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Considerations on Desertification Phenomenon in Oltenia

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Abstract

The paper analyses the desertification phenomena in Oltenia, which have been more intense after 1990. Significant references are also made to the overall aspect for the entire country. The droughty periods have different meteorological characteristics compared to the last century such as: their association with intense heat waves, intensity and important areas of extension. These were caused by stable and persistent anticyclonic regimes which affected most part of the European continent. The paper is a part of series of extended studies on climate variability in Oltenia (Bogdan and Niculescu, 1999, Bogdan and Marinică, 2007, Marinică and Marinică, 2010; Marinică, 2006, 2009). The paper is useful to students, master graduates and to all specialists in climatology.

Keywords: *draughty periods, heat waves, desertification, anthropic impact*

Rezumat. Considerații privind fenomenul de deșertificare în Oltenia

În lucrare sunt analizate fenomenele de deşertificare în Oltenia, mai intense după anul 1990. Importante referiri sunt făcute şi la aspectele de ansamblu pentru întreaga ţară. Perioadele secetoase au avut caracteristici meteorologice distincte faţă secolul trecut printre care cităm asocierea acestora cu valuri intense de căldură, intensitatea şi arealele de extindere deosebite. Acestea au fost produse de regimuri anticiclonice stabile şi persistente care au afectat cea mai mare parte a continentului Europa. Lucrarea face parte dintr-o serie extinsă de studii privind variabilitatea climatului în Oltenia (Bogdan și Niculescu, 1999, Bogdan și Marinică, 2007, Marinică şi Marinică, 2010; Marinică, 2006, 2009). Lucrarea este utilă studenţilor, masteanzilor şi tuturor specialiştilor în climatologie.

Cuvinte-cheie: *perioade secetoase, valuri de căldură, deşertificare, impact antropic*

Introduction

The anthropogenic impact on clime, especially in the last century, was extremely high so that it can with no doubt be considered a modifying factor on a global, regional and local scale.

Climatic data in the last century showed, apart from a progressive general warming of the atmosphere (highlighted at global level), also a reduction of the quantities of precipitations, which became limitative factors for the growing, development and productivity of crops in certain geographic areas of the country and, in the same time, very restrictive factors for the allocation and use of water resources.

In 1997, Romania signed (through Law 629/1997) the Convention to combat desertification (CCD), adopted in Paris on June 17, 1994 and entered into force on December 26, 1994, elaborated pursuant to the resolution of the United Nations General Assembly 47/188 from December 22, 1992, as a consequence of the Rio de Janeiro United Nations Conference on Environment and Development (1991). The Convention aims to combat desertification and to reduce drought effects in the countries with serious problems of drought and/or desertification through efficient measures at all levels, in order to contribute to the fulfilment of sustainable development in damaged areas. In Romania, there has been elaborated a synthesis of studies carried out by the following specialty institutes: Forest Research and Management Institute (ICAS), Institute of Research for Pedology and Agrochemistry (ICPA), National Company – National Institute of Meteorology, Hydrology and Water Management (CN-INMHGA), Institute of Studies and Projections for Institute of Studies and Design for Land Reclamation Projects (SC ISPIF SA), National Institute for Research and Development in Environmental Protection (ICIM), Institute of Research and Technological Engineering for Irrigations and Drainages (ICITID), Research Institute for the Quality of Life (ICCV), Research Institute for Cereals and Industrial Crops (ICCPT-Fundulea) and Pasture Research Institute (ICPCP Măgurele – Braşov). This synthesis presents the problem of desertification, land degradation and drought in a national context and the action strategy in order to combat it (National Strategy and Action Programme to Combat Desertification, Land Degradation and Drought, elaborated within the Ministry of Water, Forests and Environmental Protection and hereinafter referred to as SNPAPCDDTS).

At a global level

The appearance and extension of conditions similar to deserts also in other areas of Terra was characterised in different ways.

The United Nations Conference on Environment and Development – UNCED) defined desertification as land degradation in arid, semi-arid and dry sub-

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moist areas, resulted following the action of several factors among which the most important are climate variations and human activity.

Desertification manifests in territory through:

- reduction of soil surface covered by vegetation;
- a consistent soil poverty and erosion;
- increase of albedo of adjacent surface;
- increase of solar radiation.

Desertification is therefore a severe phenomenon of climate risk whose multiple causes are related to a complex of factors.

Droughts are risk complex climate phenomena with a slow manifestation, which affects and implies (depending on their duration and intensity), a varied number of components of geographic environment. These are mainly caused by meteorological factors and manifest through effects not only on both atmospheric, hydrologic, pedological, vegetal, animal environment, etc. Consequently, in their classification it speaks of: meteorological, hydrological, edaphic (from a pedological point of view, something related to soil nature) and agricultural drought. This is due, in the first place, to the lack of precipitations or their deficit, and the negative effects caused on different components of the geographic environment are visible on vegetation, soil and hydrological resources. Drought is a time-based phenomenon, and aridity is a characteristic of a certain region on which two factors acted simultaneously, namely: clime and anthropogenic impact.

Land degradation

It is a broad term referring to both semiarid, dry sub-moist and moist areas; it is caused by different natural and anthropogenic processes, and includes: erosion due to water or wind, degradation of physical, chemical, biological or economic soil characteristics and the loss of the natural vegetation on long term. The processes of desertification contribute also to these as a consequence of climate changes.

At global level, according to data provided by CCD a third of the Earth's land surface is covered by arid lands. 70% (that is 3.6 billion hectares) of arid lands with agricultural use are moderate to highly affected by degradation. Because of the erosion, 24 billion tones of arable land are lost every year. Desertification affects 110 countries on all the continents, including 5 Member States of the European Union, namely a population of more than a billion, and the annual cost desertification is about 42 billion dollars (Marinică, 2006). Series of international projects for the assessment of current stage of land degradation were coordinated by the International Soil Reference and Information Centre (ISRIC), and these include GLASOD project, concluded in 1991 through the publication of a book (at the scale 1:10 000 000) of degraded land at a global level; AASOD project intended for this estimation (at the scale of 1:1 500 000) for Southern and South-Eastern and SOVEUR project intended for a similar description (at the scale 1: 2 500 000) for the countries of Central and Eastern Europe (including Romania).

SOVEUR project takes into account the following types of soil degradation:

- soil pollution under the following aspects: acidification, pollution with heavy metals, pollution with pesticides, eutrophication, radioactive pollution;
- erosion due to water: surface erosion, depth erosion, landslips, erosion secondary effects; - erosion caused by wind: losses of arable soil, formation of dunes and other land irregularities, erosion secondary effects;
- physical degradation with the following aspects: aridity, formation of crust, subsidence, removal from production through urbanisation or other economic activities, excess inducted by humidity.

In Romania, drought phenomena, which are extremely powerful in some periods, have increased in intensity and frequency, and dryness processes have extended not only due to climate changes at global level, but also as a consequence of some deep and major local transformations, which occurred at the level of most land heritage (agricultural and forest), superposed on a unbalanced climate background, among which: destruction of moist areas years ago as a consequence of some draining aimed to create lands for agriculture, deforestations, destruction of protection forest curtains etc., which all at their turn induce climate effects.

The processes of land degradation expand and intensify rapidly manifesting not only in moist sectors, but also in semiarid and dry sub-moist sectors. The processes of soil degradation affects at different degrees more than 1/3 of the country surface. The most notable of all these, through extension and social-economic impact is the erosion caused by water, which together with landslips cover more than 7 million hectares. In Romania, the highest percentage of eroded soils is located in: Moldova Plateau, Subcarpathians between the Trotuş and the Olt, Transylvania Plateau and Getic Plateau among which there are included the Subcarpathian hills and plateaus in Oltenia. At the level of the entire country, the annual quantity of soil lost through erosion is about 123 million tonnes (Marinică, 2006).

Meteorological data in the last one hundred years in Dobrogea, Eastern Wallachia and Southern Moldavia (we took into account 17 meteorological stations from these regions), show a potential affectation of desertification of about 3 million hectares, of which 2.8 million ha are agricultural lands, representing 20% of agricultural surface.

Drought practically affects the whole agricultural surface of the country. Because of the increase of the risk of desertification, drought phenomena and land degradation, Romania's accession to CCD was a natural need.

Data and methods

Land desertification and degradation phenomena are closely connected with drought and dryness phenomena. For the study of dryness and drought phenomena the following criteria and methods can be successfully used:
- the analyse of non-regular variation of precipitations and the deviations of the quantities of precipitations (monthly, seasonal, biannual and annual);
- the frequency of pluviometric time type (Tables 1 and 2), according to hellman criterion applied to monthly and annual quantities of precipitations (the criterion has also established deviation percentage intervals of the biannual and seasonal from the normal).
- the use of Walter Lieth climate diagrams,
- the use of standardized precipitation index (SPI).

In this paper, we have broadly used Hellman criterion and as database the recordings from the meteorological stations in Oltenia with long series of meteorological observation (some of them of more than 120 years). We drafted series of charts necessary to the comparative analysis in the study of these complex phenomena and we used the statistical data published in order to predict the effects of droughty periods.

Table 1: Pluviometric time type in 1992 according to Hellmann criterion

														No of months		
Meteorological station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An	TS	TP	TN
Craiova	ED	R	ED	N	ED	N	ED	N	ED	ED	ED	ED	ED	8	1	3
Băileşti	ED	ED	ED	VR	ED	LR	ED	ED	ED	ED	ED	ED	ED	10	2	0
Bechet	ED	VD	ED	VR	VD	ER	ER	ED	ED	VD	ED	ED	ED	9	3	0
Calafat	ED	ED	ED	ER	D	LR	ED	ED	ED	ED	ED	VD	ED	10	2	0
Tg. Jiu	ED	ED	ED	LD	ED	LR	D	ED	ED	N	D	VD	ED	10	1	1
Apa Neagră	ED	ED	ED	VD	ED	ER	VD	ED	VD	R	VD	N	ED	9	2	1
Polovragi	ED	ED	ED	D	VD	VR	D	VD	ED	N	VD	VD	ED	10	1	1
Tg. Logreşti	ED	VD	ED	LD	VD	VR	LD	ED	VD	D	VD	VD	ED	11	1	0
Dr. Tr. Severin	ED	ED	ED	LD	ED	ER	D	ED	ED	LD	ED	R	ED	10	2	0
Bâcleş	ED	ED	ED	N	ED	ER	ED	ED	ED	ED	ED	VD	ED	10	1	1
Slatina	ED	VD	VD	LD	ED	N	ED	ED	ED	ED	ED	ED	ED	11	0	1
Caracal	ED	D	ED	LD	ED	ER	ED	VR	ED	ED	ED	ED	ED	10	2	0
Rm. Vâlcea	ED	ED	ED	VD	ED	ER	ED	VD	VD	N	ED	ED	ED	10	1	1
Drăgăşani	ED	VD	ED	LD	ED	D	VD	N	ED	VD	ED	ED	ED	11	0	1
Petroşani	ED	LD	ED	LD	ED	ER	ED	D	VD	N	VD	VD	ED	10	1	1
Parâng	VD	ER	ED	VD	VD	VR	ED	N	LD	LR	D	ED	VD	8	3	1
Dry time (TS)	17	15	17	13	17	1	16	14	17	11	17	15	170	83.3%		
Rainy time (TP)	0	2	0	3	0	14	1	1	0	2	0	1	24	11.8%		
Normal time (TN)	0	0	0	1	0	2	0	2	0	4	0	1	10	4.9%		

(Source: processed data)

(ED=excessively droughty, VD=very droughty, D= droughty, LD= little droughty, N=normal, LR= little rainy, R= rainy, VR=very rainy, ER=excessively rainy, TS expressed in number of months / time dry weather station (TS), analog mention during rainy (TP) expressed in number of months / rainy weather station and time that normal (TN). For example, if the station X weather we had in Y, we say that we have a long dry month if / etc. stayed dry, this size has significant space-time useful in addressing drought and excess rainfall. lately sizes were defined which have significant space-time such as the average amount of rainfall for the entire country, monthly, annual, etc.. was noted that this size correlates well with flooding phenomena (on an average monthly rainfall of 80 litres/m^2 country - floods occur) and the drought etc.'s especially useful in climate weather problems within a month, quarter, semester, year, etc.).

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Table 2: Pluviometric time type in 1993 according to Hellmann criterion.

	Months													No of months		
Meteorological station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An	TS	TP	TN
Craiova	FD	LR	ER	ED	FD	ED	ED	FD	D	ED	ER	FD	ED	9	3	0
Băileşti	FD	FD	R	ED	N	ED	ED	FD	D	ED	ER	D	ED	9	2	1
Bechet	FD	N	LR	ED	N	ED	ED	FD	FD	ED	ER	FD	ED	8	2	2
Calafat	ED	ED	LR	ED	VR	ED	ED	N	LD	ED	ER	D	ED	8	3	1
Tg. Jiu	ED	ED	ER	FD	FD	ED	FD	D	N	ED	ER	D	ED	9	2	1
Apa Neagră	ED	ED	ER	D	D	ED	ED	N	N	FD	VR	FD	ED	8	2	2
Polovragi	ED	ED	ER	FD	D	ED	FD	D	N	FD	LR	R	ED	8	3	1
Tg. Logreşti	ED	LD	ER	FD	FD	ED	ED	VR	ER	FD	VR	LD	FD	8	4	0
Dr. Tr. Severin	ED	ED	ER	ED	N	ED	ED	N	D	ED	ER	D	ED	8	2	2
Bâcleş	ED	ED	ER	ED	LD	FD	ED	LD	D	ED	ER	FD	ED	10	2	0
Slatina	ED	N	ER	ED	D		ED	VR	ER	FD	LR	ED	ED	8	4	0
Caracal	ED	D	LR	ED	ED	ED	ED	ED	ED	D	LR	ED	ED	10	2	0
Rm. Vâlcea	ED	ED	ER	LD	FD	ED	FD	N	LD	FD	R	N	ED	8	2	2
Drăgăşani	ED	N	ER	FD	D	N	ED	FD	FD	D	N	ED	ED	8	1	3
Petroşani	FD	ED	ER	ED	FD	D	FD	D	D	ED	D	N	ED	10	1	1
Parâng	ED	N	VR	FD	D	FD	FD	N	LR	ED	LD	N	ED	7	2	3
Dry time (TS)	17	12	0	17	13	16	17	10	11	17	2	13	145	71.1%		
Rainy time (TP)	0	1	17	0	1	0	0	2	3	0	14	1	39	19.1%		
Normal time (TN)	0	4	0	0	3	1	0	5	3	0	1	3	20	9.8%		

(Source: processed data)

Discussions

1. Desertification in Oltenia

1.1. Regionalization of Romanian territory according to aridity index (R)

The aridity index R is defined as the ratio of the annual precipitation sum P and potential evapotranspiration ETP (P/ETP).

According to the values of this index there are five areas:

- hyper-arid areas, in which R · 0.05;
- arid areas, in which R ≥ 0.05 and · 0.2;
- semiarid areas, in which R≥ 0.2 and · 0.5;
- dry sub-moist areas, in which R ≥ 0.5 and · 0.65;
- moist areas, in which R · 0.65;

In Romania, R · 0.2, according to this index, the climate falls within the semiarid, dry sub-moist and moist areas, (figure no. 1). In hilly and mountainous areas, the aridity index R exceeds 0.65, in steppe areas (steppe "islands") R is comprised between 0.2 and 0.50, and for forest steppe, between 0.5 and 0.65.

1.2. Climatic characteristics of the areas with desertification risk

– In the areas with a high risk of desertification and drought, climate is warm and dry;

- the annual average values of air temperature exceed 10·C;
- the sum of average temperatures · 0·C is comprised between 4000 and 4300·C;
- the sum of average temperatures · 10·C is comprised between 1600 and 1800·C;
- the sum of annual average precipitation sum is comprised between 350 and 550 l/m^2;
- the sum of monthly average precipitations in the period April – October is comprised between 200 and 350 l/m^2;
- soil water reserves on a depth from 0 to 100 cm on March 31 are comprised between 950 and 1500 m^3/ha, and the equivalent of precipitation values is comprised between 95 and 150 l/m^2.

In Oltenia

- in Oltenia Plain R ≥ 0.5 and · 0.65;
- in the hilly areas R≥ 0.65 and · 1.0;
- in Subcarpathians and mountainous area R ≥ 1.0 and · 2.70 (Fig. 1).

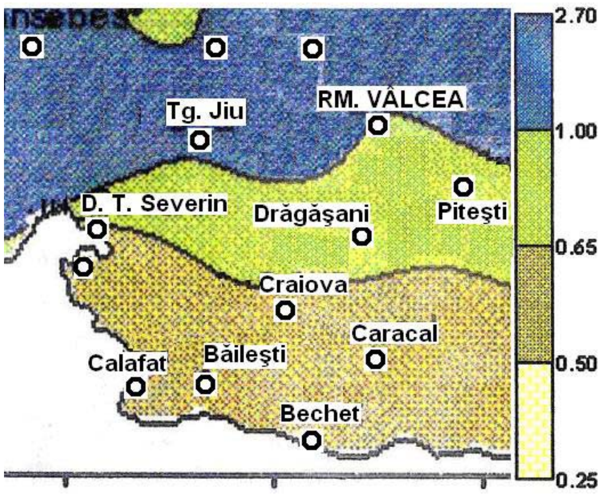

Fig. 1: Repartition of aridity index (R = P/ETP) in Oltenia *(according* to the National Strategy and Action Programme to Combat Desertification, Land Degradation and Drought*, 2000).*

Agroclimatic resources.

According to agroclimatic zoning (Fig. 2), in Romania there are three big agroclimatic areas with specific characteristics: warm-drought, moderate sub-moist and cool moist. The first one is subjected to imminent process of aridity.

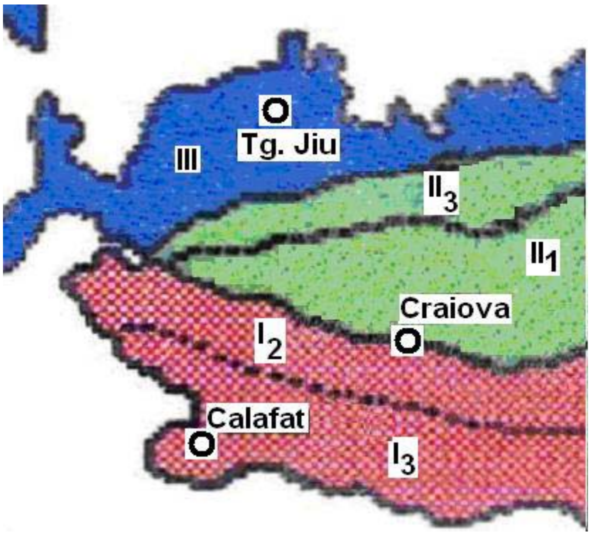

Fig. 2: Agroclimatic zoning in Oltenia *(according to the* National Strategy and Action Programme to Combat Desertification, Land Degradation and Drought, 2000). The zone I: hot dry, Σdaily average T > 4300-4000°C, annual rainfall 350-550 mm;). The zone II: moderate subhumid, Σdaily average T > 4000-3400°C, annual rainfall 550-650 mm; The zone III: cool wet, Σdaily average T> 3400-3000°C, annual rainfall 600-750 mm)*.*

The annual energetic flow is comprised between 110 and 140 Kcal/cm^2, namely by the level of the large cereal area in Europe, North America and East Asia.

The thermal potential is between 3000 and 4300·C, and the total value of temperatures in the vegetation period is comprised between 1200 and 1800·C.

In the area comprised between the annual isotherms of 6 and 8·C from the hilly-plateau, depressions and average mountains areas, people can cultivate micro and mesothermal (potato, rye, two-row barley, rape, flax), between annual isothermals of 8·C and 11·C (hilly areas) most of the agricultural plants can be cultivated, and in the area with annual average temperatures exceeding 11·C (plain) megathermal plants (cotton, rice, castor-oil plant).

The liquid resources vary as follow:

- on plain between 370 and 750 l/m^2, but have a non-uniform spatial-temporal distribution, which leads to significant annual fluctuations of crops;
- periods of time in which hydric resources provides an efficient capitalization of thermal resources representing 30% of the vegetation season, and in the rest of the time droughts or excesses of precipitation occur;
- most of the fluctuations are registered in the plain area in the south of the country in which Oltenia Plain is included with monthly values of precipitations comprised between 1 l/m^2 and 300 l/m^2 (and even 0 l/m^2 in some months);
- ***droughty periods are generally grouped in 2-4 years and returns cyclically, a fact proved by the grouping of droughty and rainy months.***

Non-regular variations of the quantities of precipitations and their negative deviations.

The regime of precipitations and temperatures, directly connected to the phenomena of dryness and drought registered great non regular variations in the last century.

The analyse of the negative deviations of the annual and monthly quantities of precipitations from the multiannual mean considered to be *normal* carried out for the southern half of Romania located at the shelter of Carpathian-Balkan orographic barrage from the western circulation, but exposed to the eastern circulation and to pontic influences, emphasized several climatic sectors: western – with oceanic and sub Mediterranean influences; central – interference of western and south-western with the eastern circulations; eastern – with continental influences, seaside with pontic influences and the sector adjacent to Carpathian Curvature with foehn effects reveal some significant results (Bogdan, Niculescu, 1999). They represented the base for the calculation of negative deviations of precipitations from the multiannual mean, considered to be normal.

2. The drought in the interval 1991-1993

The analysis of the pluviometric time type shows that this drought actually began in 1987, when in the south of Oltenia and in general in the Romanian Plain, especially in the warm season droughty and excessively droughty months registered. In the extreme south of Oltenia, droughty and excessively droughty months registered also in 1983, 1985, 1986, drought had therefore a slow evolution in time with short periods in which precipitations came back to normal, but the deficit of precipitations in soil and the phreatic layers has accumulated in time and has increased, although the annual quantities of precipitations were closed to normal.

The phase of drought maximum intensity occurred in the summer of 1993 when, seven counties in the south of the country were damaged and, the Romanian Government had to pass the Law 70/1993 on the cover of expenses made in order to set up crops (Tables 1 and 2). In these two years, drought became violent due to dryness phenomena of plants, pastures and even of some areas with

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forest vegetation. In these two years, the lack of precipitation occurred during a long period of time, for example a droughty time has been registered for 19 months of 24 in Băileşti in Oltenia Plain of which 15 were excessively droughty, as well as in Tg. Jiu and Slatina, 20 months in Caracal in the south-east of Oltenia, in Bâcleş in Mehedinţi hills, in Petroşani depression, etc. (Tables 3 and 4).

Table 3: Pluviometric time type in 2000 according to Hellmann criterion

	Months													No of months		
Meteorological station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An	TS	TP	TN
Craiova	N	N	ED	VR	ED	ED	R	ED	ER	ED	VD	ED	ED	7	3	2
Băileşti	VD	ED	ED	LD	ED	ED	VR	ED	ER	ED	ED	ED	ED	7	3	2
Bechet	LR	VD	ED	N	ED	ED	D	ED	ER	ED	VD	ED	ED	9	2	1
Calafat	VD	ED	ED	LR	ED	ED	LR	ED	N	ED	ED	ED	ED	9	2	1
Tg. Jiu	ED	ED	LD	D	VD	ED	D	ED	R	ED	ED	VD	ED	11	1	1
Apa Neagră	ED	ED	VD	D	ED	ED	VD	ED	VD	ED	ED	ED	ED	12	0	0
Polovragi	VD	ED	D	LD	ED	ED	VD	VD	N	ED	ED	VD	ED	11	0	1
Tg. Logreşti	VD	VD	VD	N	ED	ED	LR	VR	ER	ED	ED	ED	ED	8	3	1
Dr. Tr. Severin	ED	ED	ED	VD	ED	ED	N	ED	N	ED	ED	ED	ED	10	0	2
Bâcleş	ED	ED	ED	ER	ED	ED	ER	ED	ER	ED	ED	ED	ED	9	3	0
Slatina	LR	VD	ED	ED	ED	ED	LD	ED	ER	ED	ED	ED	ED	10	2	0
Caracal	D	D	ED	N	ED	ED	ED	ED	ER	ED	ED	ED	ED	10	1	1
Rm. Vâlcea	VD	ED	VD	VD	ED	ED	LD	ED	R	ED	ED	VD	ED	11	1	0
Drăgăşani	LR	D	ED	N	ED	ED	N	ED	VR	ED	ED	ED	ED	9	1	2
Voineasa	ED	ED	N	D	ED	ED	VD	LD	D	ED	ED	LD	ED	11	0	1
Petroşani	N	ED	ER	LD	VD	ED	D	ED	VD	ED	ED	N	ED	9	1	2
Parâng	R	D	ER	VD	ED	ED	ED	ED	VD	ED	ED	N	ED	10	1	1
Dry time (TS)	9	15	13	10	16	17	10	16	4	16	16	14	156	80.4%		
Rainy time (TP)	4	0	2	3	0	0	5	1	9	0	0	0	24	12.4%		
Normal time (TN)	2	1	1	3	0	0	2	0	3	0	0	2	14	7.2%		

(Source: processed data)

Table 4: Pluviometric time type in 2007 according to Hellmann criterion

	Months													No of months		
Meteorological station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An	TS	TP	TN
Craiova	ED	ER	ER	VD	ER	VD	ED	ER	ER	ER	ER	D	ER	5	7	0
Băileşti	ED	ER	N	VD	R	ED	ED	ER	ER	ER	ER	D	VR	5	6	1
Bechet	ED	ER	D	VD	N	ED	ED	ER	LD	ER	R	N	LD	6	4	2
Calafat	ED	VR	N	VD	VR	VD	ED	ER	N	ER	VR	VD	LR	5	5	2
Tg. Jiu	LD	ER	ER	VD	ER	VD	VD	ER	ER	ER	ER	D	ER	5	7	0
Apa Neagră	LD	ER	ER	VD	R	LD	ED	ER	VR	ER	ER	VD	ER	5	7	0
Polovragi	LD	ER	ER	VD	VR	ED	VD	ER	ER	ER	ER	D	ER	5	7	0
Tg. Logreşti	VD	VR	ER	VD	ER	LR	ED	ER	ER	ER	ER	VD	ER	4	8	0
Dr. Tr. Severin	ED	ER	VR	VD	VR	VD	VD	ER	D	ER	ER	VD	LR	6	6	0
Bâcleş	VD	ER	LR	VD	N	N	ED	ER	VD	ER	ER	ED	N	5	5	2
Slatina	VD	R	R	VD	VR	ED	ED	ER	R	ER	ER	LD	ER	5	7	0
Caracal	VD	ER	LR	VD	N	VD	ED	ER	N	ER	ER	VR	ER	4	6	2
Rm. Vâlcea	R	VR	ER	VD	N	VD	ED	ER	ER	ER	ER	VD	R	4	7	1
Drăgăşani	VD	N	VR	VD	N	ED	ED	ER	ER	ER	LR	VD	VR	5	5	2
Voineasa	ER	R	ER	VD	VR	VD	VR	ER	ER	ER	ER	ED	ER	3	9	0
Petroşani	ER	ER	ER	VD	VR	ED	VD	ER	VR	ER	VR	ED	ER	4	8	0
Parâng	ER	ER	ER	VD	VR	VD	LD	ER	ER	ER	ER	ED	ER	4	8	0
Dry time (TS)	13	0	1	17	0	15	16	0	3	0	0	15	80	39.2%		
Rainy time (TP)	4	16	14	0	12	1	1	17	12	17	17	2	113	55.4%		
Normal time (TN)	0	1	2	0	5	1	0	0	2	0	0	0	11	5.4%		

(Source: processed data)

Among the major negative deficits of precipitation we mention:

- *in 1992:* 259.7 l/m^2 (46.48% of the normal value) in Calafat, 275.2 l/m^2 in Dr. Tr. Severin (36.69% of the normal value), 286.0 l/m^2 in Bâcleş (46.24% of the normal value), 289.5 l/m^2 (33.5% of the normal value) in Polovragi, 296.6 l/m^2 (32.43% of the normal value) in Apa Neagră, 304.9 l/m^2 (53.72% of the normal value) in Băileşti, 308.0 l/m^2

(40.40% of the normal value) in Tg Jiu, 321.3 l/m^2 (55.02% of the normal value) in Slatina etc. ***The percentage deficits were comprised between 17.83% in Parâng in the high mountainous area and 55.02% in Slatina in Getic Plateau at the northern limit of Oltenia Plain.*** In this year, the droughty year had a percentage of 83.33% months-meteorological station.

-*in 1993:* 141.9 l/m^2 (25.40% of the normal value) in Calafat, 165.7 l/m^2 (29.19% of the normal value) in Băileşti, 181.8 l/m^2 (26.22% of the normal value) in Dr. Tr. Severin, 186.0 l/m^2 (25.69% of the normal value) in Rm. Vâlcea, 196.0 l/m^2 (34.53% of the normal value) in Bechet, 205.3 l/m^2 (22.44% of the normal value) in Apa Neagră, 222.8 l/m^2 (25.75% of the normal value) in Polovragi, 218.3 l/m^2 (28.03% of the normal value) in Petroşani, 235.4 l/m^2 (24.32% of the normal value) in Parâng, 236.1 l/m^2 (43.59% of the normal value) in Caracal etc.

The percentage deficits were comprised between 18.84% in Tg. Logreşti in Oltenia hills and 43.59% in Caracal in the south-east of Oltenia Plain.

In this year, droughty time had a percentage of 71.08% months/meteorological station.

Although in 1993 the deficits of precipitations were lower than in 1992 the effects on crops and, in general, on the vegetal cover were much more serious, thus the drought climax was reached.

In figure 3, we present the evolution of this drought in number of months/meteorological station of droughty time.

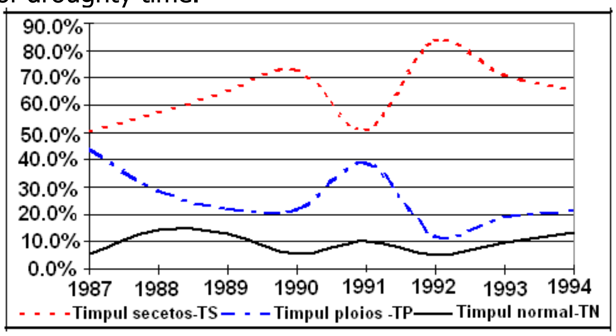

Fig. 3: Drought evolution in the interval 1987-1994 in percentages of number of cases of time type (months/meteorological station)
(Source: processed data)

In the period 1987-1993 the percentage of droughty time in Oltenia was comprised between 50.49% in 1987 and 83.33% in 1992, with an average of 64.62%.

Mehedinţi, Dolj, Olt and Teleorman were among the worst affected counties.

Some of the disasters were:

– on extended areas, corn crops were damaged in a percentage of 95–98%;

– all crops have been damaged.

For example, in Dolj county there have been damaged:

– 260 000 ha corn crop, in a percentage of 100%. At the county level the average production was of 200 kg cobs per hectare;

– 4 500 ha soy crop, damaged in a percentage of 100%;

– 3 000 ha bean crop, damaged in a percentage of 100%;

- orchards, vineyards and hay-fields were highly damaged (Marinică, 2006).

In Dolj County, 10 282 billion lei were paid (at the value of 1993), as indemnities representing only the costs of setting up crops. Drought also caused the fountains' drain and drastic decrease of underground water reserves in many localities, rivers and lakes' drain.

In many cities in the south of the country and even in Bucharest, the rationing of drinkable water was implemented. It was affected the production of electricity of the hydroelectric power stations on the Danube.

On the Danube and in Delta, special measures were taken for navigation. The analysis of flowing on the rivers in the south of the country showed that it has been the most severe drought after the drought in 1946 (Marinică, 2006).

Its duration in Oltenia was about 8 years, and in 1991, precipitations returned and a short period of interruption occurred, a typical situation since drought are interrupted by short rainy periods.

For the area of the 7 counties to which the Law 70/1993 refers, this was a catastrophic drought. The specificity of the Romanian territory is that drought does not manifest with the same intensity on the whole country and seldom affects the entire territory, an aspect due to the interaction of the Carpathian chain with the general circulation at the level of the entire European continent.

It should be noted that, from a thermal point of view, no record of maximum temperatures were broken although there were registered some hot periods during summer.

3. Drought and canicula in Oltenia in 2000

The droughty period which started in January 2000 lasted until July 17, 2002. It was interrupted by three short rainy periods in 2001 in which rains were followed by sunny days with wind gusts, which contributed essentially to the evaporation of soil water and the reappearance of water deficit in arable layer.

The summer of 2000 marked for Romania (Oltenia) the occurrence of canicula on extended periods of time. This was also accompanied by drought.

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The drought evolved slowly in the first months of the year, January, February and March, being marked by precipitations well below the norm.

The spring arrival was early during February, and afterwards, in the end of April, late hoarfrosts appeared, which were followed by spring months, April and May, with very few precipitations. In the end of June, canicular days started to appear. In July and August, the periods of prolonged canicula succeeded with short intervals of time, in which weather "cooled" slightly compared to the previous canicular days.

From a synoptic point of view, there has been an evolution of synoptic situation similar with those described in the characteristic drought types. The difference consisted in the fact that the periods of canicula, temperature maintained high even during nights.

In our country, a thermal record for July registered, on July 5, 2000, in Giurgiu 43.5° C, being the absolute maximum temperature of July.

The analysis of the pluviometric time types revealed the following aspects:

After the rainy summer of 1999, when in July there were registered 135.4 l/m^2 in Parâng, 136.4 l/m^2 in Voineasa, 136.6 l/m^2 in Slatina, 149.2 l/m^2 in Tg Jiu, 190.3 l/m^2 in Petroşani, 331.4 l/m^2 in Dr. Tr. Severin, 386.3 l/m^2 in Apa Neagră (Marinică, 2006), drought arrived gradually in Oltenia (August 1999 was droughty in most part of Oltenia, then the pluviometric poor time maintained in September, October and November, and in December the excess of precipitations returned).

The characteristics of drought in 2000 are:

The maximum intensity was registered in 2000 when 12 droughty months were registered in Apa Neagră Subcarpathian Depression and 11 months in Polovragi and Rm. Vâlcea, 10 months in Dr. Tr. Severin and Caracal, 9 months in Bechet, Calafat, Bâcleş, Drăgăşani and Petroşani, etc. (table no. 3).

In 2000, the percentage of droughty time was of 80.41%, compared to that in 1992. Among the most important annual deficits are: 294.9 l/m^2 (52.8% of the normal value) in Calafat, 296.1 l/m^2 (52.17% of the normal value) in Băileşti in Oltenia Plain, 300.00 l/m^2 (38.5% of the normal value) in Petroşani, 313.6 l/m^2 (53.7% of the normal value) in Slatina, 352.9 l/m^2 (45.5% of the normal value) in Voineasa (Vâlcea County), 373.6 l/m^2 (51.6% of the normal value) in Rm. Vâlcea, 407.7 l/m^2 (58.81% of the normal value) in Dr. Tr. Severin, 428.9 l/m^2 (56.3% of the normal value) in Tg. Jiu, 443.7 l/m^2 (45.8% of the normal value) in Parâng, 495.0 l/m^2 (57.2% of the normal value) in Polovragi and 576.6 l/m^2 (63.0% of the normal value) in Apa Neagră. The percentage annual deficits of precipitations were comprised between 36.2% in Craiova and 63.0% in Apa Neagră.

The drought of 2000 in Oltenia was in general extremely intense and associated with extended periods of canicular weather and heat waves in the intervals: June 6-10, 21-25, July 2-12, 22-27, August 3-7, 17-24. It affected the entire social life, causing the increase of food price and implicitly of other products.

According to the values of these deficits of precipitations, the entire year 2000 was excessively droughty (Table 3). The aridity processes were intense in all the southern half of Oltenia and especially in the area called "Oltenia Sahara". (*The surface of sandy soil of **over 100.000 hectares on the left of the Danube, between Calafat and Dăbuleni – known as Oltenia Sahara** (fig. no. 5) **represent an arid area, with tendencies of desertification.** The only country in Europe which owes a **Museum of Sand** is Romania. The Museum is located in the locality of Dăbuleni in the south of Oltenia. It is a surface of 12 hectares with white sand, which was left undeveloped in the communist regime in order to make the comparison between crops obtained on developed and undeveloped surfaces of land. It was declared a Museum. Nowadays, a significant percentage of the former agricultural arrangements are destroyed, and aridity processes are in progress in Oltenia Sahara (Craiova Regional Agency for Environment Protection, quoted by http://www.realitatea .net/sahara-olteniei-are-peste-100-000-de-hectare-de-teren-arid_480337.html).*

In 2001: March, April, June and July were rainy, and January, May and August were droughty, and then the excessive drought came back in the interval September, 2001 – July 17, 2002. The interruption of drought occurred in the second part of July 2002 when a rainy period began, which reached the climax in 2005.

In figure 4 we present the evolution of drought in the interval January 1, 2000-July 17, 2002.

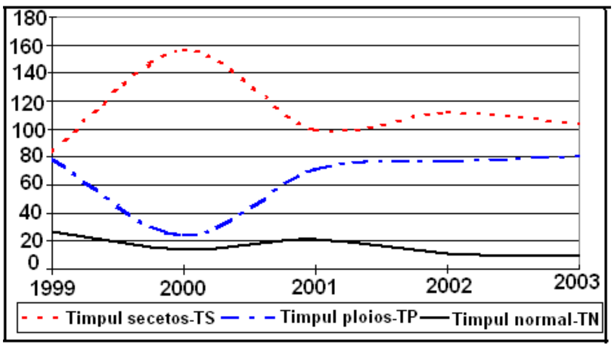

Fig. 4: Drought evolution in the interval 2000-2002 in number of cases of time type (months/meteorological station)
(*Source: processed data*)

The drought in the summer of 2000 affected 2.6 million hectares (of the entire country) and led to damages evaluated to about 6500 milliard lei (at the value of 2000) (Marinică, 2006).