SUMMARY OF PhD THESIS

Assessment of suitability for different agricultural crops based on land reclamation with emphasis on the influence of soil pollution within the Someșului Mic Corridor, Cluj Napoca-Dej sector

PhD student **Matei Ioan**

Scientific supervisor **Prof. univ. dr. Ioan Păcurar**

INTRODUCERE

The Someș river corridor represents a territory characterized by favorable conditions for living and for using the land for farming purposes, providing favorable conditions for the development of human settlements and implicitly for the economic activities carried out in the area.

The purpose of this study is to identify plots of land located outside the built-up area that can be used for arable use, a usage that is pursued thanks to the favorability created by the pedological resources, by the morphometric characteristics specific to the major riverbed of Someș River, and, last but not least, by the climatic conditions.

Therefore, the GIS technology will be used, which allows the management of the databases representing soil, relief and climate factors, thus achieving the classification of all plots by favorability classes for agricultural use.

For the correct classification by favorability classes, the degree of soil and groundwater pollution will be analyzed based on chemical test of water and soil profiles made in the perimeter of the former abandoned industrial platforms of which surfaces are intended to be reintroduced into the local economic circuit.

The highest degree of soil pollution with ammonium and sulfates will be studied in the entire studied region using large-scale synthetic pedological studies, and, as regards Dej industrial park, on the territory of the former industrial platform of the paper mill, a detail test will be carried out, because the higher degree of pollution leads to the amendment of the classes of assessment for arable use despite meeting the favorable conditions induced by climate and relief for arable crops that predominate in the study area.

The researches mainly aimed at classifying by agricultural favorability classes the main species in the category of agricultural use, using GIS techniques and in-field data in order to have an overall image of soil pollution in the Someș corridor between Cluj Napoca and Dej.

Cuvinte cheie: favorability, G.I.S. modeling, soil pollution, economic efficiency

The main objective of this study is to identify the territorial areas with high suitability for agricultural use in an area with a rich history in terms of implementation of agricultural crops, primarily due to landforms (altitudes, slope and slope orientation), climatic factors (favorable climate with rich rainfall and relatively high average temperatures), natural water intake (groundwater close to the surface) and the possibility of carrying out technical works for the implementation of irrigation due to the permanent hydrographic network (Someşul Mic River and its tributaries) which drains the analyzed area; and last but not least the easy access of all categories of farming equipment used in tillage, fine-tuning and harvesting of products grown on agricultural land.

The study area is represented by the valley corridor area of Someşului Mic (Cluj-Napoca-Dej sector), a sector that has an area of 563 km2, being located within the NW Region of Romania, Cluj County. From a morphological point of view, this sector varies in an altitudinal gap between 219 and 622 meters altitude, with a slope of relief between 0.1 and 35.86º. From the administrative point of view, at the level of this territory, there are 7 territorial administrative units (5 communes and 2 cities: Gherla and Dej).

From a pedological point of view, the analyzed area shows soils from the Cernisols class on the largest area (20247 hectares representing 35.95% of the analyzed territory), on 8436 hectares, soils from the Cambisols class (for 14.98%), Antrisols (on 20.69%) and Luvisols (on an area of 5159 hectares, representing 16.6% of the area of the studied territory), so that, on the remaining areas, there are types of soils belonging to Pelisols and Hidrisols classes.

In order to achieve the final results pursued in this doctoral thesis, the aim was to achieve specific primary and secondary objectives, such as:

• Identify the physical and chemical characteristics of the representative soils for the agricultural crops from the Someş corridor area on the territory of the analyzed territorial administrative units: Apahida, Jucu, Bonțida, Iclod, Gherla, Mintiu Gherlii, Dej.

• In order to capture the influence of environmental factors on the crops in the study area, each of the climatic elements (average annual temperature, average annual rainfall, length of bioactive period), pedological characteristics, geomorphological characteristics (altitude, slope, slope orientation) will be analyzed in detail.

• Create a database related to the mentioned ecological factors, necessary to achieve the land assessment within the study area to determine the viable agricultural plots that may continue to be used as such for the most economically profitable crops or the plots that may enter this category of use, which are currently used for other purposes.

• Run the USLE model in order to classify the studied territory by soil erosion classes.

• Grant coefficients and assessment grades related to each factor used in modeling and related to the studied crops.

• Run the GIS models for classifying the studied territory by favorability classes for the main crops of: corn, wheat, barley, peas, potatoes, beetroot, soybeans and sunflowers.

• Carry out physicochemical tests for soil profiles taken from areas considered representative for the study area in order to capture the identification of nutrient intake, but also the degree of soil pollution.

• Carry out a detailed analysis of economic suitability for the crops chosen according to the characteristics of the land plots on different classes of favorability for each crop, taking into account the distance from the road network and the intrinsic characteristics of the plots (size, slope, forest vegetation coverage degree).

• Amend the land plots affected by soil erosion and pollution.

• Make development proposals necessary for landowners and potential investors in the area, as well as to the local public administration from the Territorial Administrative Units (TAU) in the study area, namely in the corridor area of Someş river.

THE STRUCTURE OF THIS PAPER AND RESEARCH RESULTS

By choosing the topic "Assessment of suitability for different agricultural crops based on land assessment, focusing on the influence of soil pollution within the Someşului Mic Corridor, Cluj Napoca-Dej sector", a general objective was taken into account, namely the identification of territorial areas with high suitability for agricultural use at the level of a territory with features of landforms (altitudes, slope and versant orientation), climatic factors (favorable climate with rich rainfall and relatively high average temperatures), natural water intake (groundwater close to the surface) and the possibility of technical works for the implementation of irrigation due to the high density of the permanent hydrographic network.

This paper is structured in three main parts:

The current study of knowledge, where bibliographic documentation was used, which means that we studied the specialized literature in this regard. Thus, a retrospective was carried out on the previous research of the soil, climate features, as well as of the main pollutants from the study area.

***The personal* contribution, results and discussions**, that concerned several directions, respectively the identification of the pollution degree, were used as source of inspiration, collected from various locations, both from the former industrial platforms, and from Someşul Mic riverbed, water samples for which the chemical features were determined both at the sampling site, and after undergoing lab tests.

To these were added the tests carried out after taking 42 soil samples and 5 groundwater samples.

The number of collected samples was determined taking into account the size of the potentially polluted areas, the stratification of the land, as well as the high financial implications of making the tests. The samples were taken from various locations, in order to have them dispersed on all cardinal points, taking into account the possibility of the contribution of multiple potential sources of pollution, so as to capture any negative influences on the activities carried out in the proximity of the industrial sites.

As regards the drillings, it was necessary to remove the debris in order to provide the access to the drilling rig, and, as regards the concrete-covered platforms, special milling cutters capable of drilling them were required. The dry drilling rig used is a Hydra Joy 3 equipment, provided with a 100HP diesel engine, with a pressing and extraction force of 3500 kg.

After collecting soil samples, the specific chemical tests were performed both on soil samples, and on surface and underground water samples.

For the collection of groundwater samples, a PVC pipe (Ø = 70 mm) was used, PVC covers, and groundwater was sampled by means of a sampling tube (bailer) with the diameter Dn = 40 mm, volume V = 1 l, which allows the loading of a column of 0.97 m water, including the existing film, on the same water surface area. Groundwater

samples were taken after pumping 3 times the volume of water from the drilling column. These were executed up to the depth of interception of the layer considered to be the basic layer, at the depth of about 7m from the platform elevation.

The pH was determined according to ISO 10523: 2012 standards implying an accuracy of ± 0.2 and a degree of uncertainty of ± 0.2.

The MSZ ISO 9280-2: 1998 standard was used to determine the sulphate content.

The sulphide content was determined by applying ISO 10530: 1992 and for the determination of the following elements: Cadmium, Lead, Chromium, Copper and Zinc, the (ICP-MS) EPA 6020B: 2014 was applied..

Figure 1: A. Making soil profiles using ROLATEC RL46L equipment. B. Determination of water pH on sampling site C. Collection of water samples from Someș riverbed, D. Installation of water sampling tubes at the level of soil profiles. E. Collection of water

samples at the level of drillings made to collect soil samples.

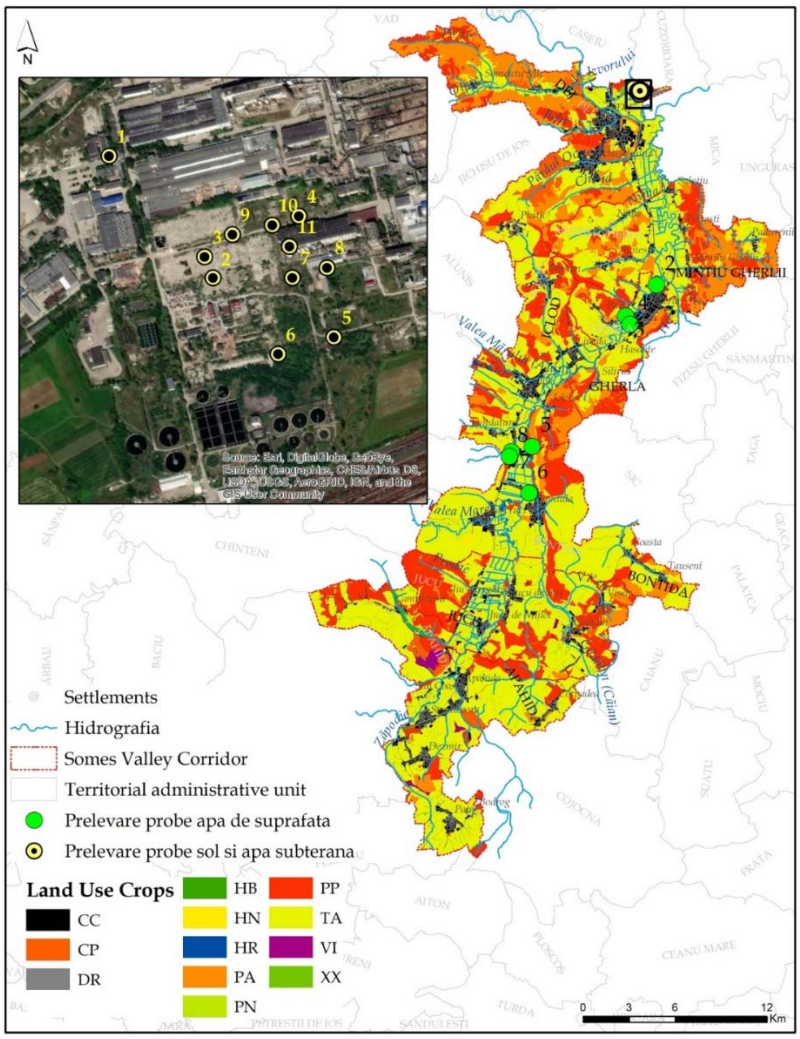

Figure 2. Geographical position of soil and water sampling sites

(where: CC- lands occupied by constructions, yards and industrial areas, CP- permanent crops, DR-lands occupied by roads and railways, HB - water surface area, HN- unproductive lands occupied by swamp vegetation, HR- lands occupied by water courses, PA- land occupied by forest vegetation, PN- refuse dumps, landfills, PP- permanent pastures, TA-the proper arable land, VI - vineyards, XX - areas for which no photointerpretation was carried out).

In order to analyze the degree of soil pollution, the alert and intervention thresholds of pollutants were used: Cd, Cr, Cu, Ni, Pb, Zn.

There are exceedances of the normal values for Nickel, but also high values for samples 4 and 5.

It is noteworthy that these substances move from the surface to the depth by dissolution and absorption, causing imbalances, migrating through the root system of the plants, reaching the fruit (cereals, particularly corn, fodder plants and legumes incorporate most of the heavy metals) and therefore the body of the animals and of humans; their effects consist in the difficulty of the photosynthesis process, for plants, and in circulatory, cardiac, digestive disorders, etc., for humans.

The estimation of the amount of eroded soil in the study area was made using the database related to the land use manner, related to relief features, such as slope and versant length, to the applied agricultural works, etc., using the U.S.L.E model. The area of meadow versants, the area of medium and high hills distinguish themselves, where the amount of eroded soil may exceed 0.280 t/hectare/year.

The meadow sector area, characterized by a low geodeclivity and alluvial soils, shows low values, less than 0.03 t/hectare/year, and they are also known for the extended vegetable areas at the time of the study.

At the level of the analyzed territory, the main geomorphological process that causes problems to agricultural territories is the landslide. Previous studies aimed at identifying these problems, analyzing the causative factors and the thresholds of accumulated precipitations determining them.

Thus, on the analyzed territory, there are 554 active landslides, stabilized, but also with reactivation potential, for which reason the territories where these geomorphological processes are manifested have received low assessment values, particularly for the favorability analysis for beetroot and potato, corn, soybean and sunflower.

After applying the GIS model using the environmental factors modeled in the Someș corridor area, databases were obtained, transposed into favorability maps for the nine crops specific to arable use according to the assessment methodology of agricultural lands in Romania.

Applying the GIS model to determine the favorability of the eight crops previously discussed as an average, all land plots succeeded in being classified by classes of agricultural use.

The analysis and discussions were kept for all the plots, regardless of their current use, because we intend that the results of this study are useful to farmers, landscapers and specialized institutions including when the aim is to change the use of plots. For the entire studied territory, for the arable use, values were identified, that are in the range 1.49-70.2.

Following the classification of each territorial administrative unit by favorability classes for the nine agricultural crops included in the category of arable use, there are ATUs with large areas located in the very high category of favorability for beetroot, such as ATU Jucu, Bonțida, Gherla. The high favorability class (61-80 assessment points) stands out for the pea crop at the level of ATU Dej, Iclod, sunflower for ATU Mintiu Gherli, Apahida and Bonțida.

With these results, farmers in the area, as well as agricultural investors, may use the results of this study to set up new crops, as well as to access non-reimbursable funds for agriculture, by expanding the territories currently used in the arable use category for agricultural crops, which have favorable development conditions. Thus, the risk of failure and lower-than-expected agricultural production will be reduced.

This study is drafted as a complex model of territory analysis, based on spatial analysis, in the GIS environment, of digital databases representing climatic, soil parameters and landform characteristics that are taken into account to identify the favorability of land to agricultural crops. The complexity of the model raises a number of issues related mainly to the quality of the databases used (MDE resolution, different scales of representation for different factors taken into account, different database structures, etc.), the integration of sub-models obtained based on implementation equations of spatial analysis or spatial interpolation, and, last but not least, of database management (approximately 110 different database structures) in the frame of the model.

The analysis of the final result highlights territorial areas favorable to the implementation of agricultural crops, particularly in the terraced areas of Someș river and on the low-sloping versants of tributaries, but also on plots situated close to large urban hubs.

Conclusions and recommendations

In the paper ""*Assessment of suitability for different agricultural crops based on land assessment, focusing on the influence of soil pollution within the Someșului Mic Corridor, Cluj Napoca-Dej sector*", a major importance is given by analyzing the characteristics of relief, soil, climate and the degree of anthropic intervention in the territory, being taken into account an area with a high population density and an area of concentration of economic, human and agricultural flows.

Following the detailed analysis of the study area, it has been pointed out that there are 9778 plots currently used as plots with different uses, that participate in the local economic circuit and therefore in the development of the region, taking into account the proximity to large urban hubs (Cluj-Napoca, Gherla, Dej), but also due to the favorable relief, soil and weather-climatic conditions.

The fact that the number of plots used as arable plots predominates (2132 plots, which represents 48% of the total number of plots in the study area), followed by plots used as permanent pastures (18.33%) and those occupied by forest vegetation (for 13%), this is an argument for conducting a study of such magnitude, that would provide a complex picture of the territory subject to analysis, particularly in the current legislative and environmental context.

As we intend to provide valuable information to landowners in the analyzed area and to investors in agriculture, so that they may make the right decisions regarding the crop that they want to achieve both at the level of their plots and for possible new investments, in the final part of the paper, we made an analysis of the economic efficiency, taking into account the class of favorability of each plot, specific to each crop; we also took into account the size of the plots, the proximity to roads for easy access both at the time of crop establishment, and during harvesting.

Thus, we currently have a detailed analysis carried out at the level of the entire analyzed territory, but also at the level of the territorial administrative unit and, at a larger scale of detail, at the level of agricultural plot on all environmental factors and favorability classes for the main agricultural crops.

Using this database, queries can be operated in the databases, in order to make the best decisions regarding the arrangement of the territory in the study area, decisions that would also benefit the local authorities, landowners or potential investors in the agricultural field.

Originality and innovative contributions of the thesis

The original contributions of the doctoral thesis are summarized as follows:

An analysis of the physical and chemical characteristics of the representative soils for the agricultural crops in the corridor of Someș river on the territory of the analyzed territorial administrative units was carried out in detail: Apahida, Jucu, Bonțida, Iclod, Gherla, Mintiu Gherlii, Dej, as well as a detailed database on environmental factors that directly influence crops in the study area, which includes each of the climatic elements (average annual temperature, average annual rainfall, length of bioactive period), pedological characteristics, geomorphological characteristics (altitude, slope);

Quantitative and qualitative modeling based on G.I.S. techniques was performed for the first time for the study area, which allowed the analysis of the mentioned ecological factors necessary to achieve land assessment in the study area, with the purpose to determine the viable agricultural plots that can continue to be used as such for the most economically profitable crops, or plots that can enter this category of use which are currently used for other purposes;

In order to capture the limiting factors on agricultural crops, the amount of eroded soil was determined, using the general soil erosion equation, adding the analysis of the negative influence of landslides in the study area, so that the assessment notes may be amended in accordance with the reality in the field, taking into account the amendment of plots of land affected by soil erosion and pollution;

Following the complex analysis carried out in the study area, both the landowners in the analyzed area, and the agricultural investors, are provided with valuable information regarding the crop with the best favorability and with the lowest investment rate, taking into account the size of the plots, the proximity to the roads for easy access both when establishing crops, and during harvesting.

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