

EXCEPTIONALLY HOT SUMMER 2022 IN SOUTH-WEST ROMANIA

ION MARINICĂ¹, ANDREEA FLORIANA MARINICĂ²

Abstract. *Exceptionally hot summer 2022 in south-west Romania* The summer of 2022, in southwest Romania, as in Romania and on the European continent, was particularly hot, marked by a progressive weather warming starting from the very last month of spring - May. According to the Hellmann criterion, June was warm (CL) with a monthly mean of 22.06°C and a deviation from normal of 2.65°C. July was warm (C) with a monthly average, for the entire Oltenia region, of 23.96°C and a deviation from normal of 2.45°C. August was warm (C) with a monthly mean of 23.59°C and a deviation from normal of 2.5°C. Summer was hot (C) with a seasonal mean of 23.2°C and a deviation from normal of 2.5°C. The heat waves had the temporal extension of 51.1% of the summer days, and after the 7.VIII a rainy period followed. The entire continent of Europe was affected by the drought and then by the rainy season. The paper analyses the climatic evolution of this summer, which was the third warmest in the history of the climate in Oltenia, and is useful to all those interested in the climate of south-western Romania.

Keywords: *drought, heat, heat waves, torrential rains, climate risks.*

1. INTRODUCTION

In Romania, as in a good part of the Northern Hemisphere, *May* was warm, and in Oltenia, as in a good part of Europe, two early moderate heat waves were recorded in the intervals 5-23.V and 25-31.V, the latter continuing and slowly intensifying in June. ***In June 2022***, according to the Copernicus Programme, several "important aspects" took place. The global average temperature for June 2022 was about 0.31°C higher than the 1991-2020 average. ***In Europe, it was the second warmest June on record, with temperatures around 1.6°C above average.*** (June 2019 is the warmest June ever recorded in Europe). Copernicus reported extreme temperatures from Spain to Italy. "Southwest Europe, which experienced the first heatwave in the second half of May, experienced a new period of exceptional temperatures four weeks later, culminating on June 17th." (<https://www.g4media.ro/iunie-2022-a-treia-cea-mai-calduroasa-luna-iunie-din-istorie-potrivit-copernicus.html>).

¹ Associate Professor, Faculty of Sciences, Department of Physics, University of Craiova., Dr. CS. II, ionmarinică@yahoo.com.

² Jacobs University Bremen, marinica.andreea@gmail.com.

July 2022 "was one of the warmest Julys in the history of meteorological monitoring", (according to the WMO). "The world has just experienced one of the three hottest Julys ever recorded. And obviously, as we all know, a very prolonged and very intense heat wave has affected parts of Europe" (WMO - Clare Nullis, in a press conference). The WMO cited data from the Copernicus Climate Change Service and stated that the temperature in July 2022 was slightly lower than in July 2019, but slightly higher than in July 2016. **The global average temperature recorded in July 2022** exceeded 0.4°C average global temperature recorded in July during the reference period 1991-2020. This recording was made in the presence of the **La Nina** natural climate process which (WMO) "has a cooling effect". (<https://www.g4media.ro/iulie-2022-una-din-cele-mai-calduroase-luni-iulie-inregistre-vreodata.html>)

August 2022 was also the hottest August ever recorded in Europe, with a significant temperature difference of 0.8°C warmer than the previous record set in August 2018. The average temperature for the continent of Europe in August 2022 was by far the warmest August on record, 1.72°C above the 1991-2020 average and 2.24°C above the 1981-2010 average. **Summer 2022 was 0.4°C warmer in Europe than the previous record**, broken in 2021". (<https://www.meteoradar.ro/stiri-meteo/record-de-caldura-vara-2022-cea-mai-fierbinte-vara-din-europa--eac61c58-0e85-4d2f-b09b-bb6c695f6bce?fbclid=IwAR1tBrB84qE9XsIYB-CO7iUnOLccABFLHUtPXq7ad71bprb8r3GIJ769RXk&category=Topics>).

Heat waves and drought affected the entire continent of Europe, and the drought was intense. **The rivers, lakes and streams of Europe** dried up, and on the Rhine and other rivers, the "hunger stones" appeared in plain sight. "As heat and drought continued to grip much of Europe, the 'hunger stones' of the past were visible in the dry rivers and streams and brought with them a dire warning: 'if you see me, mourn.'" **Hunger stones** are **hydrological monuments** found in some rivers in Central Europe, which appear when the water level drops a lot. Inscriptions on them date from the 15th c to the 19th century, the stones were embedded in dry riverbeds to warn people of the future that bad times might follow." (<https://www.descopera.ro/istorie/20154971-pietrele-foamei-ce-sunt-si-de-ce-ii-sperie-pe-europeni>). "**In Romania**, river flows have dropped to historic levels, 700 localities have been supplied with restricted water. Over 240,000 hectares of agricultural crops were affected by the drought". (<https://www.greenpeace.org/romania/articol/7731/protest-greenpeace-pe-fundul-dunarii-secate/>).

Drought has affected most countries in Europe and restrictions have been imposed on water use. Numerous wildfires have occurred all over the world. For the first time in the history of Romania and in the world, there were fires of agricultural crops, which were intentionally caused by people as a result of political orders determined by the World Reset. In the summer of 2022, as in

2021, the term *heat dome* was widely used. *Mathematical and physical weather forecasting models* gave the biggest errors in the entire history of their operation (for example for daily thermal extremes, sometimes the errors were 5...6°C compared to the real values and not only for these parameters), errors unacceptable for weather forecasting, which we reasonably suspect was done with the intention of justifying the necessity and imminence of the World Reset. Mathematical and physical models for climate forecasting have never worked satisfactorily, errors being unacceptable for making climate forecasts that have always been shown to be outside the actual climate evolution. As a result of these serious deficiencies, it is fair to say that at the present time the phrase "climate emergency" is not justified, nor the ill-conceived and unnecessary "Global Reset". As a rule, *dry periods are followed by rainy periods*. It was the same in the summer of 2022, starting from the 7.VIII the rains came gradually and in many localities and areas on the continent of Europe the rains were torrential, with large hail or in large quantities, which caused floods rapids, destruction of agricultural crops, roads, houses and bridges, etc.

We will further analyse the climate variability in the summer of 2022 in South-West Romania (Oltenia). The work is part of an extensive series of analyses of climate variability and climate changes in Oltenia (Marinică, I. 2006; Marinică I., Marinică Andreea Floriana, 2016, 2019, 2020).

2. DATA AND METHODS

To carry out the work, I used the existing synoptic maps on the Internet from international weather forecasting centres, the ANM website, satellite information as well as information published in the written press.

3. RESULTS AND DISCUSSIONS

3.1. Climatic characteristics of June 2022

The thermal regime of June 2022. The monthly air temperature averages were between 17.2°C at Voineasa and 23.9°C at Dr. Tr. Severin, and their deviations from normal were between 1.6° C at Bechet and 4.5°C at Apa Neagră (Table 1). According to the Hellmann criterion, June was warm (C) in most of Oltenia. The average monthly air temperature calculated for the entire region was 22.1°C, and its deviation from normal was 2.69°C and according to the Hellmann criterion, June 2022 was on average warm (C) for the entire region Oltenia. The minimum monthly air temperatures were recorded on the dates of 8, 15, 16, 18, 19 and 22.VI and were between 6.3°C in Voineasa and 14.5°C in Drăgășani, and their average of the entire region was 11.4°C. The maximum monthly air temperature was mostly recorded on 30.VI and was between 32.1°C

in Polovragi on 29.VI and 36.4°C in Caracal on 30.VI, and their average for the entire region was 34.2°C.

Table 1. The air temperature regime in Oltenia and the minimum and maximum temperature values at the soil surface in June 2022 (Hm = altitude of the weather station, Δ=M-N = deviation from normal of the average temperature in June, CH = Hellmann criterion, NVI = averages of temperature for the month of June calculated for the interval 1901-1990 – normal; MVI = temperature averages in the month of June 2022)

Meteorological Station	Hm	NV I	MV I	Δ=M-N	C H	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr .Severin	77	20,7	23,9	3,2	C	36,3	30	13,9	16	40,1	30	13,2	16
Calafat	66	21,0	23,7	2,7	C	35,9	30	13,3	8	41,5	28	17,1	1
Bechet	65	21,3	22,9	1,6	C L	36,2	30	10,5	19	42,5	13	12,2	16
Bailesti	56	21,1	23,1	2,0	C	35,1	30	12,0	15	43,6	20	14,3	24
Caracal	112	20,8	23,1	2,3	C	36,4	30	13,8	15	46,0	5	15,0	8
Craiova	190	20,6	23,0	2,4	C	35,4	30	13,8	19	45,0	28	9,3	29
Slatina	165	20,5	22,4	1,9	C L	35,4	30	11,6	19	44,4	21	12,9	19
Bacleş	309	19,0	22,5	3,5	C	35,1	30	13,6	15				
Tg. Logresti	262	18,8	20,9	2,1	C	34,3	30	7,7	22	58,0	30	9,4	22
Dragasani	280	19,4	22,5	3,1	C	34,9	30	14,5	19	45,1	30	15,3	19
Apa Neagra	250	16,6	21,1	4,5	C	34,2	30	9,4	18	38,8	8	11,7	17
Tg. Jiu	210	19,4	22,4	3,0	C	35,0	30	11,5	22	40,8	30	9,1	22
Polovragi	546	17,7	20,4	2,7	C	32,1	29	10	22	57,8	25	6,2	22
Rm. Valcea	243	19,0	21,9	2,9	C	35,4	30	13,1	19	62,1	28	11,3	22
Voineasa	587	15,3	17,2	1,9	C L	32,4	30	6,5	19				
Parang	1585					23,4	30	7,9	15				
Average Oltenia		19,4	22,1	2,69		34,2		11,4		46,6		12,1	
Ob. Lotrului	1404	10,8	12,9	2,1	C	26,0	30	0,8	19				

(Source: processed data from the ANM archive)

The maximum temperature values passed the scorching threshold (32.0°C) starting on 24.VI. The heatwave (temperatures ≥ 35.0°C) was recorded starting on 29.VI and prevailed in the low-altitude area of Oltenia. *The first heat wave of the summer of 2022* was registered **between 24.VI-5.VII, lasting 12 days**. At the surface of the soil, the monthly thermal maxima were recorded on

the dates of 5, 13, 20, 21, 25, 28 and 30.VI and were between 38.8°C at Apa Neagră recorded early on the date of 8.VI. 2022 and 62.1°C and in Rm. Vâlcea on 28.VI, and the average monthly maximum thermal values at the soil surface for the entire region was 46.6°C, registering an increase of 11.9°C compared to from May.

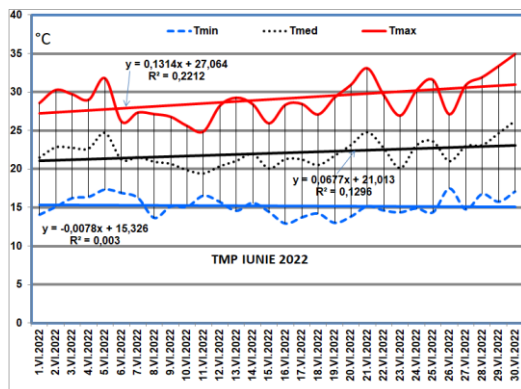


Fig. 5. The temperature field at the level of 850 hPa on 23.VII.2020 at 18 UTC (at the time of reaching the peak of the heat wave).
(after www.wetter3.de)

the daily maximums had the fastest growth, with a significant growth coefficient of 0, 1314 (fig. no. 1). The daily minima of the air temperature had a very slightly downward trend due to the cooling of the weather in the range of 19-22.VI.

Rainfall regime in June

The monthly amounts of precipitation were between 15.6 l/m² at Caracal in the Romanați Plain and 100.5 l/m² in the Voineasa intracarpethian depression, and their percentage deviations from normal values were between -78.8% at Caracal and 35.3% in Băilești.

Only at two weather stations (Calafat and Băilești) there were positive percentage deviations of the amounts of precipitation (Table 2). According to the Hellmann Criterion, the month of June 2022 was very rainy (FP) in a small area in the Oltenia Plain in Băilești, normal (N) in small areas in Calafat in the extreme south-west of Oltenia, in Bechet in the extreme south and in Voineasa, very dry (FS) in the extreme west at Dr. Tr. Severin, in the area of the hills at Tg. Logrești and in the Oltului Corridor at Rm. Vâlcea, and excessively dry (ES) in most part of Oltenia (56.3% of meteorological stations). Most precipitation values were ≤5.0 l/m². Two intervals were recorded with rains on relatively extensive areas locally significant for agriculture 10-12.VI and 25-28.VI, and torrential rains were isolated on restricted areas, accompanied by large hail or in large quantities,

The minimum monthly temperatures at the soil surface were recorded on 1, 8, 16, 17, 19, 22, 24 and 29.VI and were between 6.2°C at Polovragi recorded on 22.VI and 17.1°C in Calafat on 1.VI., and their average for the entire region was 12.1°C, registering an increase compared to May of 7.3°C.

The graphs of the variation of the parameters characterizing the air temperature in June (daily maximums, daily averages, and daily minimums) had linear increasing trends for the daily maximums and averages, and the

by the storms that caused significant destruction in the agricultural fields (in the villages of Sohodol, Valea Mare and Valea Mică in Tismana commune, Gorj county). The highest amount of precipitation in the low-altitude area was 42.0 l/m² at Bechet on 28.VI and a slightly higher value was 44.7 l/m² at Voineasa on 25.VI. The highest daily average of recorded precipitation was 10.0 l/m² on 28.VI. The hot days with maxima above 30°C were numerous, and the low rainfall as well as the pluviometric deficit period accentuated the drought and the lack of rainfall in soil.

Table 2. Amounts of precipitation recorded in the summer of 2022 (Σ), compared to the normal values (N for the period 1901-1990), the deviation ($\Delta\%$) and the type of pluviometric time according to the Hellmann criterion (CH).

Meteorological Station	Hm	June 2022				July 2022				August 2022			
		Σ VI	N	$\Delta\%$	C H	Σ VI I	N	$\Delta\%$	C H	Σ VII I	N	$\Delta\%$	C H
Dr. Tr. Severin	77	46,8	72,5	35,4	FS	50,0	49,3	1,4	N	29,7	38,2	-22,3	S
Calafat	66	68,3	65,6	4,1	N	61,4	45,6	34,6	FP	44,8	35,6	25,8	P
Bechet	65	61,0	62,3	-2,1	N	18,8	46,6	59,7	ES	77,8	37,9	105,3	EP
Băilești	56	90,0	66,5	35,3	FP	42,2	45,0	-6,2	N	84,6	39,0	116,9	EP
Caracal	112	15,6	73,7	78,8	ES	37,2	53,8	30,9	FS	39,2	39,9	-1,8	N
Craiova	190	27,5	71,2	61,4	ES	35,4	51,4	31,1	FS	76,6	42,1	81,9	EP
Slatina	165	37,5	80,6	53,5	ES	45,5	57,5	20,9	S	123	46,8	162,8	EP
Băcleș	309	20,2	72,0	71,9	ES	68,0	47,1	44,4	FP	140,4	33,4	320,4	EP
Tg. Logrești	262	43,2	72,3	40,2	FS	32,8	49,5	33,7	FS	176,8	43,6	305,5	EP
Drăgășani	280	25,6	87,6	70,8	ES	38,4	51,6	25,6	S	119,2	46,4	156,9	EP
Apa Neagră	250	35,2	99,2	64,5	ES	68,4	72,7	-5,9	N	103,1	60,1	71,5	EP
Tg. Jiu	210	33,4	93,0	64,1	ES	59,7	61,9	-3,6	N	117,6	64,3	82,9	EP
Polovragi	546	52,4	112,3	53,3	ES	82,8	88,9	-6,9	N	171,4	76,5	124,1	EP
Rm. Vâlcea	243	46,3	86,9	46,7	FS	49,9	98,0	49,1	FS	146,6	69,4	111,2	EP
Voineasa	587	100,5	106,7	-5,8	N	93,5	88,6	5,5	N	212,2	72,8	191,5	EP
Parâng	158	12,0	124,	-	ES	93,4	132,	-	S	198	90,	118,	EP

EXCEPTIONALLY HOT SUMMER 2022 IN SOUTH-WEST ROMANIA

	5		1	90, 3			1	29, 3			6	5	
Average Oltenia		44,7	84,2	46, 9		54,8	65,0	15, 6		116, 3	52, 3	122, 4	EP
Ob. Lotrului	140 4	32,8				59,1				54,9			

(Source: processed data from the ANM archive)

3.2. Climatic characteristics of July 2022

The thermal regime of July 2022. The monthly air temperature averages were between 18.3°C at Voineasa and 26.1°C at Dr. Tr. Severin, and their deviations from normal were between 1.2°C at Voineasa and 3.1°C at Dr. Tr. Severin.

Table 3. The air temperature regime in Oltenia and the minimum and maximum temperature values at the soil surface in July 2022 (Hm = altitude of the weather station, $\Delta=M-N$ = deviation from normal of the average temperature in July, CH = Hellmann criterion, NVII=means of temperature for July calculated for the interval 1901-1990 – normal; MVII = temperature averages in July 2022)

Meteorological Station	Hm	NVI I	MVI I	$\Delta=M-N$	C H	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Dat e	(°C)	Dat e	(°C)	Dat e	(°C)	Dat e
Dr. Tr .Severin	77	23,0	26,1	3,1	C	40,4	23;	13,2	18;	44,6	23;	12,3	12;
Calafat	66	23,2	26,0	2,8	C	41,7	23;	13,3	18;	47,5	23;	14,5	12;
Bechet	65	23,0	24,9	1,9	L	40,0	23;	9,2	12;	49,5	30;	15,4	12;
Bailesti	56	22,8	25,0	2,2	C	39,9	23;	10,1	12;	49,1	23;	10,7	12;
Caracal	112	22,9	25,8	2,9	C	39,5	23;	12,1	12;	48,1	23;	13,6	12;
Craiova	190	22,3	25,1	2,8	C	39,3	24;	11,1	12;	44,3	24;	10,4	12;
Slatina	165	22,0	24,6	2,6	C	39,4	24;	10,4	13;	47,6	23;	13,8	13;
Bacleş	309	21,3	24,2	2,9	C	38,6	23;	11,1	12;	-	-	-	-
Tg. Logresti	262	20,7	22,4	1,7	L	37,4	23;	6,3	13;	64,4	26;	6,5	13;
Dragasani	280	21,7	24,6	2,9	C	38,3	24;	12,2	13;	46,3	23;	14,7	11;
Apa Neagra	250	20,5	22,5	2,0	C	38,8	23;	5,5	12;	54,7	23;	7,7	12;
Tg. Jiu	210	21,3	23,9	2,6	C	38,2	23;	9,4	12;	42,2	23;	8,0	12;
Polovragi	546	19,7	22,2	2,5	C	35,1	23;	8,5	12;	60,5	27;	7,0	13;
Rm. Valcea	243	21,2	23,8	2,6	C	38,1	24;	10,5	13;	66,3	2;	9,2	5;
Voineasa	587	17,1	18,3	1,2	L	34,6	23;	5,8	13;	-	-	-	-
Parang	158	-	-	-	-	28,8	23;	5,6	12;	-	-	-	-
Average Oltenia		21,5	23,9 6	2,5		38, 0		9,6		51, 2		11, 1	

Ob. Lotrului	140 4	12,5	13,7	1,2	C L	28, 6	23;	1,5	13;	-	-	-	-
Petroșani	-	17,4	-	-	-	35, 7	23;	6,3	12;	45, 5	23;	8,1	20;

(Source: processed data from the ANM archive)

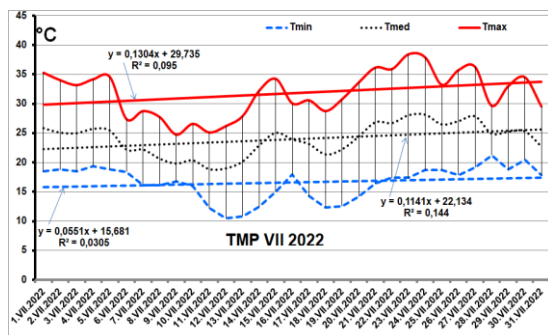


Fig. 2. Variation of air temperature averages, daily maximums, daily averages and daily minimums in July calculated for the entire Oltenia region 2022. (Source: processed data from the ANM Archive).

According to the Hellmann criterion, July 2022 was warm (C) in most of Oltenia, except for three restricted areas at Bechet in the extreme south, in the hilly area of Tg. Logrești and in the Oltului Valley at Rm. Vâlcea where it was warm (CL) (Table 3).

The average monthly temperature for the entire Oltenia region was 23.96°C, and its deviation from normal was 2.45°C, which according to the Hellmann criterion confirms that the month of July 2022 was

warm (C) on average for the entire region. According to the daily average air temperature, calculated for the entire region, the hottest days in summer 2022 were on July 23 and July 24, with daily averages for the whole of Oltenia of 28.06°C and 28.15°C, days that coincide with those in which the monthly thermal maxima were recorded.

The highest monthly air temperatures were recorded on 23.VII. 2022 and were between 34.6°C in Voineasa on 23.VII and 41.7°C in Calafat on 23.VII, and their average for the entire Oltenia region was 38.0°C, 4.5°C higher than July 2021. The monthly maximum temperature of 41.7°C was the annual maximum temperature for 2022 and exceeded the annual maximum temperature of 2021 by 0.6°C. The longest and most intense heat wave of summer 2022 was recorded between July 14-30, lasting 17 days. The first heat wave of July 2022 was recorded in the interval 1-5.VII with a duration of 5 days. In July 2022, the total duration of heat waves was 22 days (ie 70.97% of July days).

The minimum air temperatures in July were recorded on 12, 13 and 18.VII (most on 12.7 and 13.VII) and were between 5.8°C in Voineasa on 13.VII and 13.3°C in Calafat on July 18, and their average for the entire region was 9.6°C.

At the soil surface, the maximum temperatures were recorded, mostly in the second decade on the dates of 2, 23, 24, 27 and 30.VII and were between 42.2°C at Tg. Jiu on July 23 and 66.3°C in Voineasa on July 2, and their average for the entire region was 51.2°C. The minima of the temperature at the soil surface were recorded

on the dates of 5.11, 12 and 13.VII and were between 6.5°C at Tg. Logrești on July 13 and 15.4°C in Bechet on July 12, and their average for the entire Oltenia region is 11.1°C. **The graphs of the variation of the parameters that characterize the air temperature** in July 2022 have increasing trends in all three parameters (average of daily minimums, average of daily and average of daily maximums) (Fig. 2), and among them the most rapid increase was of the average of daily maximums (calculated for the entire region), whose growth coefficient was 0.1304.

Rainfall regime in July 2022

The monthly amounts of precipitation were between 18.8 l/m² in Bechet and 93.5 l/m² in Voineasa, and their percentage deviations from normal were between -59.7% in Bechet and +44.4 % in Bâcles. According to the Hellmann criterion, July 2022 was excessively dry (ES) in Bechet, very dry (FS) in Craiova, Caracal, Tg. Logrești and Rm. Vâlcea, dry (S) in Slatina, Drăgășani and Parâng, normal pluviometric (N) in Dr. Tr. Severin, Băilești, Apa Neagră, Tg. Jiu, Polovragi and Voineasa and very rainy (FP) in Calafat and Bâcles. The average monthly amounts calculated for the entire region was 54.8 l/m², and its percentage deviation from normal was -15.6%, which according to Hellmann's criterion shows that, on average, July 2022 was slightly dry (PS) for the entire region (Table 2). Deficient rainfall prevailed on 50% of Oltenia's surface, normal rainfall on 37.5%, and excess rainfall on 12.5%.

3.3. Climatic characteristics August 2022

The thermal regime of August 2022. The monthly air temperature averages were between 18.1°C at Voineasa and 25.6°C at Dr. Tr. Severin, and their deviations from normal were between 1.6° C to Tg. Logrești and 3.4°C at Dr. Tr. Severin. According to the Hellmann criterion, the month of August was warm (C) in most of Oltenia except for some restricted areas in Slatina, Tg. Logrești and Voineasa where it was warm (CL) (Table 4).

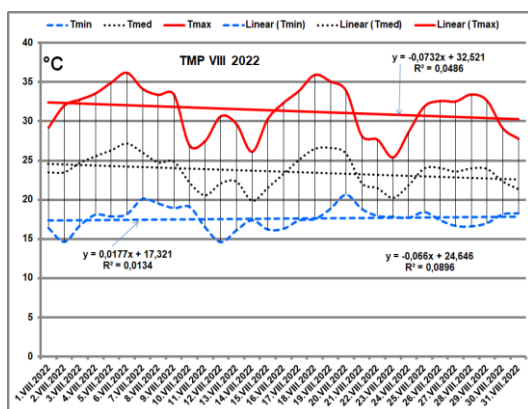


Fig. 3. Variation of air temperature averages, daily maximums, daily averages and daily minimums calculated for the entire Oltenia region in August 2022.

The monthly average of the air temperature, calculated for the entire Oltenia region was 23.59°C, and its deviation from the normal of 2.49°C and according to the Hellmann criterion, the month of August was warm (C) on average for the entire region Oltenia. *The monthly air temperature maxima* were recorded on the 5th, 6th, 18th and 19.VIII and were between 32.1°C in Voineasa on the 5.VIII and 39.2°C in Calafat on the 6.VIII, and their average for the entire Oltenia region was 35.8°C, 2.2°C lower than in July. *The minimum monthly air temperatures* were recorded on 1, 2, 11, 12 and 13.VIII and were between 9.7°C at Voineasa on 2.VIII and 17.1°C at Caracal in on 12.VIII, and their average for the entire Oltenia region was 13.7°C. *At the ground surface, maximum temperatures* were recorded on the dates of 2, 5, 6, 7 and 19.VIII and ranged between 41.0°C at Tg. Jiu on the 6th of August and 62.7°C in Rm. Vâlcea on the 7th of August, and their average for the entire region was 49.0°C.

Table 4. Air temperature regime in Oltenia and the minimum and maximum temperature values at the soil surface in August 2022 (Hm = altitude of the weather station, Δ=M-N = deviation from normal of the average temperature in August 2021, CH = Hellmann criterion, NVIII= temperature averages for August calculated for the interval 1901-1990 – normal; MVIII = temperature averages in August 2022).

Meteorologic al Station	Hm	NVII I	MVII I	Δ=M-N	C H	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Dat a	(°C)	Dat a	(°C)	Dat a	(°C)	Dat a
Dr. Tr .Severin	77	22,2	25,6	3,4	C	37,8	18	16,3	12	42,1	6	15,8	12
Calafat	66	22,7	25,5	2,8	C	39,2	6	16,6	12	46,6	6	18,4	15
Bechet	65	22,4	24,6	2,2	C	38,3	6	13,0	12	48,4	5	17,3	12
Băilești	56	22,5	24,8	2,3	C	37,5	6	14,7	2	54,5	19	14,8	2
Caracal	112	22,4	25,4	3,0	C	37,1	18	17,1	12	43,0	2	18,7	1
Craiova	190	22,2	24,6	2,4	C	36,7	6	16,0	11	41,1	6	15,4	11
Slatina	165	22,2	24,1	1,9	L	36,3	6	15,1	12	45,8	5	16,0	12
Băcleș	309	20,9	23,7	2,8	C	35,9	18	15,3	12	-	-	-	-
Tg. Logrești	262	20,2	21,8	1,6	L	35,2	6	10,7	2	58,8	7	11,1	2
Drăgășani	280	21,5	24,8	3,3	C	37,0	6	15,0	11	45,8	6	17,1	12
Apa Neagră	250	20,1	22,2	2,1	C	35,8	6	11,0	1	51,0	7	11,1	2
Tg. Jiu	210	20,9	23,4	2,5	C	36,5	6	13,4	12	41,0	6	12,4	12
Polovragi	546	19,4	21,7	2,3	C	33,4	18	12,3	2	56,5	5	11,0	12
Rm. Vâlcea	243	20,5	23,5	3,0	C	36,6	6	14,8	12	62,7	7	12,4	26
Voineasa	587	16,3	18,1	1,8	L	32,1	5	9,7	2	-	-	-	-
Parâng	1585	-	-	-	-	26,9	6	8,3	1	-	-	-	-

Average Oltenia	-	21.1	23.59	2.49	-	35.8	-	13.7	-	49.0	-	14.7	-
Ob. Lotrului	140 4	11.8	13.8	2.0	C	26, 6	19	4.9	13	-	-	-	-

(Source: processed data from the ANM archive)

The minimum monthly soil surface temperatures were recorded on 1, 2, 11, 12 and 26.VIII and were between 11.0°C at Polovragi on 12.VIII and 18.7°C at Caracal in on 1.VIII, and their average for the entire region was 14.7°C. In August, three heat waves were recorded in the intervals: 2-9.VIII (8 days); 16-20.VIII (5 days); 25-29.VIII (5 days), totalling 18 days (58.1% of the days of the month). The most intense was the first wave from the interval 2-9.VIII.

The variation graphs of the parameters that characterize the air temperature in August 2022 had decreasing trends for the daily maximums averages and the daily average, and very slightly increases for the daily minimums average (Fig. 3). Among them the fastest decreasing was of the daily maximums averages (calculated for the entire region) whose decrease coefficient was -0.0732.

Rainfall regime in August 2022

The monthly amounts of precipitation in August were between 29.7 l/m² at Dr. Tr. Severin in the extreme west of Oltenia and 212.2 l/m² at Voineasa, and their percentage deviations from normal were between -22.3% at Dr. Tr. Severin and 320.4% at Bâcleș (Table 2). According to the Hellmann Criterion, the month of August was excessively rainy in most of Oltenia and in a small area in the extreme west it was dry (S), normal at Caracal in the Romanian Plain and rainy (P) at Calafat in the south the extreme west. The average monthly amount of precipitation for the whole of Oltenia was 116.3 l/m², and its percentage deviation from normal was 122.4%, and according to the Hellmann criterion, the month of August was "on average" excessively rainy (EP) for the entire Oltenia region.

The normal climatic evolution at the latitude of Oltenia (and Romania, and even for the whole continent of Europe) is of an alternating type: after hot periods, cool or cold periods appear, after dry periods, rainy periods appear, etc. This was also the case in the summer of 2022, after periods of dry weather in June and July, rains occurred in August. The rains began gradually starting on the 6th of August, at first they were weak, then intense in limited areas accompanied by electrical discharges, intensification of wind and hail. Flooding and hail occurred in limited areas, which in some areas was quantitatively large and produced a layer of boulders on the ground. ANM has issued weather warnings of code yellow and weather warnings of code orange for dangerous weather phenomena but also for heat waves. The highest amount of precipitation recorded in Oltenia in 24 hours at the meteorological stations in August was 92.4 l/m² on August 20 in the Voineasa intra-mountain depression. **The rainy season reached its peak for the whole country**, in the interval 1-2.IX.2022 when in Horezu (Vâlcea county) 118.1 l/m² was recorded in 24 hours (2.IX.2022).

3.4. Climatic seasonal characteristics of the summer of 2022

The seasonal air temperature averages were between 17.9°C at Voineasa and 25.2°C at Dr. Tr. Severin, and their deviations from normal were between 1.6°C at Bechet and 3, 1°C at Dr. Tr. Severin. According to the Hellmann criterion, the summer of 2022 as a whole was very hot (FC) at 8 meteorological stations (53.3% of the territory) and warm at 7 meteorological stations (46.7% of the territory) (Table 5). *The seasonal average for the whole of Oltenia* was 23.2°C and the deviation from normal was 2.5°C, and according to the Hellmann criterion summer 2022 was warm (C) on average for the whole of Oltenia. In the summer of 2022, 5 heat waves were recorded in the intervals: 24.VI-5.VII with a duration of 12 days; 14-30.VII with a duration of 17 days; 2-9.VIII with a duration of 8 days; 16-20.VIII with a duration of 5 days; 25-29.VIII with a duration of 5 days. The total duration of the rain waves was 47 days, i.e. 51.1% of the summer days. According to the seasonal average air temperature for the whole Oltenia region (23.06°C), *this is the third warmest summer recorded in the last 62 years (starting with 1961, after the summer of 2012 with an average of 24.3°C and the summer of 2007 with an average of 23.36°C (in descending order of average temperature values for the entire region).* The summer of 2022 was warm in many areas of Europe and the Northern Hemisphere, but not everywhere. According to the Hellmann criterion, no summer was excessively hot (with thermal deviations $\geq 5.0^\circ\text{C}$) (not only for Oltenia, but even for any area in the Northern Hemisphere). All this shows that the phrase "climate emergency" is not justified.

Table 5. Overall rainfall and thermal regime of the summer of 2022. (Hm = altitude of the meteorological station, V2022 = average temperature values in the summer of 2022 (°C), Nv = normal values of the seasonal summer temperature averages (°C), $\Delta = V - Nv$ = average temperature deviations from normal (°C) CrH = Hellmann criterion, S = amount of precipitation in summer of 2022 (l/m²), N = normal values of precipitation in summer (l/m²), $\Delta = S - N$ = deviations from normal (l/m²), $\Delta\%$ = percentage deviations from normal).

Meteorological Station	Hm	Thermal regime (°C)				Pluviometric regime (l/m ²)				
		V2022	Nv	$\Delta = V - Nv$	CrH	S	N	$\Delta = S - N$	$\Delta\%$	CrH
Dr. Tr. Severin	77	25,2	22,0	3,2	FC	126,5	160,0	-33,5	-20,9	S
Calafat	66	25,1	22,3	2,8	FC	174,5	146,8	27,7	18,9	P
Bechet	65	24,1	22,2	1,9	C	157,6	146,8	10,8	7,4	N
Băilești	56	24,3	22,1	2,2	C	216,8	150,5	66,3	44,1	FP
Caracal	112	24,8	22,0	2,8	FC	92,0	167,4	-75,4	-45,0	ES
Craiova	190	24,2	21,7	2,5	C	139,5	164,7	-25,2	-15,3	PS
Slatina	165	23,7	21,6	2,1	C	206,0	184,9	21,1	11,4	PP
Băceș	309	23,5	20,4	3,1	FC	228,6	152,5	76,1	49,9	EP
Tg. Logrești	262	21,7	19,9	1,8	C	252,8	165,4	87,4	52,8	EP
Drăgășani	280	24,0	20,9	3,1	FC	183,2	185,6	-2,4	-1,3	N
Apa Neagră	250	21,9	19,1	2,8	FC	206,7	232,0	-25,3	-10,9	PS
Tg. Jiu	210	23,2	20,5	2,7	FC	210,7	219,2	-8,5	-3,9	N
Polovragi	546	21,4	18,9	2,5	C	306,6	277,7	28,9	10,4	PP
Rm. Vâlcea	243	23,1	20,2	2,9	FC	242,8	254,3	-11,5	-4,5	N
Voineasa	573	17,9	16,2	1,7	C	406,2	268,1	138,1	51,5	EP

EXCEPTIONALLY HOT SUMMER 2022 IN SOUTH-WEST ROMANIA

Parâng	1585	-	-	-	-	303,4	346,8	-43,4	-12,5	PS
Average Oltenia	-	23,2	20,7	2,5	G	215,9	201,4	14,5	7,2	N
Ob. Lotrului	1348	13,5	11,7	-	-	146,8	-	-	-	-

(Source: processed data from the ANM archive)

The seasonal amounts of precipitation were between 126.5 l/m² at Dr. Tr. Severin and 406.2 l/m² at Voineasa, and their percentage deviations from normal were between -45.0% at Caracal and 52.8% at Tg. Logresti. According to the Hellmann criterion, the summer of 2022 was excessively dry (ES) in Caracal, dry (S) in Dr. Tr. Severin, slightly dry (PS) in Craiova, Apa Neagră and Parâng, normal (N) in Bechet, Drăgășani and Rm. Vâlcea slightly rainy (PP) in Slatina and Polovragi, rainy (P) in Calafat, very rainy (FP) in Băilești and excessively rainy (EP) in Tg. Logrești and Bâcles. The diversity of rainfall characteristics is due to the rain showers that occupied small areas and with very different intensities. We exemplify with the torrential rain on July 2, 2022 in Craiova, which at the weather station located in the east of the city recorded only 10.2 l/m², in the south and southwest of the city where the flood was massive and very strong, the expeditionary measurement indicated a value of 120 l/m² in 60 minutes, and at a distance of 3 km from this point the measurement indicated 60 l/m².

The average seasonal amount of precipitation for the whole of Oltenia was 215.9 l/m², and its percentage deviation from normal was 7.2%, which according to the Hellmann criterion shows that the summer of 2022 was on average normal pluviometrically (N). **Rainy periods** in the summer of 2022 (considering only the days when precipitation was significant for agriculture) were in the dates of: **in June**: 10-12.VI (3 days); 25-26.VI; 28.VI (3 days) (**total in June 6 days**); **in July**: 2.VII; 4-5.VII (2 days); 7-8.VII (2 days) and 30.VII (**total in July 6 days**); **in August**: 7-10.VIII (4 days); 14.VIII; 20-21 and 23.VIII (3 days); 31.VIII (**total in August 9 days**). So in the summer of 2022 there were 21 days with significant rain for agriculture (22.8% of the summer days).

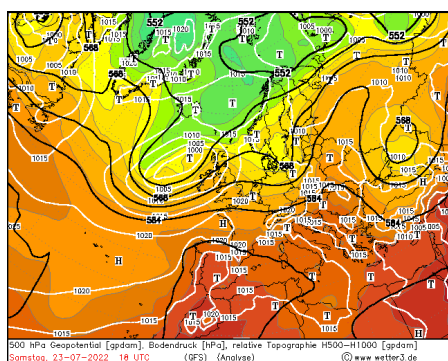


Fig. 4. The geopotential field at the level of 500 hPa and relative topography TR500/1000 superimposed on the atmospheric pressure field at the level of the earth's surface on 23.VII.2022 at 18 UTC (at the time of reaching the peak of

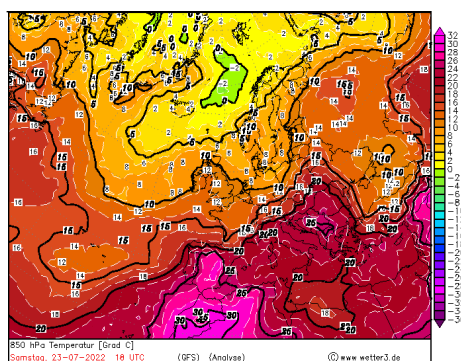


Fig. 5. The temperature field at the level of 850 hPa on 23.VII.2020 at 18 UTC (at the time of reaching the peak of the heat wave) (after www.wetter3.de)

3.5. The heat wave of 14-30.VII.2022

The most important, longest and most intense heat wave of the summer of 2022 was recorded between 14-30.VII with a duration of 17 days and the main temperature peak on the dates of 23 and 24.VII. During this heat wave on July 23, the highest temperature values of summer 2022 were recorded: 39.9°C in Băilești, 40.0°C in Bechet, 40.4°C in Dr Tr. Severin and 41.7°C at Băilești.

We will further analyze the synoptic conditions in which the maximum of this heat wave was achieved. At the time of recording the maximum intensity of the heat wave (23.VII at 18 UTC), the distribution of the pressure field *at the level of the land surface* over Europe indicated a vast low atmospheric pressure field north of the 42° parallel (lat. N) with more many cyclonic centers, and the most significant was the Icelandic Cyclone positioned northwest of Great Britain and with values at the center ≤ 1000 hPa (Fig. 4) and another with similar intensity in northwest Greenland. South of this parallel, a vast high pressure field formed by the union of the Azorean Anticyclone with the Eastern European one over Italy and the Balkan Peninsula. Above Romania, the atmospheric pressure values were close to 1015 hPa. *At the 500 hPa level* the situation was similar, and the shape of the 876 hPa isohypse (similar to the letter „Ω”) *shows a blocking atmospheric circulation over Eastern and South-Eastern Europe*. For Romania (and Oltenia) the air circulation was south-westerly bringing a very warm continental tropical (cT) air mass from North Africa. At the level of 850 hPa (about 1500 m altitude, Fig. 5) the air temperature values show that warm air dominates all of Europe except for a small area located northeast of Iceland (a very rare situation even during the summer) . The position of the 15°C isotherm

shows that warm air occupied the southern half of Europe. Almost all of Romania was located in the temperature field with values $\geq 20^{\circ}\text{C}$, and above the southern half of Oltenia, at this level the air temperature was $\geq 25^{\circ}\text{C}$. In the north of Africa (Cape Tunis area) the particularly hot air advected from over the Sahara is present with temperature values at this level of $30\text{-}35^{\circ}\text{C}$. In these conditions of very intense advection of particularly hot air, the thermal maxima of 23.VII.2022 were achieved.

In the most affected area, the highest values of the thermal comfort index - humidity temperature (ITU) were recorded: 84.3 in Calafat, 83.7 in Bechet, 82.9 in Băilești, 82.7 in Tr. Măgurele, 82.0 in Slatina and 81.7 in Craiova. The "heat dome" covered the entire southern half of Europe and persisted almost all summer (Fig. 5).

4. CONCLUSIONS

The summer of 2022 was overall particularly warm, marked by intense heat waves in July and August. The strong warming of the weather started early, even from May, which had the monthly average for the entire Oltenia region of 17.4°C and the deviation from the normal of 1.42°C , which according to the Hellmann criterion indicates a warm month (CL). The increase in the average monthly temperature compared to April was 6.7°C . The monthly average increase in June compared to May was 4.66°C , and from June to July 1.9°C . In August, the first drop in the monthly average temperature of -0.37°C was recorded. From a thermal point of view, the summer of 2022 was the third particularly hot summer, in descending order of the seasonal average, after the summers of 2012 and 2007. In the entire history of climate observations in Oltenia, only 2 very hot summers were recorded (according to the Hellmann Criterion) - the summers of 2012 (with a seasonal average of 24.3°C) and 2007 (with a seasonal average of 23.36°C). The summer of 2012 is the only summer with a seasonal average $\geq 24.0^{\circ}\text{C}$. The month of June 2022 (with an average for the whole of Oltenia of 22.06°C , is the fourth warmest June in the climate history of Oltenia after the months: June 2012 (with an average of 22.64°C), June 2007 (with an average of 22.30°C) and June 2003 (with an average of 22.49°C). The summer of 2022 is a good example of a hot, rainfall-normal summer in its ensemble where drought and heat waves occurred over extended periods of time and affected agricultural crops. Thus on 29.08.2022: The agricultural area affected by drought reached 430,996 hectares in 34 counties, according to the centralized reporting by the Ministry of Agriculture and Rural Development (MADR). (<https://www.agerpres.ro/economic-intern/2022/08/29/suprafata-agricola-afectata-de-seceta-se-apporie-de-431-000-de-hectare-in-34-de-județe-970200>). After the dry period which reached its peak during the most intense heat wave in the interval 14-30.VII, the rains gradually started and naturally followed a rainy period which

e reached its peak on the 2nd and 3rd of IX.2022. Although the rainy season came late, it blessed some of the agricultural crops, restored the water reserve in the soil and allowed the autumn agricultural campaign to be carried out in good conditions. As a rule, dry periods are followed by rainy periods and hot or cold periods are followed by cool or cold periods. In 2022, after the hot summer, the thermal regime of September has been established since 1.IX. The lowest flow of the Danube was 1850 mc/s at the end of July (31.VII.2022) and started to increase slightly from 7.VIII.2022.

REFERENCES

1. Marinică, I. (2006), *Fenomene climatice de risc în Oltenia*, Editura Autograf MJM, Craiova, 386 p. (Risk of Climatic Phenomena in Oltenia)
2. Marinică I., Marinică Andreea Floriana (2016), *Variabilitatea climatică în Oltenia și schimbările climatice*, Editura Universitaria, Craiova, 306 p. (The Climate Variability in Oltenia and the Climatic Changes)
3. Marinică , Andreea Marinică (2019), *Considerations Regarding the Variability of Earth-Sun Geometry and the Climate Variability in South-Western Romania*, Riscuri si Catastrofe, Nr. Xix, Vol. 25, Nr. 2/2019; Pp 33-55.
4. Marinică, Andreea Marinică (2020), *Climate Anomalies in South-West Romania in the Spring of 2020, In the Context Of Climate Change*, Risks and Catastrophes Journal, AN XX, **27**, **2**/2020, pp. 49-64.
5. ***<https://www.meteoradar.ro/stiri-meteo/aprilie-2022-a-sasea-cea-mai-calda-luna-la-nivel-global-mai-racoroasa-decat-media-in-romania--9cd54943-a3ab-4ea2-822f-5e7597c2dcd8>.
6. *** <https://www.g4media.ro/iunie-2022-a-treia-cea-mai-calduroasa-luna-iunie-din-istorie-potrivit-copernicus.html>.
7. ***<https://www.g4media.ro/iulie-2022-una-din-cele-mai-calduroase-luni-iulie-inregistrate-vreodata.html>.
8. *** <https://www.descopera.ro/istorie/20154971-pietrele-foamei-ce-sunt-si-de-ce-ii-sperie-pe-europeni>.
9. *** <https://www.greenpeace.org/romania/articol/7731/protest-greenpeace-pe-fundul-dunarii-secat>.