanu, G. (2012). Climatic conditions and evolution of soil profiles in Romania. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series, 42*(2), 118–123.

Laţo, A., Găvojdean, C., Frăţilă, C., Crista, F. (2016). *Monitoring of the soil fertility indicators in Barzava Plain.- Research Journal of Agricultural Science,*

Marin, D.I., Mihalache, M., Rusu, T., Ilie, L., Ciontu, C. (2016). Tillage effects on some properties of chromic luvisols and the maize crop yield. *International Multidisciplinary Scientific GeoConference: SGEM* 2, 449–454.

Mihalache, M. (2006). *Soil science - genesis, properties and soil taxonomy*, Ceres Publishing House Bucharest,

Mihalache, M., Ilie L., Marin, D., Dodocioiu, A. M. (2013). Clay minerals and potassium regime of some soils from Romania. *Current Opinion in Biotechnology*, *24*(1), S141–S142

Mihalache, D., Vrînceanu, N., Teodorescu, R.I., Mihalache, M., Bacau, C. (2019). Evaluation of the effect of 15N-labeled fertilizers on maize plant. *Romanian Biotechnological Letters*, *24*(1), 193–199.

Paulette, L., Oroian, I., Buta, M., Odagiu A. (2013) Soils Inventory of Cluj Napoca as Background Study for Different Use - ProEnvironment/ProMediu.

Radulov, I., Crista, F., Berbecea, A., Laţo, A. (2011) - *Analiza chimica a solului*, Ed- Eurobit, Timisoara

Rusu, T., Laura, P., Cacovean, H., Turcu, V. (2007) *Physical, hydro, chemistry and soil respiration*, Ed Risoprint Cluj Napoca,

Șmuleac, L., Rujescu, C., Șmuleac, A., Imbrea, F., Radulov, I., Manea, D., Ienciu, A., Adamov, T., Pascalau, R. (2020). Impact of climate change in the Banat Plain, Western Romania, on the accessibility of water for crop production. *Agriculture, 10*(10), 437.

***ICPA (1987) Pedological studies methodology from Romania. Vol. I, II and III. Ed. Didactica si Pedagogica, Bucuresti, p. 53–115.

***ICPA (2012) Romanian Soil System Taxonomy. Ed. Sitech, Craiova