International Journal of Multidisciplinary Research Updates

Journal homepage: https://orionjournals.com/ijmru/

ISSN: 2783-0179 (Online)

(RESEARCH ARTICLE)

Researches on soil degradation in the Crişurilor plain

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International Journal of Multidisciplinary Research Updates, 2021, 01(01), 026–036

Publication history: Received on 10 March 2021; revised on 16 April 2021; accepted on 19 April 2021

Article DOI: https://doi.org/10.53430/ijmru.2021.1.1.0033

Abstract

The present paper aims to study complex degradation processes and an assessment of these processes by presenting the soils affected by degradation as well as quantifying the intensity.

The surveys on the identification and mapping of degraded soils have been carried out between 2012 and 2017.

Following the correlation of field data with laboratory analyzes and previously existing scientific information, the soils of the Crişurilor Plain soils with low fertility potential due to the degradation processes were identified and mapping of surface areas was developed in order to elaborate the complex of meliorative measures to improve the trophic characteristics, in order to increase the fertility potential and establish the assortment of cultivated plants.

Keywords: Water erosion; Erosion; Sedimentation; Clogging; Compaction

1. Introduction

The total area of the studied soils was 294,229 ha, of which 217,281.1 ha have agricultural or forestry use. The degradation processes have led to a change in time of the physical and chemical properties of the Soils in the Crişurilor Plain. The intensity of the degradation processes is due to: rain and wind erosion, primary and secondary compaction, excessive moisture - phreatic or pluvial humus, decrease in humus reserves and soil nutrient reserve (N; P; K).

2. Material and methods

The identification of degraded soils by water erosion was carried out in the field by direct observations of the intensity of surface erosion processes. Determination of the degree of erosion was done by measurements of the eroded soil layer. The identification of degraded soils by primary compaction and secondary compaction was performed by comparing the apparent density values determined in laboratory analyzes with apparent density classes (for comparison and compaction appreciation was also required by granulometric analysis). The identification of the soils with excess pluvial (stagnant) humidity was, performed on the ground by direct observation, based on the existence in the soil profile of the stagnic horizons (measurable character). The identification of the soils with excess of groundwater was done in the field, by direct observation, based on the existence in the soil profile of the gleic horizons (measurable character). The identification of the soil areas represented by marshlands was done in the field, through direct observation. The identification of soils with low humus content was made by comparing the experimentally determined humus content of the Crişurilor Plain soils with the ICPA Standards for assessing of soil supply in humus and organic carbon.The identification of weak and moderately supplied soils in nitrogen was carried out by comparing the nitrogen supply of the Crişurilor Plain soils with the ICPA Standards for assessing the supply of nitrogen to the soil. The identification of weak and moderately supplied soils in phosphorus was carried out by comparing the phosphorus supply of the

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Crişurilor Plain soils with the ICPA Standards for assessing the supply of phosphorus to the soil. The identification of weak and moderately supplied soils in phosphorus was carried out by comparing the potassium supply of the Crişurilor Plain soils with the ICPA Standards for assessing the supply of potassium to the soil.

3. Results and discussion

3.1. The soils of the Crişurilor Plain degraded by water erosion

Water erosion occurs on lands located on relief units with slope angles (inclined relief units).

Surface water erosion. It occurs during torrential rains when the soil cannot store all the water, the surplus flows to the surface of the soil, causing the transport of soil material from the top of the slope and its deposition at the base of the slopes.

Along with soil material, washing of existing nutrients on the top of the soil takes place. Table 1 presents localities and soil units affected by surface water erosion processes.

Table 1 Localities and soil units affected by surface water erosion processes

Nr. crt.	Locality	Taxonomic unit of soil
1.	Leş, Nojorid, Miersig, Sepreuş, Olari, Bocsig	Eutric Cambisols
2	Leş, Nojorid, Cheresig, Miersig, Ianoşda, Husasău de Tinca, Gurbediu, Călacea, Olcea, Apateu, Sepreuş, Cermei, Craiva	Haplic Luvisols

Deep water erosion. It is rarely encountered in the Crişurilor Plain (in some of the highlands of Crişurilor Plain), is the result of drained rainwater spills on certain trails, which cause the entrainment of large amounts of soil material. In the Crişurilor Plain area it is manifested on narrow surfaces, being specific to the High Plain. On inclined relief units, surface erosion is present along valleys, deep erosion. Figure 1 shows the soils subject to or affected by water erosion

3.2. The soils in the Plain Creep are degraded by primary compacting and secondary compaction

Compaction is a form of degradation of the hydro-physical and aeration properties of soils that naturally formed during the soil formation process or as a result of anthropogenic activity.

3.3. Primary compacting

The natural compaction form is specific to all soil types that have a medium or fine texture in the A horizon, reducing porosity for aeration and increased apparent density. Much of these soils are affected by stagnant phenomena. Figure 2 shows the area of land spreading with primary or natural compaction.

3.4. Secondary compaction

It is a process of degradation of the hydro-physical characteristics of soils as a result of human activity, mainly due to the intensive use in agriculture and is manifested by the worsening of the aero-hydric regime and the manifestation of nutritional disturbances in plants. In Crişurilor Plain are affected by secondary compacting some soils located in areas where mechanized agriculture is predominantly practiced, in the area of localities: Tămăşeu, Hodoş, Sălard, Santău Mic, Bors, Palota, Tărian, Cihei, Nojorid, Sânicolau Român, Roit, Berechiu, Gepiu, Cefra, Leş, Miersig, Mădăras, Salonta, Gurbediu, Ciumeghiu, Avram Iancu, Călacea, Craiva, Cermei, Sepreuş, Beliu, Ineu, Şicula, Seleuş, Bocsig, Olari, Şimand, Macea, , Avram Iancu. Figure 3 shows the area of spreading land showing secondary compactness.

3.5. The soils in the Crişurilor Plain with excess moisture from rainfall

In the Plains of Criss, the excess rainfall of moisture is manifested on an area of over 18,847 ha, occupied by the type of soil stagnic luvisols. Representative surfaces are found in the Miersig Plain - 3304,6 ha, the Plain Plain - 740,4 ha, Cermei Plain - 5395, 1 ha, Craivei Plain - 9188.2 ha, Crişului Negru Plain - 217.8 ha. It occupies surfaces, flat or slightly inclined, with a depression, in the area of Girişu de Criş, Talpoş, Ghiorac, Tamasda, Zerindu Mic, Vânători, Sepreuş, Oradea, Sânmartin, Cihei, Chişirid, Apateu, Gurbediu, Husasau of Tinca, Bicaci, Gurbediu, Inand, Vasile Goldiş, Avram Iancu,

Coroi, Talmaci, Sosag, Berechiu. On smaller surfaces are found in luvisols and planosols. Figure 4 shows the distribution of stagnic soils in the Crişurilor Plain.

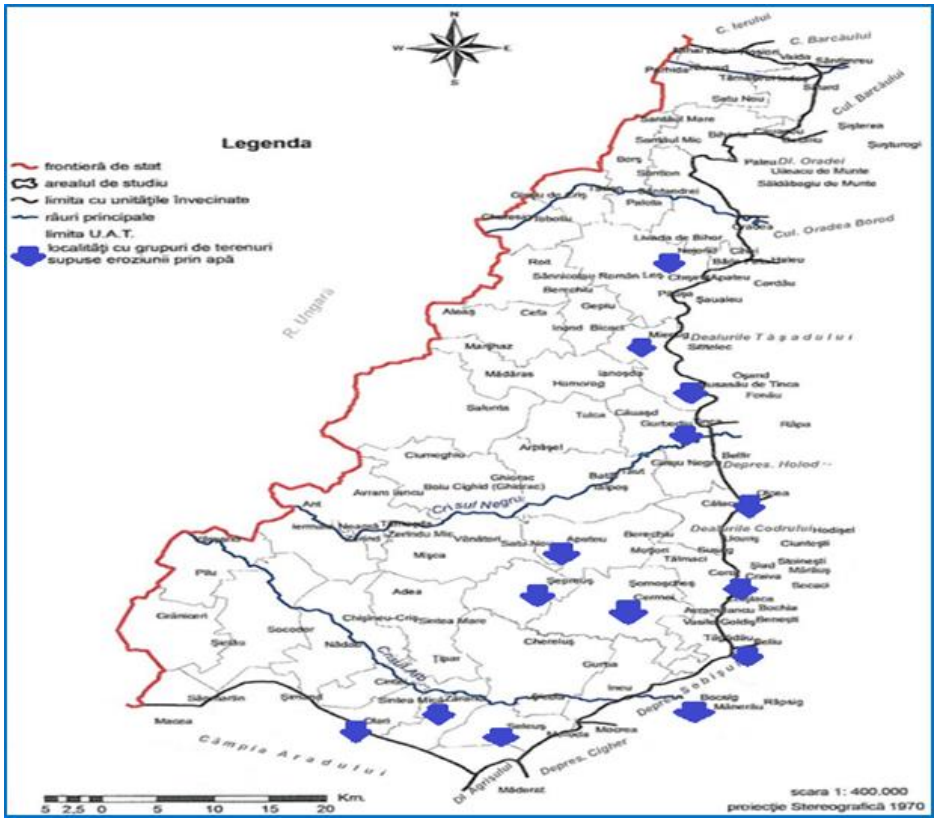

Figure 1 The Crişurilor Plain. Representation of soil surfaces subjected to or affected by water erosion

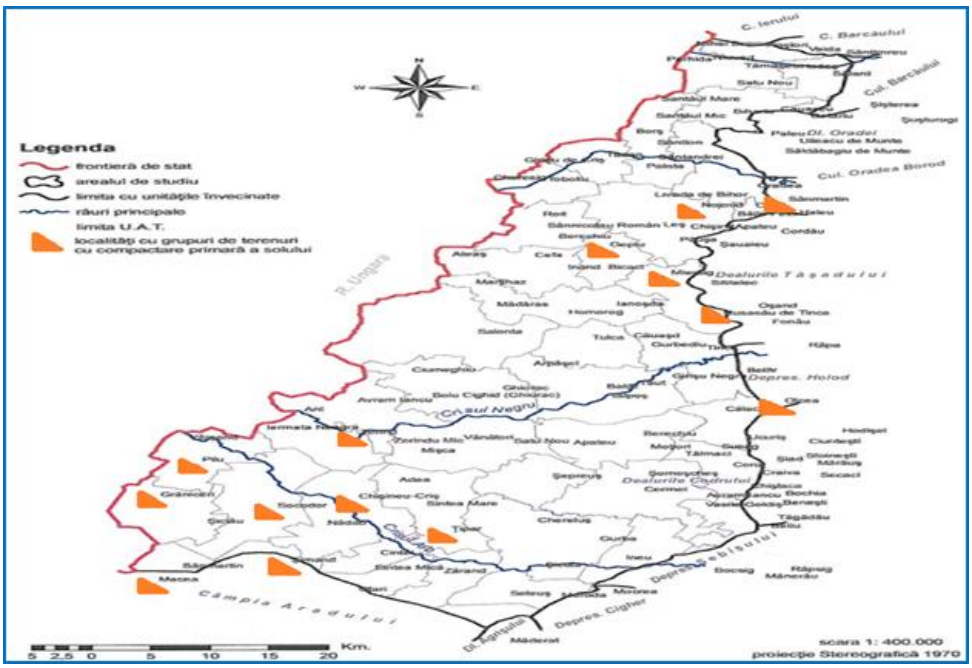

Figure 2 The Crişurilor Plain. Land with primary compaction of the soil

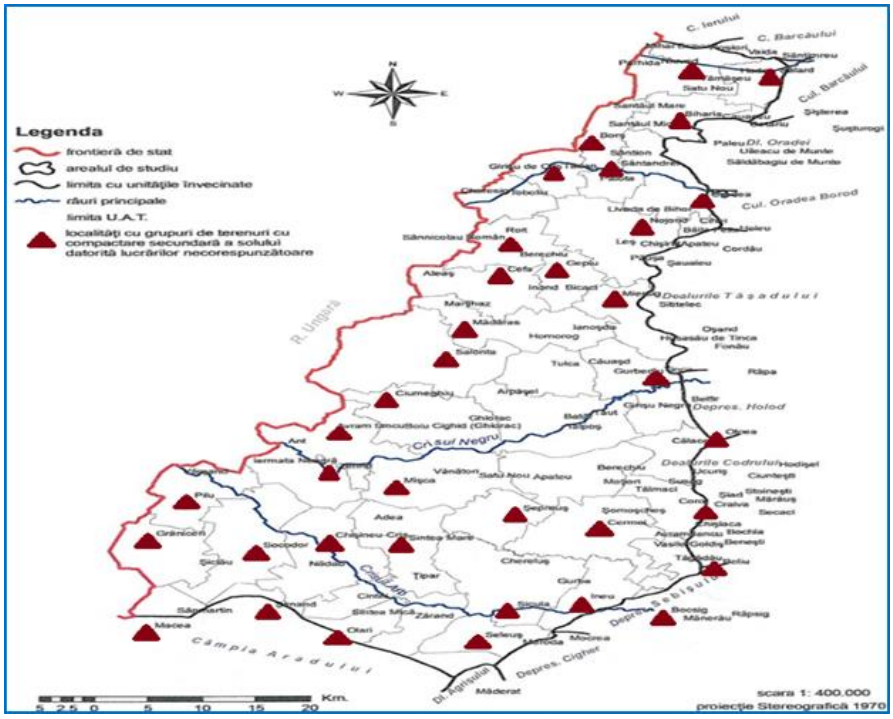

Figure 3 The Crişurilor Plain. Areas with secondary soil compaction

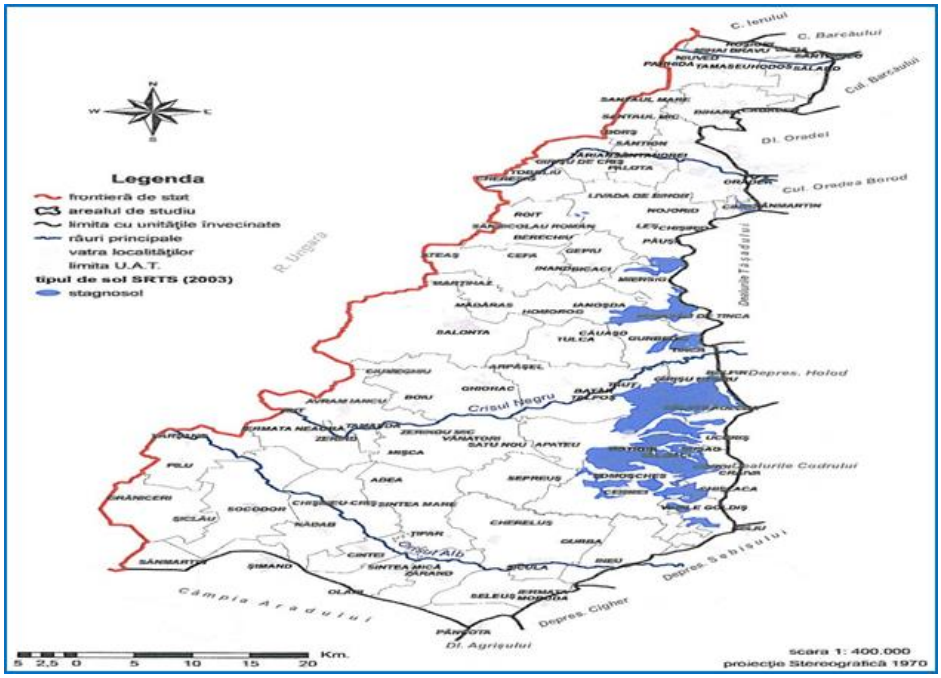

Figure 4 The Crişurilor Plain. Spread of stagnic luvisols

3.6. The soils of the Crişurilor Plain with excess of ground water

Underground water at critical or sub-critical depths determines the oxidation and reduction processes in the soil profile and, in some cases, intense spreading processes. The soils affected by excess groundwater are gleysols, occupying areas in: Bihariei Plain - 726.2 ha, Bihariei Field - 208.8 ha, Miersigului Plain - 162.8 ha, Veljurilor Plain - 550.9 ha, Cermeiului Plain - 1533 ha , Craivei Plain - 1039.1 ha, Borsului Plain- 2776.6 ha, Crişului Negru Plain - 2652 ha, Ineului Plain 2358.2 ha, Chişinău Criş Plain - 144.9 ha. Major areas are found in low grasslands with underground waters at a critical depth

of 1-2 m in Borş, Santău Mic, Santău Mare, Toboliu, Sântion, Mihai Bravu, Parhida, Inand, Satu Nou, Tamasu, Tulca, Ghiorac, Cefa, Inand, Homorog, Salonta, Ciumeghiu, Avram Iancu, Biharia, etc. Figure 5 shows the extent of gleyosols spread in the Crişurilor Plain.

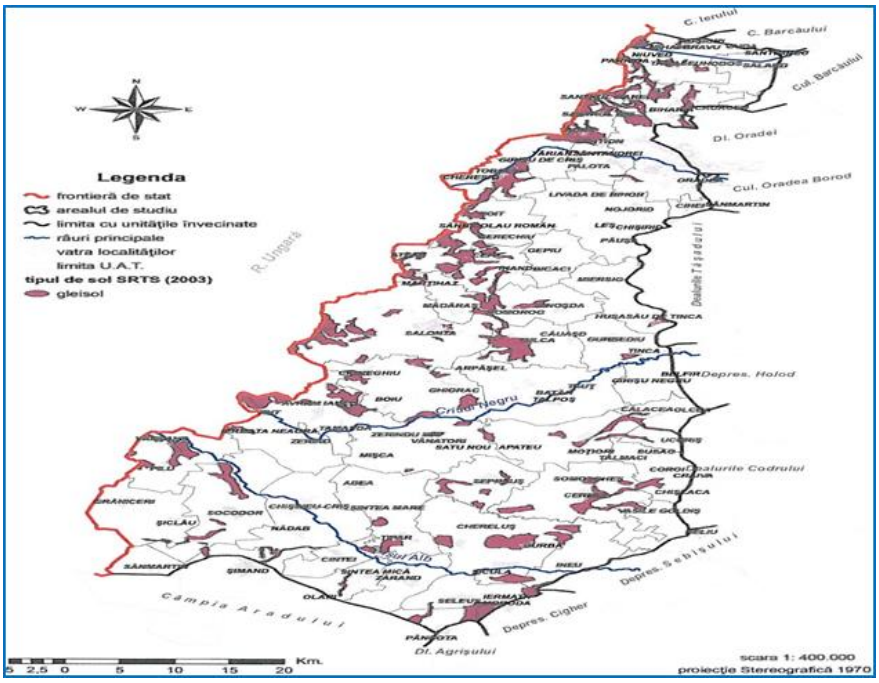

Figure 5 Crişurilor Plain. Spread of gleysols

Figure 6 shows the land plots in the Crişurilor Plain with permanent excess of groundwater

3.7. The soils of the Crişului Plain affected by the formation of marshes

In the Crişurilor Plain, in some low areas, the existence of the aquifer close to the surface, at depths of less than 1 m, led to the formation of large marsh areas, about 1200ha, most of which are currently transformed and amened like ponds: in Cepha (670ha), Lake Inand (200ha), Madaras (30ha), Homorog (105ha), Tamasda (206ha), the lakes of Crişului Alb (Bocsig, Ineu, Seleus), Cermei lake in the Teuz basin, Cigher, Lake Socodor (155ha), Lake Pilu (260ha).

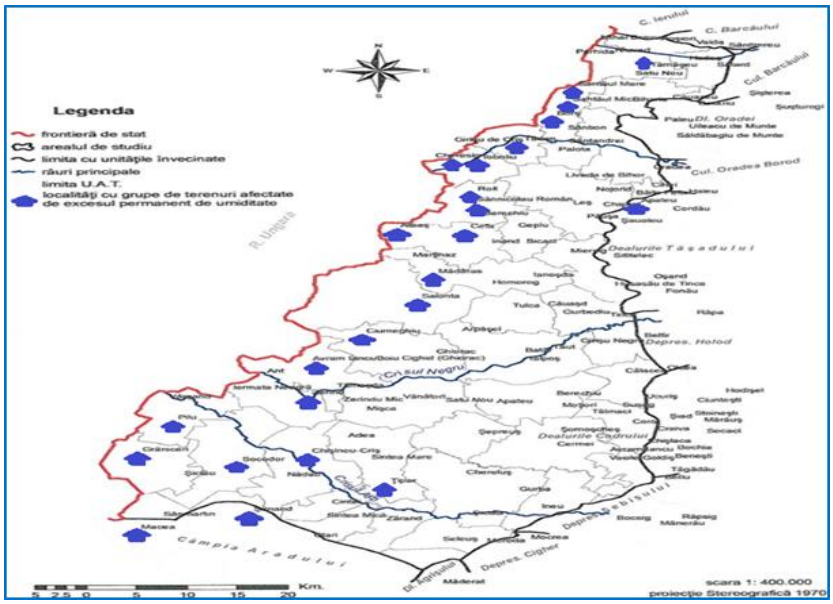

Figure 6 The Crişurilor Plain. Representing land with permanent excess of groundwater

Figure 7 shows the areas occupied by swamps in the Crişurilor Plain Figure 7 shows the areas occupied by swamps in the Crişurilor Plain.

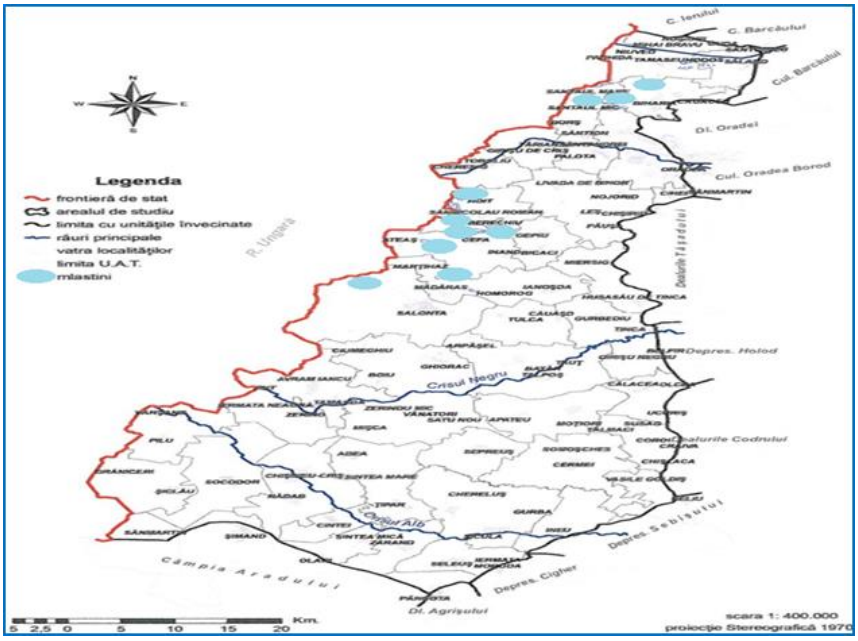

Figure 7 Crişurilor Plain. Areas occupied by lakes and marshe

3.8. The soils of the Crişurilor Plain with a low humus content

In the Criss Plain, the phenomenon of decrease of the humus reserves was emphasized in all types of soils that are in agricultural use. After the intensive cultivation of the soils, the phenomenon of the humus accumulation process was stopped, and on the other hand, by the processes of mineralization of humus and specific consumption of the crops, the considerable decrease of the reserves occurred. Figure 8 illustrates poor soil supply in humus. Table 2 presents the humus reserve of some soils on the 0 - 50 cm depth of the Crişurilor Plain and interpretation according to texture.

Table 2 Humus content of some types of soils on the depth of 0 - 50 cm from the Crişurilor Plain and texture inference

Soil Type	Locality	Texture	Humus (%)	Reserve (0-50 cm) tons / ha	Interpretation
Luvic Chernozems	Sânmartin	LN	2.12	238.5	average content
Haplic Chernozems	Livada de Bihor	LN	2.2	247.5	average content
Greyc Phaeoyems	Nojorid	LL	1.55	96.87	small content.
Greyc Phaeoyems	Nojorid	LN	2.1	131.25	average content
Eutric Fluvisols	Toboliu	LL	1.8	112.5	small content.
Eutric Cambisols	Sălard	LL	1.7	106.25	small content.
Haplic Luvisols	Palota	LL	1.76	110	small content.
Haplic Luvisols	Tulca	LL	1.1	71.5	small content.
Haplic Planosols	Ciuhoi	SF	1.64	106.6	small content.
Haplic Solonetz	Zerind	AL	1.32	85.8	small content.

In the case of stagnant soil types and gleysols a high humus reserve (gleysols - Tulcea locality - 4.78% humus, Stagnant soil - Callacea - 3.92%) was found to be of poor quality, (organic matter at different stages of transformation and humification)

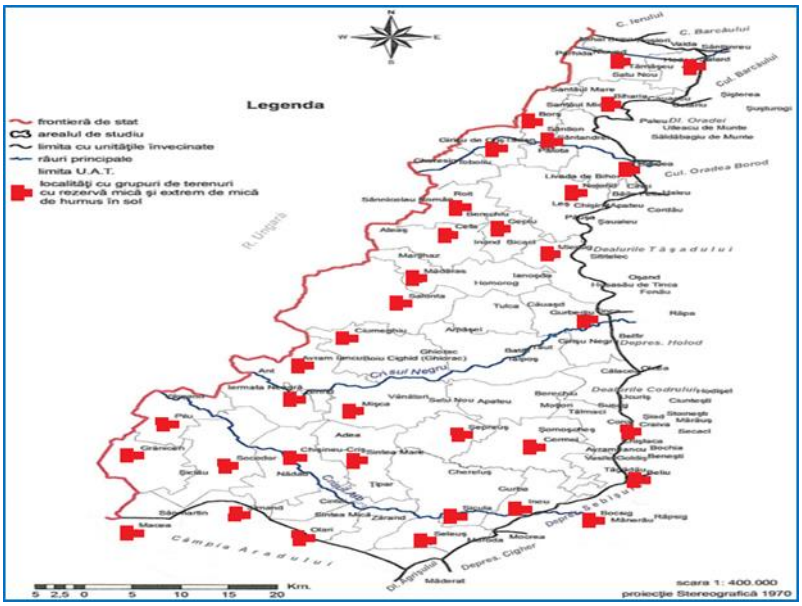

Figure 8 Crişurilor Plain. Representation of very low and low humus reserves

3.9. The soils in Crişurilor Plain with low content and nitrogen medium

The chemical analyzes carried out on the Crişurilor Plain soils revealed values of nitrogen supply between 5.2 ppm and 10.3 ppm, which correspond to a supply from low to moderate. Table 3 presents the supply in nitrogen, in the arable layer of some types of soils in the Crişurilor Plain and interpretation according to the actual acidity (pH).

Table 3 Nitrogen content in the arable layer of certain types of soils in the Crişuri Plain and the actual acidity (pH)

Soil Type	Locality	pH	$N - NH_4^+ + N - NO_3^-$ (ppm)	Interpretation
Luvic Chernozems	Sânmartin	6.65	8.3	average content
Haplic Chernozems	Livada de Bihor	6.6	9.6	average content
Greyc Phaeoyems	Nojorid	6.4	7.4	average content
Greyc Phaeoyems	Nojorid	6.5	7.9	average content
Eutric Fluvisols	Toboliu	6.4	6.6	average content
Eutric Cambisols	Sălard	6.3	5.7	small content.
Haplic Luvisols	Palota	6.4	5.6	small content.
Haplic Luvisols	Tulca	6.1	5.2	small content.
Haplic Planosols	Ciuhoi	6.2	5.2	small content.
Haplic Solonetz	Zerind	8.4	6.9	small content.

Figure 9 shows low and moderate nitrogen content soil areas

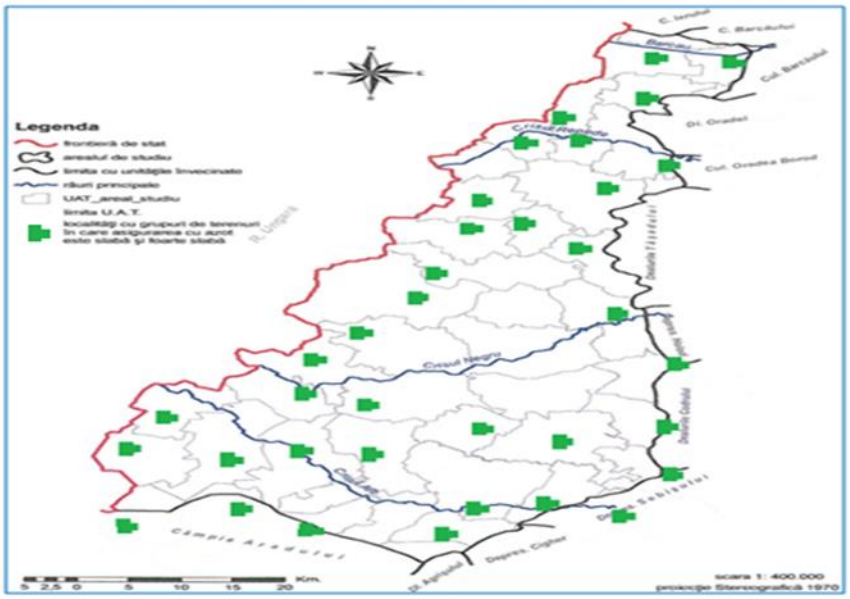

Figure 9 Crişurilor Plain. Representation of low and moderate nitrogen content

3.10. The soils in the Crişurilor Plain with low and moderate phosphorus content

Following the analysis of soil phosphorus content in the Crişurilor Plain, values ranging from 6 to 36 ppm in phosphorus were obtained, values corresponding to a very low to medium supply state. Most soils due to intensive use in agriculture have a phosphorus content in the range of 6-18 ppm, with a very poor and poor supply state. Table 4 presents the phosphorus content in the arable layer of some soil types in the Crişurilor Plain and the inertia.

Table 4 The phosphorus content in the arable layer of certain types of soils in Crişurilor Plain

Soil Type	Locality	ppm P	Interpretation
Luvic Chernozems	Sânmartin	28	average content
Haplic Chernozems	Livada de Bihor	19.7	average content
Greyc Phaeoyems	Nojorid	17.7	small content.
Greyc Phaeoyems	Nojorid	16.9	small content.
Eutric Fluvisols	Toboliu	15.8	small content.
Eutric Cambisols	Sălard	13.2	small content.
Haplic Luvisols	Palota	12.1	small content.
Haplic Luvisols	Tulca	9.4	small content.
Haplic Planosols	Ciuhoi	8.6	small content.
Haplic Solonetz	Zerind	6.1	very small content
Dystric Gleysols	Toboliu	14.5	small content.
Stagnic Luvisols	Călacea	9.2	small content.

Figure 10 shows the areas of the Crişurilor Plain with low and very low phosphorus content

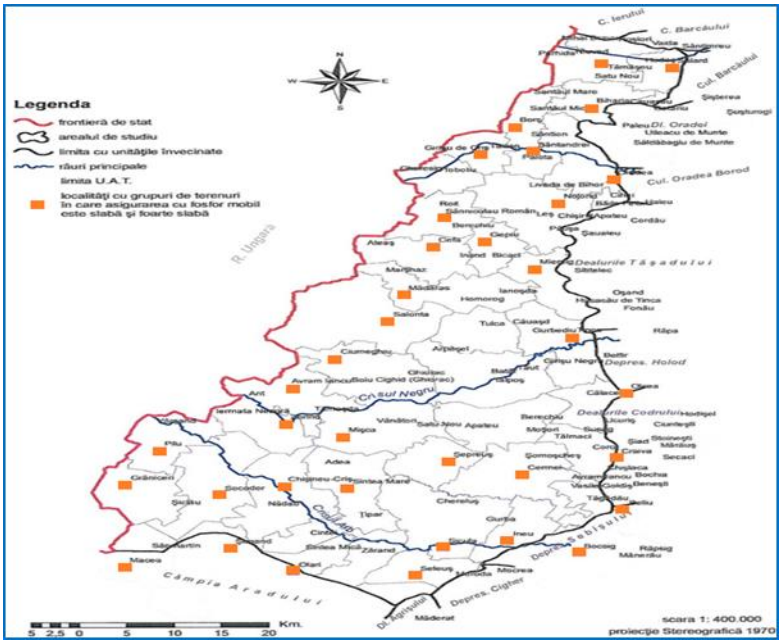

Figure 10 Crişurilor Plain. Representation of low-phosphorus land

3.11. Soils in the Plains of Crişurilor Plain with low and moderate potassium content

In order to assess the potassium content of soils in the Crişurilor Plain, studies have been carried out on the content of soils in potassium. Values ranging from 60 to 132 were obtained, with most agricultural soils ranging between 60 and 110, corresponding to a low to medium supply.

Table 4 presents the potassium content in the arable layer of some soil types in the Crişurilor Plain and the interpretation.

Table 4 Potassium content in the arable layer of certain types of soils in Câmpia Crişurilor

Soil Type	Locality	ppm K	Interpretation
Luvic Chernozems	Sânmartin	120	average content
Haplic Chernozems	Livada de Bihor	110	average content
Greyc Phaeoyems	Nojorid	110	average content
Greyc Phaeoyems	Nojorid	105	average content
Eutric Fluvisols	Toboliu	90	average content
Eutric Cambisols	Sălard	65	small content.
Haplic Luvisols	Palota	60	small content.
Haplic Luvisols	Tulca	55	small content.
Haplic Planosols	Ciuhoi	60	small content.
Haplic Solonetz	Zerind	55	small content.
Dystric Gleysols	Toboliu	60	small content.
Stagnic Luvisols	Călacea	65	small content.

Figure 11 shows the soils areas in the Crişurilor Plain with low and medium potassium content.

Figure 11 Crişurilor Plain. Representation of surfaces with soils with low and medium potassium content

4. Conclusion

The studies and researches carried out in the Crişuri Plain constitute a real basis for the solving of some less studied or neglected issues so far concerning:

- Obtaining and making cartograms on: soil characteristics, soil technology indicators and cartograms on production capacity
- Conservation and rational use of the entire land fund
- knowledge of the soils affected by erosion and the establishment of anti-erosion measures to capitalize on these lands
- Knowing the surfaces of soils affected by excess pluvial or phreatic humidity
- Knowledge of degraded soils due to agricultural activities
- knowledge of soils with strong and moderate acidity
- knowledge of soil areas affected by the decrease in humus reserves and nutrients
- Improving the soils affected by excess rain or flood humidity
- organization of the territory
- designing land improvement works
- the correct application of different agrotechnical units in the agricultural units by the correlation of the physico-chemical characteristics of the soil with the requirements of the crop plants
- Qualification and technological characterization of land areas

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest.

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