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CONSIDERATIONS OVER CAUSES OF DESERTIFICATION IN BRAILA COUNTY

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Abstract

Land reclamation engineering technologies habe been succesfully applied to improve crop quality and compensate the natural inconspicuous and counterproductive factors for a long and radical evolution of the agricultural production. Still, an incorrect use of these technologies, inadequate agricultural exploitation and alcaline to salty soils, led to profound ecosystem degradation, up to desertification. It is the case of some specific areas in Braila county, Romania, which degraded from agricultural to desertified land. The paper aims to track the transformation of these areas over a 35 years period and to conclude whether stakeholders should follow the natural path and find a way to work along with the raw environment. The analisys passes in review the transformations of Braila plain from 1974 to 2010, based on graphic analysis of arridity index, Lang pluviometric index and Gaussen obrothermic diagram, corroborated with pedologic conditions, soil quality and climate factors variation, leading to the desertification of more than 2000 hectars, classified nowdays with the IV-th and V-th fertility grade. Administrative measures have been proposed by the local authorities but not applied on the site, due to high costs of implementation and the question to be answer is whether an eco management and economic solutions would better generate profitable use of these desertified soils.

Key words: *agriculture, desertfication, ecosystem asessment, irrigation, land degradation*

INTRODUCTION

The United Nations Convention on Desertification (UNCCD), stated in 1994, is the first international step in order to combat desertification worldwide, and to diminish the effects in countries facing serious problems because of desertification and drought. Romania has ratified the UNCCD in 1997 through Law 629, by engaging to take all the necessary measures at all levels to minimise the extension and effects of desertification (www2.unccd.int). According to the Convention's definition, *desertification is the process of land degradation, specific to aride, semiaride and underwet areas, as a result of numberous causes, including climatic and antropic activities.* But, land degradation up to desertification, can occur in any climatic region, despite the general opinion on a aride, half-aride and dry areas allocation. All nations must act in order to combat desertification as it is a vulnerability fenomena, both for the environment and quality of life, installing slowly and, most of the times, irreparably. The climatic factors are the main vectors, out of which prelonged drought, low water intake and high temperatures are the most dangerous to start and fix the desertification process. It is essential to maintain an optimum equilibrum between ecosystems processes, functions and services, including antropic activities, in order to avoid land degradation, conceptualising desertification as a result of biosfera total degradation, earth surface and beneath, considering soil, land, surface and underground water, plants and animals, human activities and their results for the entire area. Scientific literature estimations, aproximate a 50% of dry land would be affected by desertification, by the end of 21 century, reducing the productivity of biomass, of wood quantities, perene plants land cover, soil water retention and social disorder. Statistics of UNCCD and World Meteorological Organization shows that annualy more than 40,000 new square km can be classified as desertification affected areas, trigging the alarm on the speed this fenomena can take.

Desertification in non traditional areas, such as continental causes, is mostly caused by climate change, generating long periods of drought, as dual fenomena acting biophisically and antropically and interacting in the eco-social systems of all worldwide populations (Reed and Stringer, 2016).

Worldwide more than 100 countries facing the desertification problem; combinating processes such as wing and hidro erosion, vegetation devastation, land cover diminish, unrationalised water consume, soil salinisation, are agregate intensified by antropic activities, generating desertification and speeding up the process, in some regions. Scientific and organisational international comunities consider desertification as a major environmental issue and evenly an antropic disaster, placing desertification the third, after climate change and fresh water diminishing sources, in a classification of most important concerns of the 21st century.

In Romania, a traditionally continental country, out of the total agricultural land, about 1/3 is affected by different stages of degradation, the most important triggering factors being water erosion and landslide, affecting 7 million ha (http://www.unccd.int/ActionProgrammes/romania-eng2000.pdf). In order to minimise and reduce the effects of climate change and antropic actions, generating desertification in vulnerable areas, Romaia is implementing the National Strategy for Drought Effects Reduction, Prevention and Control of Land Degradation and Desertification, for Short, Medium and Long Terms, elaborated in 2000 and updated in 2008.

The main objectives of the Strategy is to indicate and implement actions for short, medium and long term in order to reduce the vulnerability of local communities, natural ecosistems and socio-economic activities and to diminish their impact and effect over social order, local economies and natural environment (http://old.madr.ro/pages/strategie/strategie_antiseceta_update_09.05.2008.pdf).

The affected areas in Romania are Moldova plateau, sub-Carpathian hills between Trotus and Olt rivers, Transylvanian plateau and Getic Piedmont, where estimations are of annual 123 tons of soil losses due to erosion.

Climatic indexes for the last 35 years indicate that Romania's climate has a high tendency to arid, influencing and intensifying the pedologic resources degradation up to desertification, mostly in the dry areas of the country. Over the years, Romania has had a numerous drought intervals, which favorited the desertification of vulnerable areas, such as:

- First interval, between 1894–1905, with pick of the drought in 1897;
- Second interval, between 1942–1953, where 1944 was an extremly drought afflicted year (Ionescu-Sisesti Gh., 1946);
- Third interval, from 1992–2000, considered the first and last years as the most dried ones;
- Fourth interval, from 2006 to 2008, with 2007 as benchmark for high temperatures, the winter of this year being the mildest in the history of meteorological registry in Romania.

The considerations to establish the drought intervals, relay on at least 14 consecutive days in the cold season (December to March) and at least 10 consecutive days in the warm season (April to September), with no precipitation or, with quantities of less than 0,1 mm/day (Bogdan, 1981). Braila county is situated in the south est of Romania, as part of the Romanian Plain, with a total area of 4765.8 square km. Despite the general plain aspect, the relief is quite diverse, with numerous hillocks and hollows, sand dunes, largi river junctions, meanders and patchs.

The most important hydrological artery is the Danube, along with the rivers: Siret, for only 50 km, Buzau for 126 km and Calmatui for 84 km; the hydrological network si completed by lakes, Ianca with 332 hectares, Plopu with 300 hectares and Lutul Alb with 357 hectares, formed in loess or cenote, floatable lough, such as Jirlau with 1086 hectares, Caineni with 74 hectares and Ciulnita with 92 hectares, functioning as natural compensation pond; also, due to a high concentration of salt, some of the lakes in the county have been clasified as balneo climateric resort, such as Lacu Sarat - Braila, Sarat Batogu, Tataru-Caineni and Movila Miresii, whith therapeutic properties.

The total arabil area is of 395,870 hectars, out of which only 20,652 hectars of forests, meaning less than 4% which places the county on a dangerous low level, compared to the 28% average in Romania or 35% in Europe.

Without the forestration protection and corroborated with the antropic and natural

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conditions, the agricultural terrain have been degrading in an alert and irreversible pathern, leading to desertification. The desertification is a process continuously growing across the Europe, and measures to reduce and minimise the extension of deserted agricultural land have been taken but not fast enough implemented. More than 2000 hectars have been inventaries over the last 5 years as impropiate for agricultural use, being catalogised with the IV-th or V-th degree of fertility (out of 5 grades). According to the Agricultural and Industry Authority in Braila, in 2010, more than 2000 desertified hectares were registered, out of which more than 500 hectars in Insula Mare (a highly fertile plain, artificially created through the embankment of Danube's old wings) Dudesti with 200 hectars, Faurei with 600 hectars, Insuratei with more than 200 hectars, Stancuta with 300 hectars, Tichilesti with 400 hectars and Gropeni with about 100 hectars.

Figure 1. Administrative Territorial Units of Braila county, Romania. Sourse: www.prefecturabraila.ro

Starting with 1971, the Institute for Pedological Research and Studies has conducted multi annual tests to evaluate the ecosistems and soil quality evolution, considering the drainage and irrigation sistem maximum functionally, since the innauguration in 1968. The first conclusions, from 1971, stated there is a great benefit from the agricultral point of view, as most of the areas with land rehabilitation works have had a history in low freatic and capilar water level. Most of these areas were intensively irrigated and fertilised, for high agricultural productions, leading to problems such as: high level of mineralization of the ground water, leading to a secondary mineralization of the soil (mostly for gleised cernozioms with level of 1 – 2 metres), distruction of the superior structure of soil, due to heavy agricultural machines, leadind to a hardpan of 20-30 centimeters . Due to high precipitation regime during the following years, by 1977 some of the soils affected by nowdays desertification were already classified with secondary salinization, in Plopu, Ianca, Esna, Secu and Faurei areas, with low biological indexis, which could have been improuved by ameliorative land rehabilitation works, such as: efficient drainage system, pedo-ameliorative solutions, periodical ablutions, agro-phito-technical measures.

Figure 2. Irrigation systems, 1985. Source: www.comunismulinromania.ro/old/Arhiva-foto

After 1990, the functionality of the irrigation and drainage systems has been sistematicaly reduced simultaneously with the fragmentation of agricultural surfaces, exploitation, irrigation and works as a result of the landownership.
The integrated management of the agricultural expence was replaced with local stakeholders' sollutions, leading to a continuous degradation of soil and ecosystems peculiarity (Burghila et al., 2016). Recent studies from 2009 and 2010, brought the attention on a medium to low humus quantity over the entire county, with a decrese of aproximately 1%, due to climate changes and climatic regime: long periods of drought, alternated by dryed winters with low

temperatures and intense winds, luck of fertilisation and crop rotation, extensively and uncontrolled grazing. The cultivated area of Braila County has grown since 1974 to 1990, due to the irrigation systems installed across, covering over 380,000 hectares, the second place in Romania after Constanta county, with more than 400,000 hectares of irrigation systems. Social and economic context contributed to a descent of the agricultural surfaces from 1990 to 1995 and has had a growing tendency ever since, on account of private investments, according to the statistics of Agricultural Authorities, reprezented in Figure 3.

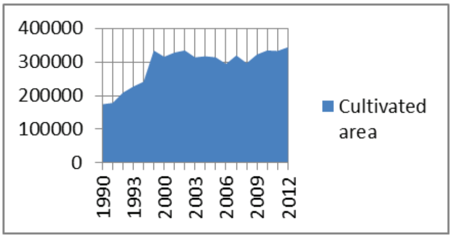

Figure 3. Variation of cultivated area, in Braila County. Source: http://statistici.insse.ro

A practical sollution to allow a natural amelioration of the desertification affected soils would have been the forestration, but there is an estimation of about 1,5 million lei (aprox. 330,000 euro) per hectar which is a major limitation for the local authorities and private owners.

MATERIALS AND METHODS

The aim of the present paper is to determine the influence of climatic vectors combined with anthropic actions inducing desertification in Insula Mare, Dudesti, Faurei, Insuratei, Stancuta, Tichilesti and Gropeni area, in Braila County. The climatic vectors used for this analysis are annual mean temperatures and vegetation period mean temperatures, annual mean precipitations and vegetation mean precipitations, during 1974 to 2010, registered at the meteorological station in Braila.

First climatic vector to be analysed is the **aridity index De Martonne** (1925) calculated both annually and for the vegetation period, the results being referred to the aridity intervals defined as in Table 1.

Table 1. Climatic classification according to De Martonne (1926)

Type of climate	De Martonne Index
Very dry = desert (arid)	0-5
Dry = steppe, semiarid (semi desert)	5-15(5-12)
Semi-dry (dry sub-humid)	15-20
Mildly wet (moist sub-humid)	20-30
Wed (wet)	30-60
Very wet(humid)	over 60

Results of the calculations presented in Figure 4, prove that annual De Martonne index values based on annual mean temperatures would place Braila County in the Semi-dry type, with values over 15. A more relevant aridity index, calculated for the vegetation period, confirm that during the warm season, from April to October, the aridity index is for 25 out of the 30 years of analysis way below 15 (considered the demarcation between semi-arid and semi-dry climate) with lowest values in 1992 (7,41), 1995 (7,66) and 2009 (7,69).

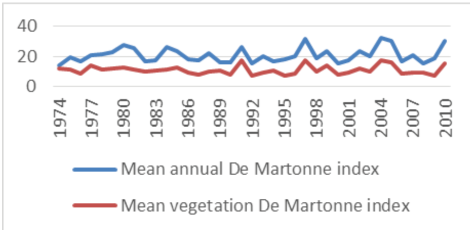

Figure 4. Variation of aridity index for the time frame 1974 – 2010. Source: Own calculation

The pluviometry index was defined by Lang, and is representative for the dry areas, where the ecosystems are directly influenced by the dependency between quantity of precipitations and temperature value, leading to evapotranspiration. It is important to compute the values of this index, as the desertification of most of the areas in Braila County, has been determined by the absence of vegetal cover which allowed water and wind erosion (Manea and Tirla, 2015). The pluviometry index values represent the fraction between annual mean precipitations and monthly mean temperatures (1) for the periods of time with more than 10^0C, according to the formula:

$$Ipt^{an} = \frac{P}{\sum T \geq 10^0 C} \qquad (1)$$

Values for the pluviometry index were determined just for the warm season, from April to October, considering no extreme phenomena was registered during the analysis interval, and are presented in Figure 5 (Constantin and Vatamanu, 2015).

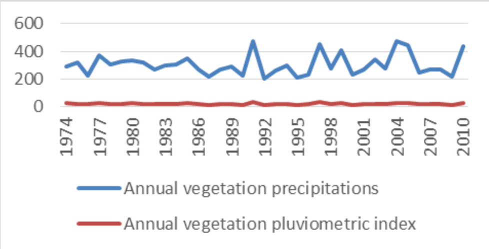

Figure 5. Variation of the annual pluviometry index during the warm season. Source: Own calculation

The calculation of exact values for evapotranspiration is almost impossible, considering that by 1989, the county used to have 3 meteorological stations in Braila, Faurei and Viziru, and since 1990, the last two were closed.

The present analysis, considering the interval between 1974 and 2016, has been using a single set of data, most probably from Braila meteorological station.

As such, for the computing of **potential evapotranspiration** we will be using **Turc formula** (2), with data of mean temperatures and mean precipitations of the vegetation period:

$$ETP = \frac{P(0{,}05T^2+25T+300)^2}{P^2+0{,}9(0{,}05T^2+25T+300)^2} \text{ (mm)} \quad \ldots\ldots (2)$$

Considering: P = mean precipitations of the vegetation period, in mm; T = mean temperatures of the vegetation period, in ^{0}C.

Variation of the evapotranspiration, for the analysed interval, is presented in Figure 7; it is important to conclude the differences between evapotranspiration and precipitation values during the warn season, as this defines the water resources plants can rely on, since evapotranspiration is a complex loss of water by plants, transpiration and evaporation.

In Braila County during 1974 – 2016, the range of evapotranspiration is from (-5,615,618) to (-373,061) it is easy to see the precursory conditions of desertification installed in the middle-south-west part of the county.

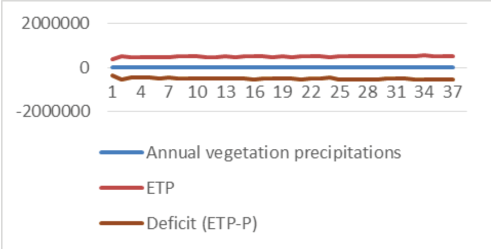

Figure 6. Annual evapotranspiration variations and water deficit during the warn season. Source: Own calculations

The humidity deficit leading to loss of vegetation and preceding the wind or water erosion of vulnerable soils is presented in Figure 7, through **Gaussen ombrothermic diagram**, relating temperatures and precipitations annual mean variation during the study interval, on the same graph with different scales. The humidity deficit is defined by the sections were temperatures values (thermic line) are above the precipitation values.

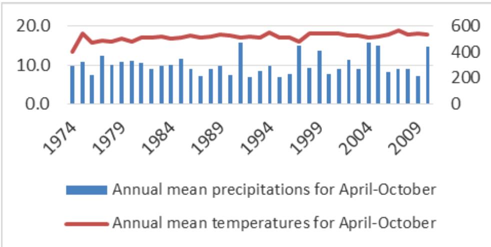

Figure 7. Gaussen ombrothermic diagram. Source: Own calculations

The climatic indices were computed based on simple mathematical formulas (1 and 2), mostly based on the reports of the two environment elements: the annual mean air temperature and warm season mean temperatures and annual mean precipitations and warm season mean precipitation, considering the warn season from April to October. Data used in this study were registered between 1974 – 2010 by Braila county meteorological station, located in Braila city, at an altitude of 20 m, latitude 45^{0}16' and longitude of 27^{0}15'. The aim to calculate and analyse the De Martonne aridity index, the Lang precipitation index and to achieve Gaussen obrothermic diagram, is to show the presence, frequency and intensity of the dryness and drought phenomena to allow desertification in Braila County (Constantin and Vatamanu, 2015).

RESULTS AND DISCUSSIONS

The desertification areas in Braila county, covering over 2000 hectares from agricultural potential land, is a result of both natural and atrophic causes. Conclusions of the pedological and environment factors study cases led by The National Institute of Research and Development, Agro-chemistry and Environment Protection, in consecutive years, starting with 1971 to 2010, confirm that land desertification is a reality. Based on the calculations and the classification defined by the index's aplicability, Braila County has had for the last 35 years a dry to semi-dry climate, with steppe natural vegetation represenative. Lang pluviometry index, considered an indicator for continentalism climate, computed for the 35 years' time frame, based on annual means of the warm season, from April to October, indicates a relatively constant very low limit.

The evapotranspiration, computed with Turc formula, applied according to the spatial location of the meteorological station recording input data, was represented in comparison with the annual mean precipitation for the warm season, concluding to the same constant outdistance between precipitation and evapotranspiration, leading to a deficit of water resources for agricultural crops. Gaussen obrothermic diagram, integrates information on annual mean precipitations and annual mean temperatures, indicating very long intervals with dry and drought, on consecutive years, precursory to desertification instalment.

CONCLUSIONS

The obvious conclusion leads to the natural causes to determine desertification in Braila County. The temporal interval to compute the index is meaningful to establish that anthropic induced modification of the soil structure, due to incorrect use of the irrigation and drainage system, on vulnerable soils with secondary salinity natural tendency, were the cause of the present situation, implying measures must be taken as fast as possible to limit the extension of these areas or of new ones.

We must also consider the climate change effects, resulting in variations of temperatures, precipitations altering hydrological systems or climate related hazards (Burghila et al., 2015). Desertification must be prevented and minimised and practical solutions to follow up soil and ecosystems evolution are being implemented by national and EU geospatial data systems, thru remote sensing and inventory of Essential Climate Variables in order to limit the vulnerability of ecosystems and of people to desertification.

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