THE EVOLUTION OF THE DEGRADATION PROCESSES OF THE PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS FROM CRIŞURILOR PLAIN IN THE PERIOD 2017 – 2020

Berchez Octavian*, Lazăr Andra*

*University of Oradea, Faculty of Environmental Protection, 26 General Magheru St., 410048 Oradea,Romania, e-mail: berchez_octavian@yahoo.com, ienciuandra@yahoo.com,

Abstract

This paper aims to study the evolution of complex soil degradation processes in the Criţurilor Plain between 2012 and 2020 and a quantifiable assessment of these processes. Surveys on the identification and mapping of degraded soils were carried out between 2012 - 2017 and 2018 - 2020. The paper continues the studies conducted between 2012 and 2017. Correlation of field data with laboratory analyzes and previously existing scientific information, the soils from the Crişurilor Plain with low fertility potential were identified due to degradation processes and these areas were mapped in order to develop a complex of improvement measures to improve the fertility potential to increase the fertility potential.

Key words*:* erosion, clogging, compaction, sedimentation, water

INTRODUCTION

Soil degradation is a major environmental problem and there is strong evidence that such processes pose an immediate threat to both biomass and economic yields. The morphological characteristics and physico-chemical properties of the soils are strongly affected by all degradation processes. The total area of the studied soils was 294.229 ha, of which 217.281.1 ha have agricultural or forestry uses. The degradation processes led to a change in time of the physical and chemical properties of the soils from Crişurilor Plain. The intensity of degradation processes, against the background of changing climatic conditions, is due to: rain and wind erosion, primary and secondary compaction, excessive humidity - groundwater or rain, decreased humus reserves and soil nutrient reserve (N; P; K).

MATERIAL AND METHOD

The identification of soils degraded by water erosion was performed in the field by direct observations of the intensity of surface erosion processes. The degree of erosion was determined by measurements of the eroded soil layer. The identification of degraded soils by primary compaction and secondary secondary compaction was performed by comparing the bulk density values determined in the laboratory analyzes with the bulk density classes (for comparison and assessment of compaction was also necessary by particle size analysis). The identification of soils with excess rainfall (stagnant) moisture was performed on the soil by direct observation, based on the existence in the soil profile of the horizons of stagnation (measurable character). The identification of soils with excess groundwater was done in the field, by direct observation, based on the existence in the soil profile of the ice horizons (measurable character). The identification of the soil areas represented by the swamps was done on the field, by direct observation. The identification of soils with low humus content was made by comparing the experimentally determined humus content of the soils of the Crișurilor Plain with the ICPA Norms for the evaluation of the soil supply in humus and organic carbon. The identification of weak and moderately supplied soils in nitrogen was performed by comparing the nitrogen supply of the soils in the Crișurilor Plain with the ICPA Norms for the evaluation of the soil nitrogen supply.

The identification of weak and moderately phosphorus and potassium supplied soils was performed by comparing the phosphorus and potassium supply of the soils of the Crișuri Plain with the ICPA Norms for the evaluation of the phosphorus and potassium supply of the soil.

RESULTS AND DISCUSSION

The soils of the Crisului Plain degraded by water erosion

Water erosion takes place on lands located on relief units with inclination angles (inclined relief units).

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

Together with the soil material, the existing nutrients are washed on top of the soil.

The localities and soil units affected by the surface water erosion processes are:

- Leș, Nojorid, Miersig, Sepreuș, Bocsig with Cambisol Eutric
- Leș, Nojorid, Cheresig, Miersig, Ianoșda, Husasău de Tinca, Gurbediu, Călacea, Olcea, Apateu, Sepreuș, Cermei, Craiva with Haplic Luvisols.

Compared to 2017, in 2020 there is an increase in soil surfaces due to surface erosion, in the localities of Avram Iancu, Tălmaci, Ineu, Păuşa, Girişul de Criş, Berechiu, Miersig, Husasău de Tinca. The increase is mainly due to the increase in the frequency of torrential rains and hill - valley plowing. Plowing on contour lines and overturning the furrow upstream would slow down the erosion process. Also making grass strips and terracing are recommended methods to stop erosion.

Deep erosion. It is rarely found in Crişurilor Plain (in some of the high areas of Crişurilor Plain), it is the result of drained rainwater runoff on certain routes, which causes the entrainment of large amounts of soil material. In the area of Crişuri Plain, it is manifested on narrow surfaces, being specific to the High Plain.

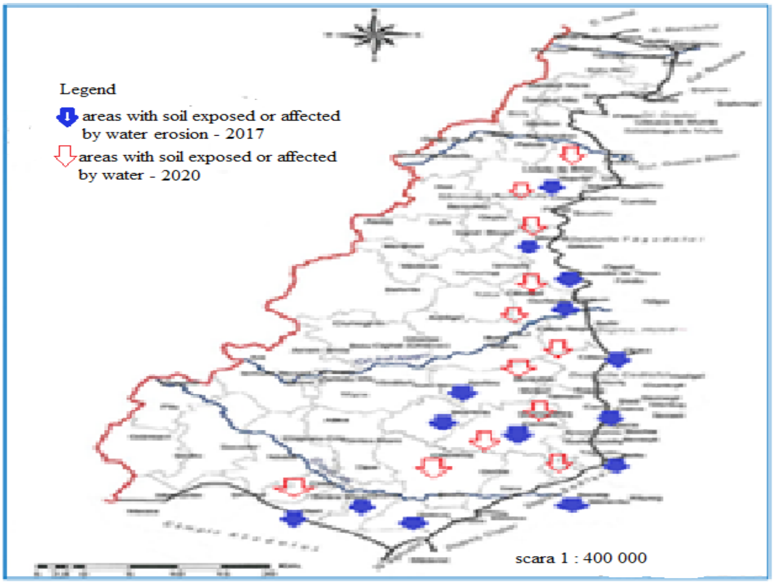

Fig. 1. Crişurilor Plain. Representation of soil surfaces subject to or affected by water erosion in 2017 and 2020

The soils in the Plain are degraded by secondary compaction

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

Figure 2 shows the land area with secondary compaction, at the level of 2017 and 2020.

Secondary compaction

It is a process of degradation of the hydrophysical characteristics of soils due to human activity, mainly due to intensive use in agriculture and is manifested by the worsening of the aerohydric regime and the manifestation of nutritional disorders in plants. One of the causes of primary compaction is the practice of monoculture, crop rotation is practiced only in agricultural units with large areas of land. Individual producers practice monoculture intensively, due to the small areas of land they have. In Crişurilor Plain, they are affected by the secondary compaction of 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, Cefa, Leş, Miersig, Mădăras, Salonta, Gurbediu, Ciumeghiu, Avram Iancu, Călacea, Craiva, Cermei, Sepreuş, Beliu, Ineu, Șicula, Seleuş, Bocsig, Olari, Șimand, Macea, Avram Iancu. Compared to 2017, there is an increase in areas.

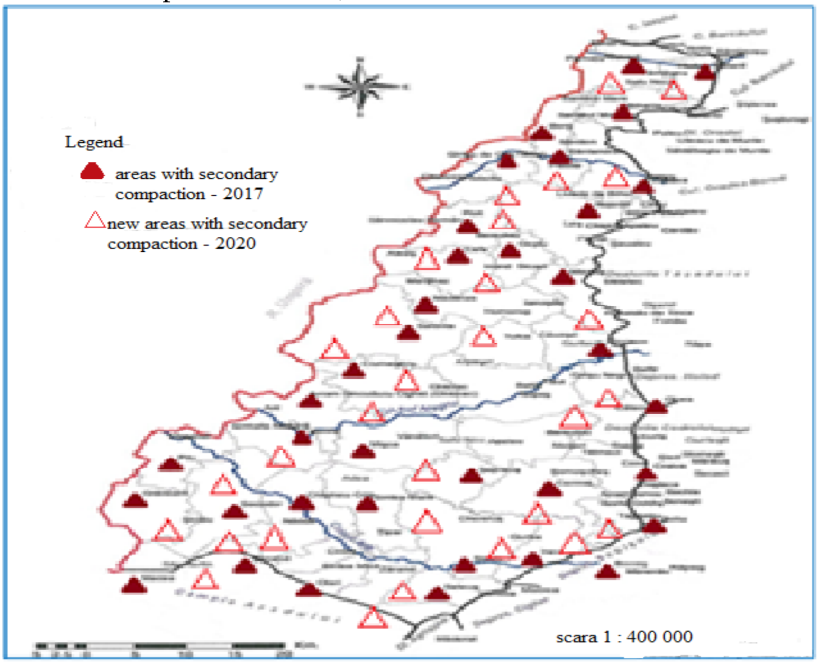

Fig. 2 The land area secondary compaction, at the level of 2017 and 2020

The soils in the Crişului 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 soils. Representative surfaces of stagnic soils are found on surfaces, flat or slightly inclined, in the depression areas, 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 3 shows the distribution of stagnic soils in the Crişuri Plain.

At the level of 2020, there is a decrease of the areas affected by the temporary excess moisture from precipitations, due to the deficient pluviometric regime.

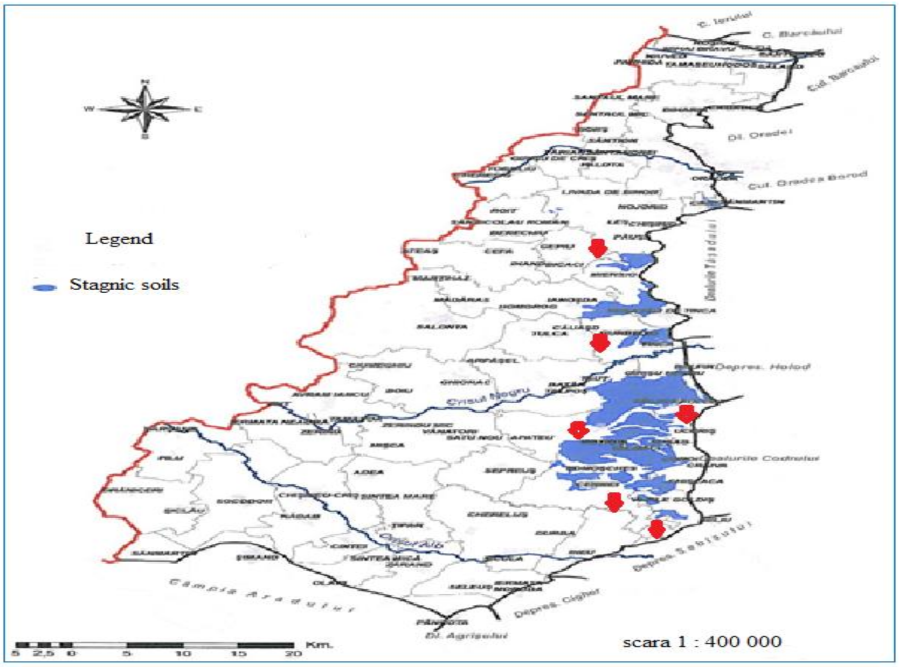

Fig. 3. Crişurilor Plain. Areas occupied by stagnant soils (2020) and the downward trend of areas due to poor rainfall (red)

The soils of the Crişului Plain with excess of ground water

The soils affected by the excess groundwater are the gleysols, occupying in the Crişurilor Plain a total area of 15,342 ha. The major areas are found in low meadows with groundwater at a critical depth of 1-2 m in Borş, Santău Mic, Santău Mare, Toboliu, Sântion, Mihai Bravu, Parhida, Inand, Satu Nou, Tămasu, Tulca, Ghiorac, Cefa, Inand, Homorog, Salonta, Ciumeghiu, Avram Iancu, Biharia, etc. Figure 5 shows the distribution of gleyosols in the Crişuri Plain. Compared to 2017, between 2017 and 2020, due to the deficient rainfall regime, the groundwater level was at minimum levels, without affecting agricultural crops. A 10% decrease in groundwater areas is estimated to fall. n the Crișuri Plain, in some low areas, the existence of the aquifer close to the surface, at depths less than 1 m, led to the formation of large areas of swamp, about 1200 ha, most of which are currently transformed and improved as ponds. : in Cepha (670ha), Inand Lake (200ha), Madaras (30ha), Homorog (105ha), Tamasda (206ha), Crisul Alb lakes (Bocsig, Ineu, Seleus), Cermei lake in Teuzu basin, Cigher, Socodor Lake (155ha), Pilu Lake (260ha). The low rainfall regime from 2017 to 2020, correlated with the decrease of the groundwater level led to the decrease of the areas occupied by the swamps by approximately 400 ha.

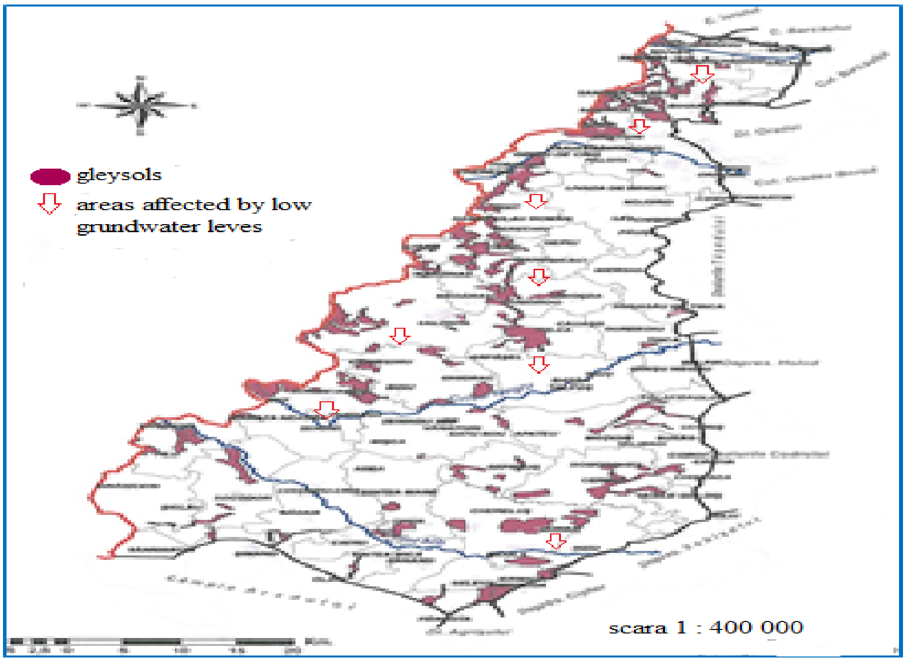

Fig. 4. The area occupied by gleiosols and the tendency of decreasing the surfaces affected by the groundwater level

Soil humus reserve

Compared to 2012 at the level of 2020, there is a sharp decrease in the humus reserve in all soil units in Cîmpa Crișurilor. Due to the intensive cultivation of the soil, the monoculture, the lack of organic fertilizers, led to a continuous decrease of the humus reserve of the soils. The continuous decrease of humus reserve was due to the specific consumption of crops, unilateral fertilization, widespread use of chemical fertilizers, lack of organic fertilizers (Sandor, 2007).. Table 1 presents the humus reserve of some soils on the depth of 0 - 50 cm of the Crișuri Plain and the interpretation depending on the texture for the period 2012 - 2017 and the period 2017-2020.

For the types of stagnant soil and gleysol, there was a stagnation of the raw humus reserve (gleysol - Tulcea - 4.78% humus, stagnant soil - Callacea - 3.92%) the processes of humification of organic matter being slowed by the climate (high temperatures and lack of water in the soil) (Ciobanu and Domuța, 2003).

Table 1.

The evolution of the humus content and of the reserve, at the level of 2020 compared to 2017, for some soils from Crişurilor Plain

Soil Type	Locality	Texture	Humus (%) 2017	Humus (%) 2020
Luvic Chernozems	Sânmartin	LN	2.12	1.96
Haplic Chernozems	Livada de Bihor	LN	2.2	1.82
Greyc Phaeoyems	Nojorid	LL	1.55	1.36
Greyc Phaeoyems	Nojorid	LN	2.1	1.88
Eutric Fluvisols	Toboliu	LL	1.8	1.68
Eutric Cambisols	Sălard	LL	1.7	1.54
Haplic Luvisols	Palota	LL	1.76	1.62
Haplic Luvisols	Tulca	LL	1.1	0.90
Haplic Planosols	Ciuhoi	SF	1.64	1.46
Haplic Solonetz	Zerind	AL	1.32	1.18

Soil Type	Locality	Reserve (0-50 cm) tons/ha 2017	Reserve (0-50 cm) tons/ha 2020	Interpretation
Luvic Chernozems	Sânmartin	238.5	132.2	average content
Haplic Chernozems	Livada de Bihor	247.5	127.4	average content
Greyc Phaeoyems	Nojorid	96.87	95.3	small content.
Greyc Phaeoyems	Nojorid	131.25	131.6	average content
Eutric Fluvisols	Toboliu	112.5	117.6	small content.
Eutric Cambisols	Sălard	106.25	107.8	small content.
Haplic Luvisols	Palota	110	113.4	small content.
Haplic Luvisols	Tulca	71.5	63.0	small content.
Haplic Planosols	Ciuhoi	106.6	102.2	small content.
Haplic Solonetz	Zerind	85.8	82.6	small content.

Soils from Crişurilor Plain with low and medium nitrogen content

The chemical analyzes performed on the soils from Crişurilor Plain showed values of nitrogen intake between 5.2 ppm and 9.6 ppm for the period 2012-2017, which correspond to a low to moderate intake. For the period 2017-2020, a decrease of the ratio was found by approximately 0.4 units. Table 2 compares the nitrogen contribution at the level of 2017 and 2020, in the arable layer of some soil types from Crişurilor Plain and the interpretation according to the real acidity (pH).

Table 2

The evolution of the nitrogen content in the arable layer of certain types of soils from Crişurilor Plain during 2017 - 2020 and the effective acidity (pH).

Soil Type	Locality	pH	N – NH_4^+ + N – NO_3^- (ppm) 2017	N – NH_4^+ + N – NO_3^- (ppm) 2020	Interpretation
Luvic Chernozems	Sânmartin	6.65	8.3	7.9	average content
Haplic Chernozems	Livada de Bihor	6.6	9.6	8.6	average content
Greyc Phaeoyems	Nojorid	6.4	7.4	6.8	average content
Greyc Phaeoyems	Nojorid	6.5	7.9	7.2	average content
Eutric Fluvisols	Toboliu	6.4	6.6	6.1	average content
Eutric Cambisols	Sălard	6.3	5.7	5.8	small content.
Haplic Luvisols	Palota	6.4	5.6	5.2	small content.
Haplic Luvisols	Tulca	6.1	5.2	4.8	small content.
Haplic Planosols	Ciuhoi	6.2	5.2	4.9	small content.
Haplic Solonetz	Zerind	8.4	6.9	6.2	small content.

Figure 5 shows the areas with soils with low and moderate nitrogen content and the areas where the decrease in nitrogen content took place (for the period 2017 - 2020)

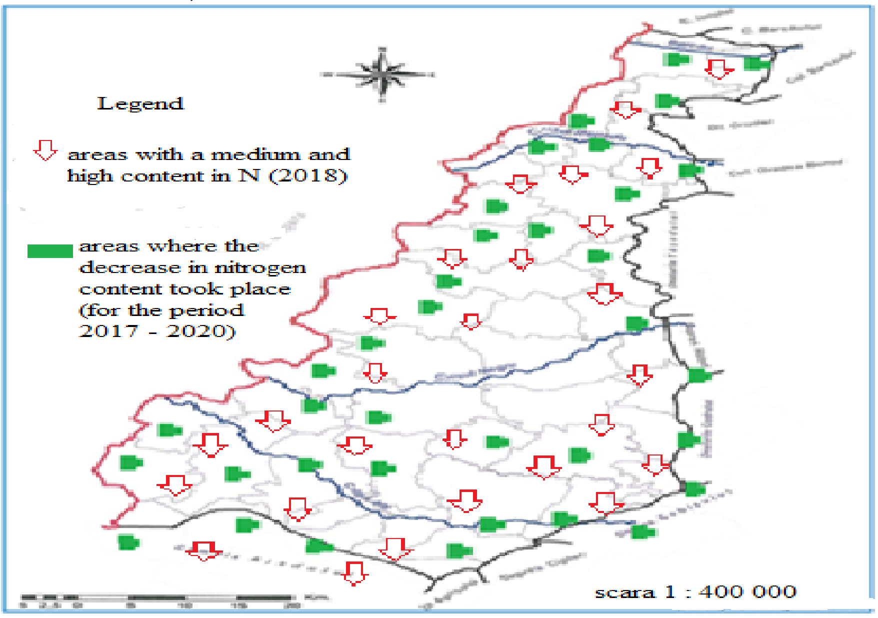

Fig. 5 The areas with soils with low and moderate nitrogen content and the areas where the decrease in nitrogen content took place (for the period 2017 - 2020)

Soils from Crișurilor Plain with low and moderate phosphorus and potassium content

Following the analysis of the phosphorus content in the soil in the Crisului Plain, values between 6 and 36 ppm in phosphorus were obtained, values corresponding to a very low to medium supply state in 2017. For 2020, there is a decrease of about 1.3 - 4.2 units. Most have a phosphorus content in the range of 4-16 ppm, corresponding to a very poor and poor supply state.

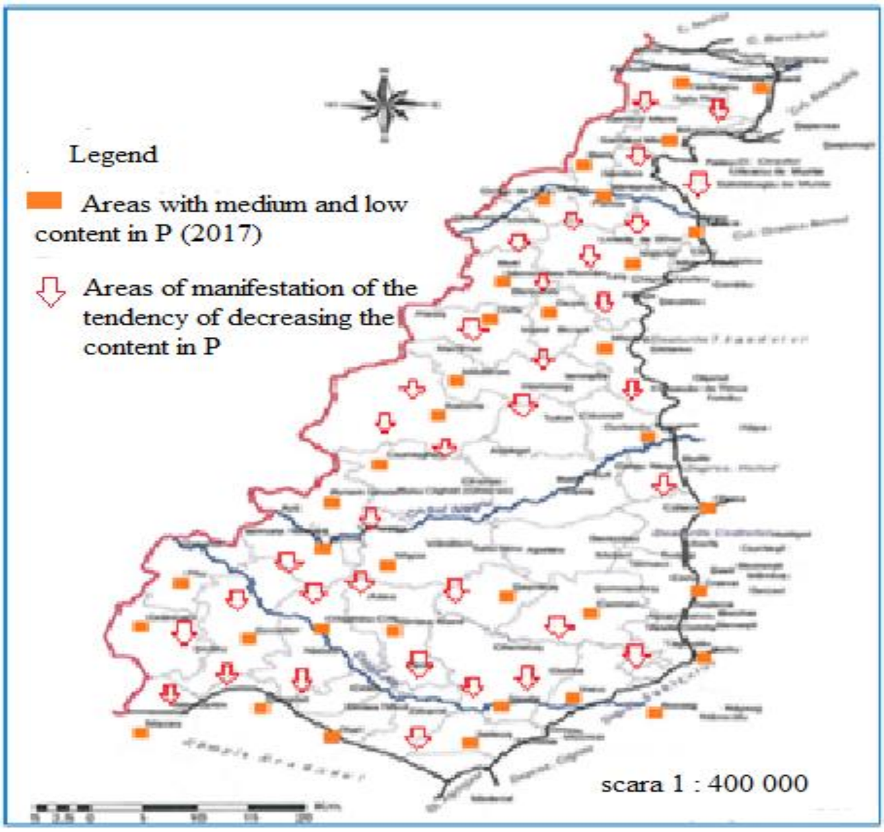

Fig. 6 The areas of the Crisului Plain with medium and low phosphorus content and the evolution in the period 2017 – 2021

In order to evaluate the potassium content of the soils in Crișurilor Plain, analyzes were performed on the potassium content of soils. At the level of 2017, the values were between 60 and 132 ppm, most of them presenting values in the range 60 -110, corresponding to a small to medium supply. For 2021, there is a decrease in content by 10 to 15 units.

Table 3

The phosphorus and potassium content in the arable layer of some soil types in the Crişurilor Plain and the interpretation at the level of 2017 and 2021

Soil Type	Locality	ppm P-2017	ppm P-2020	Interpretation
Luvic Chernozems	Sânmartin	28	24,6	average content
Haplic Chernozems	Livada de Bihor	19.7	17.5	average content
Greyc Phaeoyems	Nojorid	17.7	15.3	small content.
Greyc Phaeoyems	Nojorid	16.9	14.7	small content.
Eutric Fluvisols	Toboliu	15.8	13.4	small content.
Eutric Cambisols	Sălard	13.2	11.7	small content.
Haplic Luvisols	Palota	12.1	10.7	small content.
Haplic Luvisols	Tulca	9.4	7.2	small content.
Haplic Planosols	Ciuhoi	8.6	7.1	small content.
Haplic Solonetz	Zerind	6.1	5.2	very small content
Dystric Gleysols	Toboliu	14.5	11.9	small content.
Stagnic Luvisols	Călacea	9.2	7.6	small content.

Soil Type	Locality	ppm K-2017	ppm K-2020	Interpretation
Luvic Chernozems	Sânmartin	120	115	average content
Haplic Chernozems	Livada de Bihor	110	95	average content
Greyc Phaeoyems	Nojorid	110	95	average content
Greyc Phaeoyems	Nojorid	105	90	average content
Eutric Fluvisols	Toboliu	90	80	average content
Eutric Cambisols	Sălard	65	55	small content.
Haplic Luvisols	Palota	60	50	small content.
Haplic Luvisols	Tulca	55	45	small content.
Haplic Planosols	Ciuhoi	60	50	small content.
Haplic Solonetz	Zerind	55	45	small content.
Dystric Gleysols	Toboliu	60	45	small content.
Stagnic Luvisols	Călacea	65	45	small content.

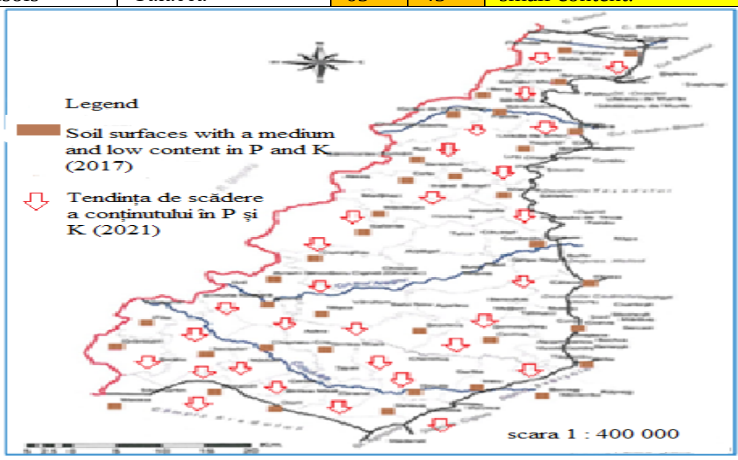

Fig. 7. The soil areas in the Crişurilor Plain with low and medium potassium content, at the level of 2017 and 2021

Restoring degraded soils is crucial to stop the expanding footprint of land degradation and feed our growing human population. To return degraded landscapes to productivity, sandy soils must first be improved to enhance water and nutrient holding capacity (Menzies Pluera et al., 2020).

CONCLUSIONS

The studies and research carried out in the Crișurilor Plain constitute a real basis for solving some problems less studied or neglected so far regarding:

- obtaining and making maps on: soil characteristics, soil technology indicators and maps on production capacity;
- conservation and rational use of the entire land fund;
- knowledge of soils affected by erosion and establishment of anti-erosion measures for the capitalization of these lands;
- knowledge of soil surfaces affected by excess rainfall or groundwater;
- knowledge of soils degraded due to agricultural activities;
- knowledge of the soil areas affected by the decrease in humus and nutrient reserves
- improvement of soils affected by excess rain or flood moisture;
- organization of the territory and design of land improvement works;
- the correct application of the different agrotechnical units in the agricultural units by correlating the physico-chemical characteristics of the soil with the requirements of the crop plants.
- monitoring the evolution over time of the main soil trophicity indicators.
- performing crop maintenance works by correlating the N, P, K content of the soil, with the requirements of crop plants.
- raising the degree of soil trophicity
- crop rotation, as a measure of achieving an optimal ratio between nutrient consumption, to avoid imbalances due to preferential consumption (in the case of monoculture).
- differentiated application of cultivation technologies, in relation to the plant and the type of soil.

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