

# EXCESSIVELY DROUGHTY AUTUMN IN THE SOUTH-WEST OF ROMANIA DURING 2011

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**ABSTRACT.** - **Excessively droughty autumn in the south-west of Romania during 2011.** The atypical weather of 2011 continued also in autumn. Consequently, Oltenia had two distinct parts: a first warmish and droughty part, and a second cold part, characterized by drought too. In September, 7 days with maximum temperature values exceeding 35°C were registered. The warmish weather continued also in the first week of October, followed by a sudden cooling. This was the first excessively droughty autumn of the last 13 autumns in Oltenia. In November the weather was colder than normal and negative maximum thermal values were registered during the day, which means that there were winter days. The paper analyzes the characteristics of this autumn in detail and the study is completed by a comparison to the last 12 autumns. The paper is useful to researchers, specialists in climatology, master graduates and Ph.D. candidates.

**Keywords:** rainy autumn, heat waves, Hellmann criterion, warm autumn, record maximum thermal values.

## 1. INTRODUCTION

The autumn of 2011 was excessively droughty not only in Oltenia, but also in the whole country. November 2011 was the droughtiest month in the last 30 years according to the data NAM (Elena Mateescu –NAM Bucharest, „Ferma” 19.XII.2011). The drought of 2011 settled in Romania, as well as in Oltenia in the end of July, when, once with the fast decreasing of precipitations the weather became warmish, scorching in some days of August and September on long periods of time, the daily maximum temperature values were comprised between 33°C and 34°C, that is close to the threshold of scorching heat.

The drought manifested on extended areas not only of Romania, but also of the European continent, and, as a consequence, the Danube flow rapidly decreased which, on 18.09.2011, registered 2450 m<sup>3</sup>/s, value below the multiannual mean of the month of September (3800 m<sup>3</sup>/s). the hydrologic forecast estimated the continuous decreasing of the flow that would reach at 2250 m<sup>3</sup>/s on 25.09.2011, subsequently the flow falling below this vale. As a consequence of this situation, starting with 13.IX.2011, 11 convoys of waterway vessels (more than 250 vessels)

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were blocked at Calafat and Drobeta Turnu Severin and a crisis unit was established at the level of the Ministry of Transport.

The water reserve in the soil has fallen at values corresponding to the degree of extreme pedological drought causing serious problems to the autumn agricultural campaign and notably to the works of setting up the autumn crops.

We will further analyze this period of excessive drought in the south-west of Romania, its effects and causes.

## 2. DATA AND METHODS

We have used for our research on this droughty autumn the data from Oltenia MRC Archive, NAM (National Administration of Meteorology) Bucharest, the maps made by the Agrometeorology Laboratory (NAM), synoptic maps, the data offered by the archive, the satellite and radar images as well as the facilities offered by Office.

## 3. CLIMATIC CHARACTERISTICS OF SEPTEMBER 2011

**3.1. Pluviometric regime of September 2011.** The monthly quantities of precipitations were comprised between  $0.0 \text{ l/m}^2$  in the south-east of the region (Craiova, Caracal, Slatina areas) and  $6.8 \text{ l/m}^2$  at Băilești. In the mountainous area at Parâng there was registered  $5.8 \text{ l/m}^2$  and at Voineasa  $33.8 \text{ l/m}^2$  due to the local conditions which on 6.IX favored the showers which registered a value of  $32.9 \text{ l/m}^2$ . This value led to an increase of the general mean from  $2.5 \text{ l/m}^2$  to  $4.5 \text{ l/m}^2$  for the entire region.

The percentage deviations from the monthly multiannual means were comprised between  $-80.3\%$  at Băilești and  $-100\%$  in the south-east of Oltenia (Caracal, Craiova, Slatina), excepting the restricted area at Voineasa where the deviation was  $-38.7\%$ .

Using the Hellmann classification criterion, it results that in the entire Oltenia the type of pluviometric time was exceptionally droughty (ED), excepting the area Voineasa where it was very droughty (VD).

The result is confirmed by the general mean deviation of  $-90.5\%$  from the multiannual mean.

As a consequence of this poor pluviometric regime and the high temperature in the air and soil, at the end of September the humidity reserve in the soil accessible for plants, in the layer of 0-20 cm has fallen to values ranged between  $50\text{-}100 \text{ m}^3/\text{ha}$  in the eastern half of the region where the extreme drought was registered (ED), values between  $100\text{-}150 \text{ m}^3/\text{ha}$  while in the central and west part where the strong drought was registered (SD), and values between  $150\text{-}200 \text{ m}^3/\text{ha}$  in the northern part where the drought was moderate (MD).

The precipitations regime is closely linked to the air temperature regime and, consequently, it is useful to analyze:

**3.2. The thermal regime of September 2011.** *The monthly temperature means* were comprised between 18.5°C at Băcleș (only at Craiova, Slatina and Băcleș were <20°C) and 22..8°C at Calafat, and their deviations from the monthly multiannual means were comprised between 0.9°C at Slatina and 9.3°C at Voineasa (table no. 1), designating a thermal regime comprised between normal (N) at Slatina and very warm (VW) at Băilești, Tg. Logrești, Polovragi, Voineasa, Parâng and Ob. Lotrului.

*The general mean deviation* for the entire region was 3.9°C which means a warm month (W) for the entire region.

This is also confirmed by the fact that *all the daily maximum thermal values were ≥ 25°C which means that all the days of September were summer days. Among them 18 days (registered in the intervals 1-8.IX and 10-19.IX) were tropical days, that is they had the daily maximum thermal values ≥ 30°C.*

*The monthly thermal value was 36.8°C, registered at Calafat* (the warmest area of Oltenia) on 14.IX.

Four scorching days were registered in south and south-west, that is the maximum thermal values were ≥ 35°C (1, 12, 13 and 14.IX) and in another three days the daily maximum thermal values were closed to the scorching heat threshold (they was ≥ 34.5°C) (registered on 4, 5 and 11.IX).

**Table no. 1. The thermal regime of September<sup>3</sup> 2011 (°C)**

Meteorological station	Hm	NIX	MIX	Δ=M-N	CH	MinIX	Data MinT	MaxIX	Data MaxT
Dr. Tr. Severin	77	18.4	21.5	3.1	W	11.3	30.IX.2011	36.1	14.IX.2011
Calafat	66	18.4	22.8	4.4	W	8.5	28.IX.2011	36.8	14.IX.2011
Bechet	65	17.7	20.9	3.2	W	4.8	28.IX.2011	35.8	15.IX.2011
Băilești	56	17.7	22.7	5.0	WV	6.8	28.IX.2011	35.5	14.IX.2011
Caracal	112	17.8	20.6	2.8	W	10.3	28.IX.2011	35.3	13.IX.2011
Craiova	190	17.7	19.9	2.2	W	9.5	28.IX.2011	34.7	13.IX.2011
Slatina	165	17.9	18.8	0.9	N	8.1	28.IX.2011	34.9	13.IX.2011
Băcleș	309	16.6	18.5	1.9	WS	11.0	30.IX.2011	34.2	14.IX.2011
Tg. Logrești	262	15.9	22.7	6.8	WV	5.6	28.IX.2011	33.7	14.IX.2011
Drăgășani	280	17.6	21.5	3.9	W	11.0	10.IX.2011	34.1	13.IX.2011
Apa Neagră	250	15.9	22.3	6.4	WV	5.2	28.IX.2011	34.8	14.IX.2011
Tg. Jiu	210	16.6	21.1	4.5	W	7.7	29.IX.2011	35.0	14.IX.2011
Polovragi	546	15.6	21.9	6.3	WV	8.1	30.IX.2011	31.8	13.IX.2011
Rm. Vâlcea	243	16.4	20.7	4.3	W	9.3	10.IX.2011	34.8	14.IX.2011
Voineasa	587	12.3	21.6	9.3	WV	4.9	19.IX.2011	29.2	12.IX.2011
Parâng	1585	8.7	15.4	6.7	WV	6.0	30.IX.2011	23.6	12.IX.2011
Media Oltenia		16.3	20.2	3.9	W	8.0		33.8	
Ob. Lotrului		8.0	17.0	9.0	WV	-0.4	28.IX.2011	24.6	14.IX.2011

(Source: Data processed).

The value 36.8°C was the second of the monthly maximum thermal values registered in the last 51 years at Calafat in a decreasing order.

<sup>3</sup> NIX = monthly multiannual means in September, calculated for 1901-1990; MIX = average temperature in September; MinIX = Monthly minimum temperature in September; MaxIX = monthly maximum temperature in September; Data TMin = Date of minimum monthly temperature in September; Analog for maximum temperature, October and November. Δ=M-N= deviation of average temperature from the normal temperature.

Here, the frequency of the monthly maximum thermal value was  $\geq 35^{\circ}\text{C}$  in the last 51 years, being registered starting with 1992 and, thus, confirming the September climatic warming.

***The monthly maximum thermal values was  $33.8^{\circ}\text{C}$*** , higher with  $0.9^{\circ}\text{C}$  than that of June 2011 and with only  $1^{\circ}\text{C}$  lower than that of July 2011 which means a value comparable with one of the summer months. In a percentage of 86.7% the monthly maximum thermal values were  $\geq 33.7^{\circ}\text{C}$ .

*The monthly minimum temperature values* were comprised between  $4.9^{\circ}\text{C}$  at Voineasa and  $11.3^{\circ}\text{C}$  at Dr. Tr. Severin, most of them being registered in the interval 28-30.IX.2011, and their mean for the entire region was  $8.0^{\circ}\text{C}$ .

The weather cooling slowly occurred starting with 20.IX when the daily means for the entire region has fallen below  $20.0^{\circ}\text{C}$ . In the daily temperature evolution we observe two cooling intervals: on 9 and 10.IX and 20-30.IX.

#### **4. CLIMATIC CHARACTERISTICS OF OCTOBER 2011**

##### **4.1. The pluviometric regime of October 2011**

*The monthly quantities of precipitations* registered in October at the meteorological stations in Oltenia were comprised between  $39.8 \text{ l/m}^2$  in the south-east of the region at Caracal and  $68.6 \text{ l/m}^2$  in the Subcarpathian depression at Polovragi, and the percentage deviations from the multiannual means were comprised between -82.0% in the sub-mountainous area at Voineasa and  $23.5 \text{ l/m}^2$  in the south of Oltenia at Bechet.

According to Hellmann criterion the types of pluviometric time were comprised between exceptionally droughty (ED) in the most part of the region and rainy (R) at Bechet.

The precipitations mean for the entire regions was  $28.1 \text{ l/m}^2$ , and its percentage deviation from the monthly annual mean was -47.9%. Thus, according to Hellmann criterion it may be classified as a very droughty month (VD) for the entire region.

The classification of normally pluviometric month (N) at Craiova and Slatina and rainy (R) at Bechet is due to the rains on 8.X.2011 produced by the only frontal passage which affected Oltenia in this autumn whose quantities registered  $30.6 \text{ l/m}^2$  at Craiova,  $41.2 \text{ l/m}^2$  at Slatina and  $37.8 \text{ l/m}^2$  at Bechet, and  $30.0 \text{ l/m}^2$  at Drăgășani (where the month was droughty (D)) being the only significant precipitations in the month of October.

As a consequence, notably because of the rains produced by the frontal passage on 8.X.2011 as well as because of the low thermal regime (which caused low values of the evaporation), the water reserve in the soil was better on 31.X.2011 than at the end of September: almost in satisfactory limits (AS) in the most part of the region and almost optimum (AO) only on a restricted area at Bechet.

**4.2 The thermal regime of October 2011.** *The monthly temperature means* were comprised between 6.7°C at Voineasa and 12.3°C at Dr. Tr. Severin, and the percentage deviation from the monthly multiannual means were comprised between -1.5°C at Tg. Logrești and 0.6°C at Băilești, designating a thermally normal month (N) in most part of the region excepting the areas Tg. Logrești, Apa Neagră, Polovragi where it was cool (CO) (due to the high frequency of the phenomenon of thermal inversion which led a lower temperature means) and in the mountainous area at Ob. Lotrului (table no. 2).

*The monthly minimum thermal values* were comprised between -1.0°C at Drăgășani and -11.4°C at Ob. Lotrului, most of them being registered in the interval 17-19.X.2011 causing phenomena of early frosting in the air and soil, as well as early autumn hoarfrosts which damaged the vegetables crops. In the south of the region the monthly minimum thermal values were registered on 31.X.2011. Starting with 12.X.2011 and until the end of the month, the daily minimum thermal values were negative in the whole Oltenia.

*The monthly maximum temperature values* were comprised between 24.2°C at Voineasa and 30.4°C at Calafat and Apa Neagră. Most of them were registered on 1.X.2011.

## 5. CLIMATIC CHARACTERISTICS OF NOVEMBER 2011.

**5.1. The pluviometric regime of november 2011.** *The monthly quantities of precipitations* were ranged between 0.0 l/m<sup>2</sup> in the south-east of the region at Caracal, Slatina, in Mehedințiului Hills at Băcleș and in the mountainous area at Parâng and 4.3 l/m<sup>2</sup> in the subcarpathian area at Apa Neagră and Tg. Jiu.

**Table no. 2. The thermal regime of October 2011 (°C).**

Meteorological station	Hm	NX	MX	Δ=M-N	CrH	MinX	Data TMin	MaxX	Data TMax
Dr. Tr. Severin	77	12.2	<b>12.3</b>	0.1	N	-2.0	18.X.2011	30.0	1.X.2011
Calafat	66	11.9	12.0	0.1	N	-4.6	31.X.2011	<b>30.4</b>	1.X.2011
Bechet	65	11.3	10.4	-0.9	N	-4.6	31.X.2011	28.5	1.X.2011
Băilești	56	11.2	11.8	<b>0.6</b>	N	-3.5	18.X.2011	29.1	1.X.2011
Caracal	112	11.5	11.0	-0.5	N	-2.2	31.X.2011	28.0	1.X.2011
Craiova	190	11.4	11.0	-0.4	N	-2.2	18.X.2011	28.3	1.X.2011
Slatina	165	11.2	10.4	-0.8	N	-1.7	17;19.X.2011	27.8	1.X.2011
Băcleș	309	10.9	10.9	0.0	N	-2.1	18.X.2011	27.4	1.X.2011
Tg. Logrești	262	10.1	8.6	<b>-1.5</b>	CO	-6.9	18.X.2011	27.7	1.X.2011
Drăgășani	280	11.7	11.1	-0.6	N	<b>-1.0</b>	18.X.2011	27.7	1.X.2011
Apa Neagră	250	10.2	9.1	-1.1	CO	<b>-11.4</b>	18.X.2011	<b>30.4</b>	1.X.2011
Tg. Jiu	210	10.6	10.1	-0.5	N	-5.6	18.X.2011	29.7	1.X.2011
Polovragi	546	10.2	8.8	-1.4	CO	-5.1	17.X.2011	25.1	1.X.2011
Rm. Vâlcea	243	10.6	10.4	-0.2	N	-3.7	18.X.2011	28.0	1;6.X.2011
Voineasa	587	7.2	<b>6.7</b>	-0.5	N	-6.8	18.X.2011	<b>24.2</b>	7.X.2011
Parâng	1585	4.7	3.8	-0.9	N	-7.9	17.X.2011	17.2	5.X.2011
Media Oltenia		10.4	9.9	-0.5	N	-4.5		27.5	
Ob. Lotrului	1348	4.1	2.6	-1.5	CO	-12.0	17.X.2011	19.2	5.X.2011

(Source: Data processed).

The percentage deviation of these quantities from the monthly multiannual means were comprised between -100.0% at Caracal, Slatina, Băcleș and Parâng and -93.1% at Tg. Jiu, and according to Hellmann criterion November was an excessively droughty month (ED) at all the meteorological stations of Oltenia.

The monthly mean for the entire region was 1.1 l/m<sup>2</sup>, and the percentage deviation from the multiannual mean was -98.1% which confirms the classification of excessively drought month (ED). Starting with 10.X.2011 the precipitation were insignificant, and in the interval 25.X.2011-9.XI.2011 they were totally lacking in the most part of the region and continued to be insignificant after. As a consequence of this situation the water reserve in the soil was drastically reduced. Thus, on 30.XI.2011, in Oltenia, there was a moderate drought (MD) on extended areas in the south-west and north-east of the region (the humidity reserve in the layer soil of 0-50 cm was between 300 and 600 m<sup>3</sup>/ha) and in the most part of the region it was almost in satisfactory limits (AS).

The data from the archive confirms that **November 2011 was the driest month registered after 1950**, which represents a climatic record. No meteorological station in Oltenia has registered so low quantities of precipitation starting with 1950.

**5.2 The thermal regime of November 2011.** The monthly temperature means were comprised between 1.0°C at Voineasa at 3.9°C at Dr. Tr. Severin, and their deviation from the multiannual means were comprised between -4.0°C at Apa Neagră and -1.7°C at Băcleș. According to Hellmann criterion the classification of the thermal time type for the month of November was cold (CL) for the entire Oltenia excepting a restricted area in Mehedențiului Hills at Băcleș where it was cool (CO). In the mountainous area at Parâng November was cool (CO) (table no. 3).

**Table no. 3. The thermal regime of November 2011 (°C)**

Meteorological station	Hm	NXI	MXI	Δ=M-N	CH	MinXI	Data TMin	MaxXI	Data TMax
Dr. Tr. Severin	77	6.4	<b>3.9</b>	-2.5	<b>CL</b>	<b>-5.7</b>	30.XI.2011	<b>20.2</b>	9.XI.2011
Calafat	66	6.0	3.1	-2.9	<b>CL</b>	<b>-9.6</b>	30.XI.2011	<b>21.7</b>	9.XI.2011
Bechet	65	5.6	1.9	-3.7	<b>CL</b>	<b>-8.4</b>	19.XI.2011	<b>16.7</b>	9.XI.2011
Bailești	56	5.5	2.9	-2.6	<b>CL</b>	<b>-7.8</b>	19.XI.2011	<b>20.2</b>	9.XI.2011
Caracal	112	5.5	3.2	-2.3	<b>CL</b>	<b>-5.9</b>	19.XI.2011	<b>16.5</b>	9.XI.2011
Craiova	190	5.5	3.1	-2.4	<b>CL</b>	<b>-7.3</b>	19.XI.2011	<b>16.7</b>	9.XI.2011
Slatina	165	5.6	2.8	-2.8	<b>CL</b>	<b>-7.0</b>	19.XI.2011	<b>15.9</b>	9.XI.2011
Băcleș	309	4.8	3.1	-1.7	<b>CO</b>	<b>-4.6</b>	21.XI.2011	<b>17.8</b>	9.XI.2011
Tg. Logrești	262	4.8	1.0	-3.8	<b>CL</b>	<b>-9.9</b>	30.XI.2011	<b>16.9</b>	28.XI.2011
Drăgășani	280	5.6	3.5	-2.1	<b>CL</b>	<b>-4.8</b>	22.XI.2011	<b>16.9</b>	28.XI.2011
Apa Neagră	250	4.8	0.8	-4.0	<b>CL</b>	<b>-10.7</b>	26.XI.2011	<b>15.4</b>	1;2.XI.2011
Tg. Jiu	210	5.1	1.9	-3.2	<b>CL</b>	<b>-8.1</b>	27.XI.2011	<b>16.1</b>	1.XI.2011
Polovragi	546	4.8	1.7	-3.1	<b>CL</b>	<b>-10.7</b>	22.XI.2011	<b>17.2</b>	9.XI.2011
Rm. Vâlcea	243	5.2	3.2	-2.0	<b>CL</b>	<b>-5.9</b>	30.XI.2011	<b>16.5</b>	1.XI.2011
Voineasa	587	2.2	<b>-1.0</b>	-3.2	<b>CL</b>	<b>-10.3</b>	30.XI.2011	<b>15.3</b>	9.XI.2011
Parâng	1585	0.4	0.0	-0.4	<b>N</b>	<b>-8.1</b>	12.XI.2011	<b>11.6</b>	4.XI.2011
Media Oltenia		4.9	2.2	-2.7	<b>CL</b>	-7.8		17.0	
Ob. Lotrului	1348	-1.0	-2.3	-1.3	<b>CL</b>	<b>-14.6</b>	25.XI.2011	<b>13.8</b>	5.XI.2011
Petroșani	607	3.6	0.8	-2.8	<b>CL</b>	<b>-11.4</b>	23.XI.2011	<b>17</b>	1.XI.2011

(Source Processed data).

*The monthly temperature mean for the entire region was 2.2°C, and its deviation from the multiannual mean was -2.7°C, which means a cold month (CL) according to Hellmann criterion.*

*The monthly maximum thermal values were comprised between 15.3°C at Voineasa and 21.7°C at Calafat and many were registered on 9.XI.2011, and the mean of the monthly maximum thermal values for the entire region was 17.0°C.*

*The monthly minimum thermal values were comprised between -10.7°C in the Subcarpathian Depression at Apa Neagră and Polovragi and between -4.6°C at Băcleș.*

The variation tendency of the temperature was fast decreasing, and in the interval 20-23.XI.2011 negative maximum thermal values (winter days) were registered in the most part of the region. The small intervals of a slight warming occurred on 5, 9 and 27-28.XI.

## 6. CONCLUSIONS

Although, usually, in Oltenia as well as in Romania, the secondary maximum of precipitation is registered, the autumn of 2011 was excessively droughty (ED).

***In 2011 the droughty season in the second part of summer prolonged during the whole autumn season, and the secondary pluviometric maximum was no more registered.***

***The precipitations registered in November are the lowest in the whole range of data in the last 61 years which represents a climatic record for this month.***

From a thermal point of view, the autumn of 2011 had two distinct parts: a first warmish part (1.IX.2011-7.X.2011), when summer and tropical days were registered and a second cold part when, in some days, negative maximum thermal values were registered (winter days).

The atypical evolutions we have studied during 2011 (Marinică and collaborators 2011) demonstrate the increasing of climatic variability not only in Oltenia, but also in the entire Romania.

Taking into account that the characteristic of warmish month for the month of September as well as the maximum thermal values registered, we can state that the summer of 2011 lasted in Oltenia 4 months.

The drought in the last summer and autumn month of 2011 affected extended regions on the European continent, notably the regions next to Mediterranean Sea and the most part of the west and center, leading to a drastic fall of the Danube flow, and severely damaging the fluvial navigation.

The phenomena are due to the positive phase of the North-Atlantic oscillation and it shows us that as long as the Atlantic and Iceland Cyclones have trajectories situated over the northern continent, the Mediterranean Cyclones do not form or they are poorly developed, their trajectories being over the south of Balkan

Peninsula, and most of the continent remains in a warmish anticyclonic regime, the Atlantic-East-European anticyclonic girdle being positioned so that for Romania the air circulations from the western sector dominate.

These kinds of circulations have, in general, a great stability in time which leads to the prolongation of the droughty season to more than 6 months sometimes.

However, 2011 was considered a good agricultural year due to the excessive precipitations registered in the first 7 months of the year.

The excessive drought in the last summer and autumn month caused serious problems for the autumn agricultural campaign, because of the dry soil in big depth the autumn ploughlands were no longer possible, the autumn crops were set up quite late after 8.X.2011 when the first insufficient rains were registered, and, after that, the drought has worsen again.

The lack of precipitations caused the late spring of crops, even if their set up was made at the right time.

As a consequence of the intensity and duration (prolonging also in December), the drought of the autumn of 2011 affected the agricultural year of 2011-2012 too.

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