ANALYSIS OF THE 2011 DROUGHT IN WESTERN ROMANIA

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Abstract.*The phenomenon of drought currently affects large areas all over the world. In 1992, E. Bryant, following a multi-criteria hierarchy, considers the drought as the most important risk phenomenon affecting the planet. Many scientific studies and research have as main issue this phenomenon in different regions of the world (Assessment of the Regional Impact of Droughts in Europe, 2001, Sectoral Impacts of Drought and Climate Change, 2008, Evaluation of Arizona Drought Watch: The State's Drought Impacts Reporting System, 2009, State Drought Planning in the Western U.S.A. Multi-RISA-Agency-NIDIS Collaboration, 2010). The specialists say droughts and phenomena (aridity and desertification) generated by them are based, in addition to changes in the general circulation of the atmosphere caused by increased greenhouse effect and anthropogenic causes, due to wasteful use, deforestation and changes in landscape, with negative effects on the water balance. Destructive impact of droughts and growing area of their production, comprising one quarter of the total land surface of the Earth, make the phenomenon to be considered, after pollution, the environmental risk with the largest amplitude and stability. Studies and reports elaborated by specialized international institutions and also from Romania proved that some regions of our country are affected by drought, that, on extended periods, lead to aridisation processes lack of vegetation, and in some areas, even to desertification but not Sahara type (DRAGOTĂ, 2006).*

INTRODUCTION

Climate analysis on Romania taking into account the last 40 years of the twentieth century, reveal the decrease of the annual amounts of precipitation especially in the southern and south-eastern parts of the country areas with high risk of droughts and also due to higher temperatures (BOGDAN AND NICULESCU, 1999).

In the last decades, the agrometeorologists observed the drought expanding to west and center of the country. So, surface weight which includes steppe and steppe zones is a risk indicator for exposure to drought and to all other consequences arising from this phenomenon. In this respect, it outlines three types of territorial units subject to drought and/or aridisation: high-risk counties (whose surface coincides entirely with the steppe and forest steppe zone), medium-risk counties (accounting for 50% of the territory covered by steppe and forest steppe zone vegetation- Timis county) and counties with low risk (with an area less than 30% covered with steppe forest steppe: Bihor, Arad).

MATERIAL AND METHODS

The literature on the months in which they occur, it is mentioned that droughts often preferred, September, March and April, and June rarest.

Drought as a phenomenon resulting from hydro climatic conditions is considered to be one of the most complex of natural phenomena, since the outbreak involving more than one category of factors (SOROCOVSCHI, 2009):

- climatic factors: rainfall, reserve soil water available for plants, air moisture and temperature, evapotranspiration, wind speed etc. these being the main climatic parameters defining the state of weather: wet or dry
- factors which define the active surface: of relief, soil, phreatic aquifer depth, vegetation coverage, etc;

- factors that define the physiological peculiarities of plants: plant variety, growth phase, resistance to dryness;
- anthropogenic factors: field condition and the agrotechnics used that facilitate soil water depletion (DONCIU, 1928, OCTAVIA BOGDAN, 1978, 1980, *GEOGRAFIA ROMÂNIEI*, I, GEOGRAFIA FIZICĂ, 1983).

Considering the criterion of evolutionary phases, there are several stages of drought: pedological, hydrological, agricultural and mixed.

Meteorological drought (atmospherical) appears mainly due to the absence of precipitation and the decrease in the relative air humidity below 40% under the conditions of high temperature air.

On Hellman's conception a dry period is characterized by the absence of rainfall in 5 consecutive days (BOGDAN AND NICULESCU, 1999) while it has not rained at all or, if it rained, precipitation did not exceed that daily average.

Drought is also characterized by the absence of rainfall in at least 14 consecutive days within the cold season (October-March) and at least 10 consecutive days within the year warm season (April to September), or, when precipitation occurred, they have not amounted a weight greater than 0.1 mm. A persistence of dryness causes drought installation.

In terms of climate, droughts represent the risk phenomena that can occur throughout the year and after release mode fits on slow character phenomena (BRYANT, 1992, MOLDOVAN, 2003, CROITORU, 2003, BOGDAN ŞI MARINICĂ, 2007).

Besides radiative factors whose diurnal and annual regime is considered to be quasi-constant, drought persistent depends to a large extent by the general circulation of the atmosphere and baric centers operating across the continent factors that are par excellence dynamics.

Atmospheric blocking lead to stagnation of meteorological characteristics over a particular region. In the case of blocking the same pattern of weather was repeated for a few days or even weeks. This can lead to floods, droughts, higher or lower than normal temperatures and other extreme weather.

It is important to recognize the pattern of atmospheric blocking since its initial development. The meteorologist will be able to forecast the persistence of the phenomena for several days in advance, with a high degree of accuracy. Atmospheric blockings are best observed in the upper atmosphere analysis and on forecast maps.

Blockings most common appear over vast regions associated with high pressure systems (anticyclonic), as long as they cover large areas and tend to move slower than cyclones.

The five main types of atmospheric blocking are:

- "Omega Block"
-"Rex Bock"
-"Ring of Fire" or "Cut-off high"
-"split flow"
- "Low Cut-off".

In Romania, droughts occur on the background of specific synoptic configurations. In principle it's the persistence of an anticyclonic field due to expansion across the country of ridges (Siberian High, Azores High, Scandinan High, North African High) or by the existence of a high pressure field due to the presence of an anticyclonic belt form by connection of Azores High ridges with Siberian High ridges. In these circumstances prevails arid air masses, with very low moisture (relative humidity between 10 and 20 %). They can be cold air (continental arctic), or, most often, dry and hot (tropical continental). Droughts are specific in Extracarpathic areas, because blocking of wet western air masses by mountains ridges. (BOGDAN, NICULESCU, 1999).

RESULTS AND DISCUSSIONS

For this study, we analyzed precipitation data recorded at weather stations in western Romania, belonging to Banat Crişana Regional Meteorological Center.

According to the analysis based on the Hellman's criterion made by E. Stanciu (2005), the order of exceptionally dry years registered at meteorological and pluviometrical stations in Banat between 1950-1999 from the point of view of decrease in intensity of droughts, is 1983 1961, 1950 as top three, and 1962, 1992, 1993 on fourth place.

According SPI (Standardized Precipitation Index) proposed in 1993 by McKee et al., particularly for measuring deficiency or excess of precipitation, can be identified following situations:

- a little dry: SPI between -1.0 and -1.49;
- moderate dry: SPI between -1.5 and -1.99;
- drought: SPI between -2.0 and -2.49;
- very drought: SPI between -2.5 and -2.99;
- extremely drought: SPI ≤ -3.0

The driest years on western Romania from the last four decades of the last century considering SPI values are shown in the next table:

Table 1.

The driest years on western Romania from the last four decades of the last century

Year	SPI
1986	-2.2
1963	-1.6
2000	-1.5
1987	-1.2
1990	-1.2

Latest, almost the entire year 2000 (according to some authors, this year's drought is comparable to the 1945-1946 one) and summer of 2001 are considered examples of very dry intervals. In the case of 2000 year drought, very intense between May to November, precipitation deficit, facilitated by prevailing blocking circulations, was exacerbated by persistent high temperatures especially in the SW part of the country: over 42°C in July, more than 40°C in August, above 25°C in October to 24°C in November.

As a result of drought during the period 1 May to 15 June 2000 were affected over 1.5 million ha in 30 counties, especially in the Banat.

In this general context, in the first decade of this century, in the western Romania the summer of 2000 was the driest, followed in descending order of intensity by the summer of 2003.

In 2007, as already mentioned, April was very dry, with stations where it has not rained even one mm: Baile Herculane 0.8 mm, 0.2 mm Sânnicolau Mare, Arad 0.0 mm. And 2007 was remarkable on this, only heavy rainfall in August (month improper to high rainfall) were overweight, statistically canceling all their absence during the spring and a large part of summer in that year.

In 2011 the first signs of rainfall deficit in the western part of Romania began to appear in late spring (June), on the border with Hungary (Arad). Aggravation moisture deficit expanded in area and intensity in August, both north and South (Chisineu Cris, Borod or Timisoara) and to the inside of the region (Lugoj, Caransebeş). At Sânnicolau Mare values of rainfall deficit reached extreme values (SPI -3.46). Rainfall from September and October, although slightly more substantial than in August (except Caransebeş in September with SPI values of -3.15 and -2.14 at Deva in October) were generally well below from climatological norms. They were found in the maps (fig. 2) of soil moisture anomalies and the vegetation index (NDVI).

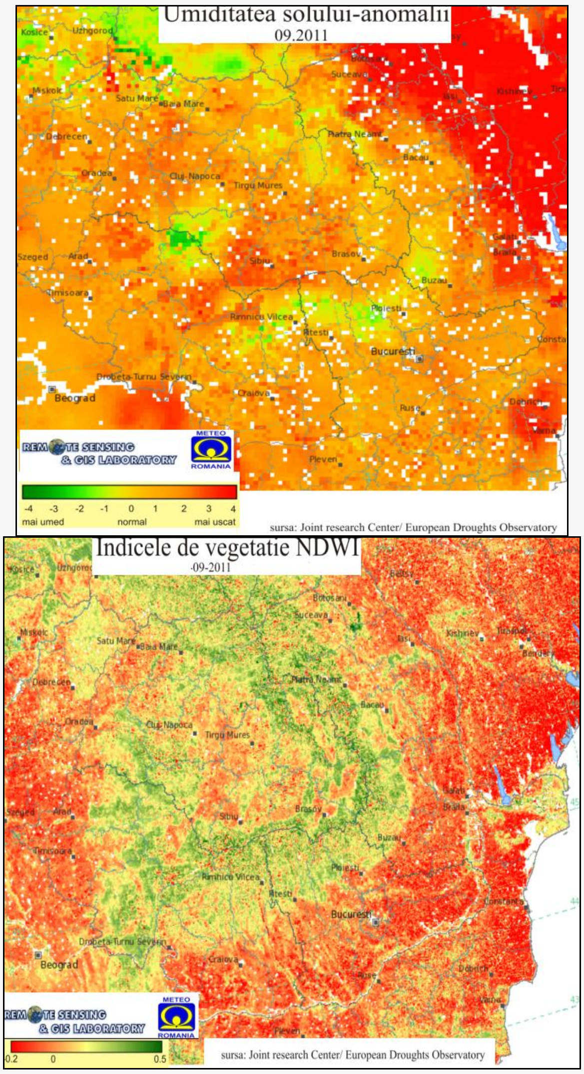

Fig. 1. Maps of soil moisture anomalies and the vegetation index (NDVI) in September 2011.

At the beginning of November, at the ground level has stationed high pressure field with values between 1025 and 1040 hPa.

In altitude, Ω shaped anticyclonic wave (fig. 3) gradually weakened in intensity opening a depression corridor to polar vortex towards the Black Sea over the Russian Plain, which favored cold air advection that continued to cool by radiation at night. Changes on ground and altitude circulation into eastern sector in the second decade, occurs with intrusion of a polar front from the north of the continent. However ground pressure values remain high; behind the front this time has intensified Scandinavian Anticyclone.

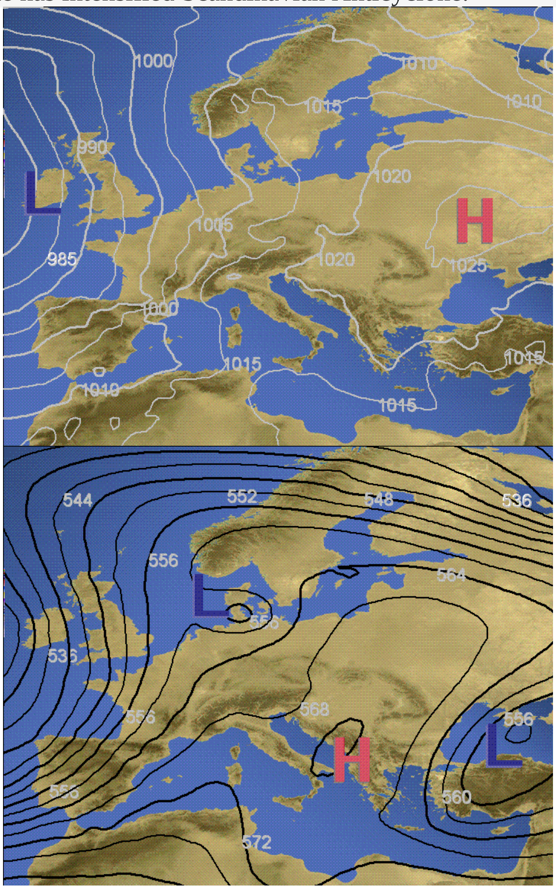

Fig. 2. Sea level atmospheric pressure and 500hPa geopotential on the first decade of November

Towards the end of the month the dynamic contribution of the Azores High will extend the life of blocking anticyclone that dominated ground baric field in November. This structure has generated intense thermal inversions in the lower troposphere near the surface.

Month's rainfall was deficient pronounced (dry). In November of 2011, rainfalls in the western regions of the country were very much under climatologically normally (fig. 4). There were 12 stations without precipitation throughout the course of the month and other 12 stations where they had extremely low values (<1 mm). Highest amounts, recording at 3 mountainous stations did not exceed even 2.5 mm. Rainfall were recorded in most cases only isolated and transient during November. In the intervals 01-06 and 12 to 18 November at all stations analyzed were not registered precipitation.

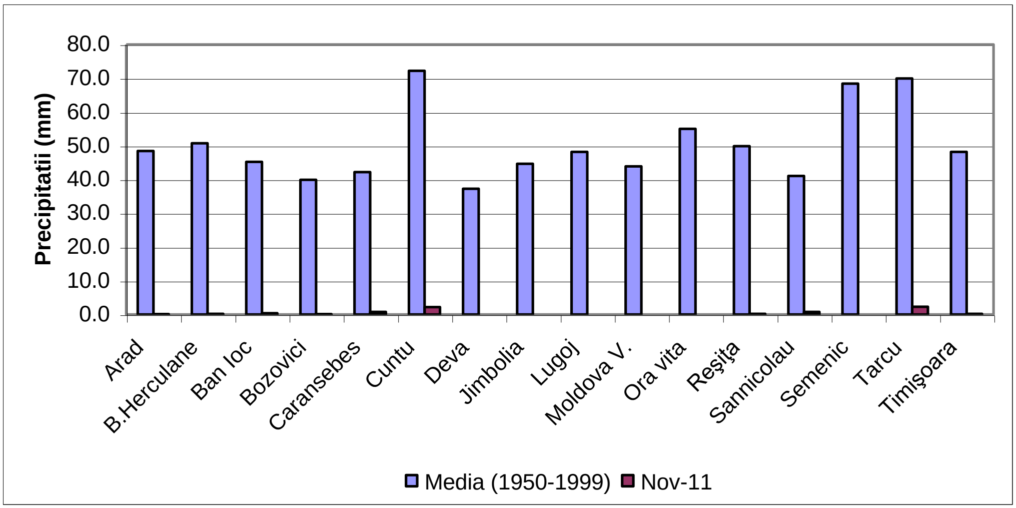

Fig. 3. Rainfall recorded at stations in western Romania in November 2011, compared with average annual quantities of November

For risk analysis as a result of deficiency rainfalls, precipitations quantities are grouped into classes of deviations (a normal class and other 6 class for quantities larger and below normal), rainfall domains (with cumulated value of all classes of the positive and negative deviations and compared them with the normal class / domain) and rainfall-risk groups by excess and deficiency respectively no pluviometrical risk groups.

We considered different risk thresholds, depending on the multiannual rainfall regime for different intervals for analysis. In order to compare effectively, we chose the same weather stations, the same period of analysis, and the time step of 1 month.

A class, respectively normal domain we considered as between -5.0% and +5.0%. For rainfall risks, we chose thresholds deviation 25.0% for the excess of precipitations risk respectively -25.0% for the deficiency precipitations risks to yearly values, semestrial and monthly, for spring and summer and for autumn and winter risk thresholds are 50.0% and -50.0% (table 2). We considered necessary this differentiation because small amounts of rainfall are recorded, usually in autumn, winter. It adds that, typically, winter precipitation falls in solid form and accumulates in the form of snow, passing into liquid gradually in early spring.

Table 2.

Classes deviations, rainfall domains and groups with / without precipitation risk for percentage deviation method compared to normal (after Croitoru, 2006)

Percentage deviation	**Class**	**Rainfall domains**	**Group with/without risk**
>75.0 %	P6		Risk by
50.1…75.0 %	P5		
25.1…50.0 %	P4		surplus
15.1…25.0 %	P3	Rainy	
10.1…15.0 %	P2		
5.1…10.0 %	P1		
-5.0…5.0 %	N	Normal	Without risk
-5.1…-10.0 %	S1		
-10.1…-15.0 %	S2		
-15.1…-25.0 %	S3	Dry	
-25.1…-50.0 %	S4		Risk by
-50.1…-75.0 %	S5		deficit
<-75.0 %	S6		

Regarding absolute deviation, in November, it was negative at all stations and ranged in area between 37 mm and considered 70 mm, which corresponds to negative percentage deviations of 97% and 100% (fig. 5). As an average over the region was a negative average deviation of 99.2%. These extremely small amounts of precipitation were generated mainly by persistent anticyclonic stable weather due to East European High in area of interest.

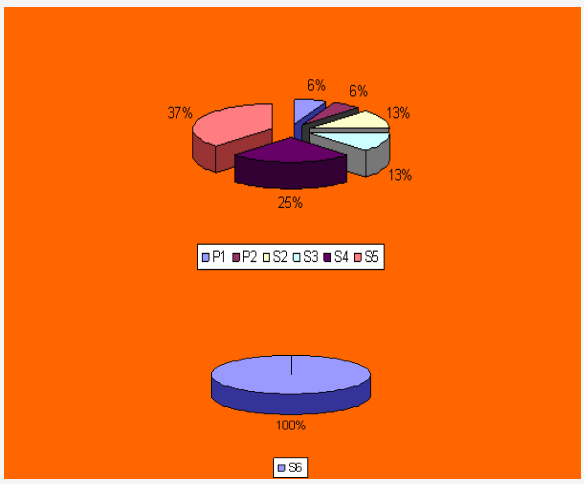

Fig. 4. Percentage distribution of deviations classes for October (left) and November 2011 (right)

Using SPI values November was one of the driest in the last 33 years, can only be compared with April 2007 as can be seen in the tables below (table 3 and 4).

Table 3

SPI on April 2007

timiso	sannic	resita	arad	oradea	hercul	borod	Oravit	lugoj	chisineu	banloc	carans
-2.98	-3.36	-2.31	-3.66	-3.14	-3.87	-2.84	-3.32	-2.38	-3.38	-3.83	-3.18

Table 4

SPI on November 2011

timiso	sannic	resita	arad	oradea	hercu	borod	Oravit	lugoj	chisineu	banloc	carans
-3.38	-3.38	-3.17	-3.35	-3.89	-3.14	-3.97	-3.55	-3.47	-3.2	-3.18	-2.71

The maps (fig. 5) of soil moisture anomalies and the vegetation index (NDVI) in November 2011 show extremes values of dryness.

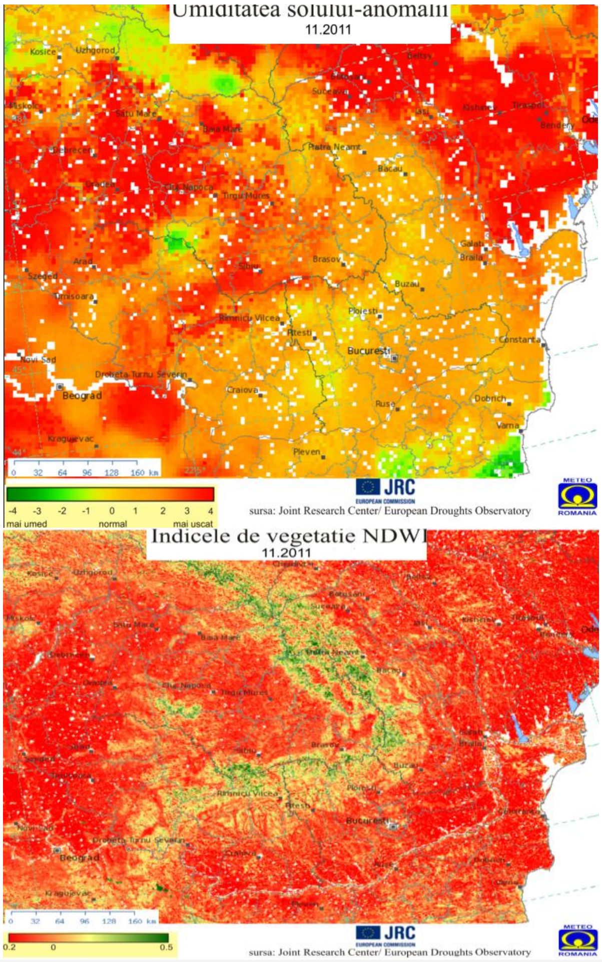

Fig. 5. Maps of soil moisture anomalies and the vegetation index (NDVI) in November 2011.

CONCLUSIONS

The most important conclusion that resulted from the analysis notes that deficient rainfall periods are characteristic especially in western extremity of West Plains. This has several negative consequences: reduced agricultural production, lowering ground water level, temporary drying of small rivers, reducing the volume of water in artificial lakes, water supply difficulties. The degree of risk increases for consecutive years and seasons with poor rainfall.

The results can be used to study the impact of droughts on main agricultural system components, crop quality and an opportunity to reduce losses respecting agricultural technologies that are necessary in drought conditions.

November drought reached its peak at all meteorological stations due to blocking anticyclone, which was the predominant structure baric field at ground level. Analysis of precipitations fields as a numerical "image" of intensity and persistence of droughts emphasizes the high values of the groups at risk at weather stations in western Romania in the period examined.

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