CLIMATIC DYSFUNCTIONALITIES OBSERVED WITH THE AID OF NDMI AND SAVI INDICES IN THE LEU-ROTUNDA AND DĂBULENI PLAINS

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ABSTRACT. – **Climatic dysfunctionalities observed with the aid of NDMI and SAVI Indices in the Leu-Rotunda and Dăbuleni Plains.** Integrant parts of the Romanați Plain, located in the southern region of the country, in the great Romanian Plain, the Leu-Rotunda and Dăbuleni Plains respectively, are arising big issues regarding the agricultural landscape, mainly due to the climatic failures which affect, in turn, the whole of Romania, but not only. So, according to the De Martonne Aridity Index, the monthly character spanning over a year period recorded at the three stations varied between humid, semi – humid and steppe.
With the help of the vegetation differentiation indices calculated based on the Landsat type satellite images, at a 30 m resolution, an attempt in the observation of the existing modifications in this area, which was profoundly affected by the aridity in the 1985-2010 periods, is being made. The NDMI (Normalized Difference Moisture Index) index is expressing the differentiated humidity content at landscape element level, especially regarding soil and vegetation. The SAVI (Soil-Adjusted Vegetation Index) index comes to reduce the effect caused by the soil illumination conditions, these conditions playing a big role in the analyzed area mainly due to the fact that the dominant soil type has a sandy texture.

Keywords: ”Leu-Rotunda and Dăbuleni Plains, De Martonne Aridity Index, NDMI, SAVI”

1. INTRODUCTION

The aim in the preparation of this article is the observation of some climatic disfunctionalities generated by the lack of sufficient humidity in the high water demand periods, demands necessary for the optimal vegetation development. The calculation networking was followed through the De Martonne aridity Index method, calculated at a monthly level on a period of 31 years (1980-2010), with the normalized difference moisture indices (NDMI), but also with the SAVI index, which shows the vegetation coverage through the correction of the soil reflectivity with the sandy texture, a dominant feature in the analyzed area. Both subunits, Leu-Rotunda and Dăbuleni Plains are integrant parts of the Romanați Plain, located in the southern Romania, subunits which don’t have characters necessary for determining their regional individualities, although they represent the biggest part of the plain. The Leu-Rotunda Plain, located between Jiu, Teslui and the Danube terraces, features an undulated surface which reclines from west to east, and the

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Dăbuleni Plain represents the southern strip of terraces, invaded by large surfaces occupied by sands (Fig.1). Due to their position that they have in the southern part of the country, with altitudes under 200 m, an open landscape towards the Danube, both analyzed subunits belong to the continental excessive climatic province, featured by high temperature amplitudes, determined by strong cooling in the winter and excessive summer time warming caused by tropical air invasions.

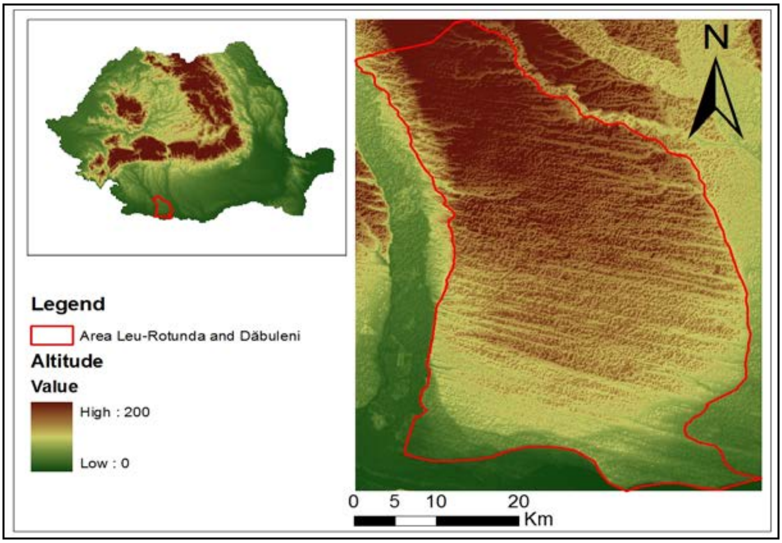


Fig.1. Localization of the Leu-Rotunda and Dăbuleni Plains inside Romanian territory

In this article, the aridity phenomena from the 1980-2010 period was analyzed for the Leu-Rotunda and Dăbuleni areas, subunits of the Romanați Plain, with the aid of the methods presented in 2.2. section.

2. DATA SOURCES AND METHODS EMPLOYED

2.1 Source and data types

The climatic data employed in the making of this article comes from the archive of the meteorological stations from the studied area: Bechet, Caracal and Craiova, very close, which are part of the National Network of the Meteorological National Administration. The data streams cover a 31 years interval (1980-2010). The analyzed climatic elements employed for identifying the aridity phenomena will be the precipitation amounts and temperatures.

With the help of the Landsat7 ETM type satellites, we have obtained a series of satellite images, with a resolution of 30 m, for the 1985-2010 period. These satellite images are available, free of charge, on http://glovis.usgs.gov/.

2.2 Used Research Metodes

For accomplishing the intended study several specific methods, for studying the main climatic elements, will be used **the specific methods**: *„De Martonne"* Aridity Index, which is being calculated for both the yearly values and, also, for the monthly values. At monthly level, the following formula is being used (Gaceu O. 2000, p. 69): $I_l = \frac{12 * P}{T + 10}$ where: P – mean monthly precipitation quantity; T – monthly mean temperature; 12 – yearly months corresponding number; 10 – a coefficient which is added for eliminating negative values.

I being utilized for pointing out the climate's restrictive character regarding some plant formations. Also, by calculating this index, some thermal – pluviometric characteristics of the studied area can be deduced.

The NDMI (Normalized Difference Moisture Index), is a vegetation differentiating index, which expresses the differentiated humidity content at landscape elements level, especially for soil and vegetation. Calculating NDMI is possible trough differentiating in the spectral signatures from near and mid infrared. This expresses the crossing of the spectral range in which the humidity increases from the inferior limit in near infrared to the superior limit in the mid infrared. The mathematical formula is:

NDMI = (NIR-IR)/(NIR+IR) where: NIR- near infrared spectral band; IR- mid infrared or infrared spectral band.

The resulting data is floating point type, and the values are between -1 and +1, the negative ones representing a low humidity level, and the positive ones representing a high one. The SAVI (Soil-Adjusted Vegetation Index), comes to reduce the effect of the soil illumination effects, by using a L constant, determined by Huete (1988), which has a value of 0,5. Its mathematical formula is:

SAVI = (NIR-RED)/(NIR+RED+L)*(1+L) = (TM 4 band –TM 3 band)/(TM 4 band + TM 3 band +0,5)*(1+0,5), where: NIR – near infrared spectral band (Near Infra-Red – Band 4 Landsat TM and ETM+); RED– red spectral band (visible, Red-Band 3 Landsat Tm and ETM+); L – Is actually, a correction factor for the soil illumination (after Esperanza Sanchez Rodriguez e otros, 2000).

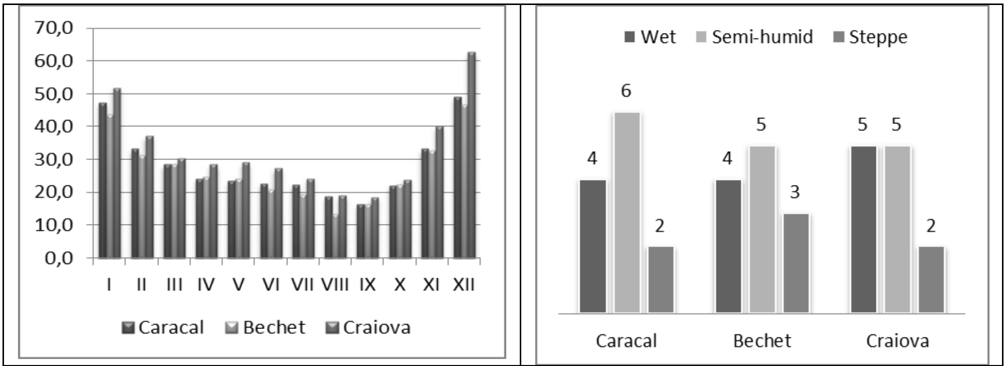
3. RESULTS

3.1 The months pluvio –thermic character according to the De Martonne Aritity Index

Precipitations and temperature are the main climatic elements needed of the climatic characterization of an area. Depending on their values, by applying the mathematical formula of the De Martonne Aridity Index is possible to point out the climate's restrictive characteristics regarding plant formations. So, according to the Index, the character of the yearly months on all three analysed stations varied between humid, semi – humid and steppe. From an overall analysis, the lowest values were recorded at the station from the southern side of the area, at Bechet, followed by Caracal, the Craiova station having the highest values. The common months that have a steppe character at all stations are September and August, but at Bechet station, July has a steppic character as well.

The months with a semi – humid characters are March, April, May, June and July, but only for the Caracal and Craiova stations. The months with a humid character are, especially, the winter months, December, January and February, but also November, indicating that the Craiova station has the highest values (Fig. 2, a).

From the analysis the appropriate number of months are shown for each climate, so that the situation is quite constant, the variations regarding the number of months from one station to another is not high, the situation in which the southern station has the highest steppe character is maintained, the other two having a more humid one (Fig. 2, b).



a) b)

Fig. 2. The monthly analysis according to the De Martonne Aridity Index (a) and the corresponding month's number assigned to the character (b)

3.2 The repartition of the sand occupied surfaces in the Leu-Rotunda and Dăbuleni areas

The litology, trough the presence of loess and dune sands deposits is influencing the ground waters by generating sectors with a humidity excess or deficit. The presence of sandy soil in the depth is influencing the developed superior part, even if that part is made of cernoziom.

The large expansion of sandy soils and sands is a main feature of the soil section of the area being analyzed, and raises special problems regarding the decrease of productivity of the pedological fund.

At the Olteniei Plain level, the Leu-Rotunda zone, and exclusively, the Dăbuleni zone is holding the highest surface of sandy soils, and at their level, the surface occupied by sandy soils is about 64 thousands ha (Fig.3).

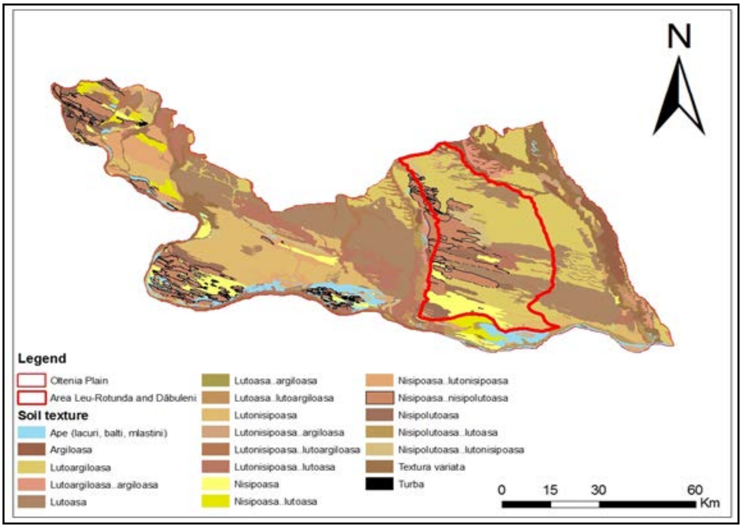


Fig. 3 Soil texture in the Leu-Rotunda and Dăbuleni areas, according to the total area of the Olteniei Plains

Sands in the Leu-Rotunda area are described as being more conglomerate and reddish in color, this resulting from the constant alluvial wash-ups of the piemontan sands from the Getic Plateau, unlike the Dăbuleni area, where from Bechet to Călărași, the meadow is raised by the Jiu alluvial fan, and its sands being traced from its meadow.

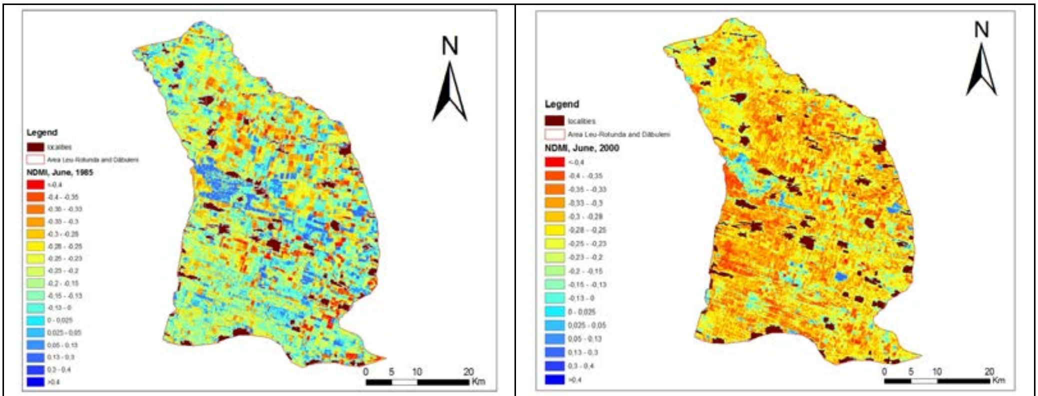
Regarding from a climatic perspective, the sandy soil areas from southern Oltenia, especially those from the Dolj county, belongs to the climatic province Cfax (according to Kopen), this having a pronounced continental temperate characteristic, with a decreased Mediterranean influence, described as an increased dryness in July – September and a surplus of precipitations in May and June.

3.3 Normalized Difference Moisture Index (NDMI)

The satellite images are an important source of geographical information, which helps the mapping of the landscape elements into thematic maps, especially for the objective assessment, on quantitative bases for the environment status. The NDMI and SAVI indices were used on the Landsat ETM+ type images, with seven spectral bands which allow remarkable possibilities of differentiating vegetation, soil and plant humidity, but also other elements.

According to the De Martonne Aridity Index, calculated for the 1980-2010 period, June has a semi – humid characteristic at all three meteorological stations, but this character varies from year to year, and also, from area to area, this feature resulting from the satellite images, after calculating NDMI.

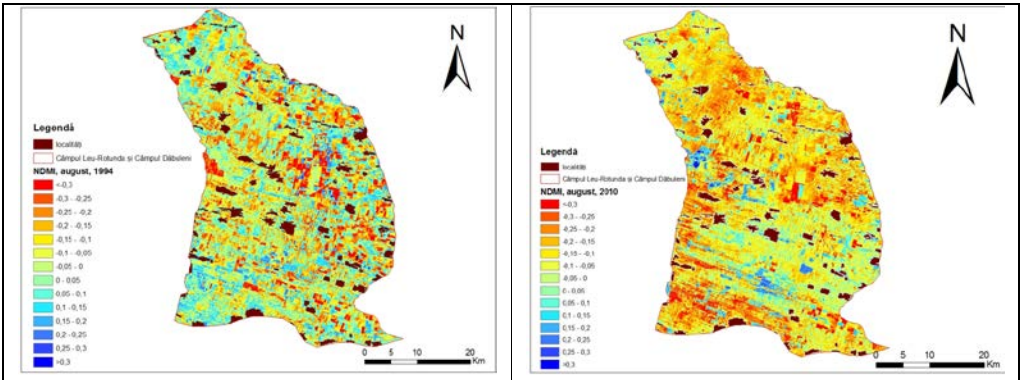
In 1985 and 2000, June was different regarding humidity at ground and vegetation level, so June from 1985 had an even more pronounced humidity character, shown by the positive values ranging between 0,025 and 0,4 or even higher than 0,4, unlike June from 2000, which had a reduced humidity character, shown by the negative values of -0,13 and higher than 0,4 (Fig. 4).



NDMI, June, 1985	NDMI, June, 2000

Fig. 4. NDMI June, 1985 and 2000

By calculating the De Martonne index, August was given a steppe character at all meteorological stations being analyzed, still in the Leu-Rotunda and Dăbuleni areas, the humidity character is differing, so on the scale attributed to the NDMI Index, with values between -1 and +1, on August from 1994 it had more positive values, resulting a higher humidity character, unlike August from 2010, when the negative values had a dominant character, resulting a lack of humidity (Fig. 5).



NDMI, August, 1994	NDMI, August, 2010

Fig. 5. NDMI August, 1994 and 2010

3.4 The Soil-Adjusted Vegetation Index (SAVI)

Using SAVI is justified enough by the simplicity of its calculation, but also of the low spatial resolution of the Landsat images, aprox.30 m above soil. Yet the SAVI index comes to complete the NDVI index, the Normalized Difference

Moisture Index, which presents a problem when working with low density vegetation areas, sometimes mingling with high reflectivity empty areas with sandy texture.

The result is that in the areas with low vegetation density, the SAVI index, using a soil reflectivity correction constant, shows only vegetation areas, and where the vegetation is missing, that cannot mingle with the soil reflectivity.

The plant covered zones, with values between 0,50 and 0,80 and even higher than 0,80 are more common seen in 1985 June than in 2000 June. These areas correspond to the low humidity areas; this can be observed by linking the two images (Fig. 6) with those of the humidity, the NDMI index.

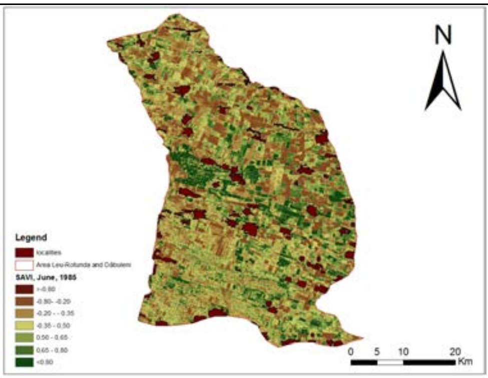
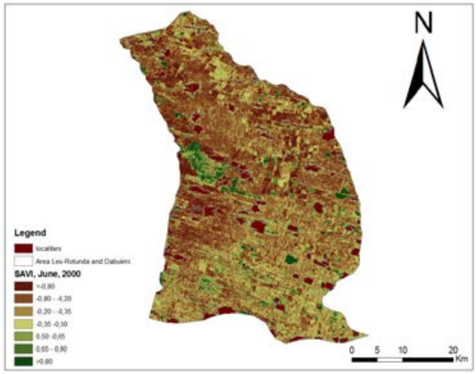
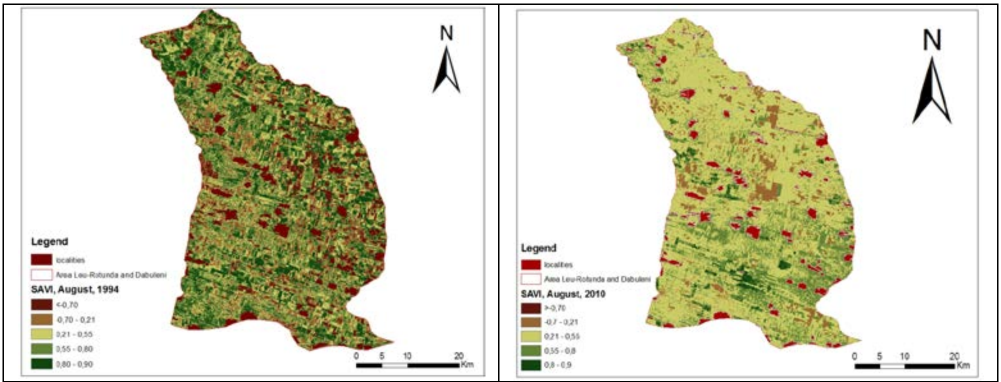
	
SAVI, June, 1985	SAVI, June, 2000

Fig. 6. SAVI June, 1985 and 2000

Although August is a month with a steppe character, which has low humidity values and excessive temperatures, however it has been found according to Fig. 7, that in 1994, the vegetation was seen having values that exceeded, on some areas, the 0,80 level, which means an appreciation of healthy vegetation.

The 2010 August has placed itself more into the steppe character, healthy vegetation being observed on narrower areas.

From the overall analysis of satellite products regarding humidity and soil vegetation coverage, but also its physiological state next thing are observed: after 2000 there is a greater degree of lack regarding humidity levels, and also, soil vegetation coverage. This fact itself can have multiple explanations regarding the water intake by using the irrigation systems, their use being much higher before 2000. Deforestation has a leading role in maintaining humidity.



SAVI, August, 1994 | SAVI, August, 2010

Fig. 7. SAVI August, 1994 and 2010

4. CONCLUSIONS

The humidity level of an area influences greatly the soil vegetation coverage, and in the case of a sandy textured soil, the issues are increasingly greater and diverse. The methods used in determining the humidity levels and soil vegetation coverage have been proven to be useful, the satellite products having an important role by showing us an impressive geographical information collection from the terrestrial surface.

After processing the two indices of vegetation differentiation is noted that over time, the humidity in the area is increasingly lower and this is shown in forests areas and across forest belts, planted for fixing and protecting sandy areas.

REFERENCES

1. Coteţ, P., (1957), *Câmpia Olteniei*, Editura Ştiinţifică, Bucureşti
2. Coteț, P., (1976), *Câmpia Română Studiu de Geomorfologie Integrată*, Editura Ceres, București.
3. Dumitrescu, Elena, Glăja, Maria (1972), *Metodica prelucrării datelor climatologice*, Centrul de multiplicare al Universităţii din Bucureşti, Bucureşti.
4. Dumitraşcu, Monica, (2006), *Modificări ale peisajului în Câmpia Olteniei,* Editura Academiei Române, Bucureşti.
5. Esperanza Sanchez Rodriguez e otros, (2000), *Comparacion del NDVI con el PVI y el SAVI como Indicatores para la Asignacion de Modelos de Combustible para la Estimacion del Riesgo de Incendios en Andalucia*, Universidat de Alcala.
6. Gaceu, Ovidiu, (2002), *Elemente de climatologie practică,* Editura Universității din Oradea,