DESERTIFICATION AND ITS EFFECTS ON ENVIRONMENT AND AGRICULTURAL PRODUCTION IN ROMANIA

Adriana Pienaru[1], Paulina Iancu[1], Severin Cazanescu[1]
[1]USAMV Buc– FIFIM, Bd. Marasti, No. 59, Sector 1, Bucharest, Romania
apienaru@yahoo.com

Abstract
Desertification is defined by the United Nation Convention to Combat Desertification (UNCCD) as "land degradation in arid, semiarid and sub-humid areas resulting from various factors, including climatic variations and human activities" (UNCCD, 1997). Desertification is an advanced stage of land degradation where the soil has lost part of its capability to support human communities and ecosystems.
The climate changes produce long dry periods and droughts which leave exposed soils, vulnerable to erosion. Droughts are often broken by intense storms that can wash away large amounts of soil. This is facilitated by low vegetation cover and poor soil conditions (low infiltration rates).
The results of some recent researches, based on the Methodology developed within DISMED Project (Desertification Information System for the Mediterranean), project extended for the Central and Eastern Europe, shows that areas placed in the southern and central part of the Europe, for which data are available, have a very high and high sensitivity to desertification. Romania is among the countries affected by this phenomenon. The methodology has as main objective to facilitate the identification of hot-spots at the regional level for early warnings.
Sensitivity to the desertification of the different spatial homogeneous units is defined by an index (ISD: index of sensitivity to the Desertification) obtained from the geometrical average of three indexes of the soil quality, climate and vegetation. Land planning and socio-economic aspects have not been included because further work is required in order to test methodologies implemented at regional or national level.
DISMED methodology computes the index of sensitivity to the desertification based on data obtained from Corinne Land Cover CLC 2000, European Soil Database ESDB v2.0 and FAOCLIM/2.
The paper presents data regarding aridity index, soil quality index, vegetation quality index and sensitivity to desertification index in Romania and FAO programs droughts and aridity control.

Keywords: climate changes, desertification**,** sensitivity to desertification**,** soil quality, agricultural production.

1. INTRODUCTION

Desertification is an advanced stage of land degradation where the soil has lost part of its capability to support human communities and ecosystems. Desertification is defined by the United Nation Convention to Combat Desertification (UNCCD) as "land degradation in arid, semiarid and sub-humid areas resulting from various factors, including climatic variations and human activities" (UNCCD, 1997).[6]
Climate changes have as result long drought periods and rainfalls in irregularly regime, which, combined with unsustainable agricultural practices and an inefficient water management, can lead to desertification phenomenon, in extreme situations. Droughts are followed by intense storms that can wash away large amounts of soil and expose the soil to erosion. This is facilitated by low vegetation cover and poor soil conditions (low infiltration rates). [1]
The results of some recent researches, based on the methodology developed within DISMED project (Desertification Information System for the Mediterranean), project extended for the Central and Eastern Europe regions, show that areas placed in Central and Eastern Europe, for which data are available, have a high and very high sensitivity to desertification, meaning around 8% of the territory, 14 million hectares, respectively. [5]
Romania is one of the countries which will be affected by this phenomenon. In our country, the most affected regions will be Dobogea, Oltenia and Banat. The changes appeared at climate and soil level will influence the agricultural crops. Thus, over 20 years, the cereal production will be 60 % less than today, these crop type will move in northern untypical areas, like Germany and Poland. [2]

The soil and the agricultural products in our country will suffer big changes, implicitly, due to global warming. In accordance to European specialists studies (among which there are also Romanian specialists) large areas in the south part of Romania risk to be difficult to live in and impracticable for developing economic activities, due to climate changes. 10 counties in Romania will have arid soils in the following 20 years. [1], [4]

2. MATERIAL AND METHODS

A forecast regarding the desertification phenomenon needs to analyze some physical and social and economic factors. The quantitative information of the causing factors are quiet poor and the use of the estimation models for the sensitivity to desertification and drought are the most common approach nowadays.[5]

DISMED Project has developed a methodology which derives from the MEDALUS methodology for Environmentally Sensitive Areas. Sensitivity to desertification and drought is defined by an index (SDI: Sensitivity to desertification index) obtained from the geometrical average of three indexes of the soil quality, climate and vegetation. [3]

The DISMED methodology only takes into account causal factors such as soil properties, climate and vegetation, while socio-economic indicators are not included as further work is still required to test and adapt methodologies implemented at regional or national level. [5]

The methodology is based on the data obtained from:

- CLC (Corinne Land Cover) 2000 for data regarding the land covering and use; (CLC 2006 is available today, since September 2009 and is based on the data collected in 2006);
- ESDB (European Soil Database) v2.0 for soil data;
- FAOCLIM/2 (FAO Climate Data base), 1961-1990 series, for climate data.

2.1 Climate quality index (CQI)

Climatic aspects has been analyzed through the Aridity Index (AI), using the methodology developed by FMA (Applied Meteorological Foundation) in accordance with the following formula:

$$AI = \frac{P}{PET} \quad (1)$$

where:

AI = aridity index

P = yearly mean rainfall

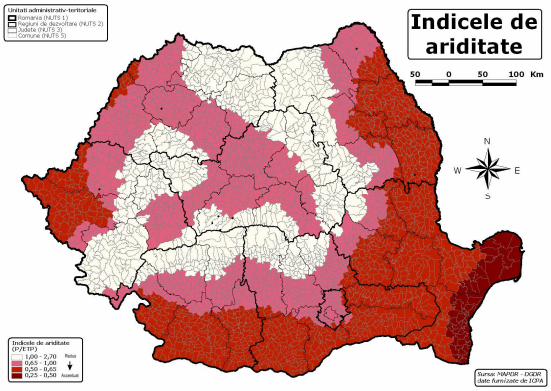
PET = yearly mean potential evapotranspiration

Within this index, the territory is classified as showed in table 1:

Table 1

CQI	Climatic zones	Classification
< 0,05	Iper - arid	2
0,05 – 0,20	Arid	1,75
0,20 – 0,50	Semi-arid	1,50
0,50 – 0,65	Dry sub-humid	1,25
> 0,65	Humid	1

Figure1 - The Romanian Aridity Index Map



2.2 Soil quality index

The soil quality index (SQI), developed by OSS (Sahara and Sahel Observatory), is based on four parameters:

- parental material
- soil depth
- texture
- slope

SQI is given by the geometric average of the indexes for the four parameters.

$$SQI = (PM \cdot D \cdot T \cdot S)^{\frac{1}{4}} \quad (2)$$

where:
PM = parental material of the soil
D = soil depth
T = soil texture
S = land slope
In case local data are not available for a single parameter, only the remaining parameters were used. [5]
Parental material has been classed in three classes as it is shown in table 2:

Table 2

Parental material	Score
Coherent parental material : limestone, dolomite, non friable sandstone, hard limestone layer	1
Parental material moderately coherent : Marno-limestone, friable sandstone	1,5
Parental material soft to friable : Calcareous clay, clay, sandy formation, alluvium and colluviums	2

For soil depth, the following classes (table 3) were proposed:

Table 3

Classes	Description	Score
Very deep	Soil thickness higher than 1.2m with a substrate non penetrable by the roots or thickness higher than 1m on a movable substrate	1
Moderate to deep	Depth from 0.8 to 1.2m with a coherent substrate or from 0.5 to 1m with a movable substrate	1,33
Not deep	Depth from 0.5 to 0.8m with a coherent substrate or from 0.3 to 0.5m with a movable substrate	1,66
Very thin	Depth lower than 0.3m	2

Because soil depth is not included in the Soil Database, and pedotransfer rules were not available, the following approach was adopted (table 4):

Table 4

Parental material	Score
Fluvisols	1
All other groups	1,5
Leptosols and regosols	2

Soil texture was grouped as follows (table 5):

Table 5

Classes	Description	Score
Texture not very light to average	loamy-sandy, sandy-loamy, balanced	1
Texture thin to average	loamy-clayey, clayey-sandy, sandy-clayey	1,33
Thin texture	clayey clayey-loamy	1,66
Coarse texture	sandy to very sandy	2

The following classes (table 6) were proposed with respect to the slope:

Table 6

Classes	Description	Score
< 6	gentle	1
6 - 18	not very gentle	1,33
9 - 35	abrupt	1,66
> 35	very abrupt	2

Because the classes given by the Soil Database didn't fit to the ones proposed, the final classification adopted was as follows (table 7):

Table 7

Classes	Description	Score
a	Level (dominant slope ranging from 0 to 8 %)	1
b	Sloping (dominant slope ranging from 8 to 15 %)	1,33
c	Moderately steep (dominant slope ranging from 15 to 25 %)	1,66
d	Steep (dominant slope over 25 %)	2

When two classes concurred in the same polygon the arithmetic mean was used.

2.3 Vegetation quality index

For the Vegetation Quality Index, it was submitted a reclassification of Corinne Land Cover (CLC90) third level classes, assigning each CLC class a value for each of these 4 parameters: erosion protection *EP*, resistance to drought *RD*, ground coverage *GC*, resistance to fire *RF*, using the same range of values for all 4 parameters:

- 0 (excluded from further consideration);
- 1 (good)
- 1,5 (moderate)
- 2 (bad)

VQI is given by the geometric average of the indexes for the four parameters.

$$VQI = (EP \times RD \times GC \times RF)\ ¼ \quad (3)$$

2.4 Index of sensitivity to the desertification

The final overall ISD index is obtained as a geometrical average of the quality indexes.

$$ISD = (SQI \cdot CQI \cdot VQI)^{\frac{1}{3}} \quad (4)$$

Finally the ISD is grouped according to the following classes of sensitivity to desertification:

Table 8

Classes	ISD (Sensitivity desertification index)	Description
1.	< 1,2	Non affected areas or very low sensitive areas to desertification
2.	1,2 ≤ ISD <1,3	Low sensitive areas to desertification
3.	1,2 ≤ ISD <1,3	Medium sensitive areas to desertification
4.	1,2 ≤ ISD <1,3	Sensitive areas to desertification
5.	ISD ≥ 1,6	Very sensitive areas

The quality of the assessment is strongly dependent on the methodology used and the quality of data on causal factors. Firstly, for all the components of the assessment (climate, vegetation and soil) there is a scale factor that is very relevant when considering processes, such as erosion, with important local elements. The second issue is the simplification of the methodology for the vegetation layer since land cover data were used to parameterize the role of the vegetation in protecting the soil and its susceptibility to forest fires. Finally, the scale of the soil data is coarse given its relevance in the assessment.[5]

In relation to the propagation of the errors in the calculation process, it is estimated that depending on the region, the error may range from 20 to 30 %.

3. RESULTS AND DISCUSIONS

Figure 2 - Vegetation Layer

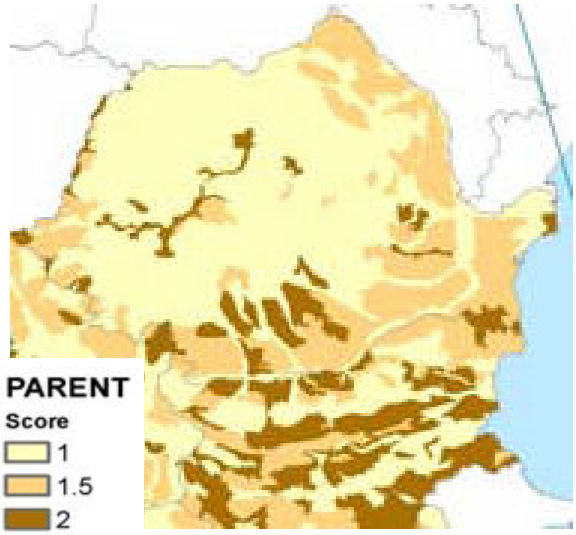


Figure 3 - Soil Layer – Parent

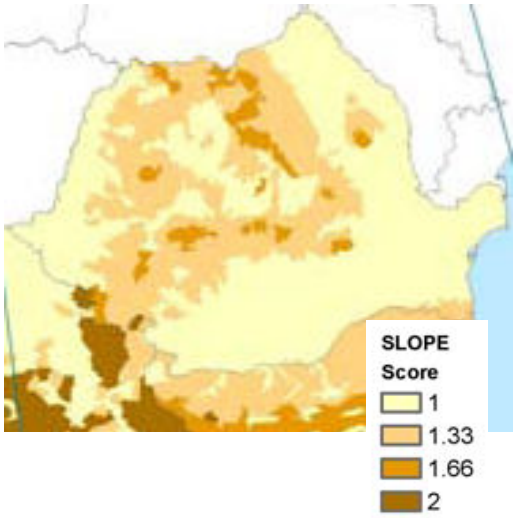


Figure 6 - Soil Layer - Slope

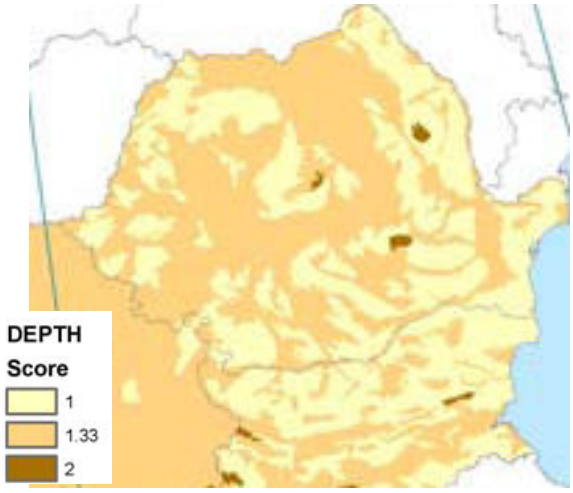


Figure 4 - Soil Layer - Depth

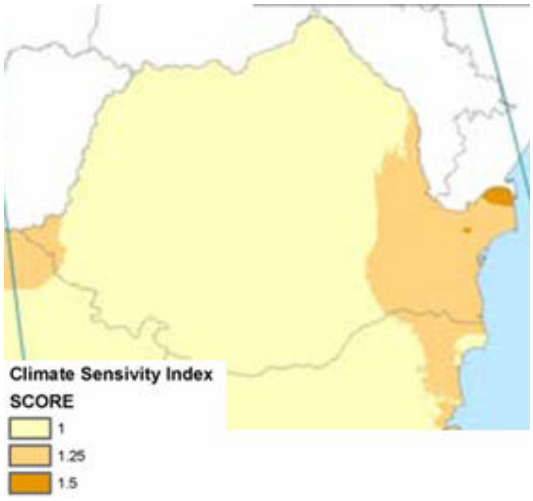


Figure 7 - Climate Layer

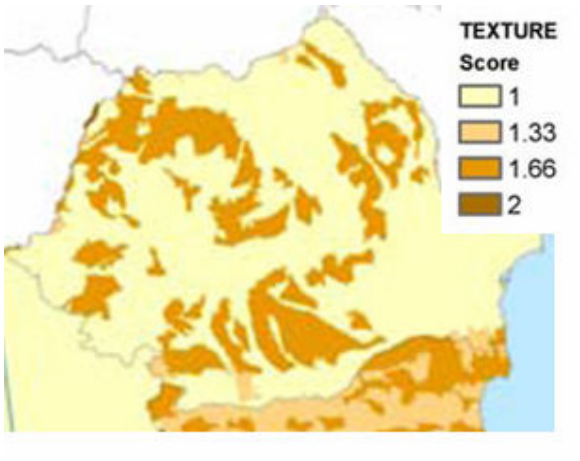


Figure 5 - Soil Layer - Texture

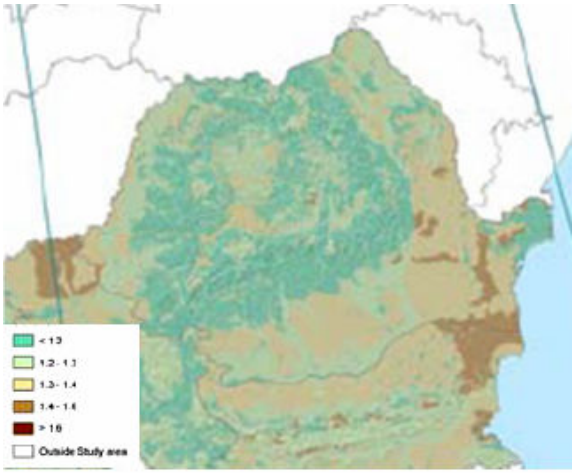


Figure 8 - Final Layer

4. CONCLUSIONS

The climate changes produce long dry periods and droughts which leave exposed soils, vulnerable to erosion. Droughts are often broken by intense storms that can wash away large amounts of soil. This is facilitated by low vegetation cover and poor soil conditions. Romania is one of the countries which have to face the desertification phenomenon and the paper presents data regarding aridity index, soil quality index, vegetation quality index and sensitivity to desertification index in our country. [3]
FAO develops programs for drought and aridity phenomenon control, programs designated both to the specialists in agricultural and land reclamation field and to the farmers.

Among these programs, there are:

- programs for irrigation water management;
- programs for soil management and for land use.

5. REFERENCES

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