Geospatial Data Interpretation of the Land Suitability of Heavy Chernozems (Karasolutsi) from North – East Bulgaria for Growing Agricultural Crops

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Abstract

Geographic information systems (GIS) and geospatial analysis are the modern platform (method) for intelligent data interpretation. The study presents the results of geospatial data analysis of the land suitability of Heavy Chernozems (Karasolutsi) from Dobrich region - North-Eastern Bulgaria. The results are visualized in the form of thematic maps by suitability for growing main agricultural crops, land category, and land classification according to FAO. The investigated soils are the most suitable for growing wheat and corn (from the cereal crops), sunflower (from the technical crops), alfalfa (from the fodder crops) and cherries (from the fruit crops). They mainly refer to the 3rd and 4th categories or "good lands", and according to the FAO classification - class S1 suitable lands and class S2 moderately suitable lands.

Keywords: land evaluation, heavy chernozems, agricultural crops, geographic information system, geospatial analysis

Introduction

The main zonal soil type of Northern Bulgaria are the Chernozems. They are the most fertile soils in the country and a large range of agricultural crops can be grown on them (Krasteva et al., 2015). In the North-East and North-West Bulgaria in the form of larger or smaller patches, among the rest of the Chernozems, are the clay variants of the Chernozems. In the North-Western part of the country (Kula, Gramada, Medkovets etc.) they are known as clayey (heavy) Chernozems, and in North-Eastern Bulgaria, known in soil science circles as "Karasolutsi". The genetic-diagnostic characterization of these soils is described in detail by Lyubenova (Lyubenova, 2009). The land evaluation of the clayey (heavy) Chernozems of North-Western Bulgaria is reviewed by Krasteva et al., 2009. Heavy Chernozems are found in the most fertile part of Bulgaria - the Danube Plain, but they are distinguished from the Chernozems, distributed in the same regions by a number of diagnostic parameters, one of which is their heavy soil texture and the resulting unfavorable physico-mechanical properties.

Geographic information systems (GIS) is the modern platform (method) for collecting, creating, storing, analyzing, modeling, visualizing and sharing spatial data from various

sources (land cover data, Global Positioning System, field data, descriptive data, laboratory data, analog maps, satellite data, etc.). GIS manages and analyzes this large data flow in order to solve various tasks and makes management decisions. GIS is the best environment for working in the field of land cover and resource management.

The paper aims to perform a geospatial data analysis of the land suitability of the Chernozems (Karasolutsi) of Dobrich region and to regionalize the main agricultural crops, to indicate the most suitable crops and to visualize the results in the form of maps.

Materials and Methods

The Chernozems (Karasolutsi) are distributed in Southeastern Dobrudja, in the Ludogorsko-Dobrudzhanska and Dobrudzhansko-Chernomorska provinces of the Northern Bulgarian forest-steppe zone (Ninov et al., 1972) in the form of larger or smaller patches among the rest of the Chernozems. They have the widest distribution in the Dobrich region and more limited in the regions of Varna (Gradinarovo, Belogradets, Suvorovo, Varna, etc.) and Shumen (Ivanovo, Madara, Pet Mogili, etc.) (Figure 1.).

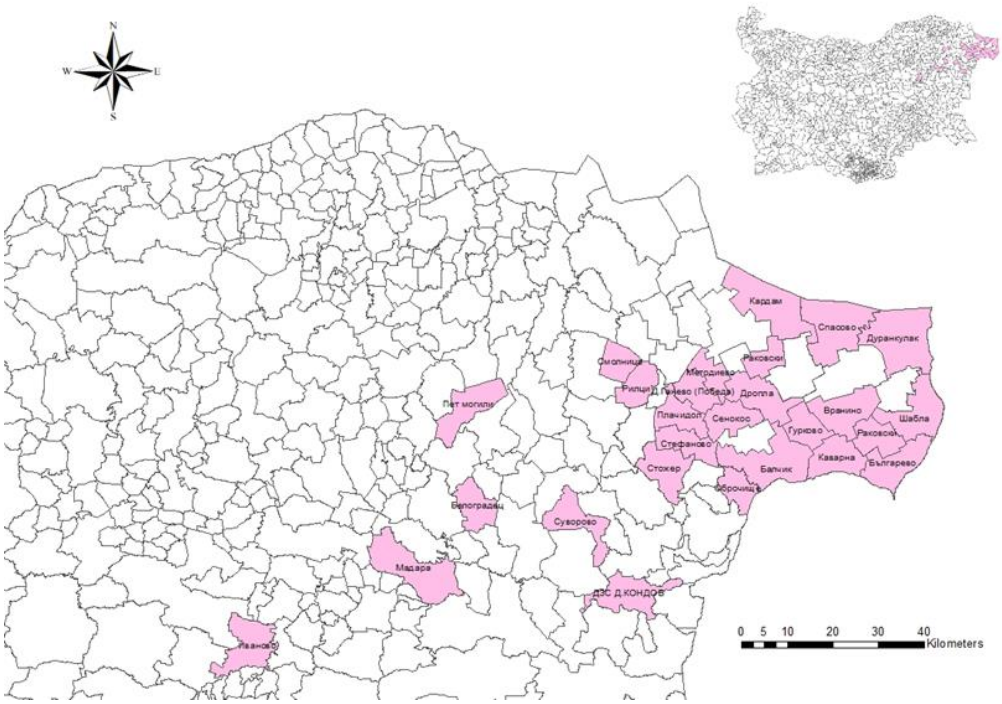


Figure 1. *Localization of the lands where the Karasolutsi are spread*

Dobrich District occupies most of South Dobrudja. It falls in the easternmost part of the Danube hilly plain. The relief is hilly-plateau-like, with characteristic low plateaus up to 150-200 meters above sea level (figure 2.). The investigated soils mainly occupy the relief 's micro-depressions and weakly expressed slope forms, mostly with North-East and North-West exposures. The climate is one of the driest in the country, but at the same time the area is very fertile and is called "the granary of Bulgaria." Agriculture is typical for the region.

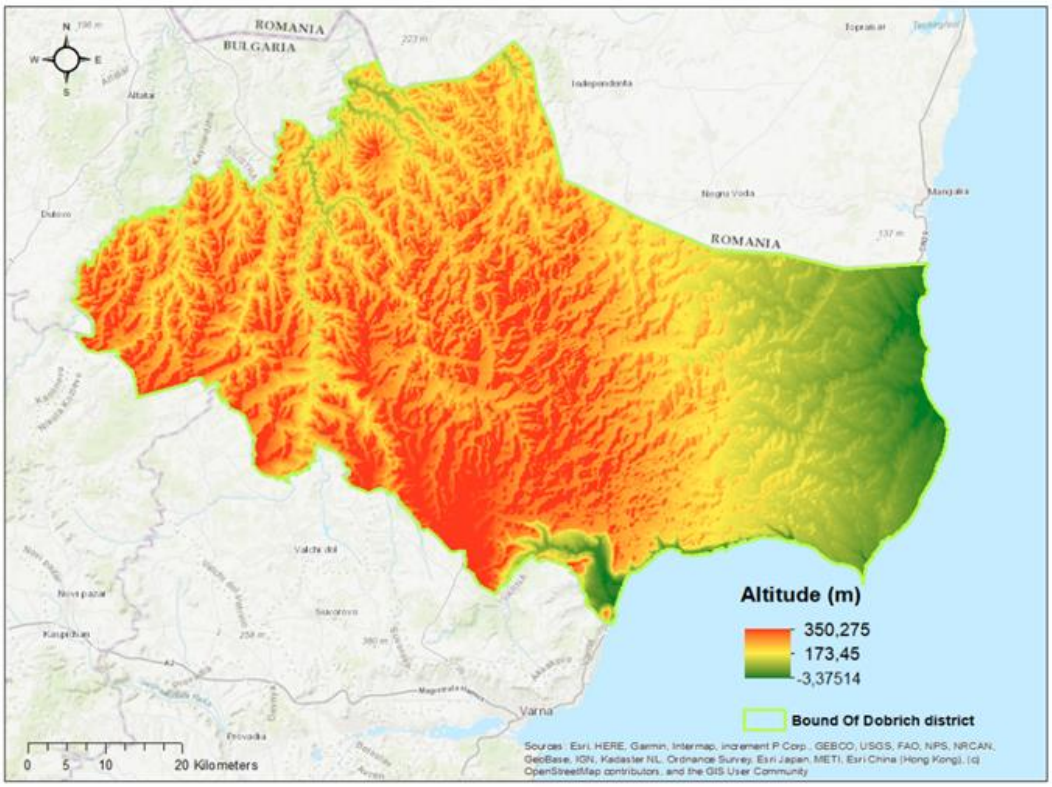


Figure 2. *Altitude of the Dobrich region*

In Dobrich region, the Chernozems (Karasolutsi) cover different sized areas in the lands of the villages: Bulgarevo, Spasovo, Dropla, Stefanovo, Stozher, Metodievo, Smolnitsa, Riltsi, Vrachantsi, Rakovski, H. Dimitar, Poruchik Chunchevo, Vranino, Mogilishte, Dimitar Ganevo, Kotlentsi, Plachi dol, Primortsi, Senokos, Durankulak and the cities of Kavarna, Shabla, Balchik. They are represented by all three subtypes: carbonate, typical and leached Chernozems (Karasolutsi) (slightly, moderately and strongly leached) with a total area of 11992.56 ha (Figure 3.). The leached Karasolutsi predominate – 6940,25 ha, of these, 2643,48 ha are moderately leached, 2641,67 ha are leached, and 1655,10 ha are strongly leached.

Acording to WRBSR, 2014 and latest Bulgarian soil classification (Teoharov et al, 2019) the Chernozems (Karasolutsi) are classified as Vertisols – Calcic Vertisols (carbonate and typical Karasolutsi) and Haplic Vertisols (liched Karasolutsi).

The data used for the land evaluation of the Karasolutsi from the Dobrich region are from Lyubenova's Ph.D. thesis (Lyubenova, 2009) where in preparation of the land evaluation were used soil, climate and agroecological data from ISSAPP "N. Pushkarov archives and Climate Reference Books (Koleva and Peneva, 1990; Kyuchukova, 1979; 1983; Hershkovich, 1970). The land evaluation was made using "Methodology for work on the cadaster of agricultural lands in the NRB" (Petrov et al., 1988) and according to an equation compiled by B. Georgiev (Georgiev, 2007).

For the geospatial data interpretation, the software ArcGIS for Desktop (ArcMap 10.8) was used, as well as digitized soil maps from of ISSAPP "N. Poushkarov" archives.

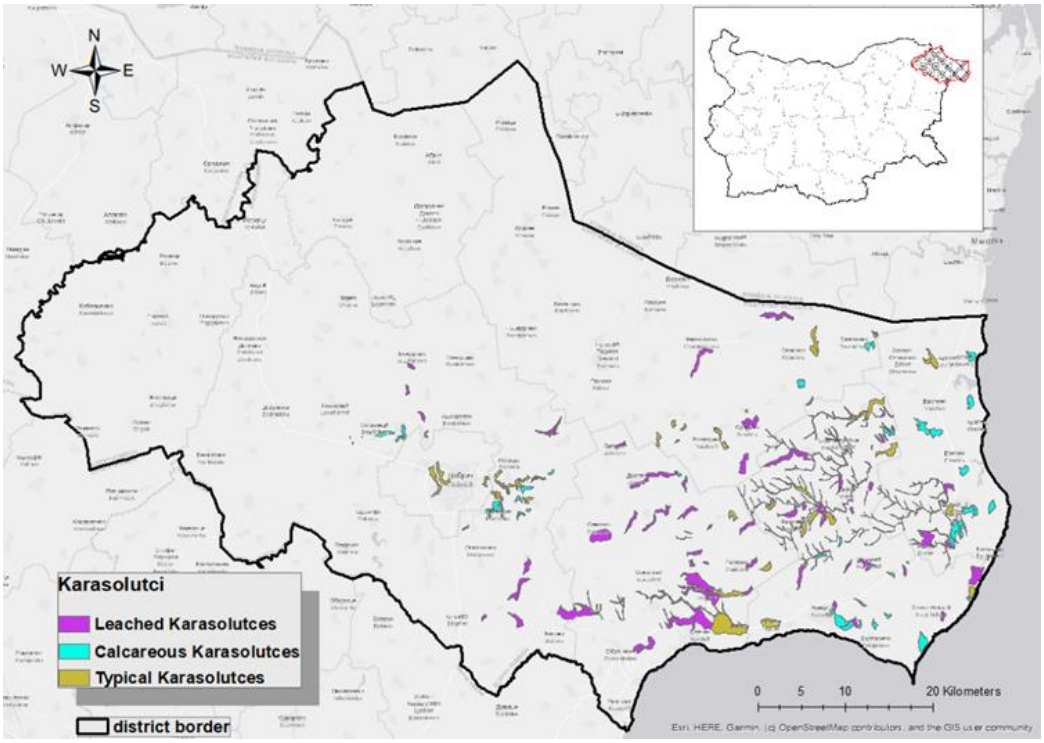


Figure 3. *Subtypes of Karasolutsi on Dobrich region*

Results and Discussion

The results of the land suitability of the Karasolutsi from Dobrich region (Lyubenova, 2009) have been interpreted and analyzed in a GIS environment and a regionalization of the main crops was made. The most suitable crops for cultivation have been indicated. The final classification of the Karasolutsi, according to the Bulgarian methodology, is in line with the recommendations of the FAO (FAO, 1976), using long-term research on the harmonization of the two classifications by Georgiev, 2007. The results are visualized in the form of thematic maps.

According to the land evaluation, the Karasolutsi belong to the group "very good lands" with ratings of 80-100 points for wheat. There are several soil differences in the lands of Smolnitsa, Shabla, Kavarna, Dorich, Pobeda, etc., where ratings are in the range of 70-76 rating grades, i.e. "good lands" (figure 4.).

The land evaluation for corn shows that part of the Karasolutsi from the lands of Plachi dol, Tsarichino, Senokos, Slaveevo, Pchelino, Krapets, Shabla, Travnik, Belgun, etc. belongs to the "very good lands". In the remaining majority of the lands, the ratings are in the range of 60-80 points, i.e. "good lands". There are relatively few places - the lands of Shabla, Ezerets, Kavarna, Smolnitsa, Kozloduytsi, in which the land assessment for corn has lower values from 40 to 60 points or "moderately good lands" (Figure 5.).

In the areas of Durankulak, Stozher, Dimitar Ganevo, Bozhurovo, Stefanovo, Dropla, Senokos there are "good lands" for growing soy.

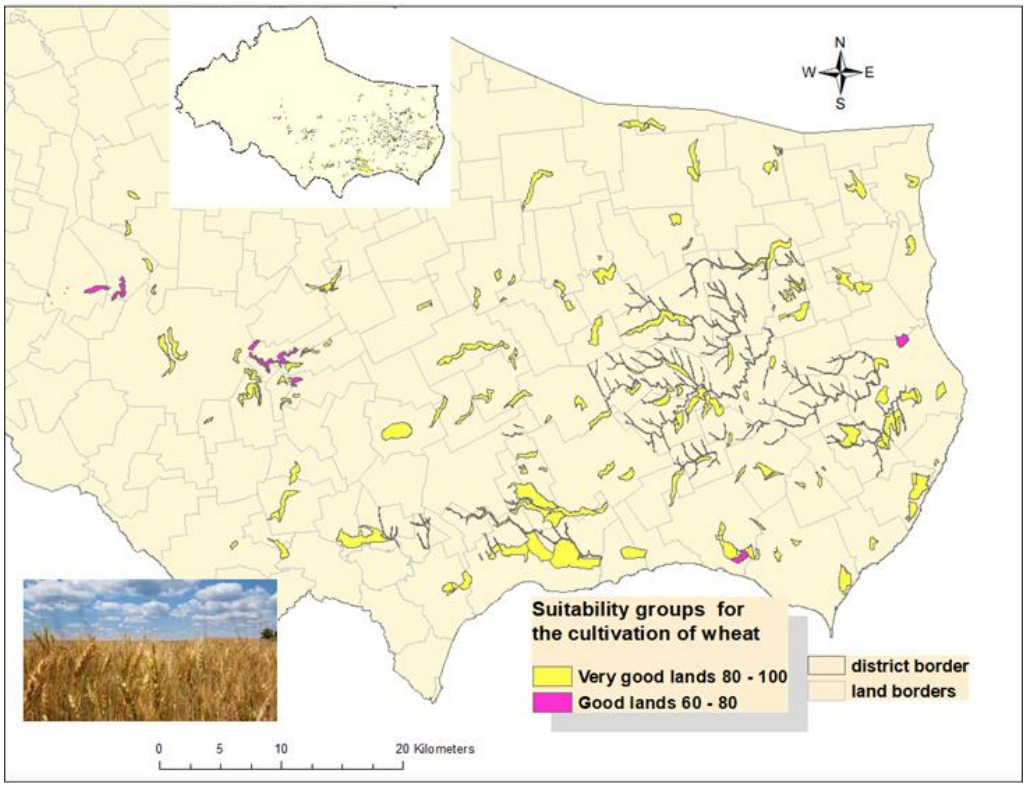


Figure 4. *Suitability of the Karasolutsi from Dobrich region for growing wheat*

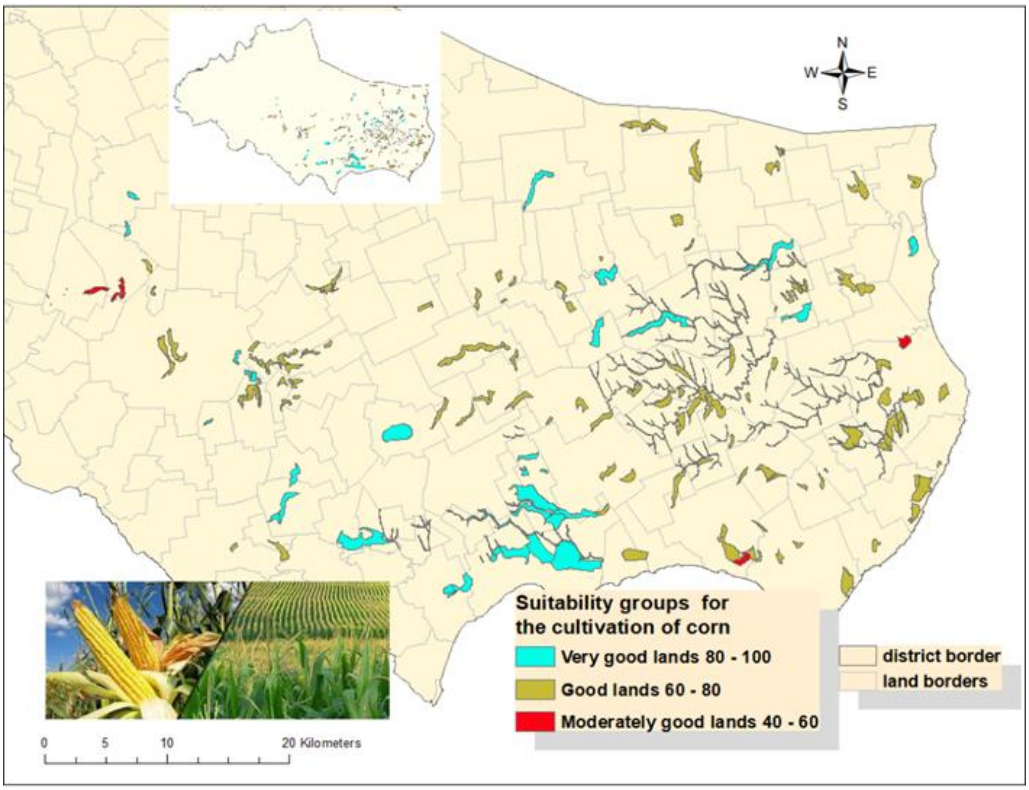


Figure 5. *Suitability of the Karasolutsi from Dobrich region for growing corn*

In almost all regions, the conditions for growing sunflower are "very good" and "good". Less suitable are the lands in Shabla, Staevtsi, Bulgarevo, Kavarna, Kamen bryag, as they belong to the "moderately good" group (Figure 6.).

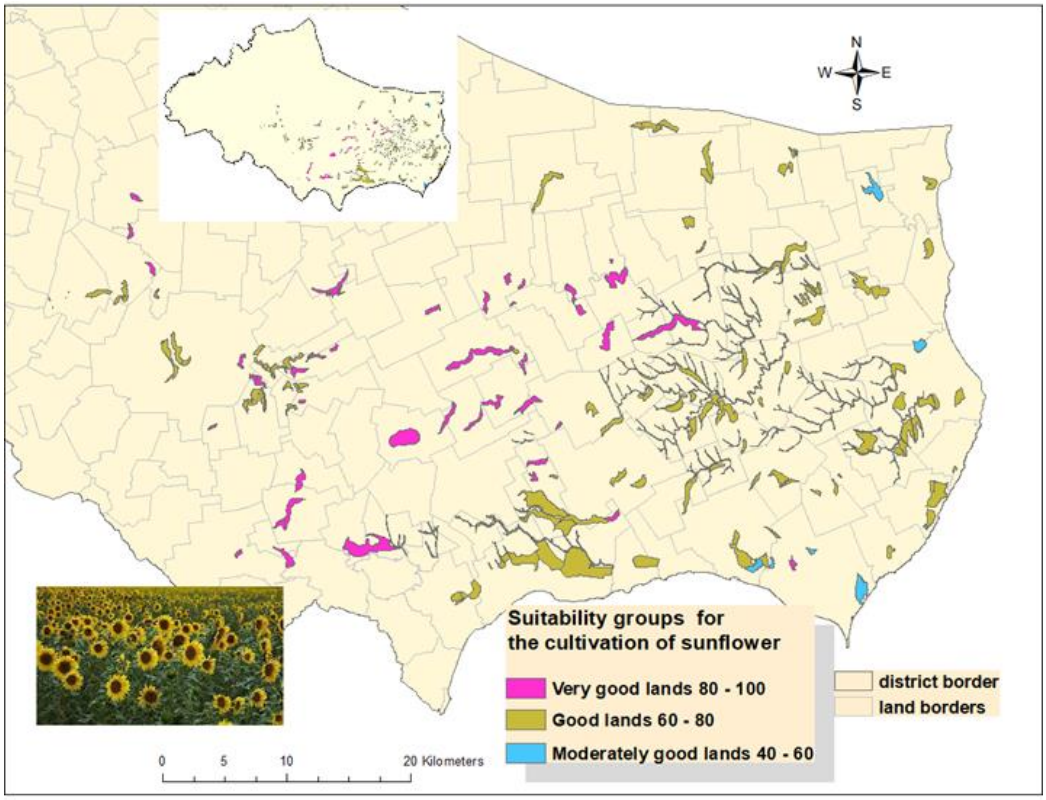


Figure 6. *Suitability of the Karasolutsi from Dobrich region for growing sunflower*

The land evaluation for sugar beet and large-leaf tobacco groups the majority of Chernozems (Karasolutsi) into the category of "good lands". Only in a few areas the soil assessment is over 80 points, i.e. "very good lands" - Durankulak, Bozhurovo, Stefanovo, Senokos. In the lands of Shabla, Kavarna and Vranino, the value is in the range of 40-60 points - "moderately good lands".

Vegetable crops - tomatoes and pepper are grown only with provided irrigation. The soil rating for these crops is from 60 to 80 points - "good lands" for all Karasolutsi.

The investigated soils refer to "very good" and "good" lands for growing alfalfa, with the exception of very small areas in the lands of Shabla and Kavarna, where the assessment is 52-56 points, i.e. "moderately good lands". (Figure 7.).

The soil ratings for pastures and meadows are lower.

Of the fruit crops, the conditions are most suitable for growing cherries - "good" and "very good lands", with very few exceptions (the lands of Vasilevo, Kalina and Preselenci), where the Karasolutsi being defined as "moderately good lands" with a soil rating of 58 points (Figure 8.). The conditions for growing apples, pears and plums are "good" and "moderately good lands". For peaches, the investigated soils are defined as "bad lands" and "moderately good".

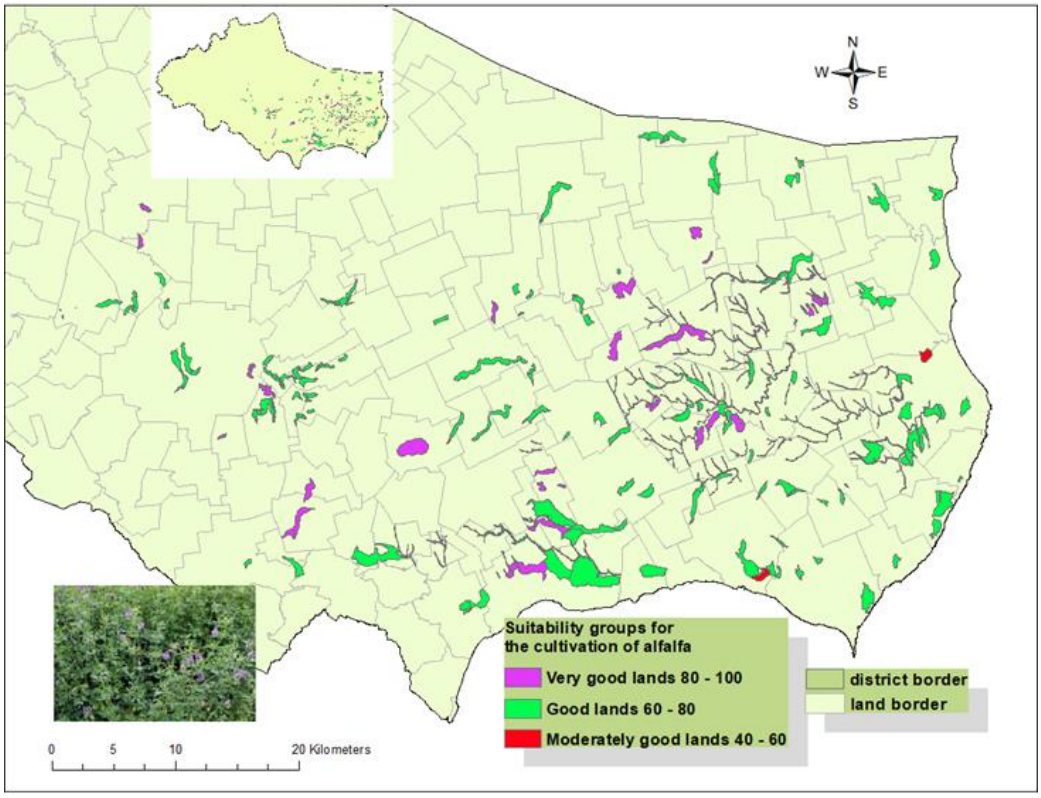


Figure 7. *Suitability of the Karasolutsi from Dobrich region for growing alfalfa*

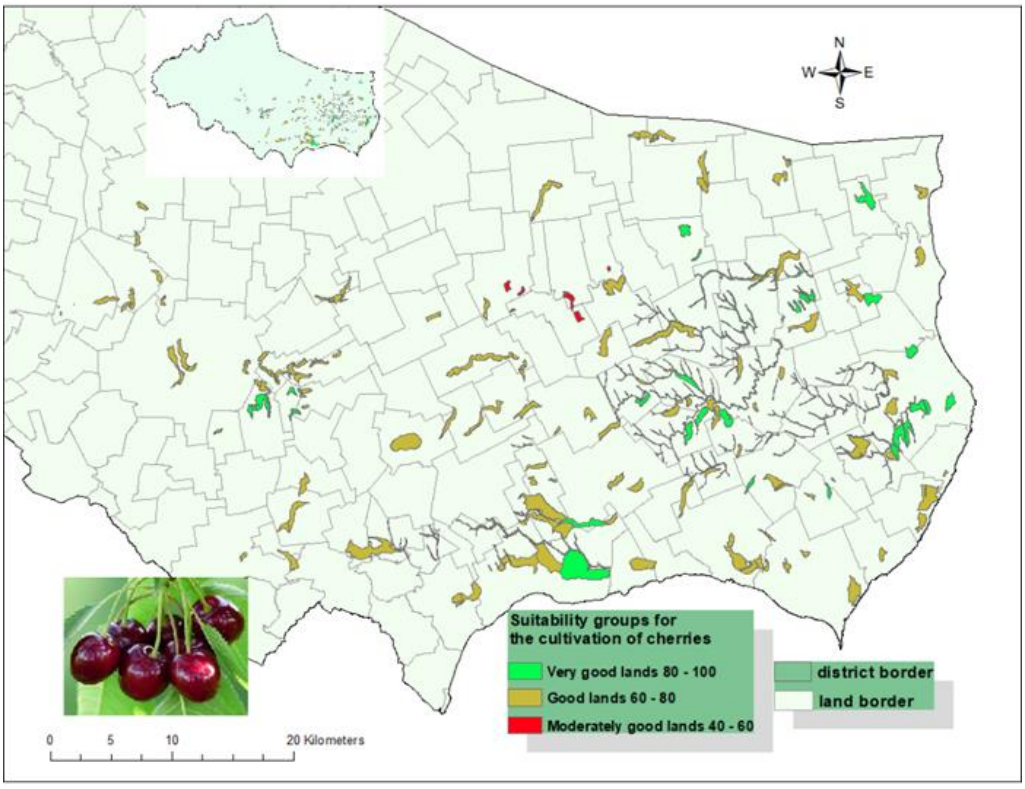


Figure 8. *Suitability of the Karasolutsi from Dobrich region for growing cherries*

The ecological conditions in the region define the Karasolutsi as "good" and "moderately good " lands for growing vineyards. In the lands of Rakovski, Shabla, Balchik,

Hadji Dimitar, Gurkovo, Tsarichino, Bojanovo and Ezerets, there are also "very good lands" with a rating of 81-93 points (Figure 9.).

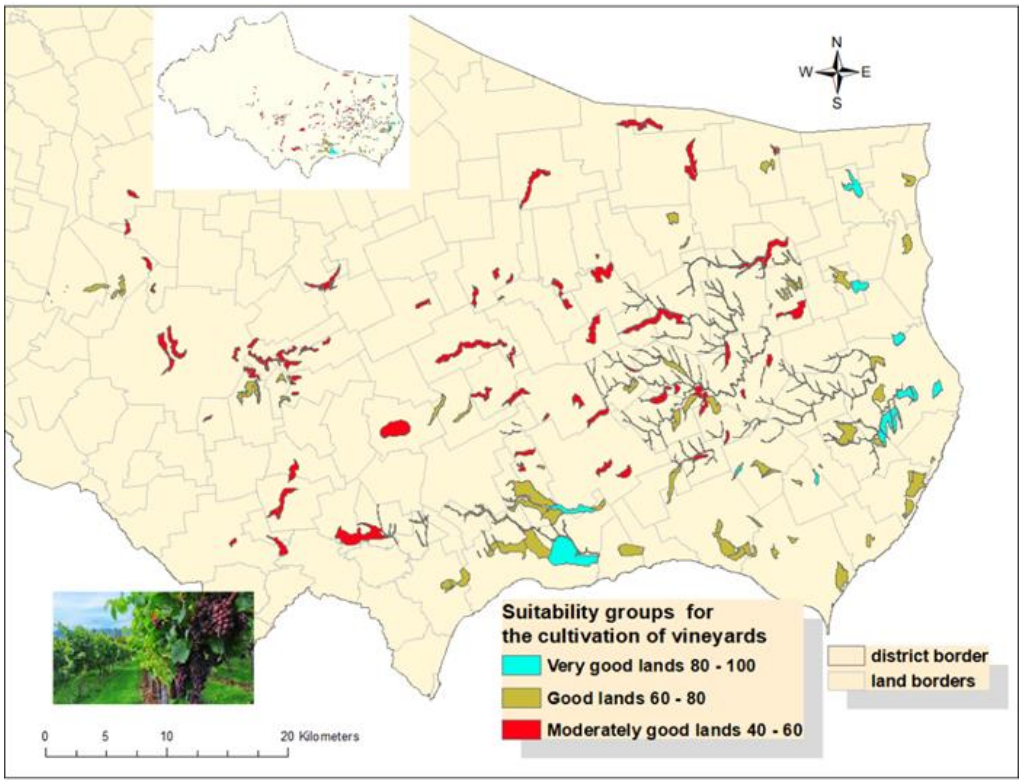


Figure 9. *Suitability of the Karasolutsi from Dobrich region for growing vineyards*

The worst rating is for potatoes, rice and oriental tobacco - "unsuitable lands" (0-20 points) and "bad lands" (20-40 points).

Regarding the total agronomic value of the Chernozems (Karasolutsi), the average agronomic score defines them as the 3rd and 4th categories of land, except for a very small part of the carbonate Karasolutsi in the land of Kavarna, which belongs to the 5th lands category, where the limiting factor is the stoniness of the soils (Figure 10.).

The land evaluation classification of the investigated soils, according to FAO (Figure 11.) classifies them as follows*: class S1* suitable land (9802,416 ha) and *class S2* moderately suitable land (2190,147 ha).

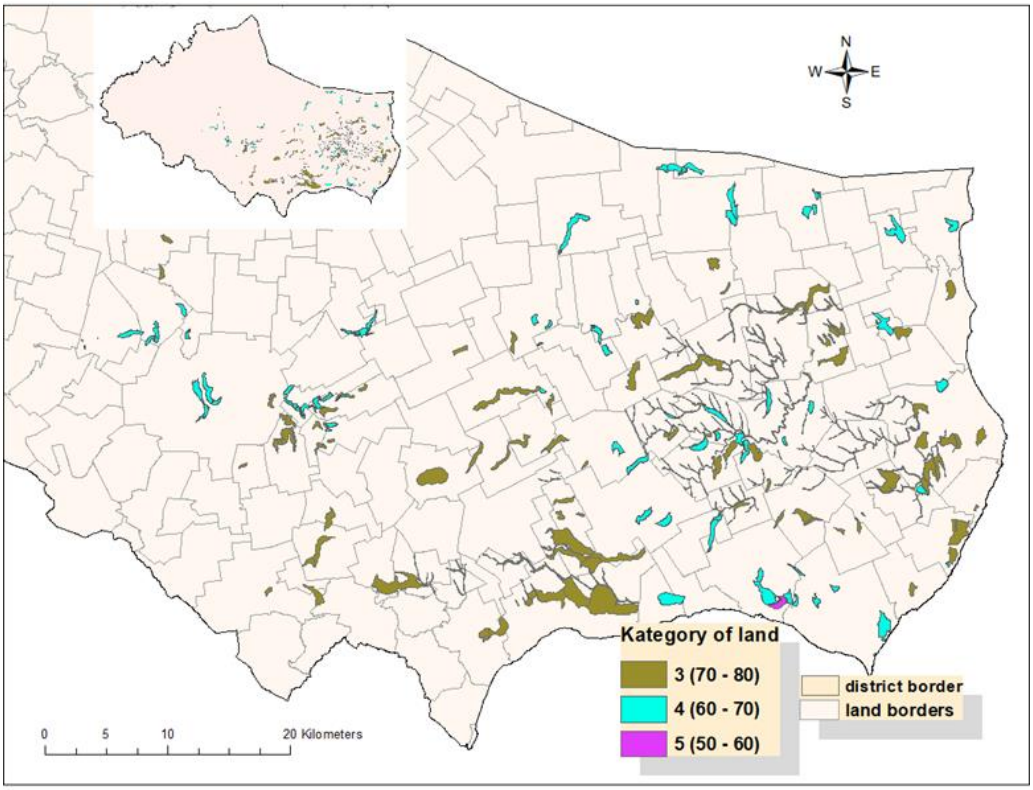


Figure 10. *Category of agricultural lands occupied by Karasolutsi from Dobrich region*

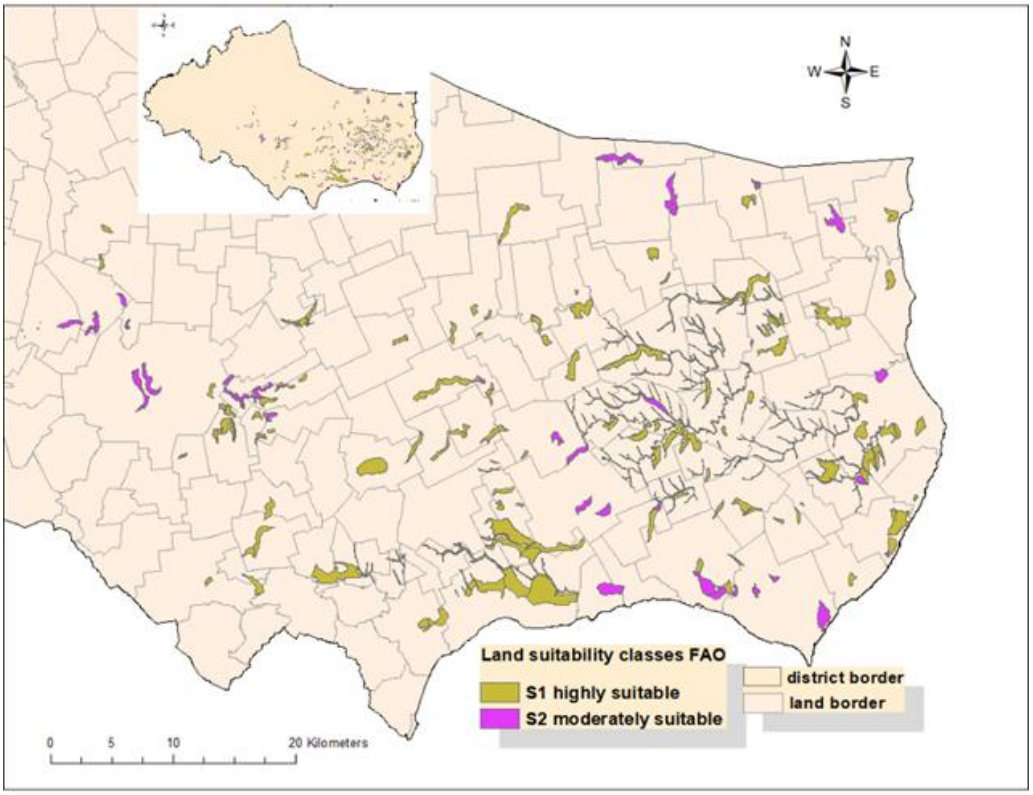


Figure 11. *Suitability classes of agricultural lands occupied by Karasolutsi from Dobrich region according to the FAO classification*

Conclusion

The Karasolutsi in the Dobrich region are most suitable for growing wheat and corn (from the cereals), sunflower (from the technical crops), alfalfa (from the fodder crops) and cherries (from the fruit crops).

Some of them are very suitable for sugar beet, large leaf tobacco, vegetable and fruit crops. In this case, the heavy soil texture plays a positive role with the possibility of greater moisture retention, which in the dry periods of the vegetation of the plants limits the reduction of yields.

The Karasolutsi in the Dobrich region refer mainly to the 3rd and 4th category or "good lands", and according to the FAO classification - class S1 “suitable lands” and class S2 “moderately suitable lands”.

As a result of the geospatial interpretation, the data on the agronomic suitability of agricultural lands with Karasolutsi are visualized in the form of thematic maps for the geographical distribution of Karasolutsi in the Dobrich region, their suitability for growing main agricultural crops and the category of land, according to the Bulgarian classification and the FAO classification scheme.

The data interpretation approach used, namely geographic information systems (GIS), makes it possible to add new soil information and data at any time in the future, to be analyzed, compared and visualized in the form of maps, graphs, etc.

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