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RESEARCH ON SOIL AND CROP MACROELEMENTS CONTENT CORELATED WITH LAND RECLAMATION WORKS

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Abstract

As we know, in the last century agriculture began to be very intensively developed from a chemical point of view, which currently created certain problems on its organic component. Soil as matter is made up of two fundamental parts: organic and chemical. The organic part is made up of humus which directly represents soil fertility, the chemical part is represented by some macro and micro elements present in its structure. The studied area is located in the meadow area of Alba County, more precisely on the right bank of the Mureș River between the localities of Aiud and Ciugud. With the help of the I.C.P.A laboratory, we analyzed from different collection points the main indices of the soil pH, Humus, N, P, K. We also analyzed with a drone the N.D.V.I index which shows us the state of vegetation of the crops based on the chlorophyll in the plant. Following the analysis of the specified indexes above, we can state that a decrease in the organic of the soil is observed below its average.

Key words: *agriculture, fertility, humus; soil, vegetation.*

INTRODUCTION

The soil plays an essential role in the normal functioning of terrestrial and aquatic ecosystems, representing an immense global-scale factory that continuously produces, through automorphic processes, the phytomass which forms the basis for the development of heterotrophic organisms, including humans. Without the provision of carbohydrates, proteins, and other compounds by phytomass, as well as the necessary energy, life on Earth would not exist and could not proceed (Burlacu et al., 2003).

The increasing pressure on land use and water management in agriculture, stemming from a series of complex relationships between water, food, and energy, requires enhanced integrated management of water and soil resources (Ragab et al., 2002).

Land improvement means "making the land capable of supporting more intense use by modifying its general characteristics, by draining excessively wet lands, irrigating arid and semi-arid lands, and reclaiming lands from seas, lakes, and rivers". Land improvement addresses a form of land degradation, while land development (land improvement) refers to increasing land value and productivity. Land improvements are an important component of water management in agriculture and have widespread influences across all components: land-water-climate-energy. These land improvement works provide important ecosystem services including groundwater recharge, flood retention, carbon sequestration, organic matter accumulation in soil, soil nutrient recycling, and support for flora and fauna diversity by creating habitats. Integrating these benefits into agricultural water management requires breaking down barriers between engineers, ecologists, agronomists, economists, hydrologists, and climate researchers, and applying valid climate-energy-economy models as well as land use models. (Halbac et al., 2015)

MATERIALS AND METHODS

In order to observe the quantity of macroelements present in the soil, as well as the migration of soil masses incorporating these macroelements, use a series of equipment's, namely equipment necessary for soil sampling and a drone equipped with multispectral sensors to conduct aerial mapping. The research is located in the floodplain area of the Mureș River in Alba County.

It chosen two different locations, namely: Ciugud (Figure 1), a locality located on the left bank of the Mureș River, where I analyzed the component called soil from a physico-chemical-multispectral perspective, and Mesentea (Figure 2), situated on a tributary of the Mureș River, namely Galda. In this case, was analyse the soil solely from a physico-chemical-aerial perspective, as at the time of our field visit, the crop had already been harvested.

Figure 1. Ciugud Area

Figure 2. Mesentea Area

With the help of orthophotoplans provided by the drone, I gained an overview of the works, especially those related to surface erosion, both from water and due to the organization of land preparation for the next crop.

The period during which I conducted field research was from August to October 2023. The equipment used in the following research is as follows:

-DJI Mavic 3 MultiSpectral drone together with the DJI D-RTK 2 mobile station.

-Soil sampling system consisting of a Polaris Ranger Electric UTV equipped with a Wintex 1000 electro-hydraulic probe capable of sampling up to 30 centimeters deep.

The equipped drone features a sensor comprising 5 cameras, the first being a 20-megapixel 4/3 CMOS RGB sensor with a 24 mm lens. The other four sensors constitute the multispectral sensor, which consists of 4 cameras: green, red, red edge, and near-infrared, each with a resolution of 5 megapixels 1/2.8 CMOS and a 25mm lens. Additionally, the drone is equipped with an RTK module that receives GNSS signals in accordance with the D-RTK station, providing centimeter-level precision. For image processing to create cartograms, we utilized DJI Terra and Agisoft Metashape software, while soil study data were processed using Microsoft Word and Excel packages.

RESULTS AND DISCUSSIONS

As mentioned, the study area is located in the floodplain of the Mureș River near the municipality of Alba Iulia. The first field under study is situated in the outskirts of the Ciugud locality, near the Mureș River, while the second is in the hilly area of Mesentea, near the Galda stream, a left tributary of the Mureș River. For ease of identification, we will generically refer to these fields as Mesentea and Ciugud. Soil samples and terrain mapping were conducted using the equipment outlined in the previous chapter. To obtain more specific results, we chose fields from diametrically opposite zones:

- The Ciugud field is located in close proximity to the Mureș River, covering an area of 5 hectares, and its terrain exhibits a nearly flat profile with minimal slope;
- The Mesentea field is situated in the hilly area on the right side of the Galda stream, spanning an area of 18 hectares, with an average slope of 7.4%.

I specifically chose these fields because in the following sections, I will present certain differences in terms of soil mass movement under various external factors. Soil samples were collected at a depth of 30 cm in both fields. The collected samples were analysed in the laboratory of the National Institute for Research and Development in Pedology and Environmental Protection.

After the samples were naturally dried, the analyses were conducted using the following methods:
- The phosphorus and potassium content, as mobile forms, were determined using the Egner-Riehm-Domingo method in ammonium lactate-acetate extract (PAL and KAL), with results expressed in ppm;
- Total nitrogen content was determined using the Kjeldahl method, expressed in percentage;
- Humus content was assessed using the oxidimetric method, specifically the Walkley-Black variant modified, with results expressed as a percentage;
- pH was measured in aqueous suspension, determined at a soil/water ratio of 1: 2.5, potentiometrically, using a glass-calomel electrode pair.

With the help of the drone, we generated orthophotomaps of the surfaces, and for the Ciugud field, I will also analyze the crop from a multispectral perspective to compare the data with the physico-chemical ones.

According to the data presented in Figure 1, we conclude that both areas are under the incidence of floods, which leads us to consider certain limiting factors.

The main constraints of agricultural soil quality are: drought; periodic excess soil moisture; soil water erosion; landslides; wind erosion; excessive surface skeleton; soil salinization; secondary soil compaction due to improper work; primary soil compaction; crust formation; low to extremely low humus reserves; strong and moderate acidity; poor to very poor availability of mobile phosphorus; poor to very poor availability of mobile potassium; poor nitrogen availability; microelement deficiencies; physico-chemical soil pollution; land covering with waste and solid residues (Table 1).

Soil degradation is evident across almost the entire area of Alba County. Critical areas are encountered in the Târnavelor Plateau, in terms of soil erosion and landslides (OSPA Alba). The Mureș River floodplain and the Galda Plateau are prone to flooding, while periodic drought has affected soils in the Șibot, Sebeș, Cunța, Blaj, Ocna Mureș, and Mureș River floodplain areas. Sandy soils are found in the Blaj, Crăciunelu de Jos, and Vințu de Jos areas.

The land improvement works carried out in Alba County during the period 2016-2021 are detailed in Table 2 that irrigation works covered 3.691 hectares of arable land in 2021, 51 hectares less than in 2016. Drainage works covered 1.454 hectares of arable land in 2021, 5 hectares less than in 2016. Regarding soil improvement and erosion control works, the serviced areas remained the same for all categories of agricultural land. O.S.P.A Alba (2023).

Table 1. Limiting factors for soil quality in the Alba County, O.S.P.A Alba (2023)

Degradation factors	Zone
Erosion	Târnavelor Plateau
Landslides	Târnavelor Plateau
Flooding	Mureș, Galda Meadow
Acidity	Montan Zone
Lack of macroelements	All Alba County
Reduced edaphic volume	Montan Zone
Saliniy	Ocna Mureș Plateau
Moisture excess	Medrow Zone
Gleyzation	All Alba County
Pseudogleyzation	All Alba County
Periodic Drought	Mureș Meadrow
Sandy Grounds	Meadrow Zone

Table 2. Land Improvement works in Alba County (2016-2021)

Works/year	2016	2017	2018	2019	2020	2021
Irrigation	3.742	3.691	3.691	3.691	3.691	3.691
Soil Erossion Control	23.318	23.318	23.318	23.318	23.318	23.318
Drainage and dewatering	1.459	1.454	1.454	1.454	1.454	1.454

Equipments that formed the basis for collecting field samples (Figures 3-6). In Figure 1, the equipment for probing consists of a Polaris UTV and a Wintex 1000 Soil Probe. In the second figure, as can be seen on the drone remote control screen, the drone is performing a soil scanning mission. Both images, were presented in the Mesentea land.

Figure 3. Soil Sampling Equipment

Figure 4. Drone RC Plus-Controller

In Figure 5, the probing equipment is pictured frontally, and in Figure 6, we can observe the mobile D-RTK station, as well as how a UAV operator must monitor every movement of the drone both on the remote control display and physically where it is positioned. Similar to the previous images, we are still on the Mesentea land.

Figure 5. Front of the UTV

Figure 6. Me and the D-RTK Mobile Station

Table 3. The results obtained from the laboratory analyses for Ciugud field

Probe	Ph	Humus	Nt	P	K
U.M	-	%	%	ppm	ppm
1-4	8.01	2.62	0,164	36	138
5-7	8.05	2.62	0,143	22	125
Average	8.03	2.62	0,153	29	132

As we can observe in Table 3, according to the laboratory analyses, the average pH value is 8.03, indicating that the soil reaction is slightly alkaline; the amount of humus present in the soil is moderate; the analysed macroelements show average values except for potassium, which falls within the upper limit.

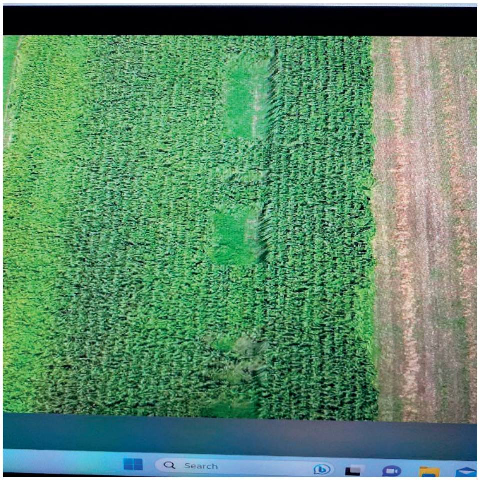

Figure 7. Ciugud land with corn planted before harvesting

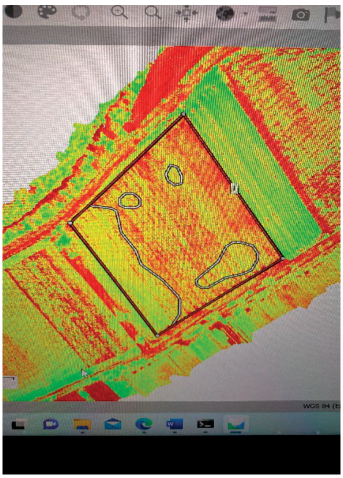

Figure 8. Ciugud land N.D.V.I analysis

In Figures 7 and 8, prior to harvesting, corn for silage was sown as a crop. Based on the orthophoto plan, we calculated the Normalized Difference Vegetation Index (NDVI), which is a numerical indicator of plant health, reflecting the quantity and quality of vegetation cover in a specific area of the field. It is calculated using drone or satellite imagery and depends on the degree of absorption and reflection of light waves. The formula for calculating it is: (NIR-R)/(NIR+R). Based on the N.D.V.I. imagery and overlaid with fizical analyses, it can be observed that this plot did not have sufficient nitrogen during the initial growth stage, leading to an average yield. The vegetation index calculation was performed using the Agisoft Metashape software.

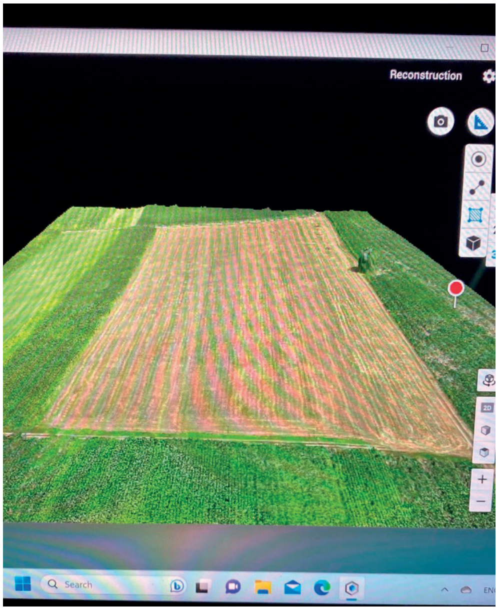

Figure 9: Ciugud land after harvesting, image was processed with DJI Terra Software

Based on the previously presented information for the Ciugud plot, it can be inferred that nitrogen, in this case, was leached under the influence of environmental factors (precipitation and water table), mostly in the form of ammonia. Regarding the other macroelements, their values remain constant compared to previous years because loss only occurs through physical soil displacement, and in this case, with no slope terrain, the loss is minimal.

Table 4. The results obtained from the laboratory analuses for Mesentea field

Probe	pH	Humus	Nt	P	K
U.M	-	%	%	ppm	ppm
1	6.74	3.12	0.132	15	190
2	6.49	3.33	0.111	9	182
3	6.32	3.28	0.154	22	205
4	6.28	3.41	0.180	26	186
5	6.21	3.88	0.198	40	213
Average	6.41	3.40	0.155	22,4	195

Figure 10. Orthophoto plan Mesentea Field processed with DJI Terra

In this case, we were unable to calculate the NDVI index as the crop had been harvested at the time of index analysis. In comparison to the Ciugud plot, the slope of the terrain in this case is around 7.4%, presenting several aspects in terms of soil movement. As observed, being situated in a coastal area under the influence of torrential rains, there is a quite pronounced erosion, noticeable in Figure 10. Additionally, the land is tilled from the top to the bottom instead of along contour lines, which exacerbates surface erosion. Table 4 precisely depicts what is observed from the drone, namely, soil erosion affecting macroelements. Soil samples were collected starting from the top of the field and continuing towards its base.

It can be observed, especially through the migration of phosphorus and potassium, how evident soil erosion is, as significant quantities have reached the base of the field. Nitrogen, like in the other plot, has been largely lost through leaching and nitrification.

CONCLUSIONS

Based on the field research conducted with the help of drones, overlaying the analyses on the obtained images, we can say that agricultural surfaces, especially under agricultural intensification both physically and chemically, accelerate the processes of organic matter depletion, especially in the case of sloping terrains. These issues can largely be avoided by adopting minimum tillage practices, working the land along contour lines, and last but not least, applying rationalized chemical fertilizers preferably based on an agrochemical study**.**

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